C. difficile is a major cause of pseudomembranous colitis and antibiotic-associated diarrhea. (Courtesy of the CDC/Dr. Gilda Jones, 1980)

CHAPTER

9

Diseases of the Gastrointestinal System

Learning Objectives

After studying this chapter, you should be able to

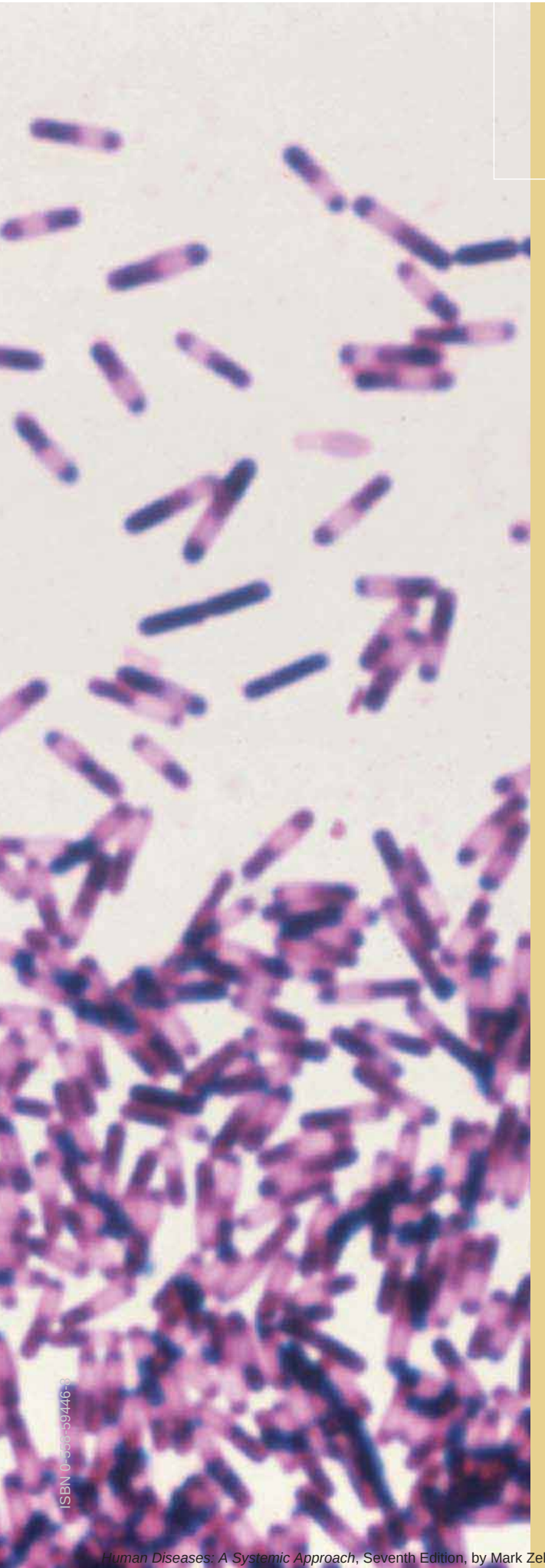
- Describe the normal structure and function of the digestive tract
- Describe the key characteristics of major diseases of the digestive tract
- Name the diagnostic tests for diseases of the digestive tract
- Explain the etiology of gastrointestinal diseases
- Describe the treatment options for diseases of the digestive tract
- Describe the normal structure and function of the liver, gallbladder, and pancreas
- Describe the key characteristics of major diseases of the liver, gallbladder, and pancreas
- Name the diagnostic tests for diseases of the liver, gallbladder, and pancreas
- Explain the etiology of liver, gallbladder, and pancreas diseases
- Describe the treatment options for diseases of the liver, gallbladder, and pancreas
- Describe age-related diseases of the digestive system

Fact or Fiction?

Cancer of the colon or rectum is the second leading cause of cancer-related death in the United States.

Fact: *The American Cancer Society estimates that each year 56,000 Americans will die of colorectal cancer, second only to lung cancer.*

ISBN 0-558-59446-8



Disease Chronicle

Dysentery

Diseases of the digestive system include common ailments familiar to nearly everyone. Some are minor annoyances; others are serious, life-threatening diseases. The impact of digestive system diseases is undeniable. During the American Civil War, 81,360 soldiers died from dysentery, while 93,443 were killed in combat. Even today, 18,000 cases of bacillary dysentery occur annually in the United States. Despite modern medical diagnosis and treatment, cancer of the pancreas, colon, and liver remain deadly, and worldwide, dysentery remains a leading cause of death among children.

ISBN 0-558-39446-3

The Gastrointestinal System

The digestive system consists of a digestive tract through which food passes and accessory organs that assist the digestive process. The digestive tract begins at the mouth and includes the pharynx, esophagus, stomach, small intestine, and large intestine. The accessory organs include the liver, gallbladder, and pancreas (Figure 9–1 ▸).

Digestion begins in the mouth with chewing, the mechanical breakdown of food. Salivation, the secretion of saliva, moistens the food and provides an enzyme for initial digestion of starch. The food is then swallowed and passes through the pharynx, or throat, and into the esophagus.

The moistened food moves down the esophagus to the stomach. A sphincter muscle at the juncture of the esophagus and stomach prevents regurgitation while digestion continues. The stomach secretes gastric juice that contains enzymes, biological catalysts that act on protein. Gastric juice also contains hydrochloric acid, which activates these enzymes. The acidic gastric contents would be irritating to the stomach lining if the lining were not protected by a thick covering of mucus. A great deal of moistening and mixing occurs within the stomach. The moistened, mixed, and acidic food is called chyme.

Chyme passes from the stomach into the small intestine through a sphincter muscle, the **pyloric sphincter**. This sphincter is closed until it receives nerve and hormonal signals to relax and open. Chyme is propelled along its course by rhythmical, smooth muscle contractions of the intestinal wall called **peristalsis**.

Most digestion occurs in the first part of the small intestine, the **duodenum**. Intestinal secretions contain mucus and digestive enzymes, which enter by means of the pancreatic duct from the pancreas. The pancreas secretes enzymes that digest protein, lipid, and carbohydrate. It also secretes an alkaline solution for the neutralization of acid carried into the small intestine from the stomach.

Bile, secreted by the liver and stored in the gallbladder, enters the duodenum through the common bile duct. Bile is not an enzyme but an emulsifier, a substance that reduces large fat droplets into much smaller fat droplets, enabling the lipid enzymes to digest fat into small, absorbable units.

When digestion is complete, nutrients such as sugars and amino acids are absorbed into blood capillaries and lymph vessels in the intestinal wall. The inner surface of the small intestine is arranged to provide the greatest amount of surface area possible for digestion and absorption. This mucosal surface contains numerous fingerlike projections called villi, each of which contains capillaries and lymph vessels for absorption (Figure 9–2 ▸).

