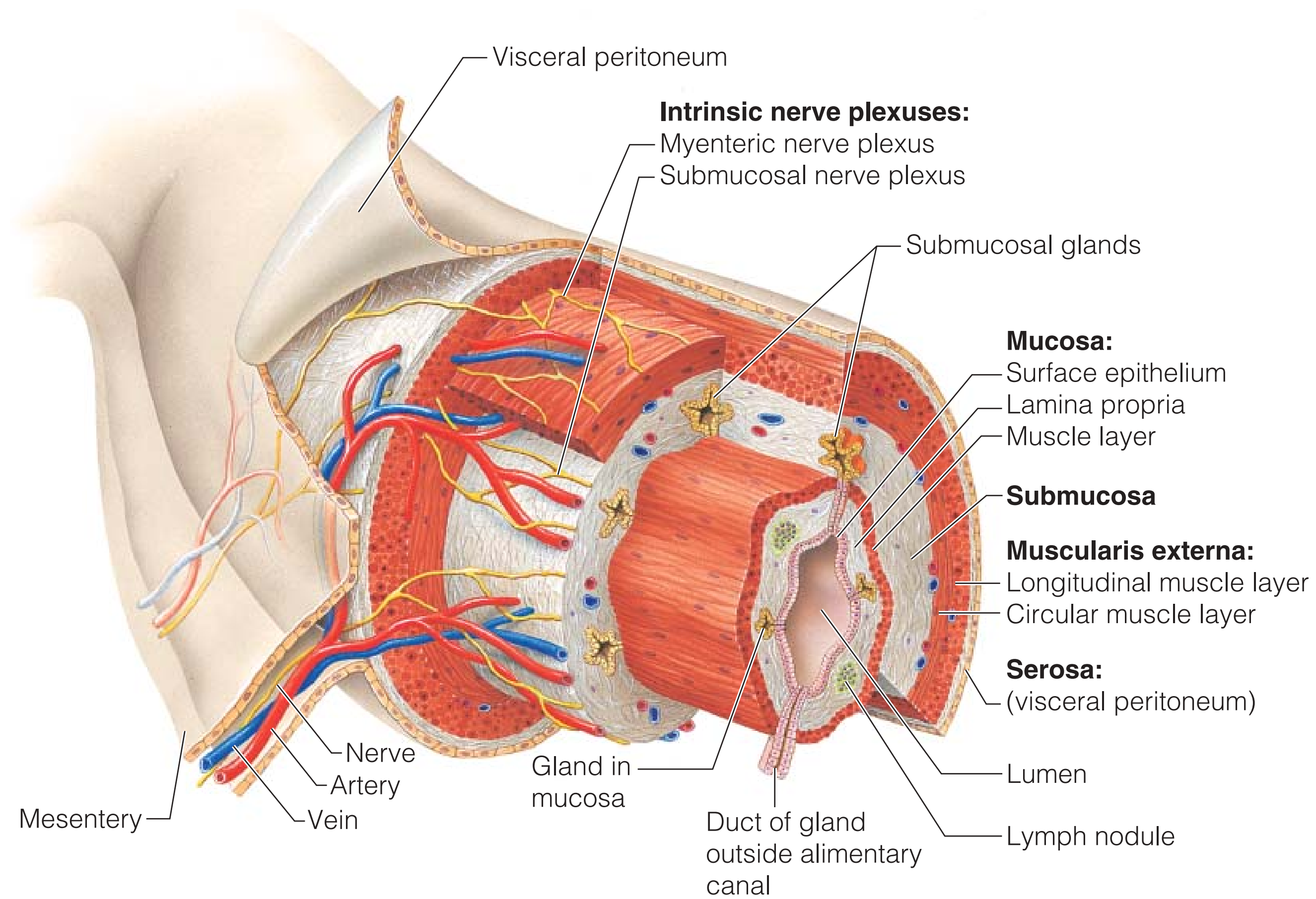

FIGURE 14.3 **Basic structure of the alimentary canal wall.**

plexus and the **myenteric** (mi-en′ter-ik; "intestinal muscle") **nerve plexus.** An additional small *subserous plexus* is associated with the serosa. These networks of nerve fibers are actually part of the autonomic nervous system. They help regulate the mobility and secretory activity of GI tract organs.

