THE ABDOMEN

• PERITONEUM AND PERITONEAL CAVITY LESSER OMENTUM
• ESOPHAGUS
• STOMACH
• DUODENUM
The peritoneum consists of two continuous layers:

- the **parietal peritoneum**, which lines the internal surface of the abdominopelvic wall, and

- the **visceral peritoneum**, which invests viscera such as the stomach and intestines.

The peritoneum is the **largest serous membrane** in the body.

In **males** it forms a **closed sac**, but in **females** it is **open** at the lateral ends of the uterine tubes. This communication constitutes a **potential pathway** of infection from the exterior.
The peritoneal cavity is a potential space between the parietal peritoneum, which lines the abdominal wall, and infoldings of visceral peritoneum, which suspend the abdominal viscera within the cavity.

It contains a small amount of serous fluid, but is otherwise empty. The fluid lubricates the visceral peritoneum and allows the mobile viscera to glide freely on the abdominal wall and each other within.
The peritoneal cavity never contains gas in normal circumstances, although the amount of fluid may be increased in inflammatory conditions of the viscera.

In females blood or fluid may occasionally escape from the uterine tubes into the pelvic peritoneal cavity during menstruation.
EMBRYOLOGY OF PERITONEAL CAVITY
The gut is the **same length** as the developing body.

In utero, the alimentary tract develops as a **single tube** suspended in the coelomic cavity by **ventral** and **dorsal mesenteries**.
The primordial gut comprises the:
- foregut,
- midgut, and
- hindgut.

From **foregut**:
- esophagus,
- stomach,
- pancreas,
- duodenum,
- liver, and
- biliary ducts.

Artery: **CELIAC TRUNK**
From **midgut**:  
• the small intestine distal to bile duct,  
• cecum,  
• appendix,  
• ascending colon, and  
• most of the transverse colon  

**Artery**: SMA

From **hindgut**:  
• the distal part of the transverse colon,  
• descending colon,  
• sigmoid colon,  
• rectum  

**Artery**: IMA
By the end of the 10th week of development, the gut is much longer than the body that contains it.

The gut must gain freedom of movement relative to the body wall at an early stage.

Ultimately, the ventral mesentery is largely resorbed, although some parts persist in the upper abdomen and form structures such as the falciform ligament.

The mesenteries of the intestines in the adult are the remnants of the dorsal mesentery.
The migration and subsequent fixation produce **four separate intraperitoneal bowel loops** suspended by mesenteries of variable lengths.

These **four loops** are covered by **visceral peritoneum** which is continuous with the parietal peritoneum covering the posterior abdominal wall.
THE FOUR LOOPS:
The first intraperitoneal loop is formed by the:
- intraperitoneal oesophagus,
- stomach,
- first part of the duodenum.

The second loop is made up of the:
- duodenojejunal junction,
- jejunum,
- ileum,
- occasionally the caecum
- proximal ascending colon.
THE FOUR LOOPS:
The **third** loop contains:

- the transverse colon

The **final loop** contains the:

- sigmoid colon
- occasionally the distal descending colon.
For 4 weeks, the rapidly growing midgut, supplied by the SMA, is physiologically herniated into the proximal part of the umbilical cord.

The gut must gain freedom of movement relative to the body wall at an early stage.

The midgut forms a U-shaped loop that herniates through the primitive umbilical ring into the extraembryonic coelom.

The midgut loop consists of a cranial limb and a caudal limb.

The cranial limb forms the jejunum and upper part of the ileum.
The **caudal limb** forms the cecal diverticulum, from which the cecum and appendix develop; the rest of the caudal limb forms the lower part of the ileum, ascending colon, and proximal 2/3 of the transverse colon.

The **midgut** loop rotates a **total of 270° counterclockwise** around the **SMA** as it returns to the abdominal cavity, thus reducing the physiological herniation, around week 10-11.

