Esophagus and Stomach

Beginning and End

- The esophagus begins at the lower border of the cricoid cartilage, which marks the end of the pharynx and the start of the esophagus.
- It extends to the cardia of the stomach, making it approximately:
    - 25 cm long, 10 inches, or
    - 45 ± 2 cm from the upper incisors (clinically important measurement used in endoscopy).

Clinically, gastroenterologists use an endoscope, a flexible fiberoptic tube inserted through the oral cavity. The distance from the incisor teeth to the cardia of the stomach is around 45 cm, which confirms entry into the stomach.

Thoracic Relations of the Esophagus

Anterior Relations:

- Trachea
- Left recurrent laryngeal nerve
- Left main bronchus (especially on the left side)
- Pericardium, which separates the esophagus from the left atrium (Oblique sinus (of pericardium) lies between the esophagus and left atrium)

Posterior Relations:

- Bodies of the thoracic vertebrae
- Right posterior intercostal arteries
- Descending thoracic aorta, which lies posterior to the esophagus before it moves to its aortic opening

Right Side Relations:

- Right pleura and lung
- Azygos vein

Left Side Relations:

- Left pleura and lung
- Left subclavian artery
- Aortic arch
- Thoracic duct

Vagal Nerve Relation:

- The left vagus nerve lies on the left side of the esophagus in the thoracic region.
- As the esophagus passes through the diaphragm at the level of 10th thoracic vertebrae 1 inch to the left from midline, the left vagus becomes the anterior vagal trunk while the right vagus nerve becomes the posterior vagal trunk

Arterial Blood Supply of the Esophagus:

Esophageal Segment	Arterial Supply
Upper third (in the neck)	Inferior thyroid artery
Middle third (thoracic cavity)	Bronchoesophageal arteries or tracheobronchial arteries, and esophageal branches from the descending thoracic aorta
Lower third (below diaphragm)	Left gastric artery (branch of the celiac trunk); this artery supplies both the stomach and the lower esophagus

Venous Drainage:

- Upper and middle parts drain into the systemic venous system, including:
  - Azygos vein to the chest
  - Hemiazygos vein
- Lower third drains via the left gastric vein into the portal vein.

Clinical note: This forms a portosystemic anastomosis, which is important in conditions like portal hypertension as a result of liver fibrosis or cirrhosis, potentially leading to esophageal varices.

Lymphatic Drainage:

Esophageal Segment	Lymphatic Drainage
Upper third	Deep cervical lymph nodes
Middle third	Superior and posterior mediastinal lymph nodes (associated with the lungs)
Lower third	Left gastric lymph nodes → Celiac lymph nodes (of the abdomen)

Nerve Supply of the Esophagus: Esophageal Plexus

The esophagus is surrounded by a nerve plexus that includes both parasympathetic and sympathetic fibers, forming the esophageal plexus.

- Parasympathetic innervation: Derived from the vagus nerve
- Sympathetic innervation: Originates from the superior cervical sympathetic ganglia and

Gastroesophageal Sphincter (Lower Esophageal Sphincter, LES)

- The gastroesophageal sphincter is a physiological (functional) sphincter rather than an anatomical one.
  - Anatomically: There is no localized thickening of smooth muscle at the lower end of the esophagus.
  - Functionally: It prevents the regurgitation of gastric contents back into the esophagus, thus protecting the esophageal mucosa from acid injury.
  - The vagus nerve plays a major role in regulating its tone and relaxation during swallowing.

Foreign Bodies in the Esophagus

Children frequently place small objects in their mouths and may accidentally swallow them. In such cases, foreign bodies may enter either the gastrointestinal (GI) tract or the respiratory tract (RT). When foreign bodies enter the esophagus, they may become lodged at natural sites of anatomical constriction.

Common Sites of Foreign Body Impaction in the Esophagus:

1. Upper Esophageal Constriction
    - At the pharyngoesophageal junction (The pharynx is wider than the esophagus, making the entry point a frequent site of impaction).
2. Left main bronchus
    - Where the esophagus is crossed by the left main bronchus
        - The cartilaginous structure of the bronchus may exert pressure on the esophagus, narrowing the lumen and increasing the likelihood of obstruction.
3. The aortic arch when making pressure on the esophagus
4. Lower Esophageal Constriction (Diaphragmatic Region)
    - Where the esophagus passes through the esophageal hiatus of the diaphragm (at level T10)
    - Surrounding diaphragmatic muscle fibers create a functional narrowing which may trap foreign objects.

Stomach

Location and General Description:

- The stomach is a dilated part of the alimentary canal located primarily in the epigastric region of the abdomen.
- It extends superiorly into the left hypochondriac region.
- It lies between the esophagus and the duodenum (the first part of the small intestine).

