



## Anatomy

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number

4

Done by

Dana Alkhulaifat

Correction

Rama Al-Ashqar

Doctor

Mohammad Al- Muhtaseb

# The Esophagus:

Function: propel the bolus of food downwards from pharynx towards the stomach.

\*It starts: at the lower border of the cricoid cartilage of the larynx, so at the level of C6 cervical vertebra as a continuation to the pharynx.

\*It ends: at the cardia of the stomach at the lower esophageal cardiac sphincter (which is a **physiological sphincter**) below the diaphragm.

Esophagus has an opening in the diaphragm (esophageal orifice) at the level of T10 (1 inch to the left from midline), it descends below the diaphragm about 1.3 cm, meaning that the part of the esophagus located under the diaphragm, in the abdominal cavity is very small. The majority of it is in the chest (thoracic cavity) and part in the neck.

The esophagus is a muscular tube, 25 cm in length (10 inches) plus 2cm in tall people and minus 2cm in short people, (45 cm in length if we start from the incisors which happens if we are using a gastroscope (we will talk about it later in this lecture) which is a fibro-optic tube inserted from the oral cavity.

The pharynx differs from the esophagus that it is open anteriorly while the esophagus is a completely closed muscular tube.

The esophagus contains a lot of constrictions that may work as lodges for foreign bodies.

## **These constrictions are located:**

1. At the beginning, **at the pharynx** (as the pharynx is wide and the esophagus is narrow).
2. **Adhesion with the arch of the aorta**, so the arch of the aorta would be deviated backwards and to the left, which would put pressure on the esophagus.
3. **The left main bronchus crosses anterior to the esophagus**, also causing constriction.
4. The **opening in the diaphragm contains a physiological sphincter**

which causes constriction.

So any foreign body will be lodged in one of these four locations.

### **Relations of the Esophagus:**

*Laterally related to the lobes of the thyroid gland and carotid sheath (common carotid artery, internal jugular vein and between them the vagus nerve)*

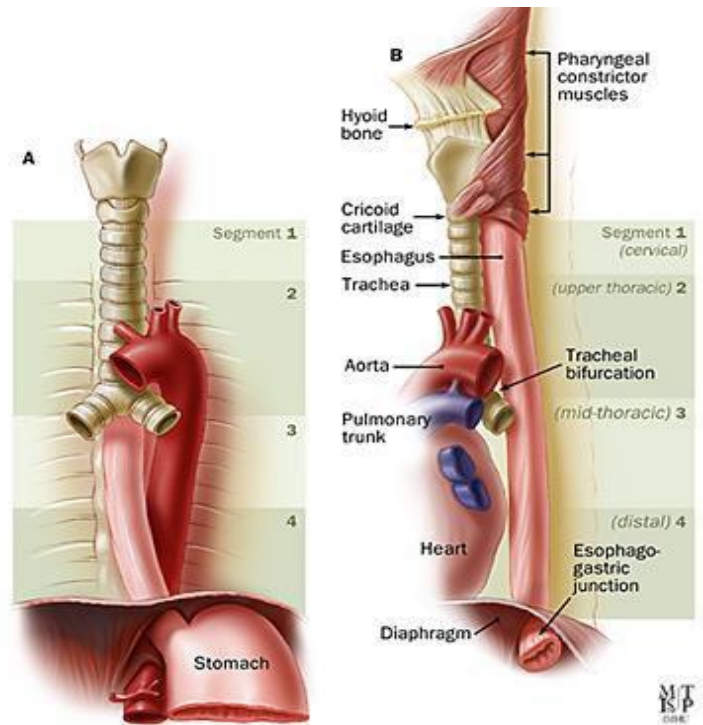
#### **Anteriorly:**

- The larynx, the trachea and aortic arch.
- Situated between the esophagus and the trachea is the left recurrent laryngeal nerve (branch from vagus nerve)
- The left main bronchus.
- The pericardium, which separates the esophagus from the left atrium.

**[Note: The left recurrent laryngeal nerve is longer than the right one** because it's a branch from the vagus nerve in the thorax (on the left side). However, with the right recurrent laryngeal nerve, the branching happens at the root of the neck, so it only ascends on the right side of the neck below the subclavian artery, meaning it doesn't pass into the thorax.]

If we take a look at the trachea we will find that at the angle of Louis also called the sternum angle, the trachea divides to right and left.

The left trachea which contains hyaline cartilage mainly pressures on the esophagus.



### Posteriorly:

- The bodies of the thoracic vertebrae, since the esophagus is located at the posterior mediastinum, in front of the vertebral column.
- Thoracic ducts
- The azygos veins (which provide venous drainage for the chest).
- Posterior intercostal arteries, which are branches from the descending thoracic aorta.

At the lower part, in order for the esophagus to pass through the opening in the diaphragm (the esophageal orifice at the level of T10), it deviates in front of the descending aorta. Then the descending aorta continues to the midline at the level of T12, opening into the aortic orifice. In other words, the descending aorta and the esophagus cross at the midline, with the esophagus going anterior to the descending aorta.

Esophagus from right to left.

Descending aorta from left to midline.

Note: **mediastinum** is the space between the two lungs.

**Esophagus** and trachea at the beginning were in the **superior mediastinum**

Heart and pericardium are in the middle mediastinum.

Posterior to the heart → **posterior mediastinum** which the descending thoracic aorta and esophagus cross.

What is the relationship of esophagus with the two vagi?

Right vagus and left vagus at the lower end form the esophageal plexus which is parasympathetic from the vagus and sympathetic from the sympathetic chain which is located on both sides of the thoracic vertebrae.

The left vagus below the diaphragm becomes anterior while the right vagus becomes posterior.

