

Peritoneum

General Arrangement

The peritoneum is a thin serous membrane that lines the walls of the abdominal and pelvic cavities and clothes the viscera (Figs. 5.5 and 5.6). 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 (Figs. 5.5 and 5.6). 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** (Figs. 5.5 and 5.7). 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.

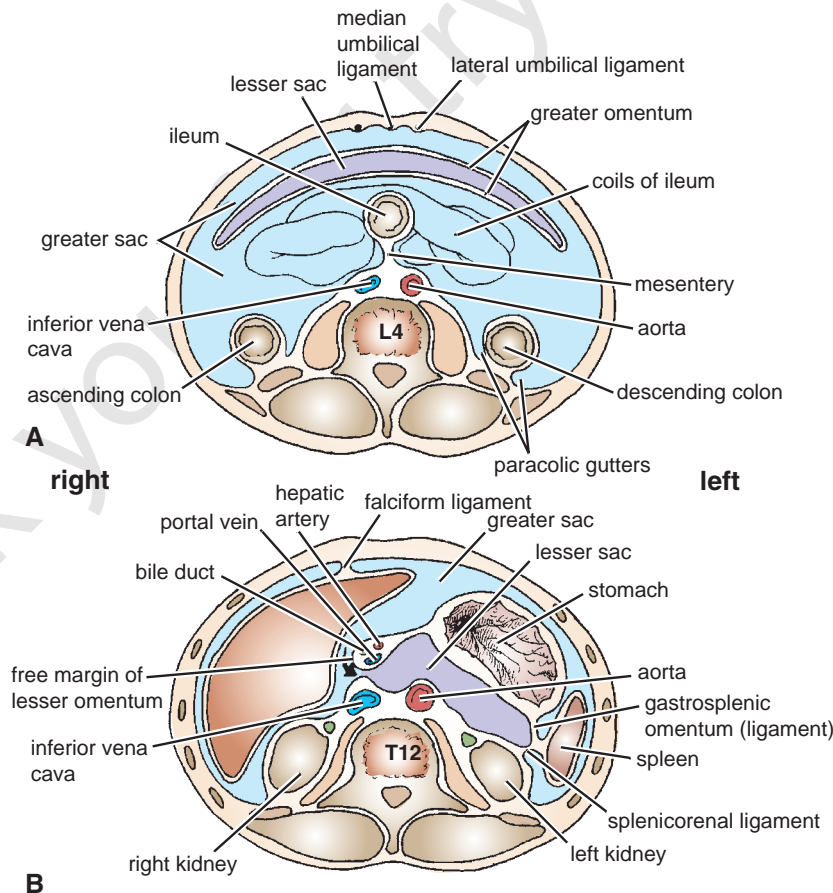


FIGURE 5.5 Transverse sections of the abdomen showing the arrangement of the peritoneum. The *arrow* in **B** indicates the position of the opening of the lesser sac. These sections are viewed from below.

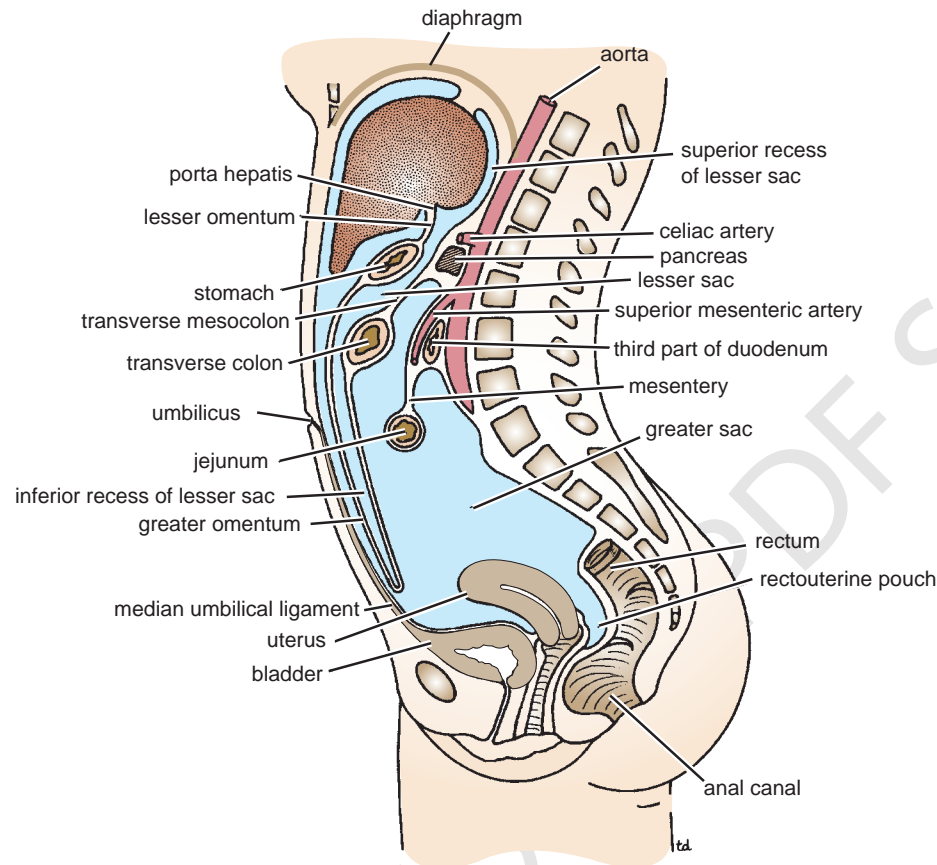


FIGURE 5.6 Sagittal section of the female abdomen showing the arrangement of the peritoneum.