**Hindgut** derivatives are supplied by the **inferior mesenteric artery** and include the distal 1/3 of the transverse colon, descending colon, sigmoid colon, rectum, and upper anal canal.
ADULT STRUCTURES DERIVED FROM EACH OF THE 3 DIVISIONS OF THE PRIMITIVE GUT TUBE

FOREGUT

Artery: celiac
Parasympathetic innervation: vagus nerves
Sympathetic innervation:
  • preganglionics: thoracic splanchnic nerves, T5-T9
  • postganglionic cell bodies: celiac ganglion

Referred Pain: Epigastrium

Foregut Derivatives:
  • Esophagus
  • Stomach
  • Duodenum (first and second parts)
  • Liver
  • Pancreas
  • Biliary apparatus
  • Gallbladder
ADULT STRUCTURES DERIVED FROM EACH OF THE 3 DIVISIONS OF THE PRIMITIVE GUT TUBE

MIDGUT

Artery: superior mesenteric
Parasympathetic innervation: vagus nerves
Sympathetic innervation:
- Preganglionics: thoracic splanchnic nerves, T9-T12
- Postganglionic cell bodies: superior mesenteric ganglion

Referred Pain: Umbilical

Midgut Derivatives
- Duodenum (second, third, and fourth parts)
- Jejunum
- Ileum
- Cecum
- Appendix
- Ascending colon
- Transverse colon (proximal two-thirds)
ADULT STRUCTURES DERIVED FROM EACH OF THE 3 DIVISIONS OF THE PRIMITIVE GUT TUBE

HINDGUT

Artery: inferior mesenteric

Parasympathetic innervation: pelvic splanchnic nerves

Sympathetic innervation:
- preganglionics: lumbar splanchnic nerves, L1-L2
- postganglionic cell bodies: inferior mesenteric ganglion

Referred Pain: Hypogastrium

Hindgut Derivatives
- Transverse colon (distal thirdsplenic flexure)
- Descending colon
- Sigmoid colon
- Rectum
- Anal canal (above pectinate line)
Early in its development, the embryonic **body cavity** (intraembryonic coelom) is lined with mesoderm, the **primordium of the peritoneum**.

At a slightly later stage, the primordial abdominal cavity is lined with **parietal peritoneum** derived from mesoderm, which forms a **closed sac**. The lumen of the peritoneal sac is the **peritoneal cavity**.
The lumen of the peritoneal sac is the **peritoneal cavity**.

As the organs develop, they invaginate (protrude) to varying degrees into the peritoneal sac, acquiring a peritoneal covering, the **visceral peritoneum**.

The kidney protrudes only partially into the peritoneal cavity; hence, it is **primarily retroperitoneal**, always remaining external to the peritoneal cavity and posterior to the peritoneum lining the abdominal cavity.
The stomach and spleen, protrude completely into the peritoneal sac and are almost completely invested by visceral peritoneum - that is, they are intraperitoneal.

Intraperitoneal organs are almost completely covered with visceral peritoneum (e.g., the stomach and spleen). Intraperitoneal in this case does not mean inside the peritoneal cavity. Intraperitoneal organs have conceptually, invaginated into the closed sac.

Extraperitoneal, retroperitoneal, and subperitoneal organs are also outside the peritoneal cavity - external to the parietal peritoneum - and are only partially covered with peritoneum - usually on just one surface.
A **mesentery** is a double layer of peritoneum that occurs as a result of the invagination of the peritoneum by an organ. It provides **neurovascular communications** between the organ and the body wall.

**Mesenteries** have a core of connective tissue containing blood and lymphatic vessels, nerves, lymph nodes, and fat.
An **omentum** is a **double-layered** extension or fold of peritoneum that passes from the stomach and proximal part of the duodenum to adjacent organs in the abdominal cavity.

A **peritoneal fold** is a reflection of peritoneum that is raised from the body wall by underlying blood vessels, ducts, and ligaments formed by obliterated fetal vessels.

A **peritoneal recess**, or **fossa**, is a pouch of peritoneum that is formed by a peritoneal fold.
The **greater omentum** is the largest peritoneal fold and hangs inferiorly from the greater curvature of the stomach. It is a double sheet (*four-layered peritoneal fold*): each sheet consists of two layers of peritoneum separated by a scant amount of connective tissue.

The anterior sheet of the **greater omentum** descends from the greater curvature of the stomach and first part of the duodenum. After descending, it folds back and attaches to the **anterior surface of the transverse colon** and its mesentery.
The lesser omentum is formed of two layers of peritoneum separated by a variable amount of connective tissue and is derived from the ventral mesogastrium.

