Abdominal Cavity

The abdominal cavity is enclosed by the abdominal walls and is completely filled by the abdominal viscera. These are the stomach and intestine, their associated glands (liver and pancreas and their associated ducts), blood and lymph vessels, the spleen, kidneys, and suprarenal glands. The kidneys, ureters, and suprarenal glands lie on the posterior abdominal wall enclosed in the fascial lining of the abdominal cavity. The other structures lie anterior to this and are surrounded to a great or lesser extent by the peritoneal cavity.

The **peritoneum** is a thin serous membrane that lines the walls of the abdominal and pelvic cavities and clothes the viscera. The peritoneum can be regarded as a balloon against which organs are pressed from outside. The parietal peritoneum lines the walls of the abdominal and pelvic cavities, and the visceral peritoneum covers the organs. The potential space between the parietal and visceral layers, which is in effect the inside space of the balloon, is called the peritoneal cavity. In males, this is a closed cavity, but in females, there is communication with the exterior through the uterine tubes, the uterus, and the vagina.

Between the parietal peritoneum and the fascial lining of the abdominal and pelvic walls is a layer of connective tissue called the **extraperitoneal tissue**; in the area of the kidneys this tissue contains a large amount of fat, which supports the kidneys.

The peritoneal cavity is the largest cavity in the body and is divided into two parts: the greater sac and the lesser sac. The **greater sac** is the main compartment and extends from the diaphragm down into the pelvis. The **lesser sac** is smaller and lies behind the stomach. The greater and lesser sacs are in free communication with one another through an oval window called the **opening of the lesser sac**, or the **epiploic foramen**. The peritoneum secretes a small amount of serous fluid, the peritoneal fluid, which lubricates the surfaces of the peritoneum and allows free movement between the viscera.

Intraperitoneal and Retroperitoneal Relationships

The terms **intraperitoneal** and **retroperitoneal** are used to describe the relationship of various organs to their peritoneal covering. An organ is said to be intraperitoneal when it is almost totally covered with visceral peritoneum. The stomach, jejunum, ileum, and spleen are good examples of intraperitoneal organs. Retroperitoneal organs lie behind the peritoneum and are only partially covered with visceral peritoneum. The pancreas and the ascending and descending parts of the colon are examples of retroperitoneal organs. No organ, however, is actually within the peritoneal cavity. An intraperitoneal organ, such as the stomach, appears

to be surrounded by the peritoneal cavity, but it is covered with visceral peritoneum and is attached to other organs by omenta.

Peritoneal Ligaments, Omenta, and Mesenteries

Peritoneal ligaments are two-layered folds of peritoneum that connect solid organs to the abdominal walls (they do not posses the dense fibrous tissue seen in the ligament associated with bones). The liver for example, is conned to the diaphragm by the **falciform ligament**, the **coronary ligament**, and the **right** and **left triangular ligaments**.

Omenta are two-layered folds of peritoneum that connect the stomach to other viscus. The **greater omentum** connects the greater curvature of the stomach to the transverse colon. It hangs down like an apron in front of the coils of the small intestine and is folded back on itself to be attached to the transverse colon. The **lesser omentum** passes from the abdominal esophagus, the lesser curvature of the stomach, and first 2 cm of the duodenum to be attached to the liver in the depth of the fissure for the ligamentum venosum and around the margin of the porta heptis. The lesser omentum ends in a free edge. Here the two layers of the peritoneum meet around the portal vein, proper hepatic artery, and bile duct. Else where the layers of the omentum enclose only extraperitoneal tissues and right and left gastric vessels close to the lesser curvature of the stomach. The gastrosplenic omentum (ligament) connects the stomach to the hilum of the spleen.

Mesenteries are two-layered folds of peritoneum connecting parts of the intestine to the posterior abdominal walls, for example, the **mesentery of the small intestine**, the **transverse mesocolon**, and the **sigmoid mesocolon**.

The peritoneal ligaments, Omenta, and mesenteries permit blood, lymph vessels, and nerves to reach the viscera.

Peritoneum as Seen on Transverse Sections of the Abdomen

at the level of the fourth lumbar vertebra the parietal peritoneum lining the anterior abdominal wall below the umbilicus is smooth, apart from the low ridges produced by the **median umbilical ligament** (the urachus, the remains of the fetal allantois, which passes from the apex of the bladder to the umbilicus) and the **lateral umbilical ligaments** (the obliterated umbilical arteries, which pass from the internal iliac arteries to the umbilicus).

The parietal peritoneum passes into the posterior abdominal wall and becomes continuous with the visceral peritoneum covering the sides and the anterior surfaces of the ascending and descending parts of the colon. In the region of the aorta and inferior vena cava, the parietal

peritoneum becomes continuous with the mesentery of the small intestine. Note the right and left **paracolic grooves or gutters** which lie lateral and medial to the ascending and descending parts of the colon respectively. Note also the peritoneum forms a continuous layer that can be traced around the abdominal cavity without interruption.

At the level of the twelve thoracic vertebra the parietal peritoneum lining the anterior abdominal wall forms a sickle-shaped fold called the **falciform ligament**. This connects the anterior surface of the liver to the anterior abdominal wall above the umbilicus and to the diaphragm. In the free border of the ligament, where the two layers of peritoneum are continuous with each other, lies the **ligamentum teres**. This is the obliterated umbilical vein of the fetus, which passes upward to enter the groove between the quadrate lobe and the left lobe of the liver.

The parietal peritoneum reaches the lateral margin of the left kidney. Here, it becomes continuous with the visceral peritoneum covering the lateral margin and part of the anterior surface of the left kidney. The peritoneum then leaves the kidney and passes to the hilum of the spleen as the posterior layer of the **splenicorenal ligament**. The visceral peritoneum covers the spleen and, on reaching the hilum again, is reflected onto the greater curvature of the stomach as the anterior layer of the **gastrosplenic omentum** (ligament). The visceral peritoneum covers the anterior surface of the stomach and leaves the lesser curvature to form the anterior layer of the lesser omentum. On the right, the lesser omentum has a free border, and here the peritoneum folds around the **bile duct**, **hepatic artery**, and **portal vein**. The free border of the lesser omentum forms the anterior margin of the opening into the lesser sac.

The peritoneum forms the posterior layer of the lesser omentum and becomes continuous with the visceral layer of the peritoneum covering the posterior wall of the stomach. Note that here the peritoneum forms the anterior wall of the lesser sac. At the greater curvature of the stomach, the peritoneum leaves the stomach, forming the posterior layer of the **gastrosplenic omentum** (ligament), and reaches the hilum of the spleen, here it is reflected backward to the posterior abdominal wall, forming the anterior layer of the **splenicorenal ligament**. The peritoneum now covers the anterior surface of the pancreas, the aorta, and the inferior vena cava, forming the posterior wall of the lesser sac. The peritoneum passes onto the anterior surface of the right kidney and sweeps around the lateral abdominal wall to reach the anterior abdominal wall. Note that the peritoneum forms a continuous layer around the abdomen.

On sagittal section of the abdomen and pelvis the parietal peritoneum can be traced upward to the left of the falciform ligament to reach the undersurface of the diaphragm. Here it is reflected onto the upper surface of the liver as the anterior layer of the **left triangular**

ligament. The visceral peritoneum then covers the anterior and inferior surfaces of the liver until it reaches the **porta hepatic**. Here the peritoneum passes to the lesser curvature of the stomach as the anterior layer of the lesser omentum. Having covered the anterior surface of the stomach, the peritoneum leaves the greater curvature forming the anterior layer of the greater omentum.

The greater omentum hangs downward as a fold in front of the coils of the intestine and contains within the lower part of the lesser sac. Having reached the lower limit of the greater omentum, the peritoneum folds upward and covers the posterior surface of the transverse colon and then leaves the colon to form the posterior layer of the **transverse mesocolon**. The peritoneum then passes to the anterior border of the pancreas and runs down ward anterior to the third part of the duodenum.

The peritoneum now leaves the posterior abdominal wall as the anterior layer of the **mesentery of the small intestine**. The visceral peritoneum covers the jejunum and then forms the posterior layer of the mesentery. On reaching the posterior abdominal wall, the peritoneum runs downward into the pelvis and covers the anterior surface of the upper part of the rectum. From here, it is reflected onto the posterior surface of the upper part of the vagina, forming the important **rectouterine pouch** (**pouch of Douglas**) in the male the peritoneum is reflected onto the upper part of the posterior surface of the bladder and the seminal vesicle, forming the **rectovesicle pouch**. The peritoneum passes over the upper surface of the uterus in the female and is reflected from its anterior surface onto the upper surface of the bladder leaving a pouch between the uterus and the bladder called the **uterovesicle pouch**. In both sexes the peritoneum passes from the bladder onto the anterior abdominal wall.

