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| **Project Title**  **Glandular stomach – Structure, types of glands, cells, and function** |

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| **Abstract**  The stomach is a muscular organ located on the left side of the upper abdomen. The stomach receives food from the esophagus. As food reaches the end of the esophagus, it enters the stomach through a muscular valve called the lower esophageal sphincter. The stomach secretes acid and enzymes that digest food. Ridges of muscle tissue called rugae line the stomach. The stomach muscles contract periodically, churning food to enhance digestion. The pyloric sphincter is a muscular valve that opens to allow food to pass from the stomach to the small intestine. **The Glandular stomach** is the [part](https://www.tititudorancea.com/z/part_en.htm) of the [stomach](https://www.tititudorancea.com/z/stomach_en.htm) that is lined with glandular [mucosa](https://www.tititudorancea.com/z/mucosa_en.htm) and [receives](https://www.tititudorancea.com/z/receive_en.htm) the [food](https://www.tititudorancea.com/z/food_en.htm) from the esophagus. The mucosa contains [gastric](https://www.tititudorancea.com/z/gastric_en.htm) glands that secret [gastric acid](https://www.tititudorancea.com/z/gastric_acid_en.htm). It includes man types of glands including [**cardiac glands**](https://en.wikipedia.org/wiki/Cardiac_glands)**,** [**fundic (oxyntic) glands**](https://en.wikipedia.org/wiki/Fundic_glands) **and pyloric glands.** |

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| **Introduction**  The glandular stomach aka glandular [mucosa](https://www.tititudorancea.com/z/mucosa_en.htm) or gastric mucosa is the [mucous membrane](https://en.wikipedia.org/wiki/Mucous_membrane) layer of the [stomach](https://en.wikipedia.org/wiki/Stomach), which contains the [glands](https://en.wikipedia.org/wiki/Glands) and the [gastric pits](https://en.wikipedia.org/wiki/Gastric_pits). In humans, it is about 1 mm thick, and its surface is smooth, soft, and velvety. It consists of simple columnar [epithelium](https://en.wikipedia.org/wiki/Epithelium), [lamina propria](https://en.wikipedia.org/wiki/Lamina_propria), and the [muscularis mucosae](https://en.wikipedia.org/wiki/Muscularis_mucosae). In its fresh state, it is of a pinkish tinge at the [pyloric](https://en.wikipedia.org/wiki/Pyloric) end and of a red or reddish-brown color over the rest of its surface. In [infancy](https://en.wikipedia.org/wiki/Infancy) it is of a brighter hue, the vascular redness being more marked.  It is thin at the [cardiac](https://en.wikipedia.org/wiki/Cardiac) extremity, but thicker toward the pylorus. During the contracted state of the organ it is thrown into numerous plaits or [rugae](https://en.wikipedia.org/wiki/Rugae), which, for the most part, have a longitudinal direction, and are most marked toward the pyloric end of the stomach, and along the [greater curvature](https://en.wikipedia.org/wiki/Greater_curvature). These folds are entirely obliterated when the organ becomes [distended](https://en.wikipedia.org/wiki/Gastric_distension).  When examined with a lens, the inner surface of the mucous membrane presents a peculiar honeycomb appearance from being covered with funnel-like depressions or foveolate of a polygonal or hexagonal form, which vary from 0.12 to 0.25 mm. in diameter. These are the ducts of the [gastric glands](https://en.wikipedia.org/wiki/Gastric_glands), and at the bottom of each may be seen one or more minute orifices, the openings of the gland tubes. Gastric glands are simple or branched tubular glands that emerge on the deeper part of the gastric foveola, inside the gastric areas and outlined by the folds of the mucosa |