Material not digested passes into the large intestine, or colon. The first part of the colon is the cecum, to which the appendix, a fingerlike mass of lymphatic tissue, is attached. Water and minerals are absorbed from the large intestine, and the remaining matter is excreted as feces.

In this chapter, the diseases of each part of the digestive system are described. These include diseases of the mouth, esophagus, stomach, small and large intestines, pancreas, liver, and gallbladder.

General Disorders of the Digestive Tract

General disorders of the digestive system, such as vomiting, diarrhea, constipation, and hemorrhoids are not diagnoses in themselves. These common disorders are signs and symptoms and could indicate the presence of any number of different diseases. The physiologic basis and significance of each disorder is described briefly.

Vomiting

Vomiting is a protective mechanism, a response to the presence of an irritant or infection, a distention, or a blockage. These stimulate sensory nerve fibers, and the message is conveyed to the vomiting center in the medulla of the brain. Motor impulses then stimulate the

ISBN 0-558-59446-8

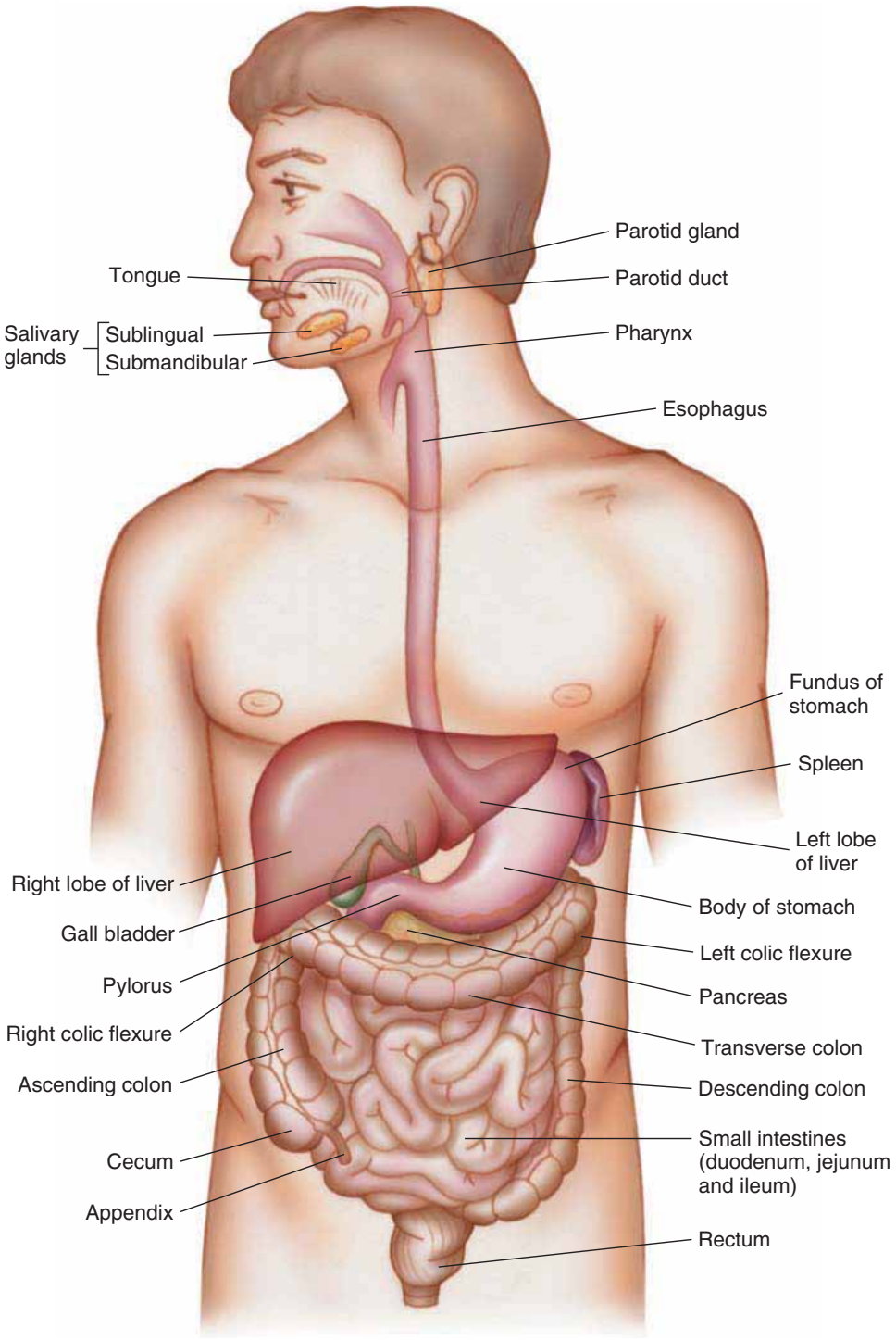


Figure 9–1 ▶ The gastrointestinal system.

diaphragm and abdominal muscles; contraction of these muscles squeezes the stomach. The sphincter at the base of the esophagus is opened, and the gastric contents are **regurgitated**. A feeling of nausea often precedes vomiting. The cause of the nausea may be factors other than a gastric or intestinal irritant. Motion sickness produces this effect. A very unpleasant smell or sight can cause nausea with possible subsequent vomiting.