Shape and External Features:

The stomach can appear in two common shapes:

- J-shaped (typical in most individuals)
- Steer horn-shaped (seen when the stomach is more distended or in certain positions)

It has the following anatomical features:

- Two openings:
    - Cardiac orifice (connects with the esophagus)
    - Pyloric orifice (leads into the duodenum)
- Two surfaces:
    - Anterior surface
    - Posterior surface
- Two curvatures:

    - Greater curvature (lateral and convex)
    - Lesser curvature (medial and concave)
- Two ends:
    - Cardiac end (upper left)
    - Pyloric end (lower right)

Sphincters:

Sphincter	Type	Features
Cardiac sphincter	Physiological only	No muscular thickening; functions to prevent regurgitation
Pyloric sphincter	Anatomical and physiological	Well-developed thickening of inner circular smooth muscle; regulates gastric emptying into the duodenum

Air in the Stomach:

- During swallowing, a small amount of air can enter the stomach along with food.
- The cricopharyngeus muscle (part of the upper esophageal sphincter) contracts to minimize air entry.
- Nevertheless, some air enters and accumulates in the fundus—the uppermost part of the stomach.
- On radiographic imaging (X-ray), this air appears as a dark area in the gastric fundus— gas spots

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Function of the Stomach

- The stomach acts as a temporary storage organ, with an average capacity of approximately 1500 mL.
- It also plays a major role in mechanical and chemical digestion:
    - Gastric secretions mix with food to form a semi-fluid chyme.
- Duration in the stomach:
    - Chyme typically remains in the stomach for 2–4 hours.
    - The pyloric sphincter gradually opens and closes, allowing chyme to pass intermittently into the duodenum.
    - After about 4 hours, most of the stomach contents are emptied.

Anatomical Parts of the Stomach:

The stomach is anatomically divided into several distinct regions:

1. Cardiac Orifice:
    - Entry point from the esophagus.
2. Fundus:
    - Dome-shaped region above the level of the cardiac orifice.
    - Often filled with gas, visible as a gas bubble on X-ray.
3. Body:
    - Central portion, extending from the fundus to the incisura angularis.
4. Pyloric Region (Pylorus):
    - Located distal to the incisura angularis.

- Subdivided into:
  - Pyloric antrum (proximal part)
  - Pyloric canal (narrow distal part)
  - Pyloric sphincter (muscular ring that controls gastric emptying)
- Opens into the duodenum via the pyloric orifice.

The incisura angularis is a small notch on the lesser curvature, which serves as a landmark dividing the body from the pylorus. A horizontal line drawn from this notch demarcates the transition.

Duodenum and Its Relation to the Stomach

- The duodenum is the first part of the small intestine.
- The initial portion is known as the duodenal cap, which lies in close proximity to the pylorus.
- This site (duodenal cap) is a common location for peptic ulcers due to exposure to acidic chyme.

Stomach Wall : Layers and Special Features

Like the rest of the gastrointestinal (GI) tract, the stomach wall consists of four layers:

1. Mucosa (Innermost Layer):

The mucosa of the stomach has three distinct sub-layers:

- **Lining Epithelium**:
  - Made of simple columnar epithelium
  - No goblet cells (unlike the intestine)
- **Lamina Propria**:
  - Loose connective tissue that houses gastric glands
- **Muscularis Mucosae**:
  - A thin layer of smooth muscle

Contains gastric pits (ducts), which are invaginations that lead the gastric glands secretions in the lamina propria to reach the surface.

Gastric Gland Cell Types:

- Parietal cells
- Chief cells :in the base
- Mucous neck cells: Secrete mucus; appear pale or white in histology
- Enteroendocrine (G) cells: Secrete gastrin

Rugae (gastric folds):

- Folds of mucosa and submucosa that allow expansion

- Longitudinal folds are especially prominent along the lesser curvature. This provides a fast-track pathway for liquids to pass quickly through the stomach with minimal mixing,
- or appear oblique or transverse in other areas

2. Submucosa:

- Contains:
  - Blood vessels
  - Lymphatics
  - Nerves (submucosal Meissner's plexus)

3. Muscularis Externa:

Unlike other parts of the GI tract (which typically have two muscle layers), the stomach has three smooth muscle layers:

- Inner oblique layer (unique to the stomach)
- Middle circular layer
- Outer longitudinal layer
- Contains the myenteric plexus between the circular and longitudinal layers, which coordinates gastric motility.

The pyloric sphincter is formed by a thickening of the middle circular muscle layer. The inner oblique fibers are absent at the sphincter.

4. Serosa (Outer Layer):

- The serosa is a visceral peritoneum, covering the entire stomach.
- It consists of simple squamous epithelium (mesothelium) and a thin layer of connective tissue.
- Since the stomach is intraperitoneal, it is fully covered by peritoneum.