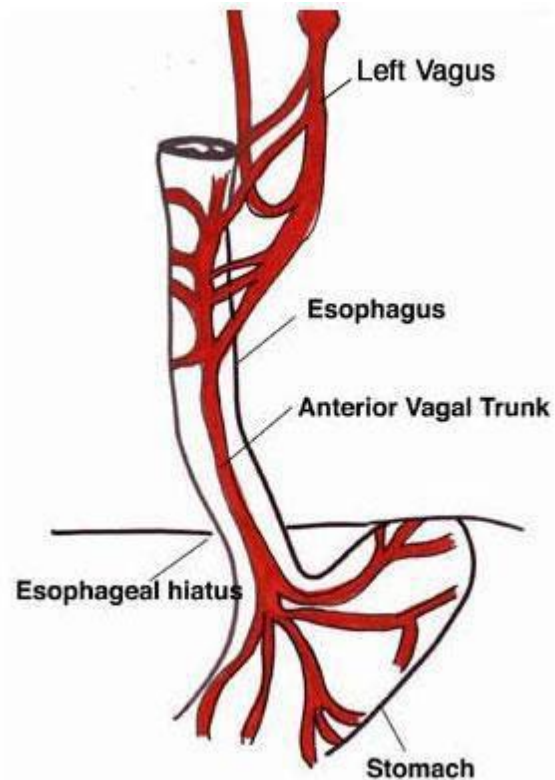
(VIP)\*

**Right side:**

- Right pleura and lung
- Azygos vein

**Left side:**

- Subclavian artery
- Arch of the aorta
- Thoracic ducts
- Left pleura and lung



**[Note:** The left and right vagus nerves descend downwards and pass through the opening of the esophagus in the diaphragm, where the left becomes anterior and the right becomes posterior. They form a plexus of nerves around the esophagus called the **esophageal plexus** which provides parasympathetic mainly and sympathetic fibers].

**Innervation:**

Parasympathetic: from the vagi nerve and is secretomotor for the gland also responsible for the peristaltic movement of smooth muscles which propagates the peristalsis.

Sympathetic: responsible for motor contraction of the sphincter and also vasoconstriction of the blood vessels.

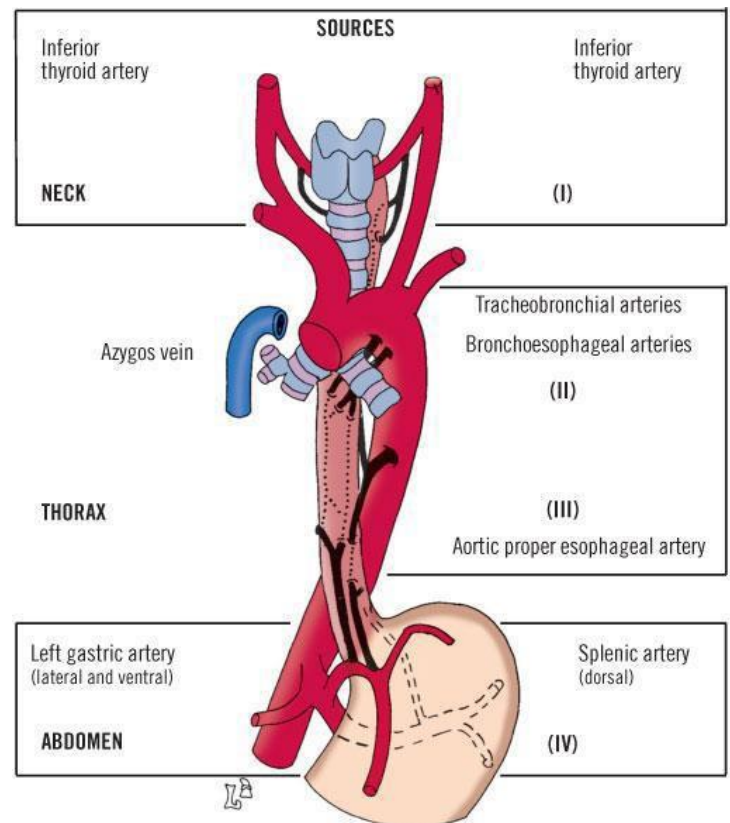
## The Blood Supply of the Esophagus:

**The upper third: (striated muscles)** receives blood supply from the inferior thyroid artery (branch from subclavian artery), and the venous drainage of the inferior thyroid vein. Lymphatic drainage: deep cervical lymph nodes.

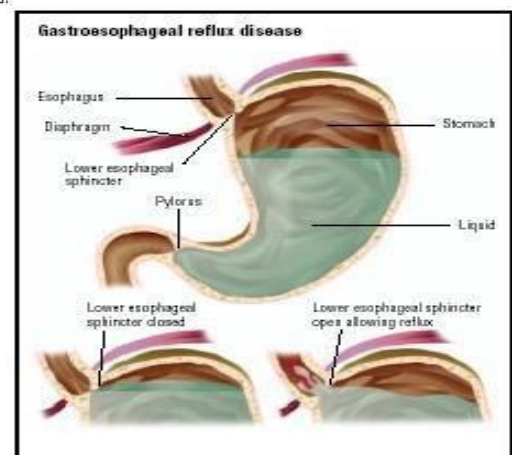
**The middle third: (striated and smooth muscles)** receives blood supply from the bronchoesophageal arteries and the tracheobronchial arteries which are branches from the descending thoracic aorta. The venous drainage goes to the azygos veins which drain into the arch of azygos, then to the superior vena cava and to the right atrium. Lymphatic drainage: mediastinum lymph nodes.

**The lower third: (smooth muscles)** receives blood supply from the left gastric artery, which is a branch from the celiac trunk. The venous drainage goes to the left gastric vein, then to the portal vein to the liver. Lymphatic drainage: celiac lymph nodes around the celiac trunk.

**Note: we said that the celiac trunk is surrounded by celiac**



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ganglia and celiac lymph nodes,  
therefor all the foregut's  
lymphatic drainage is celiac  
lymph nodes.

### **The Gastroesophageal Sphincter (cardiac sphincter)**

(The lower esophageal sphincter or gastroesophageal sphincter surrounds the lower part of the esophagus at the junction between the esophagus and the stomach. It is also called the *cardiac sphincter* or cardio esophageal sphincter, named from the adjacent part of the stomach, the cardia.) The cardiac sphincter is **not an anatomical one** since there is no thickening of smooth muscle however we consider it to be physiological because of its function in preventing the regurgitation; this is why all the material that reaches the stomach is forbidden to go back to the esophagus. Moreover, some diseases such as esophageal reflux disease where the sphincter is not functioning properly leads to the ascending of certain materials to reach the esophagus causing a heartburn in the chest and could also lead to an ulcer or even complicate to esophagitis. Another disease that could occur is Hiatus hernia; hernia in the diaphragm causing part of the stomach to appear in the chest which causes the same symptoms as esophageal reflux disease.

It is a physiological sphincter not an anatomical one. The differences between the gastroesophageal sphincter and the pyloric sphincter are in:

- a) The **location** of the sphincter: the gastroesophageal sphincter is located at the opening in the diaphragm, 1 inch to the left from the midline at the level of T10, and is 10 cm away from the anterior abdominal wall. Meanwhile, the pyloric sphincter (which is between the stomach and duodenum) is located at the level of L1, 1 inch to the right from the midline.