ISBN 0-558-59446-8

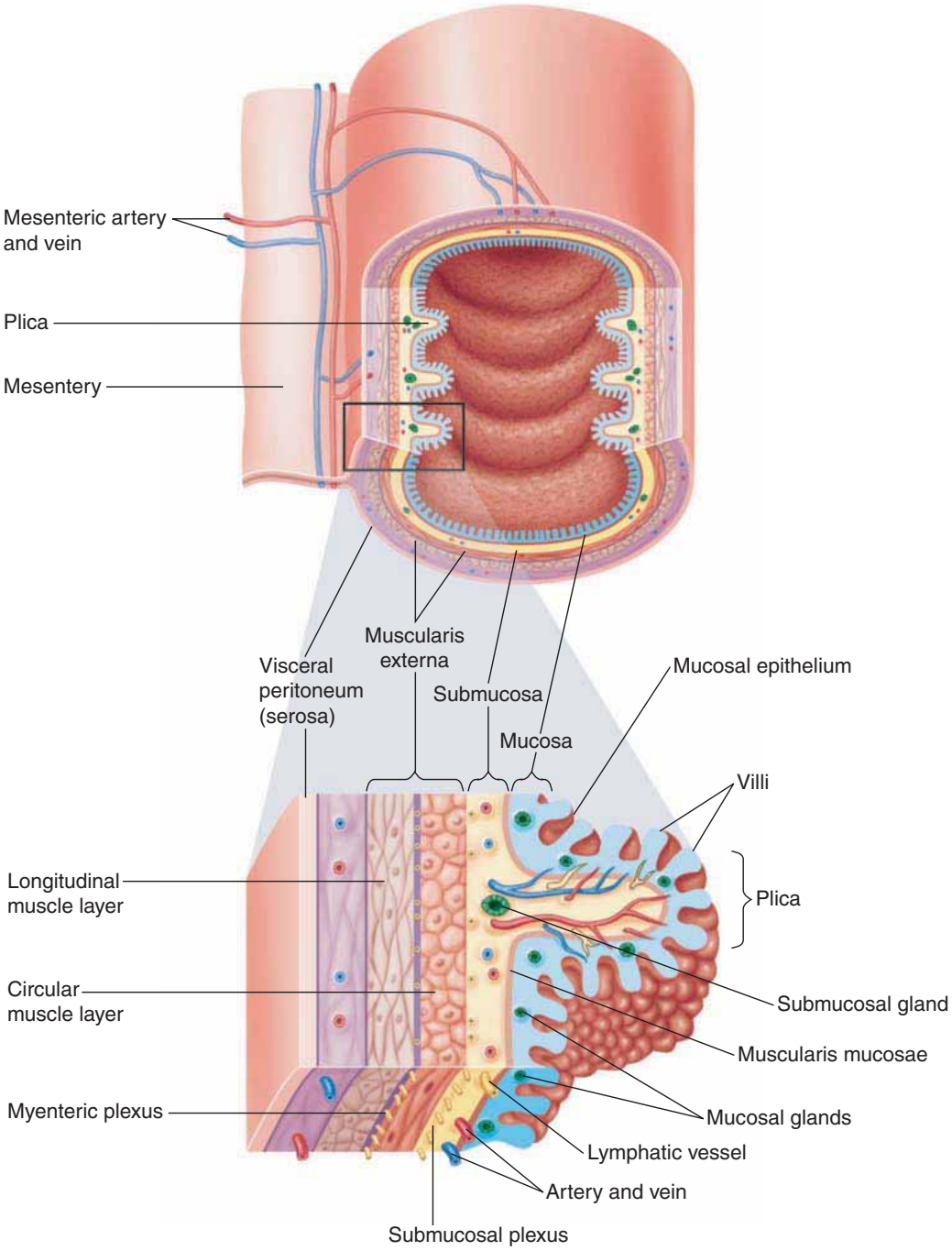


Figure 9–2 ► Mucosal surface of the small intestine.

ISBN 0-558-59446-8

Diarrhea

Diarrhea is the frequent passage of watery stools and results when the contents of the small intestine are rushed through the large intestine. It was stated earlier that the main function of the large intestine is to reabsorb water and minerals. In an episode of diarrhea, there is no time to reabsorb water because the smooth muscle in the walls of the intestine is so stimulated that peristalsis is intensified. Anxiety and stress can trigger this increased motility of the large intestine. Intestinal infections and food poisoning also can increase intestinal motility or impair water absorption by mucosal cells.

Constipation

Constipation is the inability to eliminate feces from the colon and results when feces become hard and dry. Poor habits of elimination, dehydration, and low-fiber diets may cause constipation. Defecation should be allowed to occur when the defecation reflexes are strong; otherwise feces remain in the colon too long, excessive water reabsorption occurs, and the feces become dry, making elimination difficult. A diet containing adequate amounts of fiber aids elimination by providing bulk, which stimulates intestinal motility. Fiber is obtained from fresh fruits, vegetables, and cereals. This chapter will discuss several disorders and diseases of the digestive system that cause constipation.

Hemorrhoids

Hemorrhoids are varicose veins in the lining of the rectum near the anus. Hemorrhoids may be internal or external. A physician can observe internal hemorrhoids with a **proctoscope**, a hollow tube with a lighted end. External hemorrhoids can be seen with a handheld mirror and appear blue because of decreased circulation; they can become red and tender if inflamed. Causes of hemorrhoids include heredity, poor dietary habits, inadequate fiber, overuse of laxatives, and lack of exercise. Straining to have a bowel movement can cause bleeding or cause the hemorrhoid to **prolapse**, or come through the anal opening. Hemorrhoids frequently develop during pregnancy because of pressure from an enlarged uterus. Treatment includes adding fiber and water to the diet and stool softeners to reduce straining and subsequent inflammation. Medicated suppositories and anorectal creams relieve pain and reduce inflammation.

Diseases of the Mouth

Complete coverage of diseases of the mouth is beyond the scope of this book. This chapter focuses instead on the major oral inflammatory diseases and neoplasms. Diseases of the mouth can adversely affect the ability to taste, chew, moisten, and swallow food.

Oral Inflammation

Oral inflammation, or **stomatitis**, refers to a widespread inflammation of oral tissue. Depending on the cause, stomatitis may appear as patches, ulcers, redness, bleeding, or necrosis. Stomatitis can be caused by local infection of the mouth with bacteria, viruses, or fungi, or it may be a sign of a systemic infection.

Streptococci, spread in salivary and respiratory droplets, are a common cause of oral and throat bacterial infections, resulting in red, swollen mucosa. Bacteria also cause canker sores, small circular lesions with a red border. These painful lesions heal without scars after a week. *Neisseria gonorrhea,* the cause of the sexually transmitted disease gonorrhea, causes painful ulcerations in the mouth and throat. Also sexually transmitted, *Treponema pallidum* causes syphilis, which causes oral chancres and ulcerations. These bacterial infections are treated with antibiotics.

Herpes simplex is a common cause of oral virus infections. Transmitted by oral–genital contact, herpes simplex type 2 causes vesicles that rupture to form ulcers. These lesions can appear inside and outside the mouth. Herpes simplex type 1 can also be acquired from salivary droplets. Pain makes eating, drinking, and swallowing difficult. The symptoms typically

ISBN 0-558-59446-8

subside within two weeks when the viruses move from the area to nerve tissue known as ganglia. The infection can be reactivated following stressful events or suppression of immune function. Treatment is aimed at reducing inflammation and pain with systemic anti-inflammatory and analgesic medications or topical anesthetics.

The fungus *Candida albicans* is present in the mouth in low levels normally, but can grow excessively in normal newborns and those with immune deficiencies or following long courses of antibiotic or corticosteroid treatment. The fungal overgrowth, called candidiasis or thrush, forms painless white patches that resemble cheese curds. Removing the white patches leaves a raw, damaged mucosal surface. Candidiasis of the esophagus causes throat pain and difficulty swallowing. Antibiotics and antiviral medications are not effective treatments for fungal infections (see Chapter 3). Oral candidiasis is treated with oral antifungal agents fluconazole, nystatin, or clotrimazole.

Cancer of the Mouth

The most common form of oral cancer is squamous cell carcinoma. Most of these cancers appear on the floor of the mouth, tongue, and lower lip. An aggressive form of the cancer occurs on the upper lip. Mouth and throat cancer ranks eleventh among the leading causes of cancer death worldwide. While the causes remain unknown, it is clear that tobacco, smokeless tobacco, and alcohol use are major risk factors, and it appears that use of alcohol and tobacco in combination increases the risk. Treatment for lip and tongue cancer includes surgical removal. Radiation therapy may be used to treat local cancers on the floor of the mouth. See Chapter 4 for oral cancer specifics.