Stomach

The C-shaped **stomach** (Figure 14.4) is on the left side of the abdominal cavity, nearly hidden by the liver and diaphragm. Different regions of the stomach have been named. The *cardiac region* (named for its position near the heart) surrounds the **cardioesophageal** (kar″de-o-ĕ-sof″ah-je′al) **sphincter,** through which food enters the stomach from the esophagus. The *fundus* is the expanded part of the stomach lateral to the cardiac region. The *body* is the midportion, and as it narrows inferiorly, it becomes the *pyloric antrum,* and then the funnel-shaped *pylorus* (pi-lo′rus), the terminal part of the stomach. The pylorus is continuous with the small intestine through the **pyloric sphincter,** or **valve.** The stomach is approximately 25 cm (10 inches) long, but its diameter depends on how much food it contains. When it is full, it can hold about 4 liters (1 gallon) of food. When it is empty, it collapses inward on itself, and its mucosa is thrown into large folds called **rugae** (roo′ge; *ruga* = wrinkle, fold). The convex lateral surface of the stomach is the **greater curvature;** its concave medial surface is the **lesser curvature.**

The **lesser omentum** (o-men′tum), a double layer of peritoneum, extends from the liver to the lesser curvature. The **greater omentum,** another extension of the peritoneum, drapes downward and covers the abdominal organs like a lacy apron before attaching to the posterior body wall (Figure 14.5). The greater omentum is riddled with

Q *What modification of the stomach muscularis externa allows it to mechanically digest food?*