The lesser omentum runs from the inferior visceral surface of the liver to the abdominal oesophagus, stomach, pylorus and first part of the duodenum.
The liver is almost completely covered in visceral peritoneum, and only the ‘bare area’ is in direct contact with the right dome of the diaphragm.

The liver is connected to the:
- Anterior abdominal wall by the falciform ligament
- Stomach by the hepatogastric ligament, the membranous portion of the lesser omentum.
- Duodenum by the hepatoduodenal ligament, the thickened free edge of the lesser omentum, which conducts the portal triad: portal vein, hepatic artery, and bile duct

The hepatogastric and hepatoduodenal ligaments are continuous parts of the lesser omentum
The **stomach** is connected to the:

- Inferior surface of the diaphragm by the **gastrophrenic ligament**.
- Spleen by the **gastroplenic ligament**, which reflects to the hilum of the spleen.
- Transverse colon by the **gastrocolic ligament**, the apron-like part of the **greater omentum**, which descends from the greater curvature, turns under, and then ascends to the transverse colon.
SUBDIVISIONS OF PERITONEAL CAVITY
After the rotations and development of the greater curvature of the stomach during development the peritoneal cavity is divided into the **greater and lesser peritoneal sacs.**
The omental bursa (lesser sac) lies posterior to the stomach and lesser omentum.

The omental bursa communicates with the greater sac through the omental foramen (epiploic foramen).

The omental foramen can be located by running a finger along the gallbladder to the free edge of the lesser omentum.
The boundaries of the omental foramen are:

- **anteriorly**: the **hepatoduodenal ligament** (free edge of lesser omentum), containing the hepatic portal vein, hepatic artery, and bile duct (**portal triad**).

- **posteriorly**: the **IVC** and a muscular band, the right crus of the diaphragm, covered anteriorly with parietal peritoneum.

- **superiorly**: the **liver**, covered with visceral peritoneum.

- **inferiorly**: the superior or first part of the **duodenum**.
The **omentum bur**sa is an extensive sac-like cavity that lies posterior to the stomach, lesser omentum, and adjacent structures.

The **parietal peritoneum** associated with the abdominal wall is innervated by somatic afferents carried in branches of the associated spinal nerves and is therefore sensitive to well-localized pain.

The **visceral peritoneum** is innervated by visceral afferents that accompany autonomic nerves (sympathetic and parasympathetic) back to the central nervous system.
INTRAPERITONEAL
AND
RETROPERITONEAL ORGANS
INTRAPERITONEAL AND RETROPERITONEAL ORGANS:

- **Intraperitoneal organs** are suspended by a mesentery and are almost completely enclosed in visceral peritoneum. These organs are mobile.

- **Retroperitoneal organs** are partially covered on one side with parietal peritoneum and are immobile or fixed organs. Many retroperitoneal organs were originally suspended by a mesentery and become secondarily retroperitoneal.
INTRAPERITONEAL AND RETROPERITONEAL ORGANS:

Major Intraperitoneal Organs (suspended by a mesentery)

- Stomach
- Liver and gallbladder
- Spleen
- Duodenum, 1st part
- Tail of pancreas
- Jejunum
- Ileum
- Appendix
- Transverse colon
- Sigmoid colon
INTRAPERITONEAL AND RETROPERITONEAL ORGANS:

Major Secondary Retroperitoneal Organs (lost a mesentery during development)

• Duodenum, 2\textsuperscript{nd} and 3\textsuperscript{rd} parts
• Head, neck, and body of pancreas
• Ascending colon
• Descending colon
• Upper rectum
INTRAPERITONEAL AND RETROPERITONEAL ORGANS:

Major Primary Retroperitoneal Organs (never had a mesentery)

• Kidneys
• Adrenal glands
• Ureters
• Aorta
• Inferior vena cava
• Lower rectum
• Anal canal
THE ABDOMEN

- PERITONEUM AND PERITONEAL CAVITY LESSER OMENTUM
- STOMACH
- DUODENUM
The esophagus is a muscular tube (approximately 25 cm [10 in] long) with an average diameter of 2 cm that conveys food from the pharynx to the stomach.