▶ Diseases of the Esophagus

The function of the esophagus is the controlled passage of food to the stomach. Esophageal disease manifests itself as **dysphagia**, or difficult or painful swallowing.

Cancer of the Esophagus

Cancer of the esophagus occurs most commonly in men over 60 and is nearly always fatal. The disease ranks sixth among leading causes of cancer death worldwide but is most common in Japan, China, the Middle East, and parts of South Africa. Like mouth cancer, tobacco and alcohol use are major risk factors. The cancer narrows the esophageal lumen, causing the principal symptom, dysphagia. The obstruction causes vomiting, a bad taste in the mouth, and bad breath. Esophageal cancer is accompanied by weight loss because of the inability to eat. Diagnosis includes x-ray with barium swallow to study motility and functional defects. The cancer frequently metastasizes into adjacent organs, usually the lungs and liver, and to remote sites through the lymph vessels before it is detected. Because of early metastasis, the prognosis for esophageal cancer is poor. See Chapter 4 for further information on esophageal cancer.

Esophageal Varices

Varicose veins that develop in the esophagus are called **esophageal varices**. Cirrhosis of the liver is the chief cause of esophageal varices. Cirrhosis impairs blood flow through the liver, which elevates pressure in the veins of the abdomen and elsewhere, including the esophagus. The increased venous pressure causes the esophageal veins to dilate and become knotty. The most serious danger in esophageal varices is hemorrhage. Bleeding esophageal varices require emergency treatment. Diagnosis usually requires endoscopy. Infusion of vasopressin may reduce bleeding, or bleeding can be stopped with pressure on the varices by inserting a Minnesota or Sengstaken-Blakemore tube. These are temporary measures: Surgical bypass of the portal vein to systemic circulation may reduce pressure in the veins and thus stop bleeding, but it will not repair liver damage and ultimately will not improve the prognosis.

Esophagitis and GERD

Esophagitis, inflammation of the esophagus, causes burning chest pains, "heartburn," which

ISBN 0-558-59446-8

can resemble the pain of heart disease. The pain may follow eating or drinking, and some vomiting of blood may occur. The most common trigger of esophagitis is a **reflux**, a backflow of the acid contents of the stomach. The condition is known as **gastroesophageal reflux disease** or **GERD**. GERD may be caused by an incompetent **cardiac sphincter**, which normally prevents stomach contents from ascending the esophagus. Other causes include hiatal hernia and medications that compromise the sphincter or induce excess acid secretion. The incidence of GERD increases with age, which suggests that age-related changes occur in the sphincter. Whatever the cause, regurgitated stomach acid irritates the lining of the esophagus and stimulates an inflammatory response. Diagnosis is based on history, signs, symptoms, as well as barium fluoroscopy, measure of esophageal pH, or endoscopy. Risk factors for GERD include old age, obesity, and pregnancy. Treatment includes a nonirritating diet, antacids, and acid-reducing medications. Frequent, small meals are recommended. Painful symptoms frequently occur at night while the body lies prone and relaxed; thus patients are advised to sleep with head elevated and to avoid eating 2 to 3 hours before sleeping. Alcohol is an irritant to the inflamed mucosal lining and should be avoided.

Hiatal Hernia

A hernia is the protrusion of part of an organ through a muscular wall or body opening. A **hiatal hernia** is the protrusion of part of the stomach through the diaphragm at the point where the esophagus joins the stomach. The condition is caused by either a congenital defect in the diaphragm or by increased intraabdominal pressure associated with obesity. Figure 9–3► shows this condition. Indigestion and heartburn may occur after eating; shortness of breath may also occur. Diagnosis is based on a chest x-ray that may show air behind the heart, or a barium radiograph that can show a bulge at lower esophagus, or endoscopy to visualize the hernia and rule out cancer or varices. The aim of treatment is to reduce symptoms. The most effective treatment is cholinergic drugs,

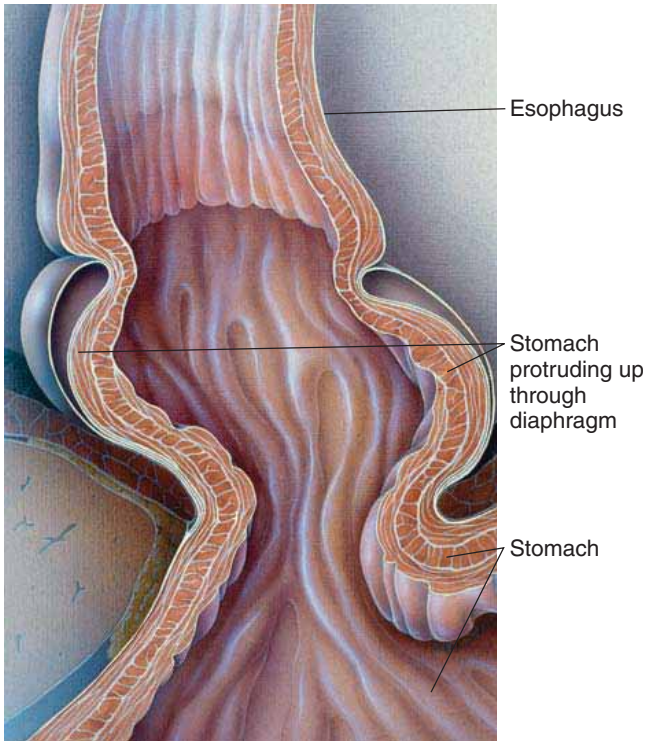


Figure 9–3 ► Hiatal hernia. (© K. Somerville/Custom Medical Stock Photo)

which strengthen the cardiac sphincter and reduce reflux after eating. Patients should avoid irritants such as spicy foods and caffeine, should take frequent small meals, and, if obese, should lose weight. Surgery may be required to correct the structural defect, but hiatal hernias tend to recur following surgery.

▶ Diseases of the Stomach

The stomach is well adapted for storing and mixing food with acid and enzymes. Alterations in the stomach lining or malignancies can cause painful and sometimes serious disease.

Gastritis

Acute **gastritis** is an inflammation of the stomach frequently accompanied by vomiting of blood. Acute gastritis is caused by irritants

ISBN 0-558-59446-8

such as aspirin, excessive coffee, tobacco, alcohol, or infection. Acute alcoholism is a major cause of hemorrhagic gastritis. Chronic alcohol use stimulates acid secretion, which irritates the mucosa. **Gastroscopy** with biopsy is extremely valuable in diagnosing this disease. A camera may be attached to the gastroscope, and the entire inner stomach is photographed. Treatment includes avoiding the aforementioned irritants and treating infections. Medical treatment includes cimetidine, which blocks gastric secretion. If bleeding is involved, surgery may be required.