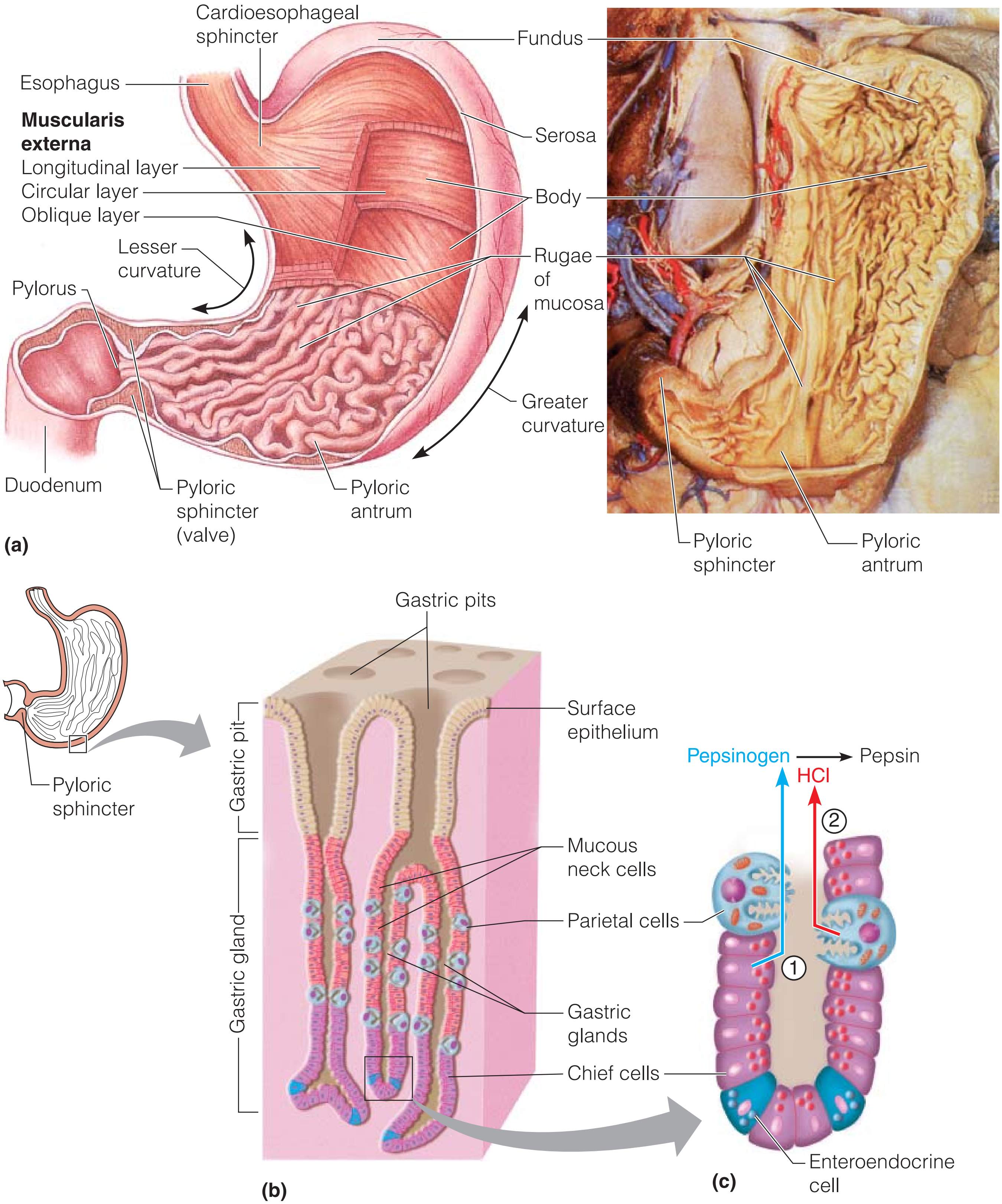

FIGURE 14.4 **Anatomy of the stomach. (a)** Gross internal anatomy (frontal section). **(b)** Enlarged view of gastric pits and glands (longitudinal section). **(c)** Schematic showing the sequence of events from ① the production of pepsinogen by the chief cells to ② its activation (to pepsin) by HCl secreted by the parietal cells.

A *Its third layer of smooth muscle, the oblique layer which allows it to knead or pummel the food.*

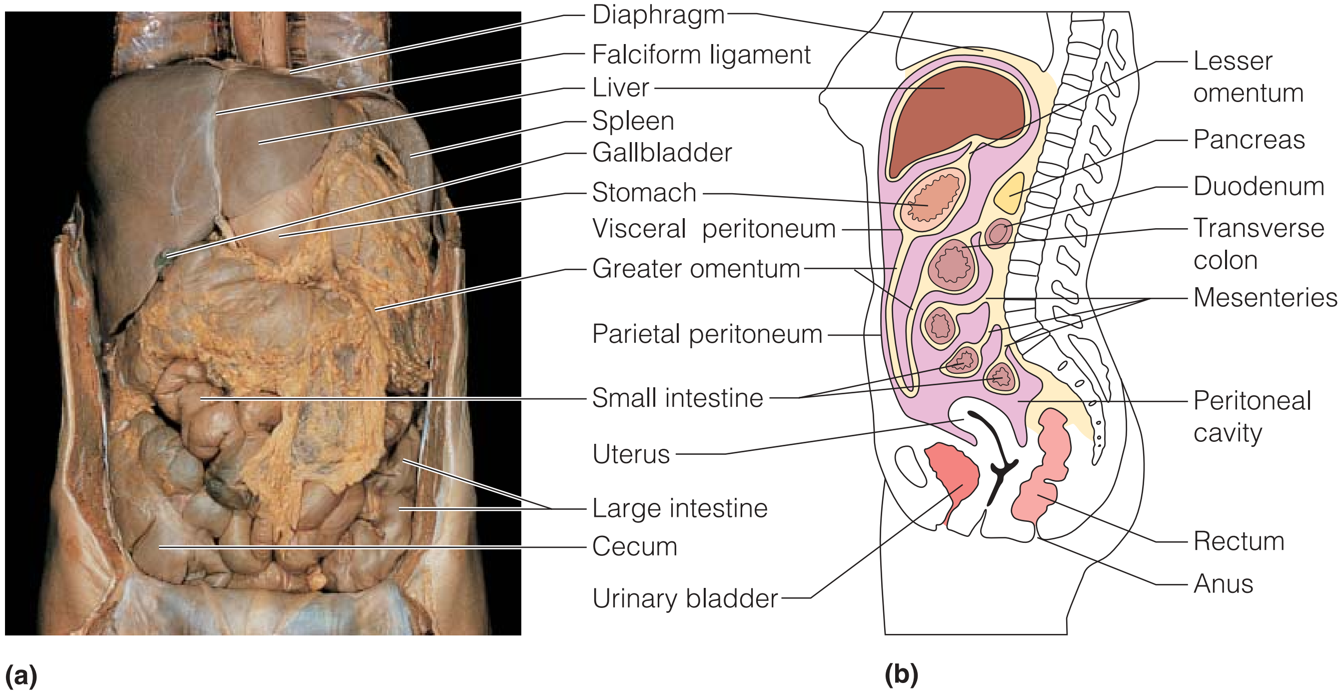

FIGURE 14.5 Peritoneal attachments of the abdominal organs. **(a)** Anterior view; the greater omentum is shown in its normal position, covering the abdominal viscera. **(b)** Sagittal view of the abdominopelvic cavity of a female.

fat, which helps to insulate, cushion, and protect the abdominal organs, and has large collections of lymph nodules containing macrophages and defensive cells of the immune system.