The esophagus has three constrictions:
- **cervical constriction** (upper esophageal sphincter): at its beginning at the pharyngoesophageal junction, caused by the cricopharyngeus muscle.
- **thoracic (broncho-aortic) constriction**: a compound constriction where it is first crossed by the arch of the aorta, and then where it is crossed by the left main bronchus.
- **diaphragmatic constriction**: where it passes through the esophageal hiatus of the diaphragm.
The esophagus has internal circular and external longitudinal layers of muscle.

- in its **superior** third, the external layer consists of voluntary striated muscle
- the **inferior** third is composed of smooth muscle
- the **middle** third is made up of both types of muscle
Passes through the elliptical esophageal hiatus in the muscular right crus of the diaphragm, just to the left of the median plane at the level of the T10 vertebra.

Emerging through the right crus of the diaphragm, usually at the level of the 7th left costal cartilage and at the level of vertebra TX, it passes from the esophageal hiatus to the cardial orifice of the stomach just left of the midline.
The **abdominal esophagus** represents the short (1–2.5 cm in length) distal part of the esophagus located in the abdominal cavity.

The **anterior surface** of abdominal esophagus is covered with peritoneum of the **greater sac**.

The **posterior surface** is covered with peritoneum of the **omentum bursa**.
The right border of the abdominal esophagus is continuous with the lesser curvature of the stomach.

The left border is separated from the fundus of the stomach by the cardial notch between the esophagus and fundus.

The esophagogastric junction lies to the left of the T11 vertebra on the horizontal plane that passes through the tip of the xiphoid process.
The **arterial supply** of the abdominal part of the esophagus is from the **left gastric artery**, a branch of the **celiac trunk**, and the **left inferior phrenic artery**.

The **venous drainage** from the submucosal veins of this part of the esophagus is both to the **portal venous system** through the left gastric vein and into the **systemic venous system** through esophageal veins entering the **azygos vein**.
The **lymphatic** drainage of the abdominal part of the esophagus is into the **left gastric lymph nodes**.

The esophagus is innervated by the **esophageal plexus**, formed by the **vagal trunks** and the **thoracic sympathetic trunks** via the greater (abdominopelvic) splanchnic nerves and **periarterial plexuses**.
THE ABDOMEN

- PERITONEUM AND PERITONEAL CAVITY LESSER OMENTUM
- ESOPHAGUS
- STOMACH
- DUODENUM
The stomach is the widest part of the alimentary tract and lies between the oesophagus and the duodenum.

The stomach is divided by arbitrary lines drawn on its external surface into a:
- fundus,
- body,
- pyloric antrum
- and pylorus.

The stomach acts as a food blender and reservoir; its chief function is enzymatic digestion.
The stomach has four parts:

- **cardia**: the part surrounding the cardial orifice (opening), the superior opening or inlet of the stomach

- **fundus**: the dilated superior part that is related to the left dome of the diaphragm

- **body**: the major part of the stomach between the fundus and pyloric antrum

- **pyloric part**: the funnel-shaped outflow region of the stomach
The **cardial notch** is between the esophagus and the fundus.

The wider part, the **pyloric antrum**, leads into the **pyloric canal**, its narrower part.

The gastric mucosa is thrown into longitudinal ridges or wrinkles called **gastric folds - gastric rugae**.

The **pyloric part of the stomach** lies at the level of the **transpyloric plane**, midway between the jugular notch superiorly and the pubic crest inferiorly.
The stomach also features two curvatures:

- **lesser curvature**: forms the shorter concave right border of the stomach
- **greater curvature**: forms the longer convex left border of the stomach
The stomach is covered by **visceral peritoneum**, except where **blood vessels** run along its **curvatures** and in a small area posterior to the **cardial orifice**.

**Anteriorly**, the stomach is related to the **diaphragm, left lobe of liver, and anterior abdominal wall.**

**Posteriorly**, the stomach is related to the **omental bursa and pancreas**; the posterior surface forms most of the anterior wall of the **omental bursa.**

**Inferiorly**, to the **transverse colon.**

**Laterally** to the stomach as it courses along the greater curvature of the stomach to the **left colic flexure.**
The **arterial supply** of the stomach arises from the **celiac trunk** and its branches.