Chronic Atrophic Gastritis

Chronic atrophic gastritis is a degenerative condition in which the stomach lining does not secrete intrinsic factor and hydrochloric acid. Intrinsic factor is required for absorption of vitamin B_{12}, and hydrochloric acid aids protein digestion. Chronic atrophic gastritis may be caused by stomach cancer, chronic alcoholism, or chronic exposure to certain irritants such as alcohol, aspirin, and certain foods. The term **atrophic** (wasting) suggests that little can be done to treat this disease. The underlying diseases or causes should be eliminated.

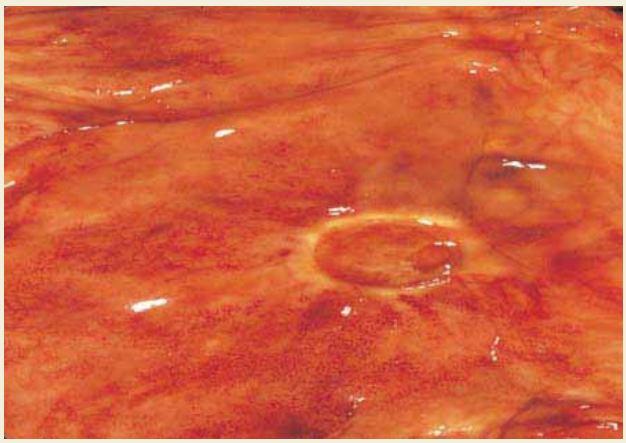
Peptic Ulcers

Ulcers are lesions of any body surface where necrotic tissue forms as a result of inflammation and is sloughed off, leaving a hole. Ulcers of the stomach and small intestine are termed **peptic ulcers**. Ulcers of the stomach are called **gastric ulcers**, and those of the small intestine are called **duodenal ulcers**. Approximately 80% of peptic ulcers are duodenal ulcers and occur most frequently in men between ages 20 and 50. Figure 9–4 ▸ shows common sites of peptic ulcers.

Peptic ulcers have three main causes, including infection with ***Helicobacter pylori***, use of nonsteroidal anti-inflammatory drugs, and an inherited disorder of acid hypersecretion. Because hydrochloric acid secretion is under nerve and hormonal control, stressful situations can trigger or exacerbate ulcers. Gastric contents contribute to ulcer formation in all cases. The ulcers are caused, in part, by pepsin, a proteolytic enzyme secreted by the stomach. Hydrochloric acid of the stomach and intestinal juice, including bile, which is regurgitated through the pyloric sphincter, also irritate the gastric mucosa. Irritated and inflamed mucous membrane may become necrotic, leaving a hole.

SIDE by SIDE ■ Gastric Ulcer

▲ Normal mucosa showing openings of gastric glands. (© C. Abrahams, M.D./Custom Medical Stock Photo)



▲ Superficial gastric ulcer in the stomach lining.

ISBN 0-558-59446-8

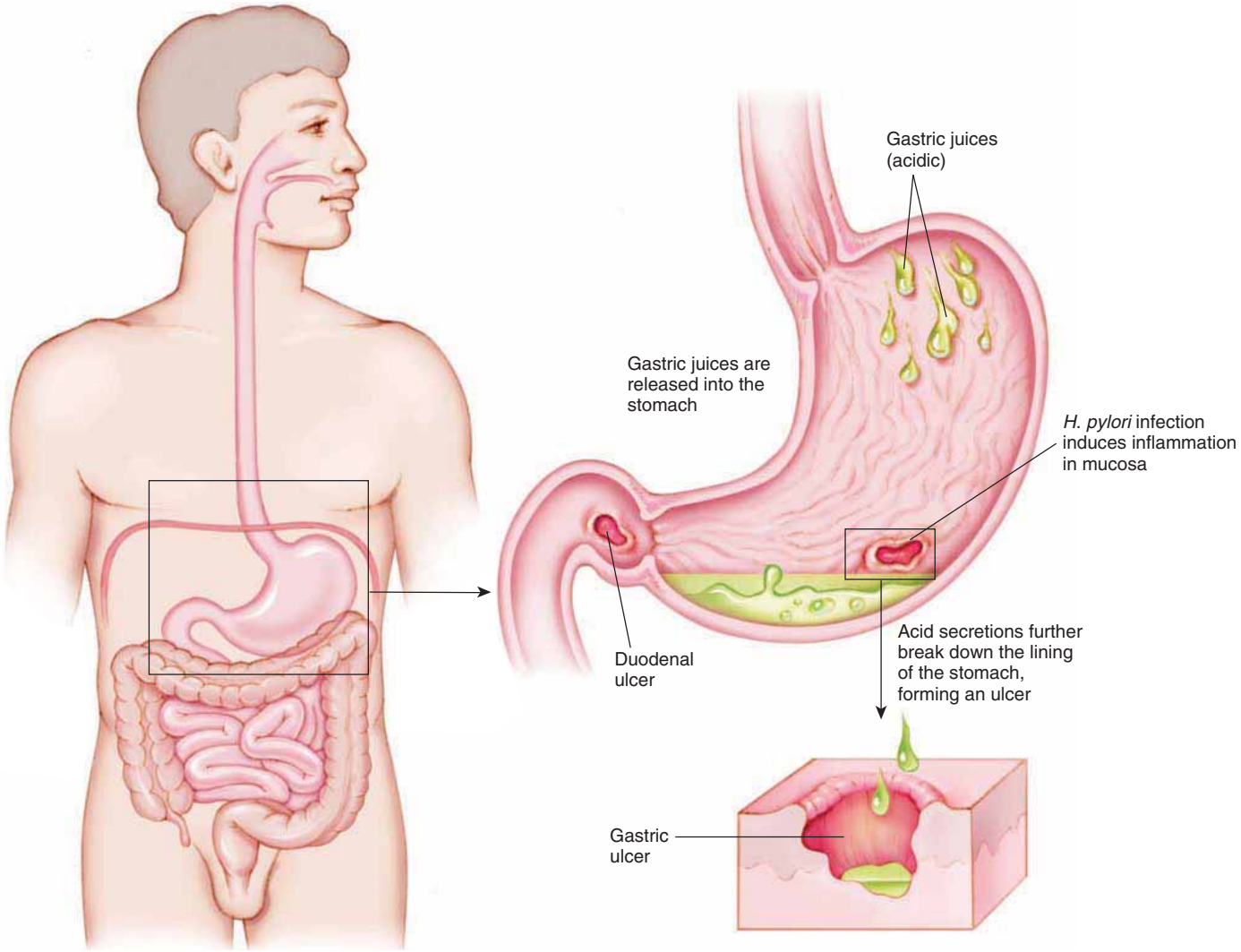


Figure 9–4 ► Peptic ulcer disease (PUD).

Heartburn and indigestion are frequently the first signs of an ulcer. The ulcer pain is caused by the action of hydrochloric acid on the exposed surface of the lesion. The muscular contractions of peristalsis also intensify the pain. Symptoms of gastric ulcer include nausea, vomiting, abdominal pain, and, occasionally, massive gastrointestinal bleeding.