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| **Project Aim and Outline**   1. What glandular stomach is 2. Types of glands in glandular stmach 3. cardiac glands (in the proximal part of the stomach) 4. fundic (oxyntic) glands (the dominating type of gland) 5. pyloric glands: 6. Surface 7. Types of cell |

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| **Results**     1. **Types of glands**   The **gastric glands** are located in different regions of the [stomach](https://en.wikipedia.org/wiki/Stomach). The glands and [gastric pits](https://en.wikipedia.org/wiki/Gastric_pits) are located in the [stomach lining](https://en.wikipedia.org/wiki/Gastric_mucosa). The glands themselves are in the [lamina propria](https://en.wikipedia.org/wiki/Lamina_propria) of the mucous membrane and they open into the bases of the gastric pits formed by the epithelium. The various cells of the glands secrete [mucus](https://en.wikipedia.org/wiki/Mucus), [pepsinogen](https://en.wikipedia.org/wiki/Pepsinogen), [hydrochloric acid](https://en.wikipedia.org/wiki/Hydrochloric_acid), [intrinsic factor](https://en.wikipedia.org/wiki/Intrinsic_factor), [gastrin](https://en.wikipedia.org/wiki/Gastrin), and [bicarbonate](https://en.wikipedia.org/wiki/Bicarbonate).   * 1. [**cardiac glands**](https://en.wikipedia.org/wiki/Cardiac_glands)**(in the proximal part of the stomach)**    They are found in the [cardia](https://en.wikipedia.org/wiki/Cardia) of the stomach which is the part nearest to the heart, enclosing the opening where the esophagus joins to the stomach. Only cardiac glands are found here, and they primarily secrete mucus. 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's_glands).  The cardiac glands mainly contain mucus-producing cells called [foveolar cells](https://en.wikipedia.org/wiki/Foveolar_cell). The bottom part of the oxyntic glands is dominated by [zymogenic (chief) cells](https://en.wikipedia.org/wiki/Gastric_chief_cell) that produce [pepsinogen](https://en.wikipedia.org/wiki/Pepsinogen) (an inactive precursor of the [pepsin](https://en.wikipedia.org/wiki/Pepsin) enzyme). [Parietal cells](https://en.wikipedia.org/wiki/Parietal_cell), which secrete [hydrochloric acid](https://en.wikipedia.org/wiki/Hydrochloric_acid) (HCl) are scattered in the glands, with most of them in the middle part. The upper part of the glands consist of [mucous neck cells](https://en.wikipedia.org/wiki/Mucous_neck_cell); in this part the dividing cells are seen.   * 1. [**fundic (oxyntic) glands**](https://en.wikipedia.org/wiki/Fundic_glands)**(the dominating type of gland)**    Called the *oxyntic glands and* found in the [fundus](https://en.wikipedia.org/wiki/Fundus_(stomach)) and body of the stomach. They are simple almost straight tubes, two or more of which open into a single duct. *Oxyntic* means acid-secreting and they secrete [hydrochloric acid](https://en.wikipedia.org/wiki/Hydrochloric_acid) (HCl) and [intrinsic factor](https://en.wikipedia.org/wiki/Intrinsic_factor).   * 1. [**pyloric glands**](https://en.wikipedia.org/wiki/Pyloric_glands)**:**   The pyloric glands contain mucus-secreting cells. Several types of endocrine cells are found in throughout the gastric mucosa. The pyloric glands contain [gastrin](https://en.wikipedia.org/wiki/Gastrin)-producing cells ([G cells](https://en.wikipedia.org/wiki/G_cell)); this hormone stimulates acid production from the parietal cells. [Enterochromaffin-like cells](https://en.wikipedia.org/wiki/Enterochromaffin-like_cell) (ECLs), found in the oxyntic glands release [histamine](https://en.wikipedia.org/wiki/Histamine), which also is a powerful stimulant of the acid secretion. The A cells produce [glucagon](https://en.wikipedia.org/wiki/Glucagon), which mobilizes the hepatic [glycogen](https://en.wikipedia.org/wiki/Glycogen), and the enterochromaffin cells produce [serotonin](https://en.wikipedia.org/wiki/Serotonin), which stimulates the contraction of the smooth muscles.   * 1. **Surface**   The surface of the mucous membrane is covered by a single layer of [columnar epithelium](https://en.wikipedia.org/wiki/Columnar_epithelium). This epithelium commences very abruptly at the [cardiac orifice](https://en.wikipedia.org/wiki/Cardiac_orifice), where there is a sudden transition from the [stratified epithelium](https://en.wikipedia.org/wiki/Stratified_squamous_epithelium) of the [esophagus](https://en.wikipedia.org/wiki/Esophagus). The epithelial lining of the gland ducts is of the same character and is continuous with the general epithelial lining of the stomach. An important [iodine](https://en.wikipedia.org/wiki/Iodine) concentration by [sodium-iodide symporter](https://en.wikipedia.org/wiki/Sodium-iodide_symporter) (NIS) is present in mucinous cells of surface epithelium and gastric pits of the fundus and pyloric part of the stomach.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Layer of stomach** | **Name** | **Secretion** | **Region of stomach** | **Staining** | | Isthmus of gland | [Foveolar cells](https://en.wikipedia.org/wiki/Foveolar_cell) | [Mucus](https://en.wikipedia.org/wiki/Mucus) gel layer | Fundic, cardiac, pyloric | Clear | | Body of gland | [Parietal (oxyntic) cells](https://en.wikipedia.org/wiki/Parietal_cell) | [Gastric acid](https://en.wikipedia.org/wiki/Gastric_acid) and [intrinsic factor](https://en.wikipedia.org/wiki/Intrinsic_factor) | Fundic only | [Acidophilic](https://en.wikipedia.org/wiki/Acidophilic) | | Base of gland | [Chief (zymogenic) cells](https://en.wikipedia.org/wiki/Gastric_chief_cell) | [Pepsinogen](https://en.wikipedia.org/wiki/Pepsinogen) and [gastric lipase](https://en.wikipedia.org/wiki/Gastric_lipase) | Fundic only | [Basophilic](https://en.wikipedia.org/wiki/Basophilic) | | Base of gland | [Enteroendocrine (APUD) cells](https://en.wikipedia.org/wiki/Enteroendocrine_cells) | [Hormones](https://en.wikipedia.org/wiki/Hormones) [gastrin](https://en.wikipedia.org/wiki/Gastrin), [histamine](https://en.wikipedia.org/wiki/Histamine), [endorphins](https://en.wikipedia.org/wiki/Endorphins), [serotonin](https://en.wikipedia.org/wiki/Serotonin), [cholecystokinin](https://en.wikipedia.org/wiki/Cholecystokinin) and [somatostatin](https://en.wikipedia.org/wiki/Somatostatin) | Fundic, cardiac, pyloric | – |  Types of cell Transverse section of fundic gland  Diagram depicting the major determinants of gastric acid secretion  There are millions of [gastric pits](https://en.wikipedia.org/wiki/Gastric_pit) in the gastric mucosa and their necessary narrowness determines the tubular form of the gastric gland. More than one tube allows for the accommodation of more than one cell type. The form of each gastric gland is similar; they are all described as having a neck region that is closest to the pit entrance, and basal regions on the lower parts of the tubes. The epithelium from the gastric mucosa travels into the pit and at the neck the epithelial cells change to short columnar granular cells. These cells almost fill the tube and the remaining lumen is continued as a very fine channel.  Cells found in the gastric glands include [foveolar cells](https://en.wikipedia.org/wiki/Foveolar_cell), [chief cells](https://en.wikipedia.org/wiki/Gastric_chief_cell), [parietal cells](https://en.wikipedia.org/wiki/Parietal_cell), [G cells](https://en.wikipedia.org/wiki/G_cells) and [enterochromaffin-like cells](https://en.wikipedia.org/wiki/Enterochromaffin-like_cell) (ECLs). The first cells of all the glands are **foveolar cells** in the neck region–also called *mucous neck cells* that produce mucus. This is thought to be different from the mucus produced by the gastric mucosa.  Fundic glands found in the fundus and also in the body have another two cell types–gastric [chief cells](https://en.wikipedia.org/wiki/Chief_cell) and [parietal cells](https://en.wikipedia.org/wiki/Parietal_cell) (oxyntic)).  