- b) The **structure** of the sphincter: the gastroesophageal sphincter is considered a physiological sphincter as it doesn't contain a thickening of the inner circular smooth muscles. However, the pyloric sphincter is an anatomical sphincter because it contains that thickening (in the inner circular smooth muscles).

## **The Stomach:**

It is a dilated part in the alimentary canal. It lies between the esophagus and the duodenum (first part of the small intestine).

### **Location of the Stomach:**

The stomach is located in the left upper quadrant mainly in the epigastric region.

**[Note1:** the doctor mentioned that the ascending and descending colons of the large intestines are retroperitoneal, they are located at the posterior abdominal wall. As for the transverse colon, it's intraperitoneal.]

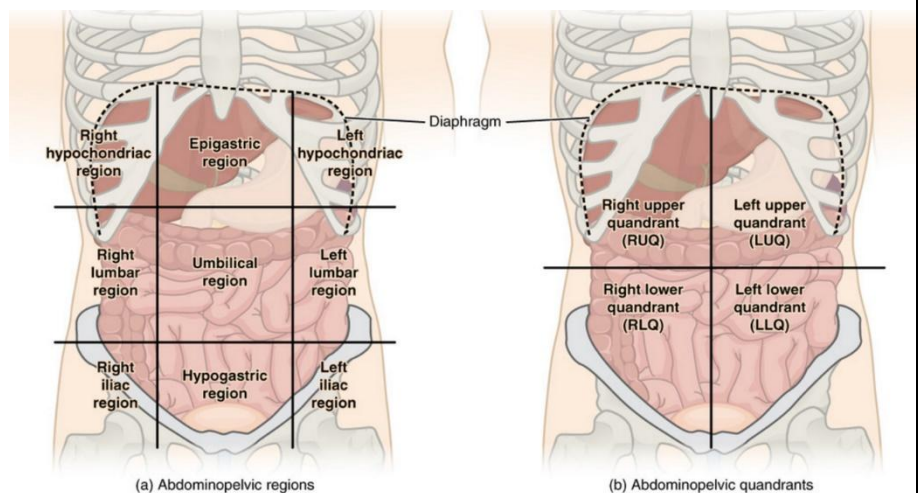
**Note2:** The small intestine is located in the umbilical region.

### **The Shape of the Stomach:**

It depends on the content, but it is J shaped (in normal people), or 'steer horn' (in obese people).

It undergoes considerable variation in the same person and depends on:

1. The volume of its contents
2. The position of the body

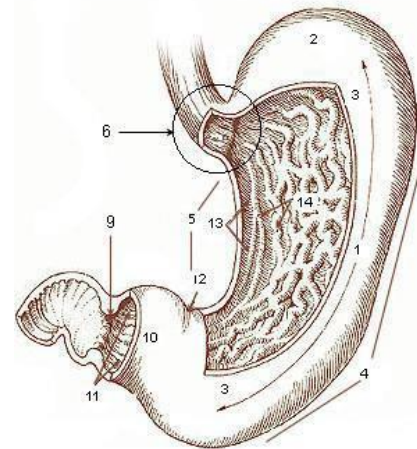




3. The phase of respiration.

### To put it simply, the stomach has:

1. **2 orifices:** cardiac orifice and pyloric orifice.
2. **2 curvatures:** the lesser curvature on the right and the greater curvature on the left.
3. **2 surfaces:** anterior surface and posterior surface (where the stomach bed is located).



### Function of the stomach: digestion mainly. (bullous→chyme)

→ As we said earlier, the bullous is formed in the oral cavity, which moves to the pharynx after deglutition then to the esophagus until it reaches the stomach where it is mixed with gastric secretions to form a semi-fluid **chyme**, which is acidic (high amount of HCL), and stays in the stomach(capacity of 1500 ml) for 2-4 hours before it is evacuated to the duodenum by the pyloric sphincter which is an actual sphincter (anatomically and physiologically)

Detailed: formation of chyme mainly occurs in the body of the stomach in which it is acidic, after that it becomes neutralized in the pylorus which only have alkaline cells and mucous cells (parietal cells and chief cells are absent in it)

### Parts of the Stomach:

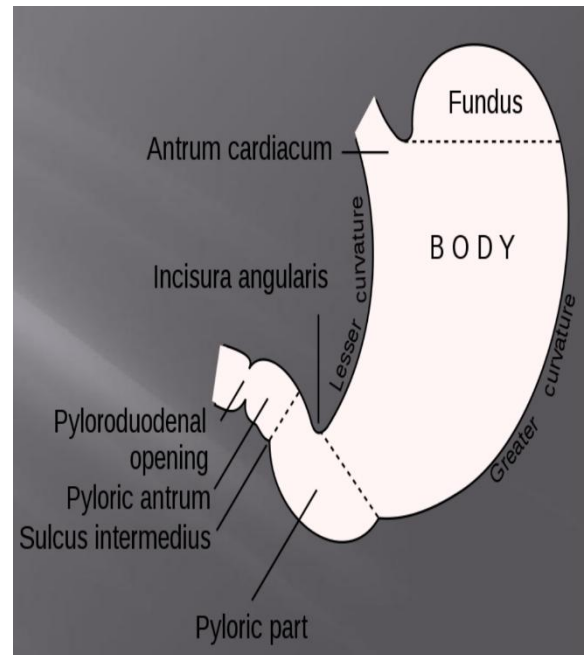
#### 1. The Fundus:

Dome shaped. Projects upward and to the left of the cardiac orifice. It is located above the level of cardiac orifice. Usually **filled with gas** (since it is the highest part in the stomach) which appears on x-ray as black spots.. Clinically: a peptic ulcer patient with perforation in

the fundus → gas leaves the fundus → goes to the abdomen to also enter the highest part which is the right copula of the diaphragm. So as a doctor if a patient showed up with severe pain in the abdomen and a history of peptic ulcer and the x-ray showed black spots (gas) under the right copula of the diaphragm you should know that he has a perforating fundus

## 2. The Body:

Extends from the level of the cardiac orifice (below the fundus) to the level of the **incisura angularis** (a constant notch in the lower part of the lesser curvature that separates the body from the pylorus).



## 3. Pyloric Region:

Divided into:

- Pyloric antrum: extends from the incisura angularis to the pylorus
- Pyloric canal: the most tubular part of the stomach (1 inch)
- Pyloric sphincter: anatomical sphincter, which contains a thickening of the inner circular muscles (most inner oblique muscles have no sphincter), controlled by sympathetic and parasympathetic. (Note: on the anterior wall of the pyloric sphincter, there is an important landmark called the **vein of mayo**. It is important for surgeons when they access the pyloric sphincter, as it is the first structure that they see.)