Homeostatic Imbalance

When the peritoneum is infected, a condition called *peritonitis* (per″i-to-ni′tis), the peritoneal membranes tend to stick together around the infection site. This helps to seal off and localize many intraperitoneal infections (at least initially), providing time for macrophages in the lymphatic tissue to mount an attack.

The stomach acts as a temporary "storage tank" for food as well as a site for food breakdown. Besides the usual longitudinal and circular muscle layers, its wall contains a third obliquely arranged layer in the *muscularis externa* (see Figure 14.4a). This arrangement allows the stomach not only to move food along the tract, but also to churn, mix, and pummel the food, physically breaking it down to smaller fragments. In addition, chemical breakdown of proteins begins in the stomach. The mucosa of the stomach is a simple columnar epithelium that produces large amounts of mucus. This otherwise smooth lining is dotted with millions of deep *gastric pits,* which lead into *gastric glands* (Figure 14.4b) that secrete the solution called **gastric juice.** For example, some stomach cells produce *intrinsic factor,* a substance needed for the absorption of vitamin B_{12} from the small intestine. The **chief cells** produce protein-digesting enzymes, mostly **pepsinogens,** and the **parietal cells** produce corrosive hydrochloric acid, which makes the stomach contents acidic and activates the enzymes (Figure 14.4c). The *mucous neck cells* produce a sticky alkaline mucus, which clings to the stomach mucosa and protects the stomach wall itself from being damaged by the acid and digested by the enzymes. Still other cells, the **enteroendocrine cells** (*entero* = gut), produce local hormones, such as *gastrin,* that are important to the digestive activities of the stomach (see Table 14.1 on p. 475).

Most digestive activity occurs in the pyloric region of the stomach. After food has been processed