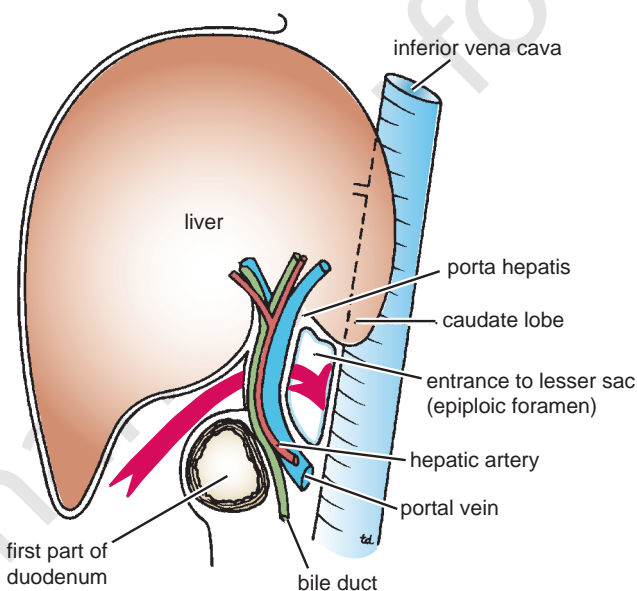


FIGURE 5.7 Sagittal section through the entrance into the lesser sac showing the important structures that form boundaries to the opening. (Note the *arrow* passing from the greater sac through the epiploic foramen into the lesser sac.)

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

Peritoneal ligaments are two-layered folds of peritoneum that connect solid viscera to the abdominal walls. The liver, for example, is connected to the diaphragm by the **falciform ligament**, the **coronary ligament**, and the **right** and **left triangular ligaments** (Figs. 5.8 and 5.10).

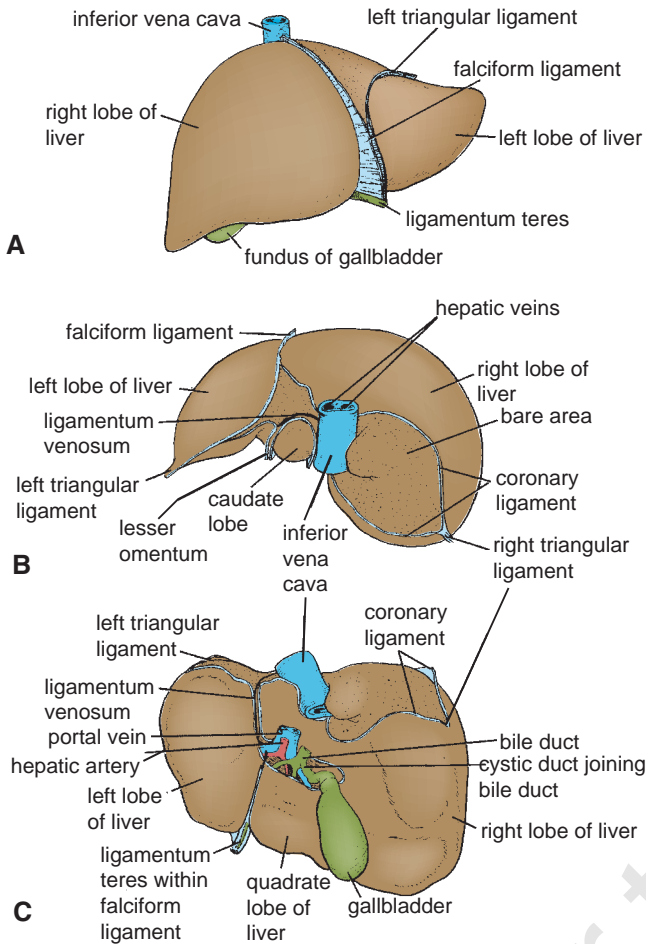


FIGURE 5.8 Liver as seen from in front (**A**), from above (**B**), and from behind (**C**). Note the position of the peritoneal reflections, the bare areas, and the peritoneal ligaments.



FIGURE 5.9 A plastinated specimen of the liver as seen on its posteroinferior (visceral) surface. The portal vein has been transfused with white plastic and the inferior vena cava with dark blue plastic. Outside the liver, the distended biliary ducts and gallbladder have been injected with yellow plastic and the hepatic artery with red plastic. The liver was then immersed in corrosive fluid to remove the liver tissue. Note the profuse branching of the portal vein as its white terminal branches enter the portal canals between the liver lobules; the dark blue tributaries of many of the hepatic veins can also be seen.

Omenta

Omenta are two-layered folds of peritoneum that connect the stomach to another viscus. The **greater omentum** connects the greater curvature of the stomach to the transverse colon (Fig. 5.2). 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 (Fig. 5.6). The **lesser omentum** suspends the lesser curvature of the stomach from the fissure of the ligamentum venosum and the porta hepatis on the undersurface of the liver (Fig. 5.6). The **gastroplenic omentum** (ligament) connects the stomach to the hilum of the spleen (Fig. 5.5).