Nerve Supply of the Peritoneum

The **parietal peritoneum** is sensitive to pain, temperature, touch, and pressure. The parietal peritoneum lining the anterior abdominal wall is supplied by the lower six thoracic and first lumbar nerve, that is the same nerves that innervate the overlining muscles and skin. The central part of the diaphragmatic peritoneum is supplied by the phrenic nerves; peripherally, the diaphragmatic peritoneum is supplied by the lower six thoracic nerves. The parietal peritoneum of the pelvis is mainly supplied by the obturator nerve, a branch of the lumbar plexus.

The **visceral peritoneum** is sensitive only to stretch and tearing and is not sensitive to touch, pressure, or temperature. It is supplied by autonomic efferent nerves that supply the

viscera or traveling in the mesenteries. Overdistension of a viscus leads to the sensation of pain. The mesenteries of the small and large intestines are sensitive to mechanical stretching.

Function of the Peritoneum

The peritoneal fluid, which is pale yellow and somewhat viscid, contains leukocytes. It is secreted by the peritoneum and ensures that the mobile viscera glide easily on one another. The movements of the diaphragm and the abdominal muscles, together with the peristaltic movement result in continuous movement of the intraperitoneal fluid toward the diaphragm, and there it is quickly absorbed into the subperitoneal lymphatic capillaries.

The peritoneal coverings of the intestine tend to stick together in the presence of infection. The greater omentum may adhere to other peritoneal surfaces around a focus of infection. In this manner, many of the intraperitoneal infections are sealed off and remain localized.

The peritoneal folds play an important part in suspending the various organs within the peritoneal cavity and serve a means of conveying the blood vessels, lymphatics, and nerves to these organs.

Large amount of fat are stored in the peritoneal ligaments and mesenteries, and especially large amount can be found in the greater omentum.

Gastrointestinal tract

Esophagus (Abdominal Portion)

The esophagus is a muscular collapsible tube about 25 cm long that joins the pharynx to the stomach. The greater part of the esophagus lies within the thorax. The esophagus enters the abdomen through an opening in the right crus of the diaphragm. After a course of about 1.25 cm, it enters the stomach on its right side. The esophagus is related anteriorly to the posterior surface of the left lobe of the liver and posterior to the left crus of the diaphragm. The left and the right vagi lie on the anterior and posterior surfaces, respectively.

The esophagus conducts food from the pharynx into the stomach. Wavelike contractions of the muscular coat, called peristalsis, propel the food onward.

Branches from the left gastric artery supply the esophagus. These branches drain into the left gastric vein, a tributary of the portal vein. The esophagus is innervated by the anterior and posterior gastric nerves (vagi) and sympathetic branches of the thoracic part of the sympathetic trunk.

Gastroesophageal Sphincter

No anatomical sphincter exists at the lower end of the esophagus, however, the circular layer of smooth muscle in this region serves as a physiologic sphincter. As the food descends through the esophagus, relaxation of the muscle at the lower end occurs ahead of the peristaltic wave so that the food enters the stomach. The tonic contraction of this sphincter prevents the stomach content from regurgitating into the esophagus.

Stomach

The stomach is the dilated portion of the alimentary canal and has three main functions: (a) it stores food, in the adult it has a capacity of about 1500 ml., (b) it mixes the food with gastric secretions to form a semifluid **chyme**; and (c) it controls the rate of delivery of the chyme to the small intestine so that efficient digestion and absorption can take place.

The stomach is situated in the upper part of the abdomen, extending from beneath the left costal margin region into the epigastric and umbilical regions. Much of the stomach lies under cover of the lower ribs. It is roughly J shaped and has two openings, the **cardiac** and **pyloric orifices**; two curvatures, the **greater** and **lesser curvatures**; and two surfaces, an **anterior** and a **posterior surface**.

The stomach is relatively fixed at both ends but is very mobile in between. It tends to be high and transversely arranged in the short, obese person (steer-hom stomach) and elongated vertically in the tall, thin person (J-shaped stomach). Its shape undergoes considerable variation in the same person and depends on the volume of its contents, the position of the body, and the phase of the respiration.

The stomach is divided into the following parts: the **fundus** is dome-shaped and projects upward and to the left of the cardiac orifice. It is usually full of gas. The body extends from the level of the cardiac orifice to the level of **incisura angularis**, a constant notch in the lower part of the lesser curvature. The **pyloric antrum** extends from the incisura angularis to the pylorus. The **pylorus** is the tubular part of the stomach. It has a thick muscular wall called the **pyloric sphincter**. The cavity of the pylorus is the **pyloric canal**.

The **lesser curvature** forms the right border of the stomach and extends from the cardiac orifice to the pylorus. It is suspended from the liver by the lesser omentum. The **greater curvature** is much longer than the lesser curvature and extends from the left of the cardiac orifice, over the dome of the fundus, and along the left border of the stomach to the pylorus. The gastrosplenic omentum (ligament) extends from the upper part of the greater curvature to the spleen, and the greater omentum extends from the lower part of the greater curvature to the transverse colon.

The **cardiac orifice** is where the esophagus enters the stomach. Although no anatomic sphincter can be demonstrated here, a physiologic mechanism exists that prevents regurgitation of stomach content into the esophagus.

The **pyloric orifice** is formed by the **pyloric canal**, which is about 2.5 cm long. The circular muscle coat of the stomach is much thicker here and forms the anatomic and physiologic **pyloric sphincter**. The pylorus lies in the transpyloric plane, and its position can be recognized by a slight constriction on the surface of the stomach. The pyloric sphincter controls the rate of discharge of the stomach content into the duodenum.

The **mucous membrane** of the stomach is thick and vascular and is thrown into numerous folds, or **rugae**, that are mainly longitudinal in direction. The folds flatten out when the stomach is distended.

The muscular wall of the stomach contains (1) longitudinal fibers, (2) circular fibers, and (3) oblique fibers. The longitudinal fibers are the most superficial and are most concentrated along the curvatures. The inner circular fibers encircle the body of the stomach and are greatly thickened at the pylorus to form the pyloric sphincter. Few circular fibers are found in the region of the fundus. The oblique fibers form the inner muscle coat. They loop over the fundus and pass down along the anterior and posterior walls, running parallel with the lesser curvature.

The **peritoneum** (visceral peritoneum) completely surrounds the stomach. It leaves the lesser curvature as the lesser omentum and the greater curvature as the gastrosplenic omentum and the greater omentum.

The stomach is related anteriorly to the anterior abdominal wall, the left costal margin, the left pleura and lung, the diaphragm, and the left lobe of the liver. Posteriorly, it is related to the lesser sac, the diaphragm, the spleen, the left suprarenal gland, the upper part of the left kidney, the splenic artery, the pancreas, the transverse mesocolon, and the transverse colon.

Blood Supply of the Stomach

The arterial blood supply of the stomach is derived from the branches of the celiac artery (a branch of the abdominal aorta).

The **left gastric artery** arises from the celiac artery. It passes upward and to the left to reach the esophagus and then descends along the lesser curvature of the stomach. It supplies the lower third of the esophagus and the upper right part of the stomach.

The **right gastric artery** arises from the hepatic artery at the upper border of the pylorus and runs to the left along the lesser curvature. It supplies the lower right part of the stomach.

The **short gastric arteries** arise from the splenic artery at the hilum of the spleen and pass forward in the gastrosplenic omentum to supply the fundus.

The **left gastroepiploic artery** arises from the splenic artery at the hilum of the spleen and passes forward in the gastrosplenic omentum to supply the stomach along the upper part of the greater curvature.

The **right gastroepiploic** artery arises from the gastroduodenal branch of the hepatic artery. It passes to the left and supplies the stomach along the lower part of the greater curvature.

These arteries drain into the portal circulation. The **left** and **right gastric veins** drain directly into the portal vein. The **short gastric veins** and the **left gastroepiploic veins** join the splenic vein. The **right gastroepiploic** vein joins the superior mesenteric vein.

The lymph vessels follow the arteries into the left and right gastric nodes, the left and right gastroepiploic nodes, and the short gastric nodes. All lymph from the stomach eventually passes to the celiac node located around the root of the celiac artery on the posterior abdominal wall.

Nerve Supply

This includes sympathetic fibers derived from the celiac plexus and parasympathetic fibers from the right and left vagus.

The **anterior vagal trunk**, which is formed in the thorax mainly from the left vagus nerve, enters the abdomen on the anterior surface of the esophagus. The trunk which may be single or multiple, then divides into branches that supply the anterior surface of the stomach. A large hepatic branch passes up to the liver, and from this a pyloric branch passes down to the pylorus.

The **posterior vagal trunk**, which is formed in the thorax mainly from the right vagus nerve, enters the abdomen on the posterior surface of the esophagus. The trunk is then divides into branches that supply mainly the posterior surface of the stomach. A large branch passes to the celiac and superior mesenteric plexuses and is distributed to the intestine as far as the splenic flexure and to the pancreas.