A potential complication of any ulcer is hemorrhage; severe hemorrhage may lead to shock. It is possible for a large artery at the base of the ulcer to rupture as the lesion erodes deeper into underlying tissues. Bleeding from the ulcer may appear as **hematemesis** or bloody vomitus, or the blood may appear in stools, where it gives the stools a dark, tarry appearance, referred to as **melena**. A serious ulcer complication is **perforation**. If an ulcer perforates—that is, breaks through the intestinal or gastric wall—there is sudden and intense abdominal pain. **Peritonitis**, inflammation of the lining of the abdominal cavity, usually results when the digestive contents enter the cavity, because this material contains numerous bacteria. Surgical repair of the perforation is required immediately. Obstruction of the gastrointestinal tract can result from an ulcer and the scar tissue surrounding it. Obstruction occurs most frequently in a narrow

ISBN 0-558-59446-8

area of the stomach, near the pyloric sphincter. Ulcer pain can cause the sphincter to go into spasm, also resulting in obstruction.

Diagnosis is based on an upper gastrointestinal barium swallow, an x-ray, detection of blood in stools, blood tests to determine elevated levels of white blood cells, and gastric content analysis. The main objectives of treatment for peptic ulcer disease are to promote healing, prevent complications and recurrences, and provide pain relief. Acid reducers, such as omeprazole or ranitidine, are more effective for peptic ulcers than are antacids and mucosal barriers such as sucraflate. However, antibiotic therapy in combination with acid reducers is required to eradicate *H. pylori* and to reduce the rate of ulcer relapse. If the ulcer is stress or tension related, certain changes in lifestyle or approach to stress might be beneficial.

Gastroenteritis and Food Poisoning

Gastroenteritis is an inflammation of the stomach and intestines. Symptoms include anorexia, nausea, vomiting, and diarrhea. The onset may be abrupt, with rapid loss of fluid and electrolytes. Possible causes are bacterial or viral infection, chemical toxins, lactose intolerance, or other food allergy, although the actual cause is not always clear. Treatment replaces fluid and nutritional requirements, including the lost salts. Antispasmodic medications can control the vomiting and diarrhea.

Food contaminated with human or animal feces may carry microorganisms that cause gastroenteritis and food poisoning. *Escherichia coli* is a normal inhabitant of human or animal intestines. Certain strains may cause disease, like traveler's diarrhea, or more serious diseases, like hemolytic uremic syndrome, in which toxins cause potentially fatal shutdown of the kidneys. To prevent infection, cook meat thoroughly and practice good hygiene in the kitchen.

One of the common forms of food poisoning is caused by the bacterium *Salmonella.* These bacteria invade the intestinal mucosa and cause sudden, colicky abdominal pain, nausea, vomiting, and sometimes bloody diarrhea and fever that begins approximately 6 to 48 hours after eating contaminated food and lasts up to 2 weeks. A stool culture can identify the bacteria. *Salmonella* food poisoning (salmonellosis) is associated with contaminated eggs and poultry, but most any food may harbor the bacteria. Treatment usually consists of replenishing water, electrolytes, and nutrients. Elderly individuals, young children, and immunocompromised people are at risk of developing serious infection, and they may require more intervention, including a short course of antibiotics and antidiarrheal medications.

Cancer of the Stomach

Cancer of the stomach may be a large mass projecting into the lumen of the stomach, or it may invade the stomach wall, causing it to thicken. As the tumor grows, the lumen is narrowed to the point of obstruction. The remainder of the stomach becomes extremely dilated due to the blockage, and pain results from pressure on nerve endings. Infection frequently accompanies cancer, which causes additional pain. Because pain is not an early sign, carcinoma of the stomach may be very advanced before it is detected. It may even have spread to the liver and surrounding organs through the lymph and blood vessels. Early symptoms are vague and include loss of appetite, heartburn, and general stomach distress. Blood may be vomited or appear in the feces. Pernicious anemia generally accompanies cancer of the stomach, because the gastric mucosa fails to secrete intrinsic factor. The etiology of this malignancy is not known, but current research suggests an association with the consumption of preserved, salted, cured foods and a diet low in fresh fruits and vegetables. The incidence of stomach cancer in the United States has dropped dramatically over the past 30 years; it has become an uncommon disease and accounts for less than 1% of all cancers. Today the mortality rate for stomach cancer is about 6 per 100,000 men. Stomach cancer is the ninth leading cause of cancer death in men, and is more prevalent among men over age 40 than among women. Stomach cancer is not among the ten leading causes of cancer death among women.

Gastric analysis by means of a stomach tube demonstrates the absence of hydrochloric acid, or **achlorhydria**. Biopsy of any lesions seen

ISBN 0-558-59446-8

through the gastroscope is an essential diagnostic procedure for carcinoma of the stomach.

H. pylori infection appears to increase the risk for stomach cancer, probably through its damaging effects on the mucosal cells. Good prognosis for this disease depends on early detection and treatment. See Chapter 4 for more information.

Diseases of the Intestines

The small intestine is the site of most of the digestion and absorption that occurs in the digestive tract, while the large intestine absorbs remaining water and stores and concentrates the feces. Diseases in these areas may manifest themselves as diarrhea, constipation, changes in stool characteristics, or secondary diseases that arise as a result of poor nutrition.

Appendicitis

Appendicitis is an acute and painful inflammation of the appendix. Appendicitis can occur at any age, but it is more common for males before puberty to age 25. The wormlike shape of the appendix and its location on the cecum make it a trap for fecal material, which contains bacteria, particularly *Escherichia coli.* Figure 9–5 ▸ illustrates this potential site of infection. Obstruction with fecal material and infections cause the appendix to become swollen, red, and covered with an inflammatory exudate. Because the swelling interferes with circulation to the appendix, it is possible for **gangrene** to develop. The appendix then becomes green and black. The wall of the appendix can become thin and rupture, spilling fecal material into the peritoneal cavity, causing **peritonitis**. Before antibiotic treatment, peritonitis was almost always fatal. Rupture of the appendix tends to give relief from the pain, which is very misleading.

Diagnosis depends on physical exam. The pain of appendicitis is not always typical, but it often begins in the middle of the abdomen and shifts to the lower right quadrant. Patients may walk or lie bent over and draw the right leg up to the abdomen to seek pain relief. Other diagnostic signs and symptoms include nausea, vomiting, fever of between 99°F and 102°F, and elevated white blood cell count. Untreated appendicitis is fatal, and surgery must be performed before rupture occurs.

Malabsorption Syndrome

The inability to absorb fat or some other substance from the small intestine is known as **malabsorption syndrome**. Signs and symptoms of malnutrition occur, including lack of energy and inability to maintain weight. Because fat cannot be absorbed from the intestine, it passes into the feces, and the result is unformed, fatty, pale stools that have a foul odor. The fat content causes the stools to float.