**Remember:** the cardiac and pyloric orifices:

- a) **The cardiac orifice** where the esophagus enters the stomach, it is a physiological sphincter (no thickening of smooth muscles). Surface anatomy: at the 7<sup>th</sup> costal cartilage, 1 inch to the left from midline at the level of T10, 10 cm from the anterior abdominal wall. 45 cm from incisors.
- b) **The pyloric orifice** is an anatomical sphincter because it contains thickening of smooth muscles. Surface anatomy: 1 inch to the right from the midline at the level of L1 [medically known: transpyloric line passes through the pylorus].

### Clinical note:

We said that the cardiac orifice is 45 cm away from the incisors.

Nowadays, all GIT specialists

have gastrosopes in their

clinics, which they use for

gastroscopy in relation to

problems in the upper GIT. The

gastroscope is a fibro-optic

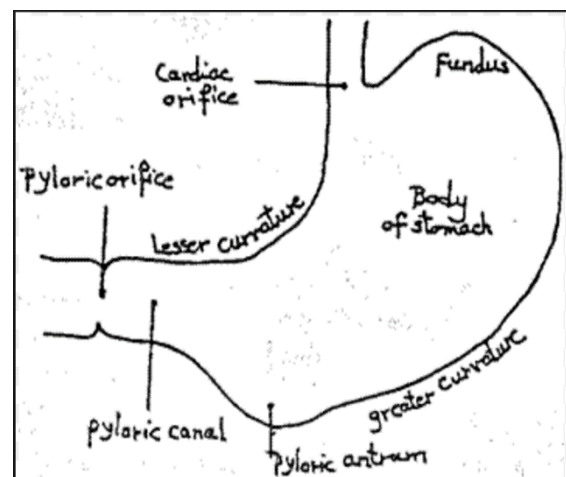
flexible tube which is inserted through the mouth with light at its tip. The

gastroscope has a scale that reads 5 cm, 10 cm, 20 cm... etc. When it reaches 45

cm, the physician will know that they have reached the cardiac orifice and,

subsequently, the stomach. It can also be used to inject medicine.

Therefore, it is a diagnostic and therapeutic tool.



*The function of the pyloric sphincter is controlled by:*

### →Nerve fibers:

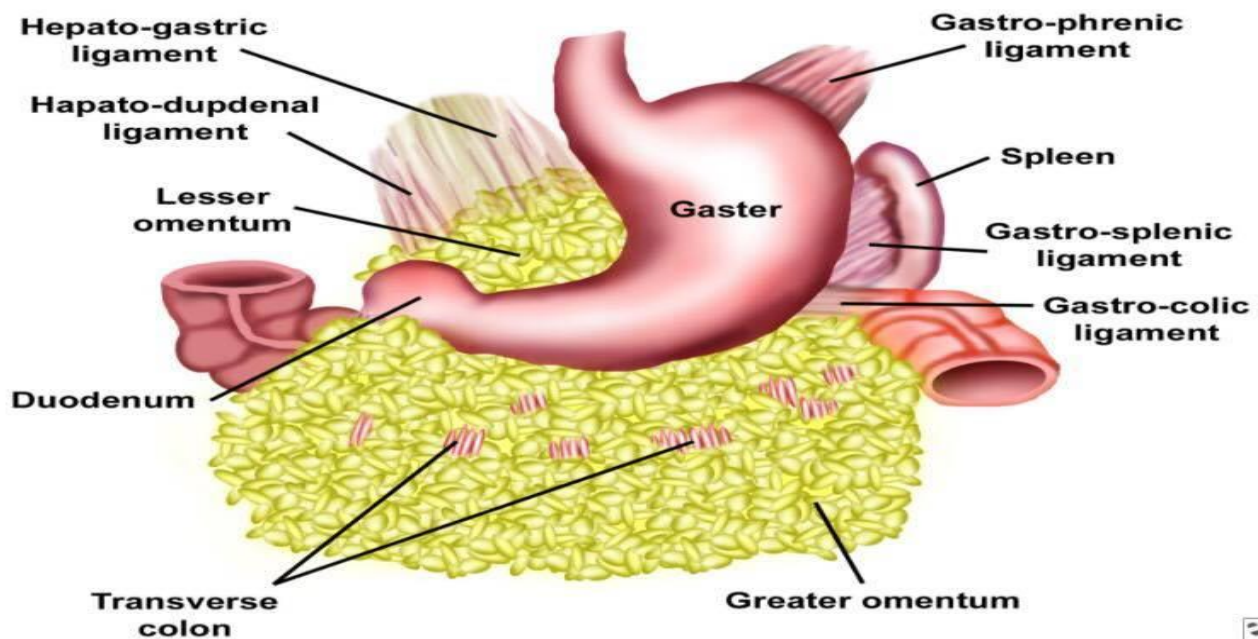
- a) **Sympathetic fibers** which are motor for the sphincter.

- b) The inhibition happens by the **vagus nerve** for drainage (**parasympathetic**)

→**Hormonal influence:** which helps in the secretion of cholecystokinin (CCK) from the duodenum.

## Curvatures of the stomach:

- 1) **The Lesser Curvature:** Forms the right border of the stomach - Extends from the cardiac orifice to the pylorus. Also has longitudinal folds for the passage of fluids which goes directly to the duodenum. Attached to it is the lesser omentum.
- 2) **The Greater Curvature:** forms the *left border of the stomach*- longer, attached to it is the greater omentum, and in the upper part, the *gastrosplenic ligament* (between the stomach{ fundus and part of greater curvature} and spleen). From greater curvature there is the *gastrocolic ligament* (attached to the transverse colon ). We also have the *gastrophrenic ligament* (extends to the underside of the left dome of the diaphragm). All of which help in the fixation of the stomach in its place, and delivers the blood supply and nerve supply to it.



## Histology of the Stomach

The stomach contains 4 layers: mucosa, submucosa(CT), muscularis externa and serosa

The layer of serosa is completely covered by peritoneum (simple squamous epithelium)

The *muscular layer* contains 3 layers:

- 1) Outer longitudinal.
- 2) Inner circular(Forms the sphincter).
- 3) The most inner, which is oblique.