Mesenteries

Mesenteries are two-layered folds of peritoneum connecting parts of the intestines to the posterior abdominal wall, for example, the **mesentery of the small intestine**, the **transverse mesocolon**, and the **sigmoid mesocolon** (Figs. 5.6 and 5.13).

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

The extent of the peritoneum and the peritoneal cavity should be studied in the transverse and sagittal sections of the abdomen seen in Figures 5.5 and 5.6.

Peritoneal Pouches, Recesses, Spaces, and Gutters

Lesser Sac

The lesser sac lies behind the stomach and the lesser omentum (Figs. 5.5, 5.6, and 5.11). It extends upward as far as the diaphragm and downward between the layers of the greater

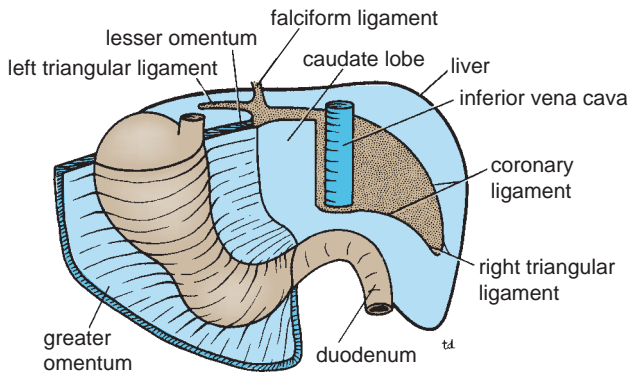


FIGURE 5.10 Attachment of the lesser omentum to the stomach and the posterior surface of the liver.

omentum. The left margin of the sac is formed by the spleen (Fig. 5.11) and the gastrosplenic omentum and splenicorenal ligament. The right margin opens into the greater sac (the main part of the peritoneal cavity) through the **opening of the lesser sac, or epiploic foramen** (Fig. 5.7).

The opening into the lesser sac (epiploic foramen) has the following boundaries (Fig. 5.7):

- **Anteriorly:** Free border of the lesser omentum, the bile duct, the hepatic artery, and the portal vein (Fig. 5.11)
- **Posteriorly:** Inferior vena cava
- **Superiorly:** Caudate process of the caudate lobe of the liver
- **Inferiorly:** First part of the duodenum

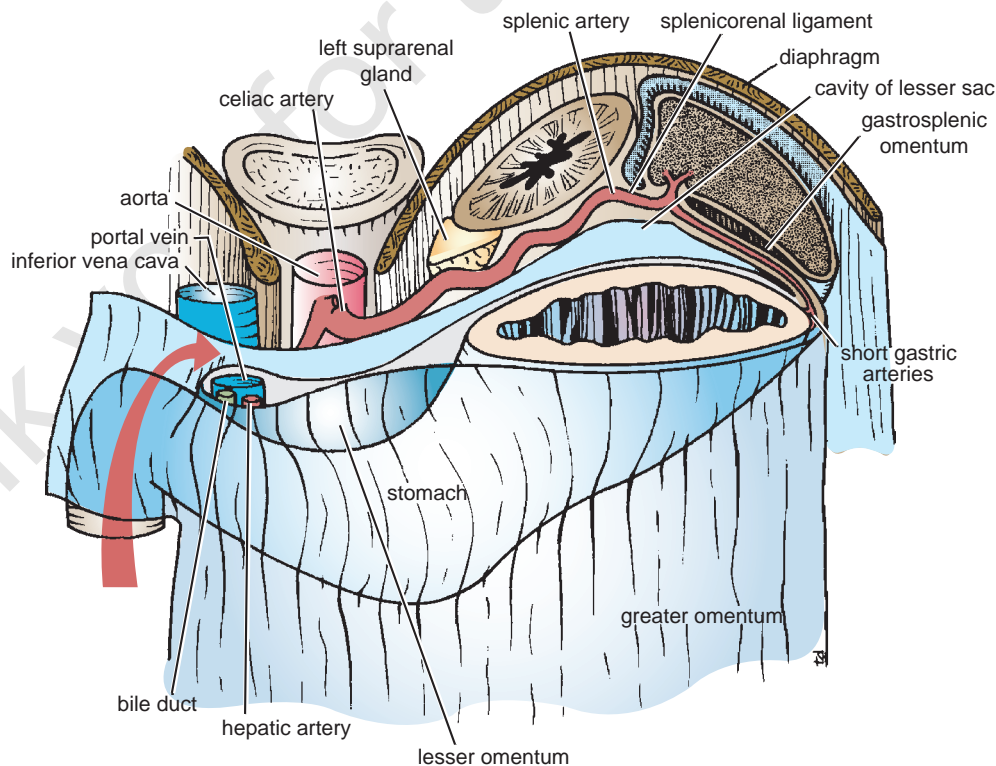


FIGURE 5.11 Transverse section of the lesser sac showing the arrangement of the peritoneum in the formation of the lesser omentum, the gastrosplenic omentum, and the splenicorenal ligament. *Arrow* indicates the position of the opening of the lesser sac.

Duodenal Recesses

Close to the duodenojejunal junction, there may be four small pocketlike pouches of peritoneum called the **superior duodenal, inferior duodenal, paraduodenal, and retroduodenal recesses** (Fig. 5.12).