Cardiac and Pyloric Orifices of the Stomach

1. Cardiac Orifice

- The cardiac orifice marks the junction between the esophagus and the stomach.
- It is a physiological sphincter, not anatomical—meaning:
  - There is no visible or palpable thickening of smooth muscle, unlike true anatomical sphincters.
  - It functions primarily to prevent the regurgitation of stomach contents into the esophagus.
  - Innervated by the vagus nerve, which helps maintain its functional tone.

Surface Anatomy of the Cardia:

- Located at the level of the 7th left costal cartilage
- Approximately (1 inch) left of the midline
- About 45 cm from the upper incisors (measured via endoscope)
- 10 cm deep from the anterior abdominal wall surface

Clinical Relevance: Surgeons must be aware of this surface anatomy during procedures involving the lower esophagus, vagus nerve, or cardiac sphincter (for GERD).

2. Pyloric Sphincter

- The pyloric sphincter is both an anatomical and physiological sphincter:
    - Formed by a thickened ring of circular smooth muscle at the end of the pyloric canal
    - Controls the rate of gastric emptying into the duodenum

Anatomical Location:

- Situated approximately 2.5 cm (1 inch) to the right of the midline
- Marks the transition from the stomach to the duodenum

Innervation:

- Sympathetic fibers stimulate contraction, tightening the sphincter
- Parasympathetic fibers (via the vagus nerve) cause relaxation, promoting gastric emptying

Surgical Landmark:

- The Vein of Mayo, a small vein that crosses the pyloric sphincter, is used as a landmark in surgeries to help identify the location of the pylorus.

Clinical Correlation: Infantile Hypertrophic Pyloric Stenosis

- A congenital condition in which the pyloric sphincter becomes hypertrophied, narrowing the gastric outlet.
- Symptom typically present in newborns after birth, especially during feeding: Projectile vomiting
- Treatment is surgical to release the thickened muscle and allow normal gastric emptying.

Curvatures and Peritoneal Attachments of the Stomach

1. Lesser Curvature:

- Located on the right (medial) border of the stomach.
- Gives rise to the lesser omentum, a double layer of visceral peritoneum connecting the stomach to the liver.
- The lesser omentum contains:
    - Fat
    - Blood vessels (including the left and right gastric arteries and veins)
    - Nerves
    - Lymph nodes and lymphatic vessels
- Subdivided into two ligaments:
    - Hepatogastric ligament (between liver and stomach)
    - Hepatoduodenal ligament (between liver and duodenum)

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2. Greater Curvature:

- Located on the left (lateral) border of the stomach.

- Much longer than the lesser curvature.
- Gives rise to the greater omentum, which:
    - Originates as two layers of peritoneum from the stomach and descends into the abdominal cavity.
    - Then folds back up as two layers and attaches to the transverse colon.
    - Contains fat, vessels and lymphatics contributing to its role as the "policeman of the abdomen."
- This connection explains why the transverse colon is intraperitoneal, whereas the ascending and descending colons are retroperitoneal (covered only anteriorly by peritoneum).

Anatomical Relations of the Stomach

The stomach is a mobile intraperitoneal organ situated in the epigastric, left hypochondriac, and partially the umbilical regions. It has important anterior and posterior relations, which are clinically relevant for surgical access and pathology.

1. Anterior Relations of the Stomach:

The structures in front of the stomach include:

- Anterior abdominal wall
- Left costal margin and costal cartilages
- Left pleura and lung (separated from the stomach by the diaphragm)
- Left lobe of the liver

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2. Posterior Relations (Stomach Bed):

The posterior surface of the stomach lies against a group of structures collectively known as the stomach bed. These include:

- Lesser sac:
    - A potential space posterior to the stomach, part of the peritoneal cavity.
    - It allows the stomach to expand posteriorly during digestion.
- Structures forming the stomach bed (from superior to inferior):
- Left crus of the diaphragm
- Spleen (lateral to the fundus; partially anterior and partially posterior to the stomach)
- Left suprarenal gland
- Left kidney
- Splenic artery (runs along the superior border of the pancreas, posterior to the stomach; the splenic vein is not in direct relation, as it lies deeper behind the pancreas)
- Transverse colon
- Transverse mesocolon

3. Peritoneal Spaces: The greater sac lies anterior to the stomach, while the lesser sac is posterior to it.

Blood Supply of the Stomach:

The stomach is primarily supplied by branches of the **celiac trunk**, which is the main arterial source for the foregut. This includes the following three branches:

- Left Gastric Artery:
  - Supplies the lower third of the esophagus and the the lesser curvature of the stomach.
- Splenic Artery:
  - Gives rise to the left gastroepiploic artery, which supplies the greater curvature of the stomach.
  - Also provides 5–7 short gastric arteries to the fundus of the stomach.
  - The splenic artery is described as a tortuous artery, as it elongates and bends during stomach dilation (similar to the uterine and facial arteries).
- Hepatic Artery:
  - Supplies the liver.
  - Right Gastric Artery (which supplies the lesser curvature of the stomach).
  - Gastroduodenal artery branches into:
    - Right Gastroepiploic Artery (which supplies the greater curvature of the stomach).
    - Superior pancreatoduodenal arteries

Gastroepiploic Arteries:

  - Right gastroepiploic artery (from the gastroduodenal artery) supplies the right side of the greater curvature.
  - Left gastroepiploic artery (from the splenic artery) supplies the left side of the greater curvature.