The sympathetic innervation of the stomach carries a proportion of pain-transmitting nerve fibers, whereas the parasympathetic vagal fibers are secretomotor to the gastric glands and motor to the muscular wall of the stomach. The pyloric sphincter receives motor fibers from the sympathetic system and inhibitory fibers from the vagus.

Small Intestine

The small intestine is the longest part of the alimentary canal and extends from the pylorus of the stomach to the ileocecal junction. The greater part of the digestion and food absorption takes place in the small intestine. It is divided into three parts: the duodenum, the jejunum, and the ileum.

Duodenum

The duodenum is a C-shaped tube about 25 cm long that joins the stomach to the jejunum. It is important because it receives the openings of the bile and pancreatic ducts. The duodenum curves around the head of the pancreas. The first 2.5 cm of the duodenum resembles the stomach in that it is covered on its anterior and posterior surfaces with peritoneum and has the lesser omentum attached to its upper border and the greater omentum attached to its lower border, the lesser sac lies behind this short segment. The remainder of the duodenum is retroperitoneal, being only partially covered by the peritoneum.

Parts of the Duodenum

The duodenum is situated in the epigastric and umbilical regions and for the purpose of description is divided into four parts.

First part of the duodenum the first part of the duodenum is 5 cm long and begins at the pylorus and runs upward and backward on the right side of the first lumbar vertebra. It thus lies on the transpyloric plane.

Anteriorly, it is related to the quadrate lobe of the liver and the gall bladder. Posteriorly, it is related to the lesser sac, the gastroduodenal artery, the bile duct, the postal vein, and the inferior vena cava. Superiorly, it is related to the entrance into the lesser sac. Inferiorly, it is related to the head of the pancreas.

Second part of the duodenum the second part of the duodenum is 8 cm long and runs vertically downward in front of the hilum of the right kidney on the right side of the second and third lumbar vertebrae. About halfway down its medial border, the bile duct and the main pancreatic duct pierce the duodenal wall. They unite to form the ampulla that opens on the summit of the **major duodenal papilla**. The accessory pancreatic duct, if present, opens into the duodenum a little higher up on the **minor duodenal papilla**.

Anteriorly, it is related to the fundus of the gall bladder and the right lobe of the liver, the transverse colon, and the coils of the small intestine. Posteriorly, it is related to the hilum of the right kidney, and the right ureter. Laterally, it is related to the ascending part of the colon, the right colic flexure, and the right lobe of the liver. Medially, it is related to the head of the pancreas, the bile duct, and the main pancreatic duct.

Third part of the duodenum the third part of the duodenum is 8 cm long and runs horizontally to the left on the subcostal plane, passing in front of the vertebral column and following the lower margin of the head of the pancreas.

Anteriorly, it is related to the root of the mesentery of the small intestine, the superior mesenteric vessels contained within it, and the coils of the jejunum. Posteriorly, it is related to the right ureter, the right psoas muscle, the inferior vena cava, and the aorta. Superiorly it is related to the head of the pancreas and inferiorly to the coils of the jejunum.

Fourth part of the duodenum the fourth part of the duodenum is 5 cm long and runs upward and to the left to the duodenojejunal flexure. The flexure is held in position by a peritoneal fold, the ligament of Treitz, which is attached to the right crus of the diaphragm.

It is rlated anteriorly to the beginning of the root of the mesentery and the coils of the jejunum. Posteriorly, it is to the left margin of the aorta and the left psoas muscle.

Mucous Membrane and Duodenal Papillae

The mucous membrane of the duodenum is thick. In the first part of the duodenum it is smooth. In the remainder of the duodenum it is thrown into numerous circular folds called **plicae circulares**. At the site where the bile duct and the main pancreatic duct pierce the medial wall of the second part is a small rounded elevation called major duodenal papilla. The accessory pancreatic duct, if present, opens into the duodenum on a smaller papilla about 1.9 cm above the major duodenal papilla.

Blood Supply

Arteries the upper half is supplied by the superior pancreaticoduodenal artery, a branch of the gastroduodenal artery. The lower half is supplied by the inferior pancreaticoduodenal artery, a branch of the superior mesenteric artery.

Veins the superior pancreaticoduodenal vein drains into the portal vein; the inferior vein joins the superior mesenteric vein.

Lymph vessels the lymph vessels follow the arteries and drain (a) upward via pancreaticoduodenal nodes to the gastroduodenal nodes and then to the celiac nodes and (b) downward via pancreaticoduodenal nodes to the superior mesenteric nodes around the origin of the superior mesenteric artery,

Nerve Supply

The nerves are derived from the sympathetic and parasympathetic (vagus) nerves from the celiac and superior mesenteric plexuses.

Jejunum and Ileum

The jejunum and ileum measure about 6 m long. The upper two-fifth of this length being the jejunum. Each has distinctive feature, but there is a gradual change from one to the other. The jejunum begins at the duodenojejunal flexure, and the ileum ends at the ileocecal junction.

The coils of jejunum and ileum are freely mobile and are attached to the posterior abdominal wall by a fan-shaped fold of peritoneum known as the **mesentery of the small intestine**. The long free edge of the fold encloses the mobile intestine. The short root of the fold is continuous with the parietal peritoneum on the posterior abdominal wall that extends downward and to the right of the second lumbar vertebra to the region of the right sacroiliac joint. The root of the mesentery permits the entrance and exit of the branches of the superior mesenteric artery and vein, lymph vessels, and nerves into the space between the two layers of the peritoneum forming the mesentery.

The living jejunum can be distinguished from the ileum by the following features:

1. The jejunum lies coiled in the upper part of the peritoneal cavity below the left side of the transverse mesocolon; the ileum is in the lower part of the cavity and in the pelvis.
2. The jejunum is wider broad, thicker walled, and redder than the ileum. The jejunal wall feels thicker because the permanent infoldings of the mucous membrane, the plicae circulares, are larger, more numerous, and closely set in the jejunum, whereas in the upper part of the ileum they are smaller and more widely separated and in the lower part they are absent.

3. The jejunal mesenteric vessels form only one or two arcades, with long and infrequent branches passing to the intestine wall. The ileum receives numerous short terminal vessels that arise from a series of three or four or even more arcades.
4. Aggregations of lymphoid tissue (Peyer's patches) are present in the mucous membrane of the lower ileum along the antimesenteric border. In the living these may be visible through the wall of the ileum from the outside.

Blood Supply

Arteries The arterial supply is from branches of the superior mesenteric artery. The intestinal branches arise from the left side of the artery and run in the mesentery to reach the gut. They anastomose with one another to form a series of arcades. The lower part of the ileum is also supplied by the ileocolic artery.

Veins the veins correspond to the branches of the superior mesenteric artery and drain into the superior mesenteric vein.

Lymph Drainage

The lymph vessels pass through many intermediate mesenteric nodes and finally reach the superior mesenteric nodes, which are situated around the origin of the superior mesenteric artery.

Nerve supply

The nerves are derived from the sympathetic and parasympathetic (vagus) nerve from the superior mesenteric plexus.

Large Intestine

The large intestine extends from the ileum to the anus. It is divided into the cecum, appendix, ascending colon, transverse colon, descending colon, sigmoid colon, rectum and anal canal. The rectum and the anal canal are studied with the structures of the pelvis and the perineum. The primary function of the large intestine is the absorption of water and electrolytes and the storage of undigested material until it can be expelled from the body as feces.

Cecum

The cecum is that part of the large intestine that lies below the level of the junction of the ileum with the large intestine. It is a blind-ended pouch that is situated in the right iliac fossa. It is about 6 cm long and is completely covered with peritoneum. It posses a considerable amount of mobility, although it does not have a mesentery. Attached to its posteromedial surface is the appendix. The presence of peritoneal folds in the vicinity of the cecum creates the superior ileocecal, the inferior ileocecal, and the retrocecal recesses.

As in the colon, the longitudinal muscle is restricted to three flat bands, the **teniae coli**, which converge on the base of the appendix and provide for it a complete longitudinal muscle coat. The cecum is often distended with gas and can then be palpated through the anterior abdominal wall in the living patient.

The terminal part of the ileum enters the large intestine at the junction of the cecum with the ascending colon. The opening is provided with two folds, or lips, which form the so called ileocecal valve. The appendix communicates with the cavity of the cecum through an opening located below and behind the ileocecal opening.

Anteriorly the cecum is related to the coils of the small intestine, sometimes part of the greater omentum, and the anterior abdominal wall in the right iliac region. Posteriorly, it is related to the psoas and the iliacus muscles, and the femoral nerve. The appendix is commonly found behind the cecum. Medially, the appendix arises from the cecum on its medial side.

Blood supply

Arteries Anterior and posterior cecal arteries from the ileocolic artery, a branch of the superior mesenteric artery.