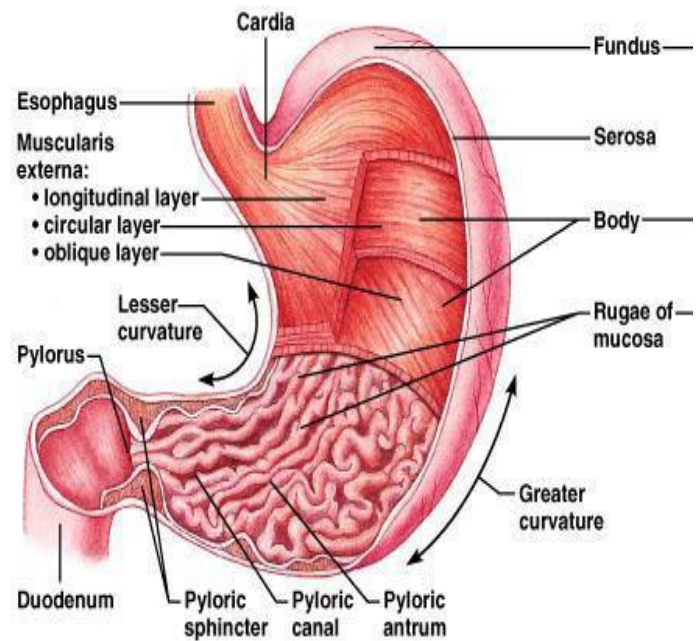
With myenteric (enteric) plexus in between the outer and inner which is mainly parasympathetic.

On the inside, the stomach contains

**rugae**, which are foldings of the

Mucosa that submucosa made as it invaginated through the mucosa. Rugae's function is to increase the surface area of mucosa for digestion. They are usually transverse and oblique, but at the **lesser curvature** they are **longitudinal folds** for the fast passage of **fluids** which goes directly to the **duodenum**. This is why the **mixing of food and fluid is minimal**; therefore don't listen to people that tell you to not drink water with food.

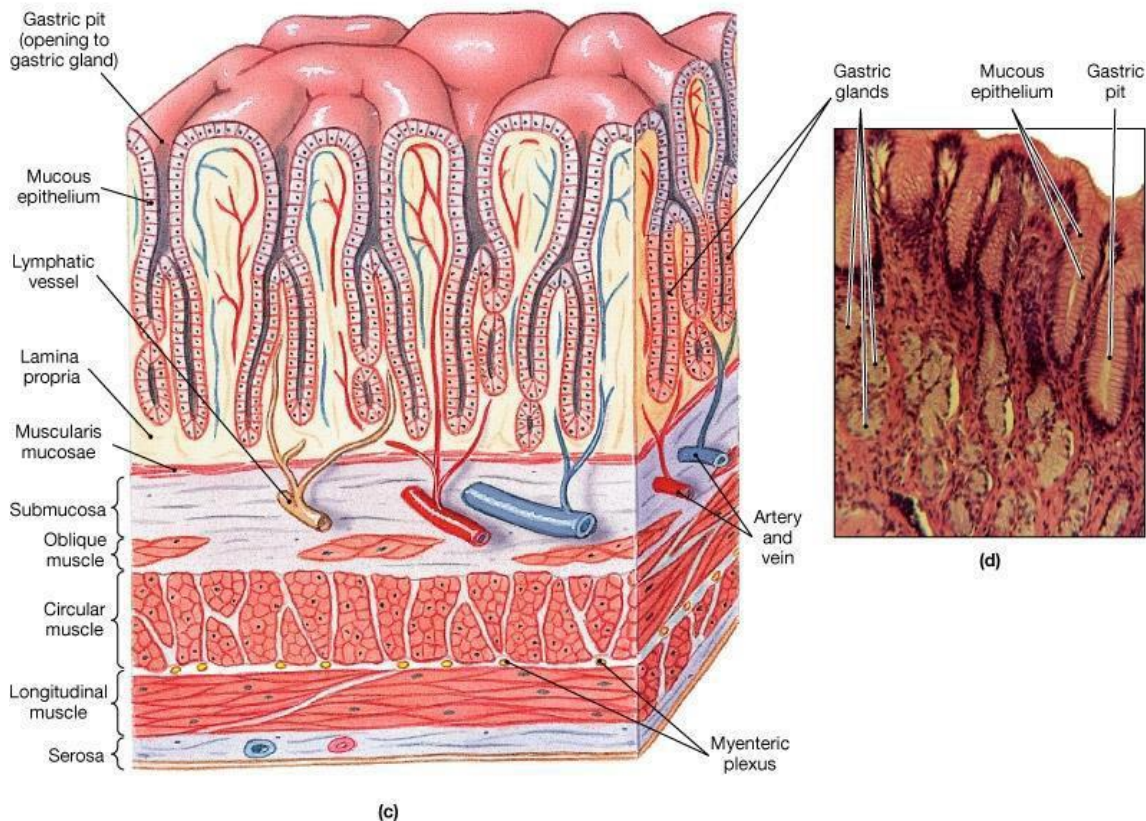
The **mucosa** contains glands and ducts called pits in order for the secretion to reach the surface, it is composed of three layers: **lining epithelium** (simple columnar without goblet cells), **lamina propria** (filled with gastric glands); contains parietal cells(secrete HCL), chief cells(secrete pepsinogen) , mucous cells, and endocrine cells (secrete gastrin hormone) and **muscularis mucosae**.



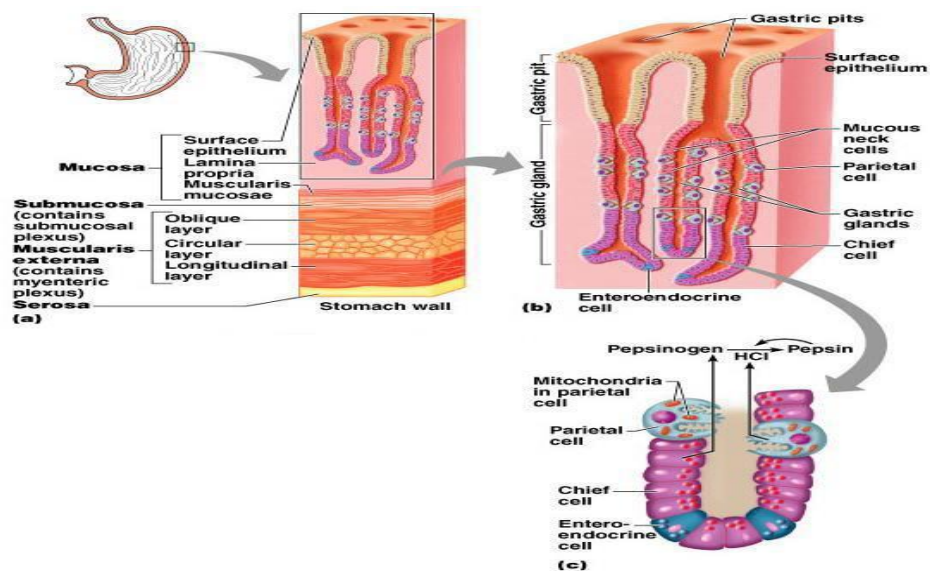
(b)



**Remember:** gastric pits, gastric gland, mucosa, myenteric plexus between the inner circular and outer longitudinal muscular layers.