Although defective mucosal cells can cause the abnormal absorption, other diseases can result in secondary malabsorption syndrome. A diseased pancreas or blocked pancreatic duct deprives the small intestine of **lipase**. In the

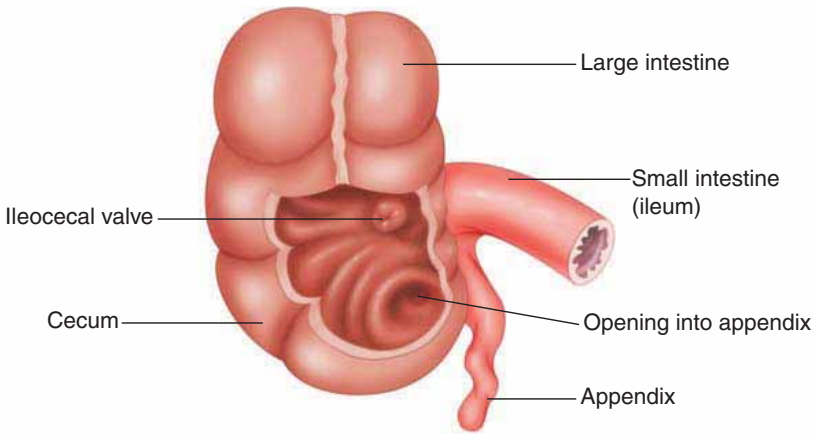


Figure 9–5 ▸ Appendix attached to cecum into which the small intestine empties.

ISBN 0-558-59446-8

Prevention PLUS!

Bacteria, Coolers, and Food Poisoning

Refrigeration and freezing do not kill bacteria. The cold temperature inhibits their growth, which can resume at warmer temperatures. Bacteria can multiply rapidly; under optimum conditions, they may double their numbers every 30 minutes. A contaminated potato salad may be safe to eat right out of the refrigerator, but it may become the source of a serious infection if brought to a picnic and left to stand at air temperature for a couple of hours. In other words, it is a good idea to keep the potato salad in the cooler while you are playing softball at your next picnic!

absence of lipase, fat is not digested and cannot be absorbed. Inadequate bile secretion, due to liver disease or a blocked bile duct, also prevents lipid digestion and causes secondary malabsorption. One of the complications of the malabsorption syndrome is a bleeding tendency. Vitamin K, a fat-soluble vitamin that is essential to the blood-clotting mechanism, cannot be absorbed. Treatment for malabsorption syndrome depends on its cause, and diet is carefully controlled. Supplements are administered, such as the fat-soluble vitamins A, D, E, and K.

Celiac Disease

Celiac disease is associated with gluten intolerance and is characterized by poor nutrient absorption. Signs and symptoms include recurrent diarrhea, gas, abdominal cramps, and systemic signs of malnutrition due to low caloric intake and poor absorption of vitamins. Onset is usually by age 1, when wheat products are first consumed. Celiac disease seems to be genetic, may involve immune dysfunction, affects twice as many females as males, and is more common among whites of European ancestry. Celiac disease affects about 2 million Americans, or 1 in 133 people. Celiac disease is diagnosed by the signs and symptoms as well as by biopsy of the small intestine, which reveals atrophy and flattening of intestinal villi. Treatment involves elimination of gluten from the diet, fluid replacement, and vitamin supplements.

Diverticulitis

Diverticula are little pouches or sacs formed when the mucosal lining pushes through the underlying muscle layer of the intestinal wall. This condition is called **diverticulosis** and may cause no harm in itself. **Diverticulitis** is an inflammation of the diverticula. Diverticulitis occurs when the sacs become impacted with fecal material and bacteria. The patient experiences low, cramplike pain, usually on the left side of the abdomen. As inflammation spreads, the lumen of the intestine narrows, an obstruction can develop, and abscesses frequently form. Diverticular disease is most prevalent in Western industrialized nations where fiber consumption is lowest. About 50% of older adults develop diverticulosis. Diverticular disease is diagnosed with a barium enema. Antibiotic therapy, together with a controlled diet, is usually effective. Figure 9–6▸ shows an example of diverticulitis.

Regional Enteritis (Crohn's Disease)

Regional enteritis is an inflammatory disease of the intestine that most frequently affects the upper colon and sometimes the distal end of the ileum. Crohn's disease is most prevalent in adults ages 20 to 40, is two to three times more common among Jewish populations, and is least common in blacks. Possible causes include allergies, immune disorders, or stress, but the exact cause remains unknown. As inflammation progresses, the intestinal walls become thick and rigid. With thickening, the lumen narrows and a chronic obstruction develops. The pain of regional enteritis resembles that of appendicitis, occurring in the lower right quadrant of the abdomen, where a tender mass may be felt. Diarrhea alternating with constipation, and **melena** (dark stools containing blood pigments) are common. Severe diarrhea can cause an electrolyte imbalance because of the large amount of water and salt lost in the stools. **Anorexia**, nausea, and vomiting lead to weight loss. Periods of exacerba-

ISBN 0-558-59446-8

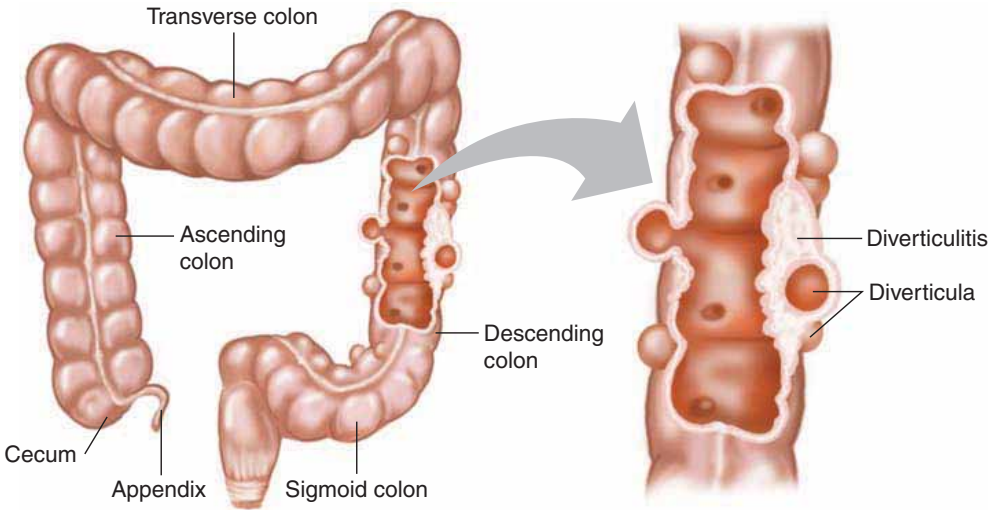


Figure 9–6 ► Diverticulitis.

tion, remission, and relapse are common; during flare-ups, the inflammation can also manifest as rheumatoid arthritis. Severe cases entail a risk for hemorrhage or perforation. Crohn's disease is diagnosed by elevated levels of white blood cells; low levels of potassium, calcium, and magnesium; and by sigmoidoscopy or colonoscopy. Biopsy confirms the diagnosis. Crohn's disease is usually treated with anti-inflammatory medications such as corticosteroids and aminosalicylates, and with immunosuppressive agents such as azathioprine, sulfasalazine, and olsalazine. Surgery is performed to correct complications such as obstruction, perforation, or massive hemorrhage. Ileostomy is necessary if the large intestine has been severely damaged.