Veins The veins correspond to the arteries and drain into the superior mesenteric vein.

Lymph drainage

The lymph vessels pass through several mesenteric nodes and finally reach the superior mesenteric nodes.

Nerve Supply

Branches from the sympathetic and parasympathetic (vagus) nerves from the superior mesenteric plexus.

Ileocecal valve

A rudimentary structure, the ileocecal valve consists of two horizontal folds of mucous membrane that project around the orifice of the ileum. The valve plays little or no part in the prevention of reflex of cecal contents into the ileum. The circular muscle of the lower end of the ileum, called ileocecal sphincter, serve as a sphincter and control the flow of contents from the ileum into the colon. The smooth muscle tone is reflexly increased when the cecum is distended; the hormone **gastrin**, which is produced by the stomach, causes relaxation of the muscle tone.

Appendix

The appendix is a narrow, muscular tube containing a large amount of lymphoid tissue. It varies in length from 8-13 cm. the base is attached to the posteromedial surface of the cecum about 2.5 cm below the ileocecal junction. The remainder of the appendix is free. It has a complete peritoneal covering, which is attached to the lower layer of the mesentery of the small intestine by a short mesentery of its own, the **mesoappendix**. The mesoappendix contains the appendicular vessels and nerves.

The appendix lies in the right iliac fossa, and in relation to the anterior abdominal wall. Its base is situated one-third of the way up the line joining the right anterior superior iliac spine to the umbilicus.

Blood Supply

Arteries The appendicular artery is a branch of the posterior cecal artery. It passes to the tip of the appendix in the mesoappendix.

Veins The appendicuar vein drains into the posterior cecal vein.

Lymph Drainage

The lymph vessels drain into one or two nodes lying in the mesoappendix and then eventually into the superior mesenteric nodes.

Nerve Supply

The nerves are derived from the sympathetic and parasympathetic (vagus) nerves from the superior mesenteric plexus. Afferent nerve fibers concerned with the condition of visceral

pain from the appendix accompany the sympathetic nerves and enter the spinal cord at the level of the tenth thoracic segment.

Ascending Colon

The ascending colon is about 13 cm and lies in the right lower quadrant. It extends upward from the cecum to the inferior surface of the right lobe of the liver, where it turns to the left, forming the **right colic flexure**, and becomes continuous with the transverse colon. The peritoneum covers the front and the sides of the ascending colon, binding it to the posterior abdominal wall.

Anteriorly, the ascending colon is related to the coils of small intestine, the greater omentum, and the anterior abdominal wall. Posteriorly, it is related to the iliacus, the iliac crest, the quadratus lumborum, the origin of the transverse abdominis muscle, and the lower pole of the right kidney. The iliohypogastric and the ilioinguinal nerves cross behind it.

Blood supply

Arteries the ileocolic and right colic branches of the superior mesenteric artery.

Veins the veins correspond to the arteries and drain into the superior mesenteric vein.

Lymph Drainage

The lymph vessels drain into lymph nodes lying along the course of the colic blood vessels and ultimately reach the superior mesenteric node.

Nerve supply

Sympathetic and parasympathetic (vagus) nerve from the superior mesenteric plexus.

Transverse Colon

The transverse colon is about 38 cm long and extends across the abdomen, occupying the umbilical region. It begins at the right colic flexure below the right lobe of the liver, and hangs downward, suspended by the transverse mesocolon from the pancreas. It then ascends to the l**eft colic flexure** below the spleen. The left colic flexure is higher than the right colic flexure and is suspended from the diaphragm by the **phrenicocolic ligament**.

The transverse mesocolon, or mesentery of the transverse colon, suspends the transverse colon from the anterior border of the pancreas. The mesentery is attached to the superior

border of the transverse colon, and the posterior layers of the greater omentum are attached to the inferior border. Because of the length of the transverse mesocolon, the position of the transverse colon is extremely variable and may sometimes reach down as far as the pelvis.

Anteriorly, the transverse colon is related to the greater omentum and the abdominal wall. Posteriorly, it is related to the second part of the duodenum, the head of the pancreas, and the coils of the jejunum and ileum.

Blood supply

Arteries the proximal two-thirds is supplied by the middle colic artery, a branch of the superior mesenteric artery. The distal third is supplied by the left colic artery, a branch of the inferior mesenteric artery.

Veins the veins correspond to the arteries and drain into the superior and inferior mesenteric veins.

Lymph Drainage

The proximal two-thirds drains into the colic nodes and then into the superior mesenteric nodes; the distal third drains into the colic nodes and then into the inferior mesenteric nodes.

Nerve Supply

The proximal two-thirds is innervated by sympathetic and vagal nerves through the superior mesenteric plexus; the distal third is innervated by sympathetic and parasympathetic pelvic splanchnic nerves through the inferior mesenteric plexus.

Descending Colon

The descending colon is about 25 cm long and lies in the left upper and lower quadrants. It extends downward from the left colic flexure, to the pelvic brim, where it becomes continuous with the sigmoid colon. The peritoneum covers the front and the sides and binds it to the posterior abdominal wall.

Anteriorly, the descending colon is related to the coils of the small intestine, the greater omentum, and the anterior abdominal wall. Posteriorly, it is related to the lateral border of the left kidney, the origin of the transversus abdominis muscle, the quadratus lumborum, the iliac

crest, the iliacus, and the left psoas muscle. The iliohypogastric, and the ilioingunal nerves, the lateral cutaneous nerve of the thigh, and the femoral nerve also lie posteriorly.

Blood supply

Arteries the left colic and the sigmoid branches of the inferior mesenteric artery.

Veins the veins correspond to the arteries and drain into the inferior mesenteric vein.

Lymph Drainage

Colic lymph nodes and the inferior mesenteric nodes around the origin of the inferior mesenteric artery.

Nerve Supply

Sympathetic and parasympathetic pelvic splanchnic plexus nerves through the inferior mesenteric plexus.

Blood Supply of the Gastrointestinal tract

Arterial Supply

The celiac artery is the artery of the foregut and supplies the gastrointestinal tract from the lower one-third of the esophagus down as far as the middle of the second part of the duodenum. The superior mesenteric artery is the artery of the midgut and supplies the gastrointestinal tract from the middle of the second part of the duodenum as far as the distal one-third of the transverse colon. The inferior mesenteric artery is the artery of the hindgut and supplies the large intestine from the distal one-third of the transverse colon to halfway down the anal canal.

Celiac Artery

The celiac artery or trunk is very short and arises from the commencement of the abdominal aorta at the level of the twelfth thoracic vertebra. It is surrounded by the celiac plexus and lies behind the lesser sac of peritoneum. It has three terminal branches: the left gastric, splenic, and hepatic arteries.

Left Gastric Artery The left gastric artery runs to the cardiac end of the stomach, gives off a few esophageal branches, then turns to the right along the lesser curvature of the stomach. It anastomoses with the right gastric artery.

Splenic Artery The large splenic artery runs to the left in a wavy course along the upper border of the pancreas and behind the stomach. On reaching the left kidney the artery enters the splenicorenal ligament and runs to the hilum of the spleen.

Branches of the Splenic Artery

1. **Pancreatic branches**.
2. The **left gastroepiploic artery** arises near the hilum of the spleen and reaches the greater curvature of the stomach in the gastrosplenic omentum. It passes to the right along the greater curvature of the stomach between the layers of the greater omentum. It anastomoses with the right gastroepiploic artery.
3. The **short gastric arteries**, five or six in number, arise from the end of the splenic artery and reach the fundus of the stomach in the gastrosplenic omentum. They anastomos with left gastric artery and the left gastroepiploic artery.

Hepatic Artery The medium-sized hepatic artery runs forward and to the right and then ascends between the layers of the lesser omentum. It lies in front of the opening into the lesser sac and is placed to the left of the bile duct and in front of the portal vein. At the porta hepatis it divides into right and left branches to supply the corresponding lobes of the liver.

Branches of the Hepatic Artery

1. The **right gastric artery** arises from the hepatic artery at the upper border of the pylorus and runs to left in the lesser omentum along the lesser curvature of the stomach. It anastomoses with the left gastric artery.
2. The **gastroduodenal artery** is a large branch that descends behind the first part of the duodenum. It divides into **right gastroepiploic artery** that runs along the greater curvature of the stomach between the layers of the greater omentum and the **superior pancreaticoduodenal artery** that descends between the second part of the duodenum and the head of the pancreas.

3. The **right** and **left hepatic arteries** that enter the porta hepatis. The right hepatic artery usually gives off the **cystic artery**, which runs to the neck of the gallbladder.