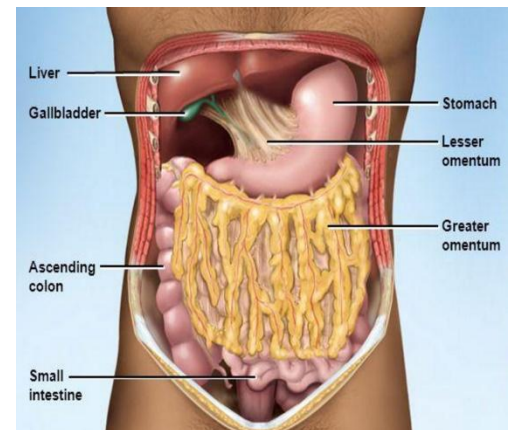
The stomach also contains mucous cells, parietal cells in the neck, chief cells at the base, and enteroendocrine cells.



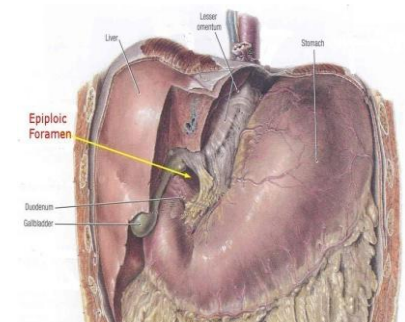
**Peritoneum of the Stomach:** The stomach is completely covered by peritoneum.

### The Lesser Omentum:

The lesser omentum is composed of 2 layers of peritoneum which extend from the lesser curvature of the stomach to the porta hepatis of the liver, and they extend upwards until they reach the diaphragm. Since there are two layers between them we are going to have blood vessels, nerves (branches from vagi-sympathetic), lymph nodes and lymphatic drainage and small amount of fat. It is divided to two parts the part attached to the stomach → hepatogastric and the part attached to the duodenum → hepatoduodenum



Note: space behind stomach: lesser sac//space in front of stomach: greater sac. Lesser omentum has a free edge, which contains an opening that lies deep to it, called the **epiploic foramen**, or **foramen of Winslow**: passage of communication between lesser and greater sac.



The importance of this foramen is that it reaches the **lesser sac of peritoneum, posterior to the stomach**. You can insert your fingers through it.

**The free edge of lesser omentum contains:**

- 1) Common bile duct
- 2) Hepatic artery
- 3) And deep to it, the portal vein.

When you insert your fingers in the epiploic foramen, these structures would be anterior to your fingers. Posterior to your fingers would be the inferior vena cava.



**The Greater Omentum:** It is composed of 2 layers of peritoneum, descending from the greater curvature of the stomach downwards in the abdominal cavity, and ascends upwards until they reach the transverse colon (intraperitoneal), surrounding it. The layers of greater omentum contain the lesser sac. Contains gastroepiploic blood vessels, veins, nerves, lymph nodes, lymph drainage and the gastrosplenic ligament, gastrophrenic ligament.

**Gastrosplenic Ligament:** the word 'ligament' means 2 layers of peritoneum which are thickened. So, the gastrosplenic ligament is located between the fundus of the stomach and a part of the greater curvature, and goes to the spleen. It contains blood vessels, nerves, lymph nodes and lymphatics.

### **Anterior Relations of the Stomach:**

- The anterior abdominal wall
- the left costal margin
- the left pleura and lung
- the diaphragm (separates left pleura and lung from the stomach)
- the left lobe of the liver

### **Posterior Relations of the Stomach (Stomach Bed)**

- The lesser sac [space behind the stomach; food goes there after aklet mansaf]
- the left crus of diaphragm
- the spleen (only a small part) most lateral
- the body of pancreas
- the transverse mesocolon and transverse colon
- the left suprarenal gland
- the upper part of the left kidney
- the splenic artery [which is tortuous also for elongation of stomach after food on upper border of pancreas]

## The Blood Supply and Venous Drainage of the Stomach:

The GI tract (according to embryology) is divided into 3 parts:

- 1) **Foregut** -> takes blood supply from the celiac trunk  
It extends from the lower third of the esophagus, the stomach, until the upper half of the duodenum.
- 2) **Midgut** -> takes blood supply from the superior mesenteric artery  
It extends from the lower half of the duodenum and ends at the lateral third of the transverse colon.
- 3) **Hindgut** -> takes blood supply from the inferior mesenteric artery  
It includes the lateral third of transverse colon, descending colon, rectum, and anal canal.

### The Celiac Trunk

It is called a trunk because it is very short (**about 1 cm in length**).

It originates from the abdominal aorta at the level of T12 (between T12 and L1).

### It gives off 3 main arteries:

- 1) **Left gastric**, which goes to the lesser curvature and gives blood supply to the stomach and the lower third of the esophagus.
- 2) **Splenic**, which moves behind the stomach, then on the upper border of the pancreas and gives blood supply to the stomach.
- 3) **Hepatic**, which moves towards the liver. It gives small branches such as:
  - a) Right gastric artery
  - b) Gastro-Epiploic artery
  - c) Gastro-duodenal artery {passes behind the first part of the duodenum}

So, in short, the blood supply of the stomach contains:

→ 2 gastric arteries

- 1) The left gastric branches from the celiac trunk.
- 2) The right gastric branches from the hepatic artery, goes towards the lesser curvature of the stomach. Supplies the lower part of the body and pylorus.