Most blood is supplied by anastomoses formed along the **lesser curvature** by the **right and left gastric arteries**.

Along the **greater curvature** by the **right and left gastro-omental (gastroepiploic)** arteries.

The **fundus** and **upper body** receive blood from the **short and posterior gastric arteries**.
The veins of the stomach parallel the arteries in position and course.

The right and left gastric veins drain into the hepatic portal vein.

The short gastric veins and left gastro-omental veins drain into the splenic vein, which joins the superior mesenteric vein (SMV) to form the hepatic portal vein.

The right gastro-omental vein empties in the SMV.
The lymphatic drainage of the stomach:

- Lymph from the **superior two thirds** of the stomach drains along the right and left gastric vessels to the **gastric lymph nodes**.
- Lymph from the **right two thirds of the inferior third** of the stomach drains along the right gastro-omental vessels to the **pyloric lymph nodes**.
- Lymph from the **left one third of** the greater curvature drains to the **pancreaticoduodenal lymph nodes**.
The anterior vagal trunk, derived mainly from the left vagus nerve (CN X)

The larger posterior vagal trunk, derived mainly from the right vagus nerve.

The sympathetic nerve supply of the stomach, from the T6 through T9 segments of the spinal cord, passes to the celiac plexus through the greater splanchnic nerve.
THE ABDOMEN

- PERITONEUM AND PERITONEAL CAVITY
- LESSER OMENTUM
- ESOPHAGUS
- STOMACH
- DUODENUM
The **duodenum** is shortest (25 cm) part of the small intestine, is also the widest and most fixed part.

The duodenum pursues a C-shaped course **around the head of the pancreas**.

It begins at the **pylorus** on the right side and ends at the **duodenojejunal flexure** (junction) on the left side.

The junction usually takes the form of an acute angle, the **duodenojejunal flexure**.
The duodenum is divisible into four parts:

- **superior (first) part**: short (approximately 5 cm) and lies anterolateral to the body of the L1 vertebra
- **descending (second) part**: longer (7–10 cm) and descends along the right sides of the L1–L3 vertebrae
- **inferior (third) part**: 6–8 cm long and crosses the L3 vertebra
- **ascending (fourth) part**: short (5 cm) and begins at the left of the L3 vertebra and rises superiorly as far as the superior border of the L2 vertebra
The first 2 cm of the superior part of the duodenum, immediately distal to the pylorus, has a mesentery and is mobile – the **ampulla**.

The **superior part** of the duodenum ascends from the pylorus and is overlapped by the **liver** and **gallbladder**.
The **descending** part of the duodenum runs inferiorly, curving around the **head of the pancreas**. Initially, it lies to the right of and parallel to the IVC.

The descending part of the duodenum is entirely **retroperitoneal**.

The **bile** and **main pancreatic ducts** usually unite to form the **hepatopancreatic ampulla** and enter posteromedial wall on the **major duodenal papilla**.
The **inferior (horizontal) part** of the duodenum runs transversely to the left, passing over the IVC, aorta, and L3 vertebra.

The anterior surface of the inferior part is covered with peritoneum.

Posteriorly the **inferior part** is separated from the vertebral column by the right psoas major, IVC, aorta, and the right testicular or ovarian vessels.

The **ascending part** of the duodenum runs superiorly and along the left side of the aorta to reach the inferior border of the body of the pancreas.

The **duodenojejunal flexure**, supported by the attachment of a suspensory muscle of the duodenum (*ligament of Treitz*).
The arteries of the duodenum arise from the celiac trunk and the SMA.

The celiac trunk, via the gastroduodenal artery and its branch, the superior pancreaticoduodenal artery.

The SMA, through its branch, the inferior pancreaticoduodenal artery, supplies the duodenum distal to the entry of the bile duct.
The **veins of the duodenum** follow the arteries and drain into the hepatic portal vein, some directly and others indirectly, through the superior mesenteric and splenic veins.

The **nerves of the duodenum** derive from the vagus and greater and lesser (abdominopelvic) splanchnic nerves by way of the celiac and superior mesenteric plexuses.