Superior Mesenteric Artery

The superior mesenteric artery supplies the distal end of the duodenum, the jejunum, the ileum, the cecum, the appendix, the ascending colon, and the most of the transverse colon. it arises from the front of the abdominal aorta just below the celiac artery and runs downward and to the right behind the neck of the pancreas and in front of the third part of the duodenum. It continues downward to the right between the layers of the mesentery of the small intestine and ends by anastomosing with the ileal branch of its own ileocolic branch.

Branches of the Superior Mesenteric Artery

1. The **inferior pancreaticoduodenal artery** passes to the right as a single or double branch along the upper border of the third part of the duodenum and the head of the pancreas. It supplies the pancreas and the adjoining part of the duodenum.
2. The **middle colic artery** runs forward in the transverse mesocolon to supply the transverse colon and divides into right and left branches.
3. The **right colic artery** is often a branch of the ileocolic artery. It passes to the right to supply the ascending colon and divides to ascending and descending branches.
4. The **Ileocolic artery** passes downward and to the right. It gives rise to a **superior branch** that anastomoses with the right colic artery and an **inferior branch** that anastomoses with the end of the superior mesenteric artery. The inferior branch gives rise to the **anterior** and **posterior cecal arteries**; the **appendicular artery** is a branch of the posterior cecal artery.
5. **Jejunal and ileal branches**. These branches are 12 to 15 in number and rise from the left side of the superior mesenteric artery. Each artery divides into two vessels, which unite with adjacent branches to form a series of arcades. Branches from the arcades divide and unite to form a second, third, and fourth series of arcades. Fewer arcades supply the jejunum compared with the ileum. From the terminal arcades, small straight vessels supply the intestine.

Inferior Mesenteric Artery

The inferior mesenteric artery supplies the distal third of the transverse colon, the left colic flexure, the descending colon, the sigmoid colon, the rectum, and the upper half of the anal

canal. It arises from the abdominal aorta about 3.8 cm above the bifurcation. The artery runs downward and to the left and crosses the left common iliac artery. Here, it changes its name and become the superior rectal artery.

Branches of the Inferior Mesenteric Artery

1. The **left colic artery** runs upward and to the left and supplies the distal third of the transverse colon, the left colic flexure, and the upper part of the descending colon. It divides into ascending and descending branches.
2. The **sigmoid arteries** are two or three in number and supply the descending and sigmoid colon.
3. The **superior rectal artery** is a continuation of the inferior mesenteric artery as it crosses the left common iliac artery. It descends into the pelvis behind the rectum. The artery supplies the rectum and upper half of the anal canal and anastomoses with the middle rectal and inferior rectal arteries.

Marginal Artery

The anastomoses of the colic arteries around the concave margin of the large intestine form a single arterial trunk called the marginal artery. This begins at the ileocecal junction, where it anastomoses with the ileal branches of the superior mesenteric artery, and it ends where it anastomoses less freely with the superior rectal artery.

Venous Drainage

The venous blood from the greater part of the gastrointestinal tract and its accessory organs drains to the liver by the portal venous system.

The proximal tributaries drain into the portal vein, but the veins forming the distal tributaries corresponds to the branches of the celiac artery and the superior and inferior mesenteric arteries.

Portal Vein

This important vein drains blood from the abdominal part of the gastrointestinal tract from the lower third of the esophagus to halfway down the anal canal. It also drains blood from the spleen, pancreas, and gall bladder. The portal vein enters the liver and breaks up into sinusoids, from which the blood passes into the hepatic veins that join the inferior vena cava.

The portal vein is about 5 cm long and is formed behind the neck of the pancreas by the union of the superior mesenteric and splenic veins. It ascends to enter the lesser omentum. It then runs upward in front the opening into the lesser sac to the porta hepatis, where it divides into right and left terminal branches.

The portal circulation begins as a capillary in the organs it drains and ends by emptying its blood into sinusoids within the liver.

The tributaries of the portal vein are the splenic vein, superior mesenteric vein, left gastric vein, right gastric vein, and cystic vein.

1. **Splenic vein**. This vein leaves the hilum of the spleen and passes to the right in the splincorenal ligament lying below the splenic artery. It unites with the superior mesenteric vein behind the neck of the pancreas to form the portal vein. It receives the short gastric, left gastroepiploic, inferior mesenteric, and pancreatic veins.
2. **Inferior mesenteric vein**. This vein ascends on the posterior abdominal wall and joins the splenic vein behind the body of the pancreas. It receives the superior rectal veins, the sigmoid veins, and the left colic vein.
3. **Superior mesenteric vein**. This vein ascends in the root of the mesentery of the small intestine. It passes in front the third part of the duodenum and joins the splenic vein behind the neck of the pancreas. It receives the jejunal, ileal, ileocolic, right colic, middle colic, inferior pancreaticoduodenal, and right gasroepiploic veins.
4. **Left gastric vein**. This vein drains left portion of the lesser curvature of the stomach and the distal part of the esophagus. It opens directly into the portal vein.
5. **Right gastric vein**. This vein drains the right portion of the lesser curvature of the stomach and drains directly into the portal vein.
6. **Cystic veins**. These veins either drain the gallbladder directly into the liver or join the portal vein.

Accessory Organs of the Gastrointestinal Tract

Liver

The liver is the largest gland in the body and has a wide variety of functions. Three of its basic functions are (1) production and secretion of bile, which is passed into the intestinal tract; (2) involvement in many metabolic activities related to carbohydrate, fat, and protein metabolism; and (3) filtration of blood, removing bacteria and other foreign particles that have gain entrance to the blood from the lumen of the intestine.

The liver is soft and pliable and occupies the upper part of the abdominal cavity just beneath the diaphragm. The major part of the liver is situated under cover of the right costal margin. The posteroinferior, or **visceral surface**, is molded to the adjacent viscera and is therefore irregular in shape; it lies in contact with the abdominal part of the esophagus, the stomach, the duodenum, the right colic flexure, the right kidney and suprarenal gland, and the gall bladder.

The liver may be divided into a large **right lobe** and a small **left lobe** by the attachment of the falciform ligament. The right lobe is further divided into a **quadrate** and a **caudate** lobe by the presence of the gall bladder, the fissure for the legamentum teres, the inferior vena cava, and the fissure for the ligamentum venosum. Experiments have shown that, in fact, the quadrate and caudate lobes are a functional part of the left lobe of the liver. Thus, the right and left branches of the hepatic artery and portal vein, and the right and left hepatic ducts, are distributed to the right lobe and to the left lobe (plus quadrate plus caudate lobe) respectively.

The **porta hepatis**, or **hilum** of the liver, is found on the posteroinferior surface and lies between the caudate and quadrate lobes. The upper part of the free edge of the lesser omentum is attached to its margins. In it lie the right and left hepatic ducts, the right and left branches of the hepatic artery, the portal vein, and sympathetic and parasympathetic nerve fibers. A few hepatic lymph nodes lie here; they drain the liver and the gall bladder into the celiac lymph node.

The liver is completely surrounded by a fibrous capsule but only partially covered by peritoneum. The liver is made up of **liver lobules**. The **central vein** of each lobule is a tributary of the hepatic veins. In the space between the lobules are the **portal canal**, which contains branches of the hepatic artery, portal vein, and a tributary of a bile duct (portal triad). The arterial and venous blood passes between the liver cells by means of **sinusoids** and drains into the central vein.

Anteriorly, the liver is related to the diaphragm, the right and left costal margins, right and left pleura, the lower margins of both lungs, xiphoid process, and anterior abdominal wall in subcostal angle. Posteriorly, it is related diaphragm, right kidney, hepatic flexure of the colon, duodenum, gall bladder, inferior vena cava, and esophagus and fundus of the stomach.

Peritoneal Ligaments of the Liver

The **falciform ligament**, which is a two-layered fold of the peritoneum, ascends from the umbilicus to the liver. It has a sickle-shaped free margin that contains the ligamentum teres, the remains of the umbilical vein. The falciform ligament passes onto the anterior and then

the superior surfaces of the liver and then splits into two layers. The right layer forms the upper layer of the **coronary ligament**; the left layer forms the upper layer of the **left triangular ligament**. The right extremity of the coronary ligament is known as the **right triangular ligament** of the liver. The peritoneal layers forming the coronary ligament are widely separated, leaving an area of liver devoid of peritoneum. Such an area is referred to as a "**bare**" **area of the liver**.

The **ligamentum teres** passes into a fissure on the visceral surface of the liver and joins the left branch of the portal vein in the portal hepatis. The **ligamentum venosum**, a fibrous band that is the remains of the **ductus venosus**, is attached to the left branch of the portal vein and ascends in a fissure on the visceral surface of the liver to be attached above to the inferior vena cava. In fetus, oxygenated blood is brought to the liver in the umbilical vein (ligamentum teres). The greater proportion of blood bypasses the liver in the ductus venosus (ligamentum venosum) and joins the inferior vena cava. At birth, the umbilical vein and ductus venosus close and become fibrous cords.