→ 2 gastro-epiploic arteries

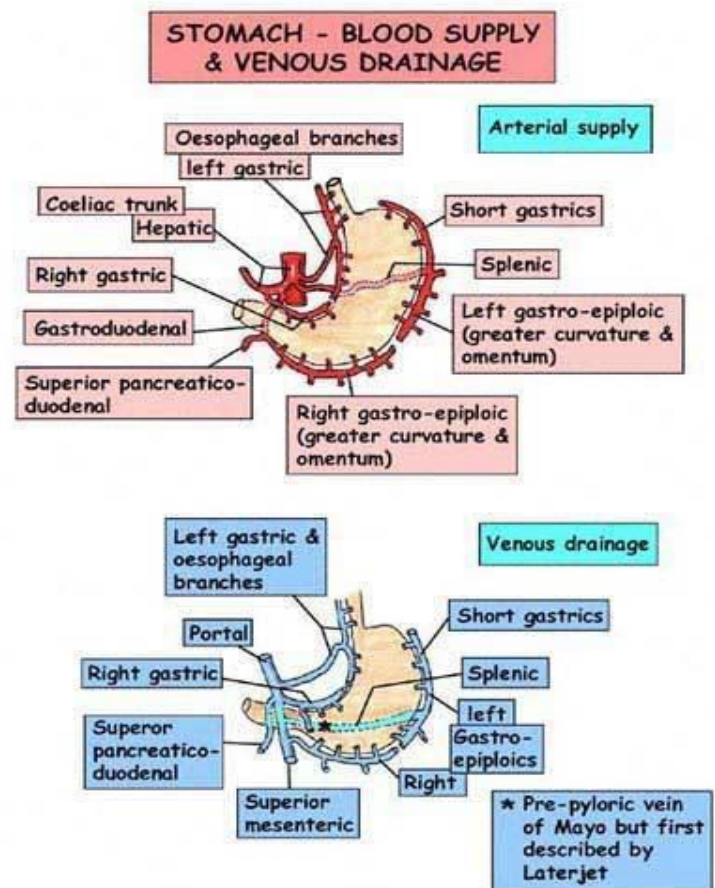
- 1) The right gastro-epiploic branches from the gastro-duodenal artery (from the hepatic) which continues towards the duodenum [superior pancreaticoduodenal artery]
- 2) The left gastro-epiploic branches from the splenic artery.

→ 5-7 short gastric arteries from the splenic artery, located in the gastrosplenic ligament and going towards the fundus.

## The Venous Drainage of the Stomach

The portal circulation contains the portal vein which carries the venous drainage to the liver. The most important function of the portal circulation is to take the absorptive material to the liver.

→ **The 2 gastric veins (left and right) drain into the portal vein.**



- ➔ The right gastro-epiploic vein drains into the superior mesenteric vein, and the left gastro-epiploic vein drains into the splenic vein.
- ➔ The short gastric veins also drain into the splenic vein.
- ➔ The superior mesenteric and the splenic behind the neck of the pancreas form the portal vein.

## The Celiac Trunk

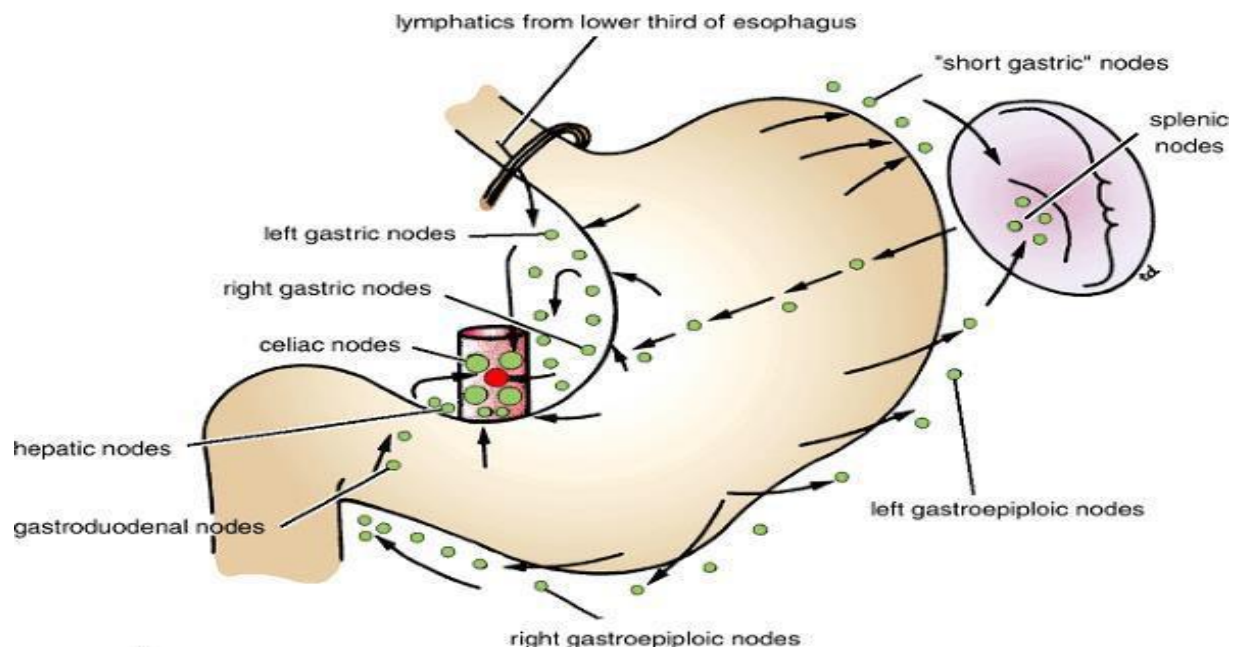
1cm in length. Between T12 and L1. On each side, it contains the celiac ganglia (contain sympathetic and parasympathetic fibers) and lymph nodes, which are named after it. Behind it, we have the crus of the diaphragm. The main arteries are the left gastric, splenic and hepatic arteries.

## The Lymphatic Drainage of the Stomach

It is very similar to the venous drainage:

- Gastric lymph nodes [with the left and right gastric veins]
- Gastro-epiploic lymph nodes at the greater curvature [with the right and left gastro-epiploic veins]
- Pancreatico-duodenal lymph nodes [around the splenic vein]

In the end, all lymphatic drainage will gather around the celiac trunk in the celiac lymph nodes.



## The Nerve Supply of the Stomach:

We have **sympathetic** fibers that go towards the *celiac plexus* of nerves around the celiac trunk. The sympathetic fibers mainly go towards the sphincters for contraction (such as the pyloric sphincter), and they also carry pain sensation.