Venous Drainage of the Stomach:

- The venous drainage of the stomach follows the arterial supply:
  - Left Gastric Vein: Drains the esophagus and the lesser curvature of the stomach into the portal vein.
  - Right Gastric Vein: Drains into the portal vein.

Drains into the superior mesenteric vein, which joins the splenic vein to form the portal vein.

Lymphatic Drainage of the Stomach:

The lymphatic vessels of the stomach primarily drain into the celiac lymph nodes, located around the celiac trunk. From there, the lymph flows as follows:

1. Lymph from the stomach (including from the left and right gastric arteries, gastroepiploic arteries, and spleen) drains into the celiac lymph nodes.
2. From the celiac nodes, lymph moves to the cisterna chyli, located near the abdominal aorta.
3. The lymph then flows to the thoracic duct and ultimately returns to the bloodstream.

Nerve Supply of the Stomach

1. Sympathetic Innervation:

- Origin: Sympathetic fibers originate from the superior cervical sympathetic ganglia and travel via the sympathetic chain to the abdomen.
- These sympathetic fibers form the splanchnic nerves, which include:
    - Greater splanchnic nerve
    - Lesser splanchnic nerve
- These fibers are post-ganglionic (bypassing the paraverterbral ganglia without synapsing), and they synapse in the celiac ganglion.
- Function: Sympathetic fibers primarily provide pain sensation.
- In the stomach, sympathetic innervation contributes to the contraction of the pyloric sphincter, inhibiting gastric emptying.

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2. Parasympathetic Innervation:

- Origin: The parasympathetic fibers arise from the vagus nerve, which descends to the abdomen.
    - Initially, the vagus surrounds the esophagus but when it passes through the diaphragm, the left vagus becomes anterior and the right vagus becomes posterior.
- Anterior Vagal Trunk:
    - The anterior vagal trunk gives branches that innervate the anterior surface of the stomach.
    - It also provides a large hepatic branch to the liver and an important branch, the Latarjet's nerve, to the pylorus, which plays a critical role in gastric emptying (evacuation).
- Posterior Vagal Trunk:
    - The posterior vagal trunk provides innervation to the posterior surface of the stomach.
    - It sends long branches to the duodenum, small intestine (ileum and jejunum), and large intestine (including the lateral third of the transverse colon).
- Function: The parasympathetic system is secretomotor (stimulating gastric secretions) and motor to the smooth muscles of the stomach, coordinating peristalsis and gastric motility.

3. Sacral Parasympathetic Innervation: S2, S3, S4 of the sacral spinal nerves provide parasympathetic fibers to the hindgut (part of the large intestine).

Clinical Notes on Peptic Ulcers

1. Peptic Ulcer Location and Malignancy:
    - Duodenal Ulcers: These are the most common type of peptic ulcers.
    - Gastric Ulcers: These are rare and, if they occur, they are often considered malignant until proven otherwise.
        - Contrast: For duodenal ulcers, any ulcer is generally considered peptic unless proven otherwise.
2. Historical Understanding of Ulcer Causes:
    - Old Theory: Previously, it was believed that peptic ulcers were caused by an increase in stomach acidity.
3. Current Understanding of Ulcer Causes:
    - Over the last 20 years, research has shown that the primary cause of peptic ulcers is an infection by a Helicobacter pylori bacteria.
4. Treatment Evolution:
    - Old Treatment: In the past, treatment involved vagotomy (cutting the vagus nerve) or truncal vagotomy under the diaphragm to reduce gastric acid secretion.

        - Highly Selective Vagotomy: This involves selectively targeting the vagus nerve at the Latarjet's nerve to assist in gastric evacuation.
    - Current Treatment: Now, treatment focuses on:
        - Antibiotics: A combination of two antibiotics is used to eradicate H. pylori infection.
        - Antacids: To reduce stomach acid production.
5. Diagnostic and Treatment Methods:
    - Gastroscopy (Endoscopy): Widely used for both the diagnosis and treatment of peptic ulcers.
    - Pyloroplasty: A surgical procedure used to improve the drainage of the stomach.

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