Cecal Recesses

Folds of peritoneum close to the cecum produce three peritoneal recesses called the **superior ileocecal, the inferior ileocecal, and the retrocecal recesses** (Fig. 5.13).

Intersigmoid Recess

The intersigmoid recess is situated at the apex of the inverted, V-shaped root of the sigmoid mesocolon (Fig. 5.13); its mouth opens downward.

Subphrenic Spaces

The **right anterior subphrenic spaces** lie between the diaphragm and the liver, on each side of the falciform ligament (Fig. 5.14). The **right posterior subphrenic space** lies between the right lobe of the liver, the right kidney, and the right colic flexure (Fig. 5.15). The **right extraperitoneal space** lies between the layers of the coronary ligament and is therefore situated between the liver and the diaphragm (see page 196).

Paracolic Gutters

The paracolic gutters lie on the lateral and medial sides of the ascending and descending colons, respectively (Figs. 5.5 and 5.14).

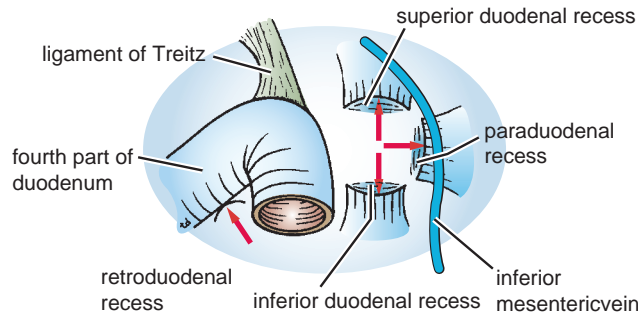


FIGURE 5.12 Peritoneal recesses, which may be present in the region of the duodenojejunal junction. Note the presence of the inferior mesenteric vein in the peritoneal fold, forming the paraduodenal recess.

The subphrenic spaces and the paracolic gutters are clinically important because they may be sites for the collection and movement of infected peritoneal fluid (see page 165).

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 1st lumbar nerves—that is, the same nerves that innervate the overlying 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 in 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 afferent nerves that supply the viscera or are traveling in the mesenteries. Overdistention of a viscus leads to the sensation of pain. The mesenteries of the small and large intestines are sensitive to mechanical stretching.

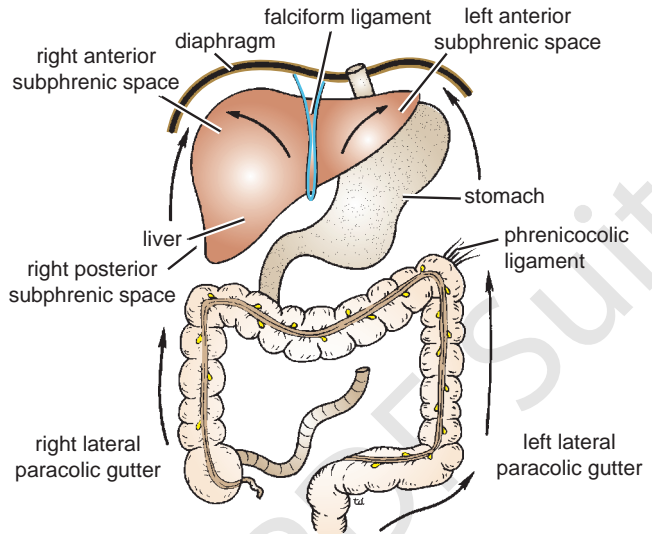


FIGURE 5.14 Normal direction of flow of the peritoneal fluid from different parts of the peritoneal cavity to the subphrenic spaces.

Functions 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. As a result of the movements of the diaphragm and the abdominal muscles, together with the peristaltic movements of the intestinal tract, the peritoneal fluid is not static. Experimental evidence has shown that particulate matter introduced into the lower part of the peritoneal cavity reaches the subphrenic peritoneal spaces rapidly, whatever the position of the body. It seems that intraperitoneal movement of fluid toward the diaphragm is continuous (Fig. 5.14), and there it is quickly absorbed into the subperitoneal lymphatic capillaries.

This can be explained on the basis that the area of peritoneum is extensive in the region of the diaphragm and the