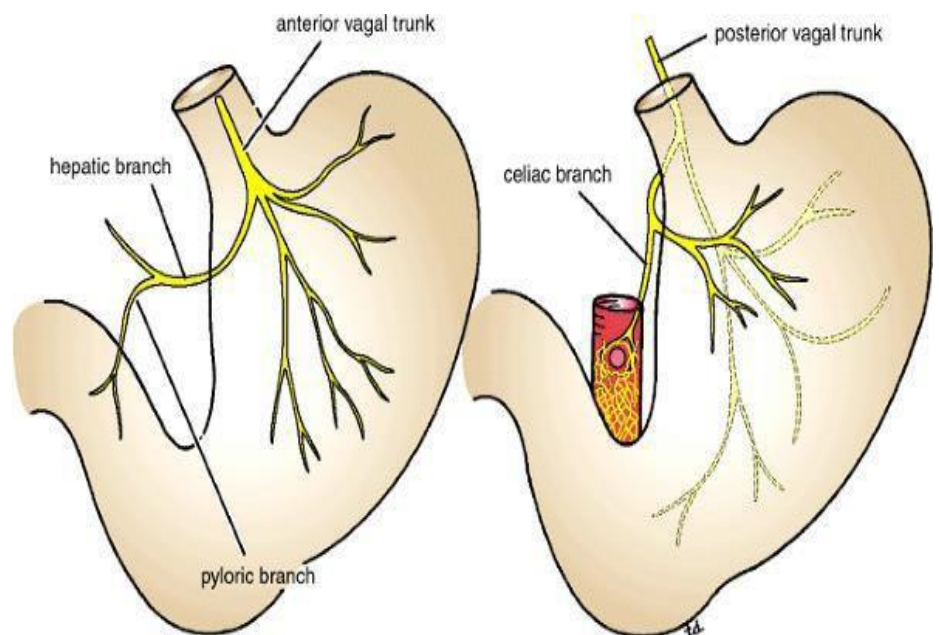
We also have **parasympathetic** fibers from the *vagi*.

The parasympathetic fibers are mainly secretomotor for the gastric glands, and motor for smooth muscles, so they are responsible for peristaltic movement.

Around the esophagus we had left and right vagus nerves. After passing through the opening, the left vagus nerve became anterior, and the right vagus nerve became posterior. They are part of the contents of the lesser omentum.

### The anterior vagal nerve innervates:

- 1) The anterior wall of the stomach.
- 2) Gives a hepatic branch that goes to the liver and gallbladder.
- 3) Gives another branch called anterior nerve of Latarjet that goes towards the pylorus, it is extremely important in its role in drainage.



### The posterior vagal nerve innervates:

- 1) The posterior wall of the stomach.
- 2) Posterior nerve of Latarjet to the pylorus.

- 3) Celiac branch which innervates the small intestines and the medial two thirds of the transverse colon.

## **Clinical Points:**

### **1) Gastric Ulcer**

15 years ago, the rule said that hyperacidity meant peptic ulcer, and its treatment was surgery to the vagus nerve.

Now, it has changed completely. The real cause of peptic ulcer is a bacteria known as **Helicobacter pylori**. It is present inside the human body and is usually non-pathogenic. Under certain conditions, when there is resistance in the body, it may lead to peptic ulcer. Its treatment consists of a combination of 4 drugs for 21 days. 95% of the cases are completely cured with this method. Peptic ulcer has two forms: gastric and duodenal. The gastric ulcer is considered malignant until proven that it is not malignant. The duodenal ulcer is a peptic ulcer until proven otherwise (they are the opposite of each other). It is very common, especially in the first inch, since it receives acidic chyme which may result in irritation → Ulcer. So, a biopsy needs to be taken to prove malignancy.

Note: common site in stomach: anterior and posterior walls of lesser curvature

### **2) Trunkal Vagotomy**

- 3) We used to cut the vagus nerve below the diaphragm, so the stomach stopped receiving parasympathetic innervations, which resulted in bad drainage. Now, we perform a highly selective vagotomy where **we cut all branches of vagi except the nerve of Latarjet.**

- 4) **Gastroscopy** (where we enter an endoscope into the oral cavity to check the stomach, esophagus, and duodenum, (to be more specific, until the second part of the duodenum)).

- 5) **Pyloroplasty**, means drainage, where the pyloric sphincter has a thickening and continuous contraction that results in no drainage. So,



they cut it and add stitches which will lead to the dilatation of the sphincter.

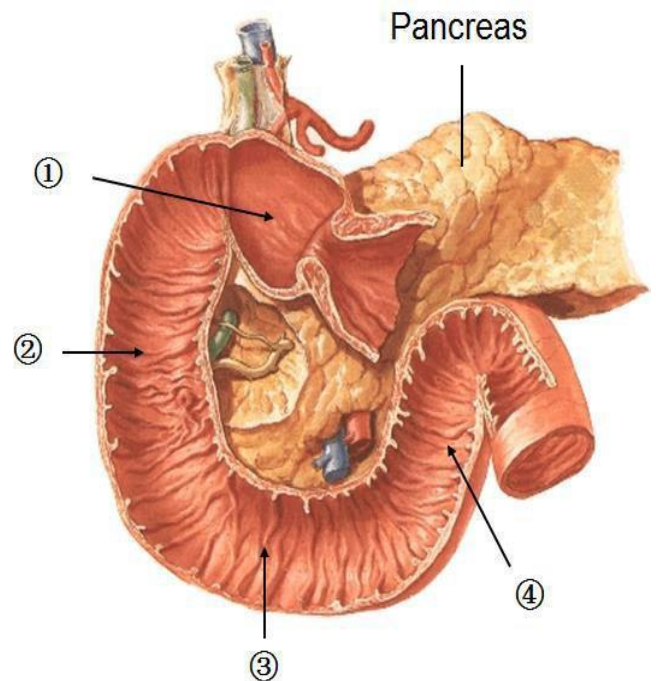
## **The Duodenum**

The small intestines are divided into 3 parts:

- 1- The duodenum  
[retroperitoneal except for the first and last inch]  
**Why?** Because the first inch is below the stomach, and the stomach is intraperitoneal.  
The last inch is before the jejunum, and the jejunum is also intraperitoneal.

- 2- The jejunum  
[intraperitoneal]
- 3- The ileum [intraperitoneal]

The main function of the jejunum and the ileum is absorption.



The duodenum forms a C-shaped curve, directed medially and backwards, and the head of the pancreas is located at the concavity of the duodenum. It is about 25 cm (10 inches) in length, whereas the entire small intestines are around 6 meters in length.

**The duodenum is divided into 4 parts:**

- 1) **The first part [2 inches]**
- 2) **The second part [3 inches]**
- 3) **The middle part of it opens for the common bile duct and pancreatic duct, in order to complete digestion (especially for fat). It also separates the duodenum into upper half [follows foregut] and a lower half [follows Midgut]. The third part [horizontal] [4 inches]**
- 4) **The fourth part [the last inch].**

*The End*