The **lesser omentum** arises from the edges of the porta hepatis and the fissure the ligamentum venosum and passes down to the lesser curvature of the stomach.

Blood supply

Arteries

The hepatic artery, a branch of the celiac artery, divides into the right and left terminal branches that enter the porta hepatis.

Veins

The portal vein divides into right and left terminal branches that enter the porta hepatic behind the arteries. The hepatic veins (three or more) emerge from the posterior surface of the liver and drain into the inferior vena cava.

Blood Circulation Through the Liver

The blood vessels conveying blood to the liver are the hepatic artery (30%) and portal vein (70%). The hepatic artery brings oxygenated blood to the liver, and the portal vein brings venous blood rich in the product of digestion, which has been absorbed from the gastrointestinal tract. The arterial and venous blood is conducted to the central vein of each liver lobule by the liver sinusoids. The central veins drain into the right and left hepatic veins, and leave the posterior surface of the liver and open directly into the inferior vena cava.

Lymph Drainage

The liver produces a large amount of lymph (about one-third to one-half of all body lymph). The lymph vessels leave the liver and enter several lymph nodes in the porta hepatis. The efferent vessels pass to celiac nodes. A few vessels pass from the bare area of the liver through the diaphragm to the posterior mediastinal lymph nodes.

Nerve Supply

Sympathetic and parasympathetic nerves from the celiac plexus. The anterior vagal trunk gives rise to a large hepatic branch, which passes directly to the liver.

Bile Ducts of the Liver

Bile is secreted by the liver cells, stored, and concentrated in the gall bladder, later is delivered to the duodenum. The bile ducts of the liver consist of the **right** and **left hepatic ducts**, the **common hepatic duct**, the **bile duct**, the **gall bladder**, and the **cystic duct**.

The smallest part of the bile ducts is the bile canaliculi, which are situated between the liver cells. The bile canaliculi form the interlobular ducts in the portal canal of the liver. The interlobular ducts join one another to form the progressive larger ducts and, eventually at the porta hepatis, form the right and left hepatic ducts. The right hepatic duct drains the right lobe of the liver and the left duct drains the left lobe, caudate lobe, and quadrate lobes.

After a short course the right and left hepatic ducts unite to form the common hepatic duct. The **common hepatic duct** is about 4 cm long and descends within the free margin of the lesser omentum. It is joined on the right side by the cystic duct from the gall bladder to form the bile duct.

The bile duct is about 8 cm long. In the first part of its course it lies in the right free margin of the lesser omentum in front of the opening into the lesser sac. Here it lies in front of the portal vein and to the right of the hepatic artery. In the second part of its course it is situated behind the first part of the duodenum. In the third part of its course it lies in a groove on the posterior surface of the head of the pancreas. Here, the bile duct comes in contact with the main pancreatic duct.

The bile duct ends below by piercing the medial wall of the second part of the duodenum about halfway down its length. It is usually joined by the main pancreatic duct, and together they open into a small ampulla in the duodenal wall, called the **ampulla of Vater**. The ampulla opens into the lumen of the duodenum by means of a small papilla, the major

duodenal papilla. The terminal parts of both ducts and the ampulla are surrounded by circular muscle, known as the **sphincter of Oddi**. Occasionally, the bile and the pancreatic ducts open separately into the duodenum.

Gall Bladder

The gall bladder is pear-shaped sac lying on the undersurface of the liver. It has a capacity of about 30 to 50 mL and stores bile, which it concentrates by absorbing water. For descriptive purposes the gall bladder is divided in to the fundus, body, and neck. The **fundus** is rounded and usually projects below the inferior margin of the liver, where it comes in contact with the anterior abdominal wall at the level of the tip of the ninth right costal cartilage. The **body** lies in contact with the visceral surface of the liver and is directed upward, backward and to the left. The **neck** becomes continuous with the cystic duct, which turns into the lesser omentum to join the common hepatic duct, to form the bile duct.

The peritoneum completely surrounds the fundus of the gall bladder and binds the body and neck to the visceral surface of the liver.

The gall bladder is related anteriorly to the anterior abdominal wall and the inferior surface of the liver, and posteriorly to the transverse colon and the first and second parts of the duodenum.

Function

The gall bladder serves as a reservoir for bile. It has the ability to concentrate the bile, and to aid this process the mucous membrane is thrown into permanent folds that unit with each other, giving the surface a honeycombed appearance. The columnar cells lining the surface also have numerous microvilli on their free surface.

Bile is delivered to the duodenum as the result of contraction and partial emptying of the gall bladder. This mechanism is initiated by the entrance of fatty foods into the duodenum. The fat causes release of the hormone **cholecystokinin** from the mucous membrane of the duodenum; the hormone then enters the blood, causing the gall bladder to contract. At the same time the smooth muscle around the distal end of the bile duct and the ampulla is relaxed, thus allowing the passage of concentrated bile into the duodenum. The bile salts in the bile are important in emulsifying the fat in the intestine and assist with digestion and absorption.

Blood Supply

Arteries Cystic artery, a branch of the right hepatic artery.

Veins the cystic vein drains directly into the portal vein. Several small arteries and veins also run between the liver and the gall bladder.

Lymph Drainage

The lymph drains into a cystic lymph node situated near the neck of the gall bladder. From here the lymph vessels pass to the hepatic nodes along the course of the hepatic artery and then to the celiac nodes.

Nerve Supply

Sympathetic and parasympathetic vagal fibers from the celiac plexus. The gall bladder contracts in response to the hormone cholecystokinin, which is produced by the mucous membrane of the duodenum on the arrival of fatty food from the stomach.

Pancreas

The pancreas is both an exocrine and an endocrine gland. The exocrine portion of the gland produces a secretion that contains enzyme capable of hydrolyzing protein, fat, and carbohydrates. The endocrine portion of the gland, the **islets of Langerhans**, produces the hormones **insulin** and glycagon, which play a key role in carbohydrates metabolism.

The pancreas is an elongated structure that lies in the epigastrium and the left upper quadrant. It is soft and lobulated and situated on the posterior abdominal wall behind the peritoneum. It crosses the transpyloric plane. The pancreas is divided into a head, neck, body, and tail.

The **head** of the pancreas is a disc shaped and lies within the concavity of the duodenum. A part of the head extends to the left behind the superior mesenteric vessels and is called the **uncinate process**.

The **neck** is the constricted portion of the pancreas and connects the head to the body. It lies in front of the beginning of the portal vein and the origin of the superior mesenteric artery from the aorta.

The **body** runs upward and to the left across the midline. It is somewhat triangular in cross section.

The **tail** passes forward in the splenicorenal ligament and comes in contact with the hilum of the spleen.

Anteriorely, the gland is related from right to the left by the transverse colon and the attachment of the transverse mesocolon, the lesser sac, and the stomach. **Posteriorly**, the gland is related from right to left by the bile duct, the portal and splenic veins, the inferior vena cava, the aorta, the origin of the superior mesenteric artery, the psoas muscle, the left suprarenal gland, the left kidney, and the hilum of the spleen.

Pancreatic Duct

The **main duct of the pancreas** begins in the tail and runs the length of the gland. Receiving numerous tributaries on the way. It opens into the second part of the duodenum at about its middle with the bile duct on the major duodenal papilla. Sometimes the main duct drains separately into the duodenum.

The **accessory duct** of the pancreas, when present, drain the upper part of the head and then opens into the duodenum a short distance above the main duct on the minor duodenal papilla. The accessory duct frequently communicates with the main duct.

Spleen

The spleen is reddish and is the largest single mass of lymphoid tissue in the body. It is oval shaped and has a notched anterior border. It lies just beneath the left half of the diaphragm close to the ninth, tenth, and eleventh ribs. The long axis lies along the shaft of the tenth rib.

The spleen is surrounded by peritoneum, which passes from it at the hilum as the gastrosplenic omentum (ligament) to the greater curvature of the stomach (carrying the short gastric and left gastroepiploic vessels). The peritoneum also passes to the left kidney as the splenicorenal ligament (carrying the splenic vessels and the tail of the pancreas).

Anteriorly, the spleen is related to the stomach, the tail of the pancreas, and the left colic flexure. The left kidney les along its medial border. Posteriorly, it is related to the diaphragm; the left pleura, the left lung, and the ninth, tenth, and eleventh ribs.

Blood Supply

Arteries

Large splenic artery, which is the largest branch of the celiac artery. It has a tortuous course as it runs along the upper border of the pancreas. The splenic artery then divides into about six branches, which enter the spleen at the hilum.

Veins

The splenic vein leaves the hilum and runs behind the tail and the body of the pancreas. Behind the neck of the pancreas the splenic vein joins the superior mesenteric vein to form the portal vein.

Lymph Drainage

The lymph vessels emerge from the hilum and pass through a few lymph nodes along the course of the splenic artery and then drain into the celiac nodes.