The **chief cells** are found in the basal regions of the gland and release a [zymogen](https://en.wikipedia.org/wiki/Zymogen) – [pepsinogen](https://en.wikipedia.org/wiki/Pepsinogen), a precursor to [pepsin](https://en.wikipedia.org/wiki/Pepsin).  The **parietal cells** ("parietal" means "relating to a wall") are found in the walls of the tubes. The parietal cells secrete hydrochloric acid–the main component of [gastric acid](https://en.wikipedia.org/wiki/Gastric_acid). This needs to be readily available for the stomach in a plentiful supply, and so from their positions in the walls, their secretory networks of fine channels called [canaliculi](https://en.wikipedia.org/wiki/Canaliculus_(parietal_cell)) can project and ingress into all the regions of the gastric-pit lumen. Another important secretion of the parietal cells is [intrinsic factor](https://en.wikipedia.org/wiki/Intrinsic_factor). Intrinsic factor is a [glycoprotein](https://en.wikipedia.org/wiki/Glycoprotein) essential for the absorption of [vitamin B12](https://en.wikipedia.org/wiki/Vitamin_B12).  The parietal cells also produce and release [bicarbonate](https://en.wikipedia.org/wiki/Bicarbonate) ions in response to [histamine](https://en.wikipedia.org/wiki/Histamine) release from the nearby ECLs, and so serve a crucial role in the [pH](https://en.wikipedia.org/wiki/PH) [buffering system](https://en.wikipedia.org/wiki/Buffering_solution).  The **enterochromaffin-like cells** store and release histamine when the pH of the stomach becomes too high. The release of histamine is stimulated by the secretion of [gastrin](https://en.wikipedia.org/wiki/Gastrin) from the G cells. Histamine promotes the production and release of HCL from the parietal cells to the blood and protons to the stomach lumen. When the stomach pH decreases (becomes more acidic), the ECLs stop releasing histamine.  The **G cells** are mostly found in pyloric glands in the antrum of the [pylorus](https://en.wikipedia.org/wiki/Pylorus); some are found in the duodenum and other tissues. The G cells secrete gastrin. The gastric pits of these glands are much deeper than the others and here the gastrin is secreted into the bloodstream not the lumen. |

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| **Conclusions**    The three types of gland are all located beneath the gastric pits within the gastric mucosa–the mucous membrane of the stomach. The gastric mucosa is pitted with innumerable gastric pits which each house 3-5 gastric glands  The cardiac glands are found in the cardia of the stomach which is the part nearest to the heart, enclosing the opening where the esophagus joins to the stomach. Only cardiac glands are found here and they primarily secrete mucus.[4] 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 with short ducts or compound racemose resembling the duodenal Brunner's glands.  The fundic glands (or oxyntic glands), are found in the fundus and body of the stomach. They are simple almost straight tubes, two or more of which open into a single duct. Oxyntic means acid-secreting and they secrete hydrochloric acid (HCl) and intrinsic factor  The pyloric glands are located in the antrum of the pylorus. They secrete gastrin produced by their G cells |

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| **References**   * Mescher, A. L. (2018). *Junqueira's basic histology: Text and atlas*. New York: McGraw-Hill Education. * McKinley, M. P., O'Loughlin, V. D., & Bidle, T. S. (2016). *Anatomy & physiology: An integrative approach*. New York, NY: McGraw-Hill Education. * Pirie, E. (2020, June 23). Stomach histology. Retrieved June 8, 2020, from https://www.kenhub.com/en/library/anatomy/stomach-histology * (n.d.). Retrieved June 7, 2020, from http://www.columbia.edu/itc/hs/medical/sbpm\_histology\_old/lab/lab13\_stomach.html   + v  D. (2010, May 17). Stomach. Retrieved June 6, 2020, from http://www.siumed.edu/~dking2/erg/stomach.htm |