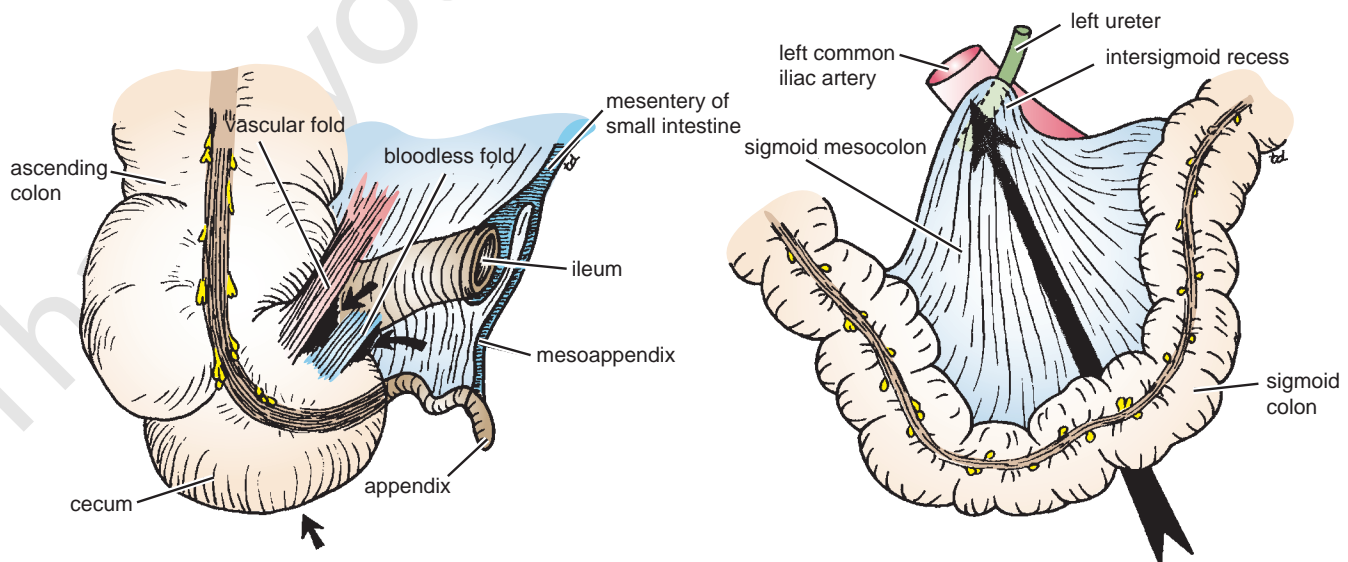


FIGURE 5.13 Peritoneal recesses (arrows) in the region of the cecum and the recess related to the sigmoid mesocolon.

respiratory movements of the diaphragm aid lymph flow in the lymph vessels.

The peritoneal coverings of the intestine tend to stick together in the presence of infection. The greater omentum, which is kept constantly on the move by the peristalsis of the neighboring intestinal tract, 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.



CLINICAL NOTES

The Peritoneum and Peritoneal Cavity

Movement of Peritoneal Fluid

The peritoneal cavity is divided into an upper part within the abdomen and a lower part in the pelvis. The abdominal part is further subdivided by the many peritoneal reflections into important recesses and spaces, which, in turn, are continued into the paracolic gutters (Fig. 5.15). The attachment of the transverse mesocolon and the mesentery of the small intestine to the posterior abdominal wall provides natural peritoneal barriers that may hinder the movement of infected peritoneal fluid from the upper part to the lower part of the peritoneal cavity.

It is interesting to note that when the patient is in the supine position the right subphrenic peritoneal space and the pelvic cavity are the lowest areas of the peritoneal cavity and the region of the pelvic brim is the highest area (Fig. 5.15).

Peritoneal Infection

Infection may gain entrance to the peritoneal cavity through several routes: from the interior of the gastrointestinal tract and gallbladder, through the anterior abdominal wall, via the uterine tubes in females (gonococcal peritonitis in adults and pneumococcal peritonitis in children occur through this route), and from the blood.

Collection of infected peritoneal fluid in one of the **subphrenic spaces** is often accompanied by infection of the pleural cavity. It is common to find a localized empyema in a patient with a subphrenic abscess. It is believed that the infection spreads from the peritoneum to the pleura via the diaphragmatic lymph vessels. A patient with a subphrenic abscess may complain of pain over the shoulder. (This also holds true for collections of blood under the diaphragm, which irritate the parietal diaphragmatic peritoneum.) The skin of the shoulder is supplied by the supraclavicular nerves (C3 and 4), which have the same segmental origin as the phrenic nerve, which supplies the peritoneum in the center of the undersurface of the diaphragm.

To avoid the accumulation of infected fluid in the subphrenic spaces and to delay the absorption of toxins from intraperitoneal infections, it is common nursing practice to sit a patient up in bed with the back at an angle of 45°. In this position, the infected peritoneal fluid tends to gravitate downward into the pelvic cavity, where the rate of toxin absorption is slow (Fig. 5.15).

Greater Omentum

Localization of Infection

The greater omentum is often referred to by the surgeons as the **abdominal policeman**. The lower and the right and left margins are

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

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

free, and it moves about the peritoneal cavity in response to the peristaltic movements of the neighboring gut. In the first 2 years of life, it is poorly developed and thus is less protective in a young child. Later, however, in an acutely inflamed appendix, for example, the inflammatory exudate causes the omentum to adhere to the appendix and wrap itself around the infected organ (Fig. 5.16). By this means, the infection is often localized to a small area of the peritoneal cavity, thus saving the patient from a serious diffuse peritonitis.

Greater Omentum as a Hernial Plug

The greater omentum has been found to plug the neck of a hernial sac and prevent the entrance of coils of small intestine.

Greater Omentum in Surgery

Surgeons sometimes use the omentum to buttress an intestinal anastomosis or in the closure of a perforated gastric or duodenal ulcer.

Torsion of the Greater Omentum

The greater omentum may undergo torsion, and if extensive, the blood supply to a part of it may be cut off, causing necrosis.

Ascites

Ascites is essentially an excessive accumulation of peritoneal fluid within the peritoneal cavity. Ascites can occur secondary to hepatic cirrhosis (portal venous congestion), malignant disease (e.g., cancer of the ovary), or congestive heart failure (systemic venous congestion). In a thin patient, as much as 1500 mL has to accumulate before ascites can be recognized clinically. In obese individuals, a far greater amount has to collect before it can be detected. The withdrawal of peritoneal fluid from the peritoneal cavity is described on page 148.