Nerve Supply

The nerve supplies accompany the splenic artery and are derived from the celiac plexus.

Retroperitoneal Space

The retroperitoneal space lies on the posterior abdominal wall behind the parietal peritoneum. It extends from the twelfth thoracic vertebra and the twelfth rib to the sacrum and the iliac crest below.

The floor or posterior wall of the space is formed from medial to lateral by the psoas and quadratus lumborum muscles and the origin of the transversus abdominis muscle. Each of these muscles is covered on the anterior surface by a definite layer of fascia. In front of the fascial layers is a variable amount of fatty tissue that forms a bed for the suprarenal glands, the kidneys, the ascending and descending parts of the colon, and the duodenum. The retroperitoneal space also contains the ureters and the renal and gonadal blood vessels.

Urinary Tract

Kidneys

The two kidneys function to excrete most waste products of metabolism. They play a major role in controlling the water and electrolyte balance within the body and in maintaining the acid-base balance of the blood. The waste products leave the kidneys as **urine**, which passes down the **ureters** to the **urinary bladder**, located within the pelvis. The urine leaves the body to the exterior through the **urethra**.

The kidneys are reddish-brown and lie behind the peritoneum high up on the posterior abdominal wall on either side of the vertebral column; they are largely under cover of the costal margin. The right kidney lies slightly lower than the left kidney because of the large size of the right lobe of the liver. With contraction of the diaphragm during respiration, both

kidneys move downward in a vertical direction by as much as 2.5 cm. on the medial concave border of each kidney is a vertical slit that is bounded by thick lips of the renal substance and is called the **hilum**. The hilum extends into a large cavity called the renal sinus. The hilum transmits, from front backward, the renal vein, two branches of the renal artery, the ureter, and the third branch of the renal artery (V.A.U.A). Lymph vessels and sympathetic fibers also pass through the hilum.

Coverings

The kidney has the following coverings.

1. **Fibrous capsule**: this surrounds the kidney and is closely applied to its outer surface.
2. **Perirenal fat**: this covers the fibrous capsule.
3. **Renal fascia**: This is a condensation of connective tissue that lies outside the perirenal fat and encloses the kidneys and suprarenal glands; it is continuous laterally with the fascia transversalis.
4. **Pararenal fat**: This lies external to the renal fascia and is often in large quantity. It forms part of the retroperitoneal fat.

   The perirenal fat, renal fascia, and pararenal fat support the kidneys and hold them in position on the posterior abdominal wall.

Renal Structure

Each kidney has a dark brown outer **cortex** and a light brown inner **medulla**. The medulla is composed of about a dozen renal pyramids, each having its base oriented toward the cortex and its apex, the **renal papilla**, projecting medially. The cortex extends into the medulla between adjacent pyramids as **renal columns**. Extending from the base of the renal pyramids into the cortex are striation known as **medullary rays**.

The **renal sinus**, which is the space within the hilum, contains the upper extended end of the ureter, the **renal pelvis**. This divides into two or three **major calyces**, each of which divides into two or three **minor calyces**. Each minor calyx is indented by the apex of the renal pyramid, the **renal papilla**.

Anteriorly, the right kidney is related to the suprarenal gland, the liver, the second part of the duodenum, and the right colic flexure. Posteriorly, the right kidney is related to the diaphragm, the costodiaphragmatic recess of the pleura, the twelfth rib; and the psoas and quadratus lumborum, and transversus abdominis muscles. The subcostal (T12), iliohypogastric, and ilioinguinal nerves (L1) run downward and laterally.

The left kidney is related anteriorly to the suprarenal gland, the spleen, the stomach, the pancreas, the left colic flexure, and the coils of jejunum. Posteriorly, the left kidney is related to diaphragm, the costodiaphragm recess of the pleura; the eleventh and twelfth ribs, and the psoas, quadratus lumborum, and transversus abdominis muscles. The subcostal (T12), iliohypogastric, and ilioinguinal nerves (L1) run downward and laterally.

Blood Supply

Arteries

The renal artery arises from the aorta at the level of the second lumbar vertebra. Each renal artery usually divides into five **segmental arteries** that enter the hilum of the kidney, four in front and one behind the renal pelvis. They are distributed to different segments or area of the kidney. **Lobar arteries** arise from each segmental artery, one for each pyramid. Before entering the renal substance, each lobar artery gives off two or three **interlobar arteries**. The interlobar arteries run toward the cortex on each side of the renal pyramid. At the junction of the cortex and medulla, the interlobar arteries give off the **arcuate arteries**, which arch over the base of the pyramids. The arcuate arteries give off several **interlobular arteries** that ascend in the cortex. The **afferent glomerular** arteries arise as branches of the interlobular arteries.

Veins

The renal vein emerges from the hilum in front of the renal artery and drains into the inferior vena cava.

Lymph Drainage

Lateral aortic lymph nodes around the renal artery.

Nerve Supply

Renal sympathetic plexus. The afferent fibers that travel through the renal plexus enter the spinal cord in the tenth, eleventh, and twelfth thoracic nerves.

Ureter

The two ureters are muscular tubes that extend from the kidneys to the posterior surface of the urinary bladder. The urine is propelled along the ureter by peristaltic contractions of the muscle coat, assisted by the filtration pressure of the glomeruli.

Each ureter measures about 25 cm long and resembles the esophagus in having three constrictions along its course: (1) where the renal pelvis joins the ureter, (2) where it is kinked as it crosses the pelvic brim, and (3) where it pierces the bladder wall.

The renal pelvis is the funnel-shaped expanded upper end of the ureter. It lies within the hilum of the kidney and receives the major calyces. The ureter emerges from the hilum of the kidney and runs vertically downward behind the parietal peritoneum on the psoas muscle, which separates it from the tips of the transverse processes of the lumbar vertebrae. It enters the pelvis by crossing the bifurcation of the common iliac artery in front the sacroiliac joint. The ureter then runs down the lateral wall of the pelvis to enter the lateral angle of the bladder.

Anteriorly, the right ureter is related to the duodenum, the terminal part of the ileum, the right colic and ileocolic vessels, the right testicular or ovarian vessels, and the root of the mesentery of the small intestine. Posteriorly, the right ureter is related to the right psoas muscle, which separates it from the lumbar transverse processes, and the bifurcation of the right common iliac artery.

The left ureter is related anteriorly to the sigmoid colon and sigmoid mesocolon, the left colic vessels and the left testicular or ovarian vessels. Posteriorly, the left ureter is related to the left psoas muscle, which separates it from the lumbar transverse processes, and the bifurcation of the left common iliac artery.

Blood Supply

The arterial supply to the ureter is as follows: (a) upper end, the renal artery; (b) middle portion, the testicular or ovarian artery; and (c) in the pelvis, the superior vesicle artery. Venous blood drains into veins that correspond to the arteries.

Lymph Drainage

Lateral aortic nodes and the iliac nodes.

Nerve Supply

Renal, testicular (or ovarian), and hypogastric plexus (in the pelvis). Afferent fibers travel with the sympathetic nerves and enter the spinal cord in the first and second lumbar segments.

Suprarenal Glands

The two suprarenal glands are yellowish retroperitoneal organs on the upper pole of the kidneys. They are surrounded by renal fascia (but are separated from the kidneys by the perirenal fat). Each gland has a yellow cortex and a dark brown medulla.

The cortex of the suprarenal glands secretes the hormones that include (a) **mineral corticoids**, which are concerned with the control of fluid and electrolytes balance; (b) **glycocorticoids**, which are concerned with the control of the metabolism of carbohydrates, fat, and proteins; and (c) small amount of **sex hormones**, which probably play a role in the prepubertal development of sex organs. The medulla of the suprarenal glands secretes the catecholamines **epinephrine** and **norepinephrine**.

The **right suprarenal gland** is pyramid shaped and caps the upper pole of the right kidney. It lies behind the right lobe of the liver and extends medially behind the inferior vena cava. It rests posteriorly on the diaphragm.

The **left suprarenal gland** is crescentic in shape and extends along the medial border of the left kidney from the upper pole to the hilus. It lies behind the pancreas, the lesser sac, and the stomach and rests posteriorly on the diaphragm.

Blood supply

The arteries supplying each gland are three in number: (1) inferior phrenic artery, (2) aorta, and (3) renal artery.

A single vein emerges from the hilum of each gland and drains into the inferior vena cava on the right and into the renal vein on the left.

Arteries on the Posterior Abdominal Wall

Aorta

The aorta enters the abdomen through the aortic opening of the diaphragm in front of the twelfth thoracic vertebra. It descends behind the peritoneum on the anterior surface of the bodies of the lumbar vertebrae. At the level of the fourth lumbar vertebra it divides into the two common iliac arteries. On its right side lie the inferior vena cava, the cisterna chyli, and the beginning of the azygos vein. On its left side the left sympathetic trunk.