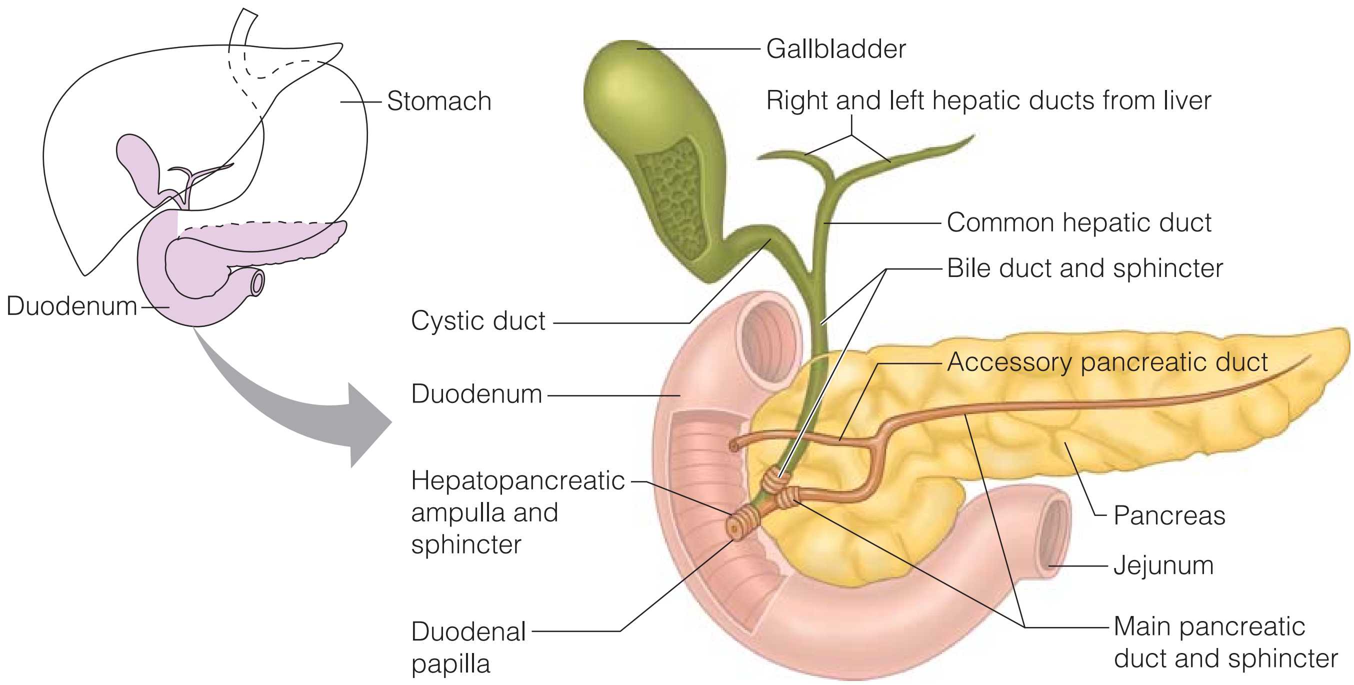

FIGURE 14.6 **The duodenum of the small intestine and related organs.**

in the stomach, it resembles heavy cream and is called **chyme** (kīm). The chyme enters the small intestine through the pyloric sphincter.

Small Intestine

The **small intestine** is the body's major digestive organ. Within its twisted passageways, usable food is finally prepared for its journey into the cells of the body. The small intestine is a muscular tube extending from the pyloric sphincter to the **ileocecal** (il″e-o-se′kal) **valve** (see Figure 14.8, p. 463). It is the longest section of the alimentary tube, with an average length of 2.5 to 7 m (8–18 feet) in a living person. Except for the initial part of the small intestine (the duodenum), which mostly lies in a retroperitoneal position, the small intestine hangs in sausagelike coils in the abdominal cavity, suspended from the posterior abdominal wall by the fan-shaped mesentery (see Figure 14.5). The large intestine encircles and frames it in the abdominal cavity.

The small intestine has three subdivisions: the **duodenum** (du″o-de′num; "twelve finger widths long"), the **jejunum** (je-joo′num: "empty"), and the **ileum** (il′e-um; "twisted intestine"), which contribute 5 percent, nearly 40 percent, and almost 60 percent of the length of the small intestine, respectively (see Figure 14.1). The ileum joins the large intestine at the ileocecal valve.

Chemical digestion of foods begins in earnest in the small intestine. The small intestine is able to process only a small amount of food at one time. The *pyloric sphincter* (literally, "gatekeeper") controls food movement into the small intestine from the stomach and prevents the small intestine from being overwhelmed. Though the C-shaped duodenum is the shortest subdivision of the small intestine, it has the most interesting features. Some enzymes are produced by the intestinal cells. More important are enzymes produced by the pancreas which are ducted into the duodenum through the **pancreatic ducts,** where they complete the chemical breakdown of foods in the small intestine. *Bile* (formed by the liver) also enters the duodenum through the **bile duct** in the same area (Figure 14.6). The main pancreatic and bile ducts join at the duodenum to form the flasklike *hepatopancreatic ampulla* (he-pah″to-pan-kre-a′tik am-pu′lah), literally, the "liver-pancreatic enlargement." From there, the bile and pancreatic juice travel through the *duodenal papilla* and enter the duodenum together.

Q *What is the functional value of the microvilli in the absorptive cells of the small intestine?*