Peritoneal Pain

From the Parietal Peritoneum

The parietal peritoneum lining the anterior abdominal wall is supplied by the lower six thoracic nerves and the first lumbar nerve. Abdominal pain originating from the parietal peritoneum is therefore of the somatic type and can be precisely localized; it is usually severe (see Abdominal Pain, page 224).

An inflamed parietal peritoneum is extremely sensitive to stretching. This fact is made use of clinically in diagnosing peritonitis. Pressure is applied to the abdominal wall with a single finger over the site of the inflammation. The pressure is then removed by suddenly withdrawing the finger. The abdominal wall rebounds, resulting in extreme local pain, which is known as **rebound tenderness**.

(continued)

It should always be remembered that the parietal peritoneum in the pelvis is innervated by the obturator nerve and can be palpated by means of a rectal or vaginal examination. An inflamed appendix may hang down into the pelvis and irritate the parietal peritoneum. A pelvic examination can detect extreme tenderness of the parietal peritoneum on the right side (see page 268).

From the Visceral Peritoneum

The visceral peritoneum, including the mesenteries, is innervated by autonomic afferent nerves. Stretch caused by overdistension of a viscus or pulling on a mesentery gives rise to the sensation of pain. The sites of origin of visceral pain are shown in Figure 5.17.

Because the gastrointestinal tract arises embryologically as a midline structure and receives a bilateral nerve supply, pain is referred to the midline. Pain arising from an abdominal viscus is dull and poorly localized (see Abdominal Pain, page 224).

Peritoneal Dialysis

Because the peritoneum is a semipermeable membrane, it allows rapid bidirectional transfer of substances across itself.

Because the surface area of the peritoneum is enormous, this transfer property has been made use of in patients with acute renal insufficiency. The efficiency of this method is only a fraction of that achieved by hemodialysis.

A watery solution, the dialysate, is introduced through a catheter through a small midline incision through the anterior abdominal wall below the umbilicus. The technique is the same as peritoneal lavage (see page 148). The products of metabolism, such as urea, diffuse through the peritoneal lining cells from the blood vessels into the dialysate and are removed from the patient.

Internal Abdominal Hernia

Occasionally, a loop of intestine enters a peritoneal pouch or recess (e.g., the lesser sac or the duodenal recesses) and becomes strangulated at the edges of the recess. Remember that important structures form the boundaries of the entrance into the lesser sac and that the inferior mesenteric vein often lies in the anterior wall of the paraduodenal recess.



EMBRYOLOGIC NOTES

Development of the Peritoneum and the Peritoneal Cavity

Once the lateral mesoderm has split into somatic and splanchnic layers, a cavity is formed between the two, called the **intraembryonic coelom**. The peritoneal cavity is derived from that part of the embryonic coelom situated caudal to the septum transversum. In the earliest stages, the peritoneal cavity is in free communication with the extraembryonic coelom on each side (Fig. 4.36B). Later, with the development of the head, tail, and lateral folds of the embryo, this wide area of communication becomes restricted to the small area within the umbilical cord.

Early in development, the peritoneal cavity is divided into right and left halves by a central partition formed by the dorsal mesentery, the gut, and the small ventral mesentery (Fig. 5.18). However, the ventral mesentery extends only for a short distance along the gut (see below), so that below this level the right and left halves of the peritoneal cavity are in free communication (Fig. 5.18). As a result of the enormous growth of the liver and the enlargement of the developing kidneys, the capacity of the abdominal cavity becomes greatly reduced at about the 6th week of development. It is at this time that the small remaining communication between the peritoneal cavity and extraembryonic coelom becomes important. An intestinal loop is forced out of the abdominal cavity through the umbilicus into the umbilical cord. This physiologic herniation of the midgut takes place during the 6th week of development.

Formation of the Peritoneal Ligaments and Mesenteries

The peritoneal ligaments are developed from the ventral and dorsal mesenteries. The ventral mesentery is formed from the mesoderm of the septum transversum (derived from the cervical somites, which migrate downward). The ventral mesentery forms the **falciform ligament**, the **lesser omentum**, and the **coronary and triangular ligaments of the liver** (Fig. 5.18).

The dorsal mesentery is formed from the fusion of the splanchnopleuric mesoderm on the two sides of the embryo. It extends from the posterior abdominal wall to the posterior border of the abdominal part of the gut (Figs. 4.36 and 5.18). The dorsal mesentery forms the **gastrophrenic ligament**, the **gastrosplenic omentum**, the **splenicorenal ligament**, the **greater omentum**, and the **mesenteries of the small and large intestines**.

Formation of the Lesser and Greater Peritoneal Sacs

The extensive growth of the right lobe of the liver pulls the ventral mesentery to the right and causes rotation of the stomach and duodenum (Fig. 5.19). By this means, the upper right part of the peritoneal cavity becomes incorporated into the lesser sac. The right free border of the ventral mesentery becomes the right border of the lesser omentum and the anterior boundary of the entrance into the lesser sac.

The remaining part of the peritoneal cavity, which is not included in the lesser sac, is called the **greater sac**, and the two sacs are in communication through the **epiploic foramen**.