Branches of the Abdominal Aorta

1. Three anterior visceral branches: the celiac artery, superior mesenteric artery, and inferior mesenteric artery.
2. Three lateral visceral branches: the suprarenal artery, renal artery, and testicular or ovarian artery.
3. Five lateral abdominal wall branches: the inferior phrenic artery and four lumbar arteries.
4. Three terminal branches: two common iliac arteries and the median sacral artery.

Common Iliac Arteries

The right and left common iliac arteries are the terminal branches of the aorta. They arise at the level of the fourth lumbar vertebra and run downward and laterally along the medial border of the psoas muscle. Each artery ends in front of the sacroiliac joint by dividing into the external and internal iliac arteries. At the bifurcation, the common iliac artery on each side is crossed anteriorly by the ureter.

External Iliac Artery

The external iliac artery runs along the medial border of the psoas, following the pelvic brim. It gives off the **inferior epigastric** and **deep circumflex iliac** branches.

The artery enters the thigh by passing under the inguinal ligament to become the femoral artery. The inferior epigastric artery arises just above the inguinal ligament. It passes upward and medially along the medial margin of the deep inguinal ring and enters the rectus sheath behind the rectus abdominis muscle. The deep circumflex iliac artery arises close to the inferior epigastric artery. It ascends laterally to the anterior superior iliac spine and the iliac crest, supplying the muscles of the anterior abdominal wall.

Internal Iliac Artery

The internal iliac artery passes down into the pelvis in front of the sacroiliac joint. Its further course will describe with the arterial supply of the pelvis.

Veins on the Posterior Abdominal Wall

Inferior Vena Cava

The inferior vena cava conveys most of the blood from the body below the diaphragm to the right atrium of the heart. It is formed by the union of the common iliac veins behind the right common iliac artery at the level of the fifth lumbar vertebra. It ascends on the right side of the

aorta, pierces the central tendon of the diaphragm at the level of the eighth thoracic vertebra, and drains into the right atrium of the heart

Tributaries

The inferior vena cava has the following tributaries:

1. Two anterior visceral tributaries: the hepatic veins.
2. Three lateral visceral tributaries: the right suprarenal vein (the left vein drains into the left renal vein), renal veins, and right testicular or ovarian vein (the left vein drains into the left renal vein).
3. Five lateral abdominal wall tributaries: the inferior phrenic vein and four lumbar veins.
4. Three veins of origin: two common iliac veins and the median sacral veins.

It is apparent that the tributaries of the inferior vena cava correspond rather closely to the branches of the abdominal portion of the aorta.

Inferior Mesenteric Vein

The inferior mesenteric vein is a tributary of the portal circulation. It begins halfway down the anal canal as the superior rectal vein. It passes up the posterior abdominal wall on the left side of the inferior mesenteric artery and the duodenojejunal flexure and joins the splenic vein behind the pancreas. It receives tributaries that correspond to the branches of the artery.

Splenic Vein

The splenic vein is a tributary of the portal circulation. It begins at the hilum of the spleen by the union of several veins and is then joined by the short gastric and left gastroepiploic veins. It passes to the right within the splenicorenal ligament and runs behind the pancreas below the splenic artery. It joins the superior mesenteric vein behind the neck of the pancreas to form the portal vein. It is joined by veins from the pancreas and inferior mesenteric vein.

Superior mesenteric Vein

The superior mesenteric vein is a tributary of the portal circulation. It begins at the ileocecal junction and runs upward on the posterior abdominal wall within the root of mesentery of the small intestine. It passes in front of the third part of the duodenum and behind the neck of the pancreas, where it joins the splenic vein to form the portal vein. It receives tributaries that

correspond to the branches of the superior mesenteric artery and also receives the inferior pancreaticoduodenal vein and the right gastroepiploic vein.

Lymphatics on the Posterior Abdominal Wall

Lymph nodes

The lymph nodes are closely related to the aorta and form a preaortic and a right and left lateral aortic (para-aortic or lumbar) chain.

The **preaortic lymph nodes** lie around the origins of the celiac, superior mesenteric, and inferior mesenteric arteries and are referred to as the **celiac**, **superior mesenteric**, and **inferior mesenteric lymph nodes**, respectively. They drain lymph from the gastrointestinal tract, extending from the lower one-third of the esophagus to the halfway down the anal canal, and from the spleen, pancreas, gall bladder, and the greater part of the liver

The **lateral aortic** (para-aortic or lumbar) **lymph nodes** drain lymph from the kidneys and suprarenal; from the testes in the male and from the ovaries, uterine tubes, and fundus of the uterus in the female; from the deep lymph vessels of the abdominal wall; and from the common iliac nodes. The efferent vessels from the right and left lumbar trunks.

Lymph Vessels

The **thoracic duct** commences in the abdomen as an elongated lymph sac, the **cisterna chyli**. This lies just below the diaphragm in front of the first two lumbar vertebrae and on the right side of the aorta.

The cisterna chyli receives (a) the intestinal trunk, (b) the right and left lumbar trunks, and (c) some small lymph vessels descend from the lower part of the thorax.

Nerves on the Posterior Abdominal Wall

Lumbar plexus

The lumbar plexus, which is one of the main nervous pathways supplying the lower limb, is formed in the psoas muscle from the anterior rami of the upper four lumbar nerves.

The iliohypogastric nerve, ilioinguinal nerve, lateral cutaneous nerve of the thigh, and femoral nerve emerge from the lateral border of the psoas, in that order from above downward.

The **iliohypogastric** and **ilioinguinal** nerves (L1) enter the lateral and anterior abdominal wall. The iliohypogastric nerve supplies the skin of the lower part of the anterior abdominal wall, and the ilioinguinal nerve passes through the inguinal canal to supply the skin of the groin and the scrotum or labium majus.

The **lateral cutaneous nerve** of the thigh crosses the iliac fossa in front the iliacus muscle and enters the thigh behind the inguinal ligament.

The **femoral nerve** (L2, 3, and 4) is the largest branch of the lumbar plexus. It runs downward to enter the thigh behind the inguinal ligament and lateral to the femoral vessels and the femoral sheath. In the abdomen it supplies the iliacus muscle.

The **obturator nerve** (L2, 3, and 4) crosses the pelvic brim in front the iliac joint and leaves the pelvis by passing through the obturator foramen into the thigh.

The **fourth lumbar root** of the lumbosacral trunk take part in the formation of the sacral plexus. It descends anterior to the sacrum and joins the first sacral nerve.

The **genitofemoral** nerve (L1 and 2) emerges on the anterior surface of the psoas. It runs downward and divides into (a) **genital branch**, which enters the spermatic cord and supplies the cremaster muscle, and (b) a **femoral branch**, which supplies a small area of the thigh. It is the nervous pathway involved in the cremastric reflex.

□□□□

حضر أعرابي على مائدة بعض الخلفاء فقدم له شاة مشوية فجعل الأعرابي يسرع في الأكل فقال الخليفة:
أراك تأكلــه بحرقــة كــأن امــه نطحتــك ! فقــال الأعرابــي :أراك تشــفق عليــه كــأن امــه أرضــعتك .

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في العيش والأجل المحتوم يقطعـه

يغتر بالـــدهر مسرورا" بصحبتــه

وقــد تيقتن أن الــدهر يــصرعه

ويجـــــمع المال حرصا" لا يفارقه

وقـد درى انه للغــير يجمـــــعه

تراه يشفق من تضييـــــع درهمه

. ولـ ـــيس يشفق من دين يضيعـه وأسوأ النـــاس تـــتدبيرا"

لعاقبــة

. مـ ن أنفق العمـر فيمالـ ـيس ينفعه

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قال ابراهيم التيمي : مثلت نفسي في الجنة آكل من ثمارها ،وأشرب من انهارها واعنق ابكارها ، ثم مثلت نفسي في النار آكل من زقومها، وأشرب من صديدها وأعالج سلاسلها واغلالها ،ثم قلت لنفسي : أي شيء تريدين ؟ قالت أريد ان ارد الى الدنيا فاعمل صالحا. فقال فأنت في الأمنية فأعملي !! .

الفقيه وصاحب الدار

سكن احد الفقهاء في بيت سقفه يفرقع باستمرار فلما جاء صاحب الدار يطلب الأجرة قال له، أصلح السقف فانه يفرقع فقال صـاحب البيـت، لا تخـف انــه يسـبح الله تعـالى أيهـا الفقيــه، فقـال الفقيــه ولكـن أخشـى ان تدركـه رقـة فيسـجد!.

Presented By:-

TAHA MOHAMMED

Special Thanks to:-

YOU !!!!!!?? (مهتفا تنا)

ولا يسع المرحلة الخامسة شكر (السجاج) سلوان تحسين وذلك لأفضاله عليها

تحياتنا لكروب لملوم