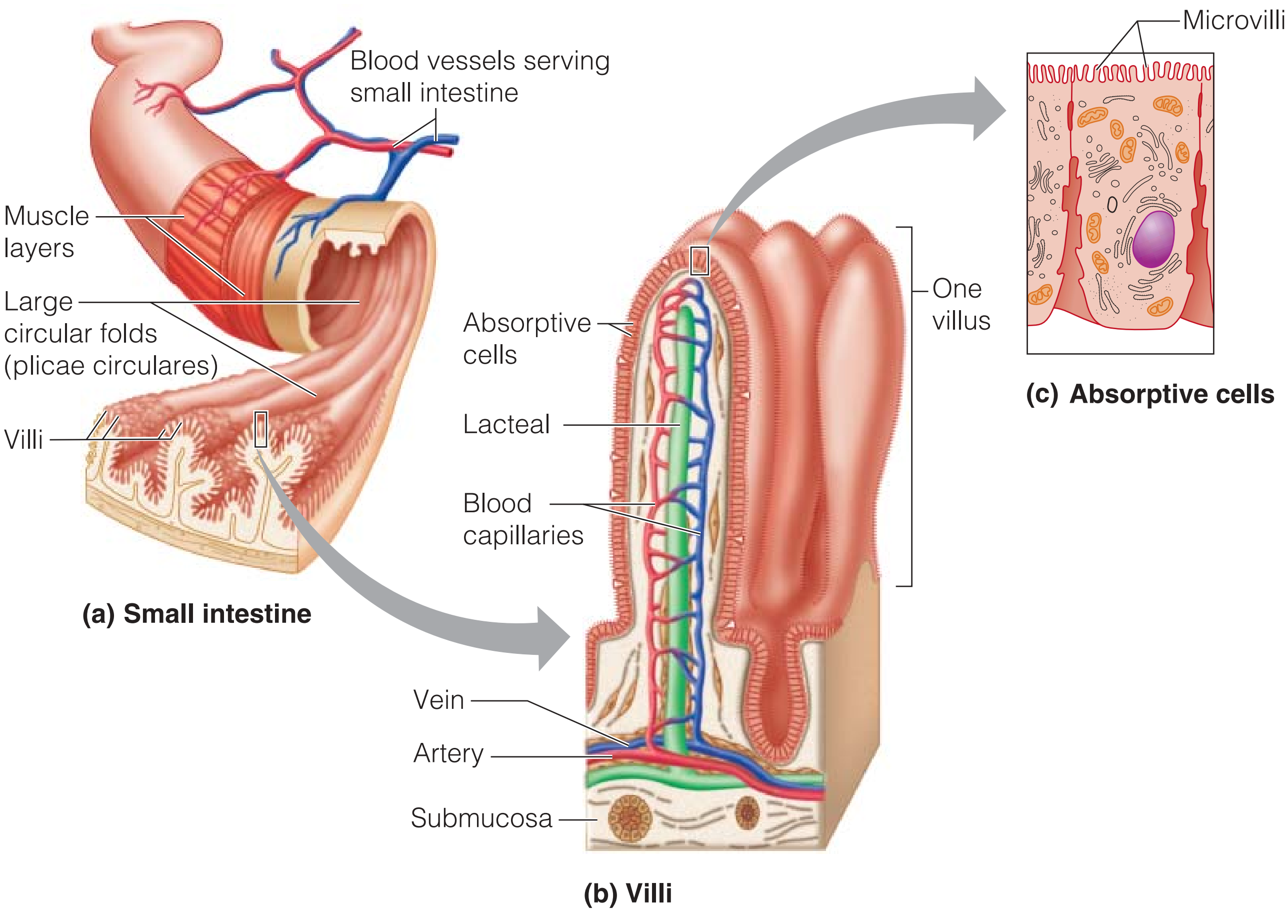

FIGURE 14.7 Structural modifications of the small intestine. **(a)** Several circular folds (plicae circulares), seen on the inner surface of the small intestine. **(b)** Enlargement of one villus extension of the circular fold. **(c)** Enlargement of an absorptive cell to show microvilli (brush border).

Nearly all food absorption occurs in the small intestine. The small intestine is well suited for its function. Its wall has three structures that increase the absorptive surface tremendously—microvilli, villi, and circular folds (Figure 14.7). **Microvilli** (mi″kro-vih′lī) are tiny projections of the plasma membrane of the mucosa cells that give the cell surface a fuzzy appearance, sometimes referred to as the **brush border. Villi** are fingerlike projections of the mucosa that give it a velvety appearance and feel, much like the soft nap of a Turkish towel. Within each villus is a rich capillary bed and a modified lymphatic capillary called a **lacteal.** The digested foodstuffs are absorbed through the mucosal cells into both the capillaries and the lacteal, as discussed on pp. 476–477. **Circular folds,** also called **plicae circulares** (pli′se ser-ku-la′res), are deep folds of both mucosa and submucosa layers. Unlike the rugae of the stomach, the circular folds do not disappear when food fills the small intestine. All these structural modifications, which increase the surface area, decrease in number toward the end of the small intestine. On the other hand, local collections of lymphatic tissue (called **Peyer's patches**) found in the submucosa increase in number toward the end of the small intestine. This reflects the fact that the remaining