Formation of the Greater Omentum

The spleen is developed in the upper part of the dorsal mesentery, and the greater omentum is formed as a result of the rapid and extensive growth of the dorsal mesentery caudal to the spleen. To begin with, the greater omentum extends from the greater curvature of the stomach to the posterior abdominal wall superior to the transverse mesocolon. With continued growth, it reaches inferiorly as an apronlike double layer of peritoneum anterior to the transverse colon.

Later, the posterior layer of the omentum fuses with the transverse mesocolon; as a result, the greater omentum becomes attached to the anterior surface of the transverse colon (Fig. 5.19). As development proceeds, the omentum becomes laden with fat. The inferior recess of the lesser sac extends inferiorly between the anterior and the posterior layers of the fold of the greater omentum.

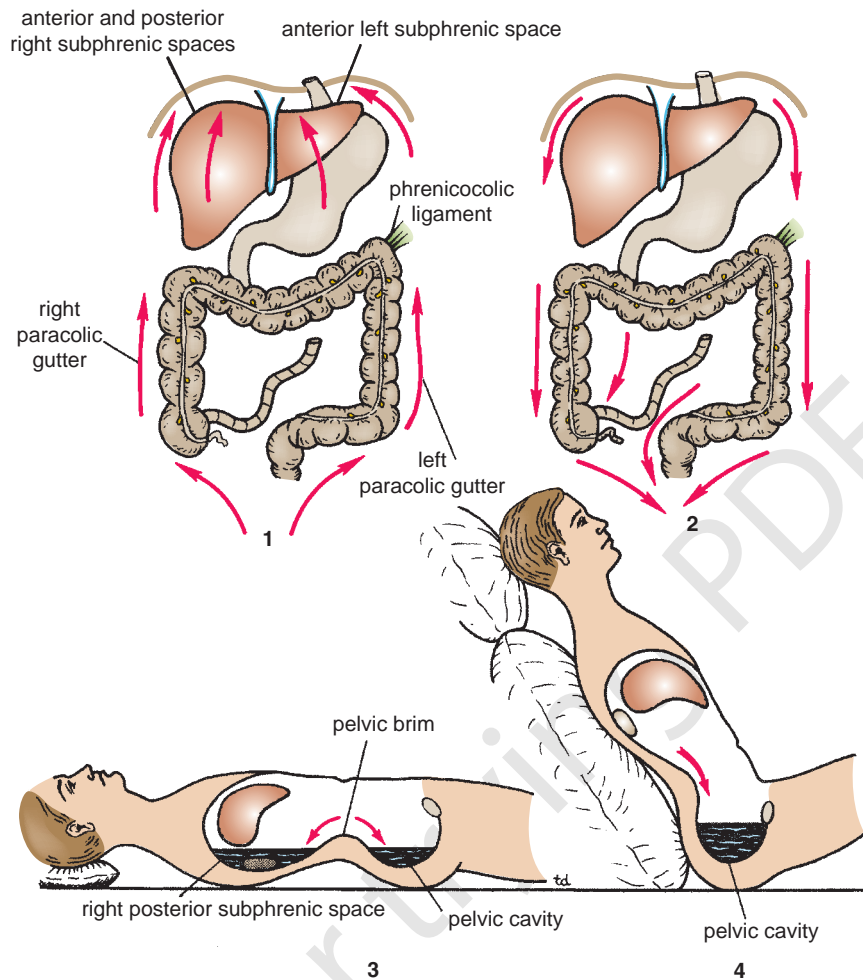


FIGURE 5.15 Direction of flow of the peritoneal fluid. **1.** Normal flow upward to the subphrenic spaces. **2.** Flow of inflammatory exudate in peritonitis. **3.** The two sites where inflammatory exudate tends to collect when the patient is nursed in the supine position. **4.** Accumulation of inflammatory exudate in the pelvis when the patient is nursed in the inclined position.

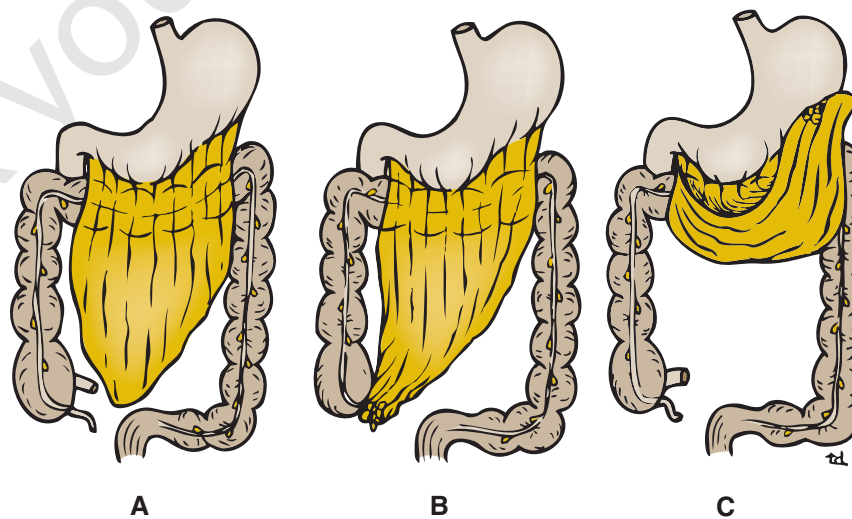


FIGURE 5.16 **A.** The normal greater omentum. **B.** The greater omentum wrapped around an inflamed appendix. **C.** The greater omentum adherent to the base of a gastric ulcer. One important function of the greater omentum is to attempt to limit the spread of intraperitoneal infections.

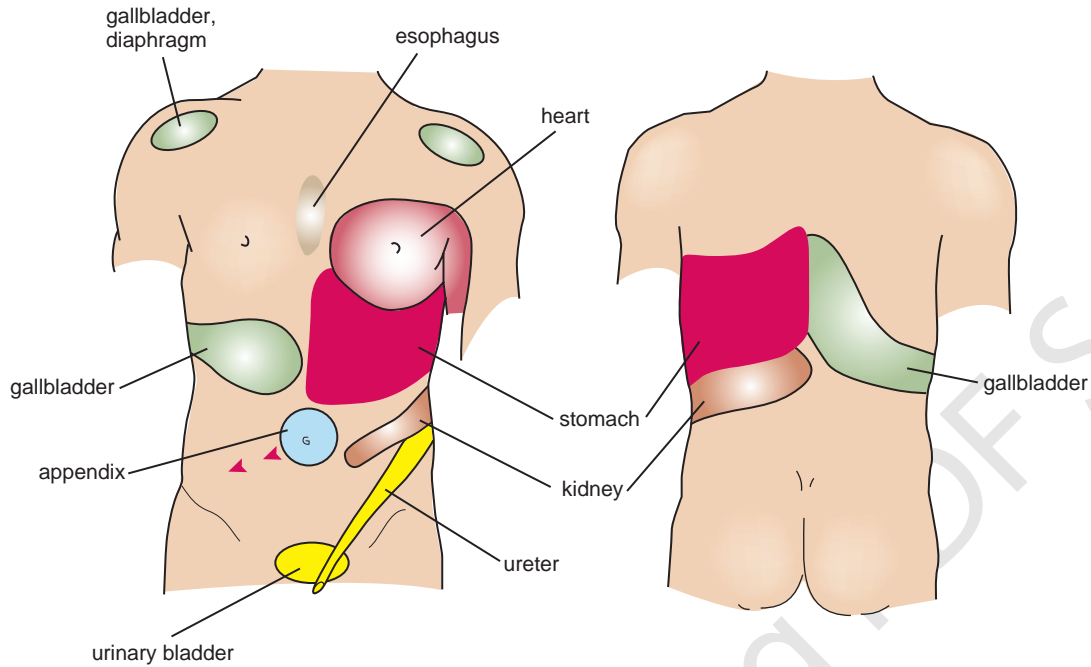


FIGURE 5.17 Some important skin areas involved in referred visceral pain.

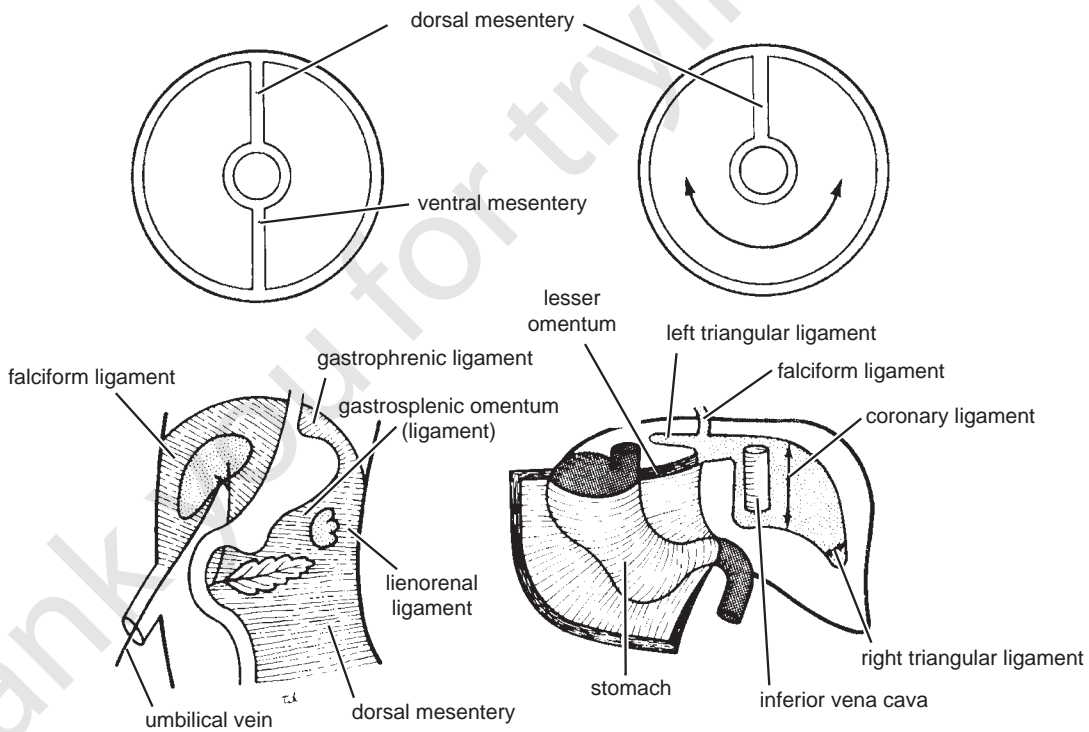


FIGURE 5.18 Ventral and dorsal mesenteries and the organs that develop within them.