A *They tremendously increase the surface area available for absorption of digested foodstuffs.*

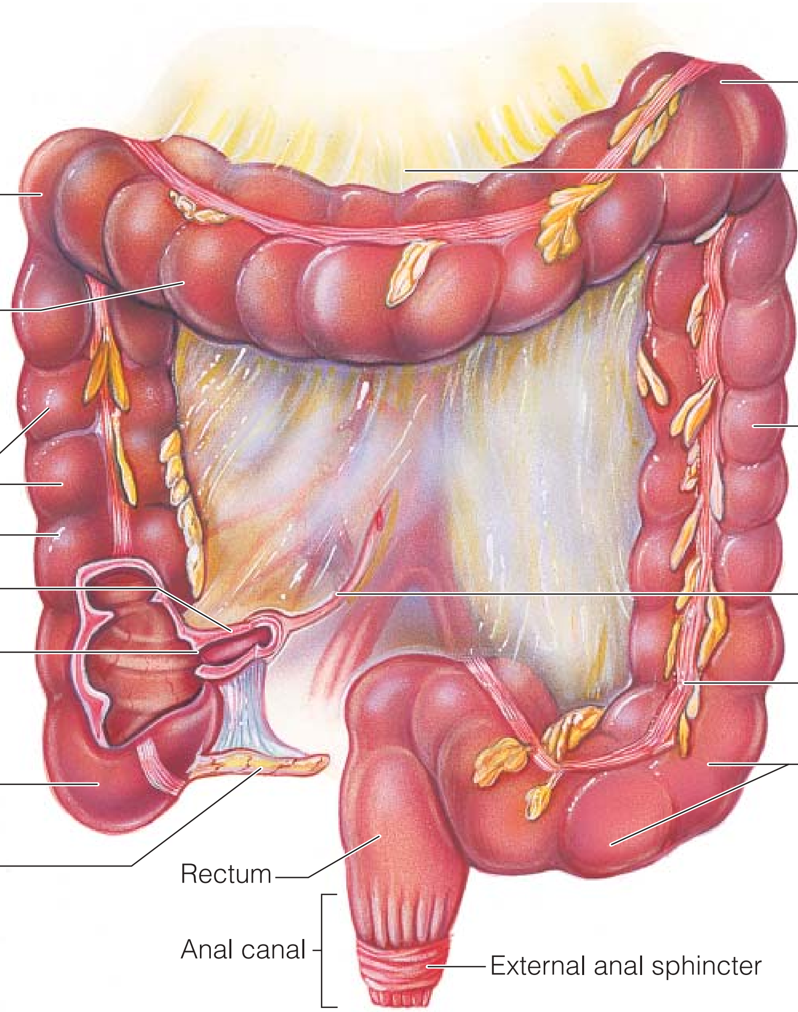

FIGURE 14.8 **The large intestine.** A section of the cecum is removed to show the ileocecal valve.

(undigested) food residue in the intestine contains huge numbers of bacteria, which must be prevented from entering the bloodstream if at all possible.

Large Intestine

The **large intestine** is much larger in diameter than the small intestine (thus its name, the *large* intestine) but shorter in length. About 1.5 m (5 feet) long, it extends from the ileocecal valve to the anus (Figure 14.8). Its major functions are to dry out the indigestible food residue by absorbing water and to eliminate these residues from the body as feces. It frames the small intestine on three sides and has the following subdivisions: **cecum** (se′kum), **appendix, colon, rectum,** and **anal canal.** The saclike cecum is the first part of the large intestine. Hanging from the cecum is the wormlike ("vermiform") appendix, a potential trouble spot. Since it is usually twisted, it is an ideal location for bacteria to accumulate and multiply. Inflammation of the appendix, *appendicitis,* is the usual result. The colon is divided into several distinct regions. The **ascending colon** travels up the right side of the abdominal cavity and makes a turn, the *right colic* (or *hepatic*) *flexure,* to travel across the abdominal cavity as the **transverse colon.** It then turns again at the *left colic* (or *splenic*) *flexure,* and continues down the left side as the **descending colon,** to enter the pelvis,