Chronic Ulcerative Colitis

Chronic ulcerative colitis is a serious inflammation of the colon characterized by extensive ulceration of the colon and rectum. The incidence of ulcerative colitis remains unknown but may be as much as 100 per 100,000. Ulcerative colitis occurs primarily in young adults, especially women, and usually begins between ages 15 and 20. No known causes have been found; however, ulcerative colitis may be related to autoimmunity, *E. coli* infection, stress, or hypersensitivity to certain foods.

Typical symptoms include diarrhea with pus, blood, and mucus in the stools, and cramplike pain in the lower abdomen. Periods of remission and exacerbation are common in ulcerative colitis. Anemia often accompanies ulcerative colitis because of the chronic blood loss through the rectum. Increased risk for colon malignancy is associated with long-standing ulcerative colitis.

Diagnosis is based on colonoscopy and a barium x-ray in which the colon has a characteristic appearance; the normal pouchlike markings of the colon are lacking, and the colon appears straight and rigid, a "**pipestem colon.**"

Treatment is aimed at reducing symptoms, replacing nutrients, stopping blood loss, and preventing complications. The symptoms may be alleviated by reducing stress, eliminating foods found to trigger symptoms, and taking adrenal corticosteroids such as prednisone and hydrocortisone to control autoimmunity. If these treatments are not effective, surgery may be necessary, occasionally requiring a colostomy. A **colostomy** is an artificial opening in the abdominal wall with a segment of the large intestine attached. Fecal waste is evacuated through this opening and collected in a bag. A colostomy may be temporary or permanent depending on the nature of the colon surgery.

Cancer of the Colon and Rectum

Cancer of the colon and rectum is a leading cause of death from cancer in the United States and is the fourth leading cause of cancer in the

ISBN 0-558-59446-8

United States. The incidence in men and women is roughly equal.

The symptoms vary according to the site of the malignancy. A change in bowel habits, diarrhea, or constipation is symptomatic. As the tumor grows, there may be abdominal discomfort and pressure. Blood often appears in the stools, and continuous blood loss from the malignant tumor causes anemia. The mass can partially or completely obstruct the **lumen** of the colon. As the tumor invades underlying tissue, the cancer cells spread through the lymph vessels and veins. Colorectal cancer is diagnosed with a digital rectal examination, sigmoidoscopy, colonoscopy, and biopsy.

Two diseases increase the risk for cancer of the colon: long-standing ulcerative colitis and familial polyposis of the colon. **Familial polyposis** is a hereditary disease in which numerous polyps develop in the intestinal tract. The polyps usually give no symptoms unless a malignancy develops. Another factor associated with risk for colon cancer is a diet high in red meat and low in food sources of fiber, such as vegetables, legumes, and whole-grain cereals.

Colorectal cancer grows slowly, tends to remain localized, and is thus potentially curable with early diagnosis. As in all cancers, early detection and treatment are essential to prevent its spread. Most malignancies of the large intestine are in the rectum or the sigmoid colon, which makes their detection and removal easier than malignant tumors in other areas of the digestive tract. Chemotherapy is used when the tumor has metastasized or if residual masses remain inoperable. (See Chapter 4.) If sections of the colon are removed, a colostomy may be necessary.

Intestinal Obstructions

An obstruction can occur anywhere along the intestinal tract, preventing contents within the tract from moving forward. **Obstructions** are classed as **organic** when there is some material blockage, or as **paralytic**, in which case there is a decrease in **peristalsis**, preventing the propulsion of intestinal contents.

Tumors and hernias, both hiatal and inguinal, can cause organic obstructions. The intestine may be twisted on itself, a condition known as **volvulus** that may be unwound surgically (Figure 9–7 ▶). The intestine may be kinked, allowing nothing to pass. **Adhesions**, the linking of two surfaces normally separate, can distort the tract. Abdominal adhesions sometimes follow surgery, when fibrous connective tissue grows around the incision. Adhesions also develop as a result of inflammation. An-

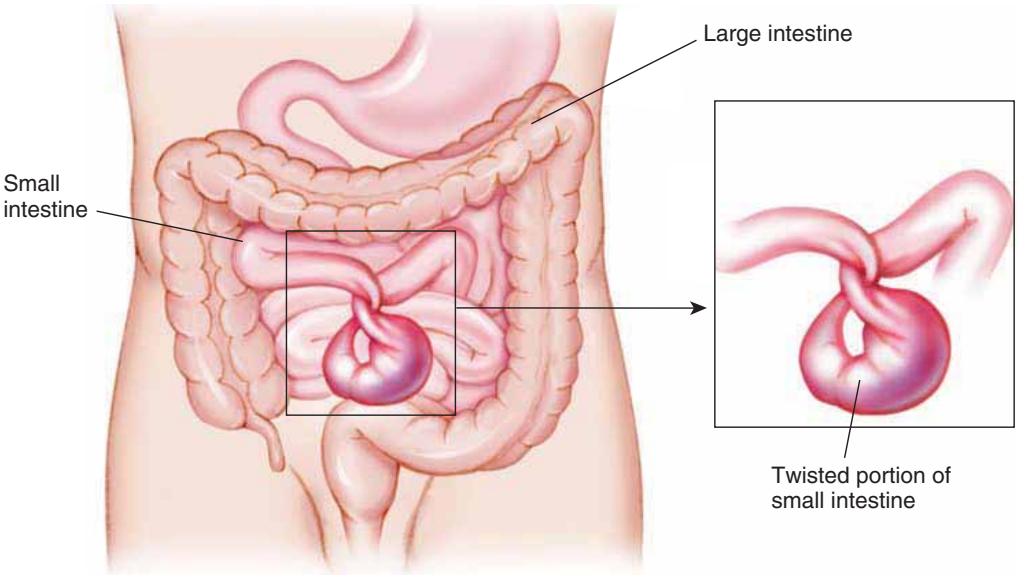


Figure 9–7 ▶ Volvulus.

ISBN 0-558-59446-8

other type of organic obstruction is **intussusception**, in which a segment of intestine telescopes into the part forward to it. This occurs more often in children than in adults. Figure 9–8► shows various types of organic obstructions. An acute organic obstruction causes severe pain. The abdomen is distended and vomiting occurs. There is complete constipation; not even gas, or **flatus**, is passed. Sometimes the obstruction can be relieved by means of a suction tube, but frequently surgery is required. If the obstruction is a strangulated hernia, a protrusion of intestine through the abdominal wall, surgery is required because the blood supply is cut off to the strangulated segment, and it can become gangrenous.

A paralytic obstruction can result from peritonitis. If a loop of small intestine is surrounded by pus from the infection, the smooth muscle of the intestinal wall cannot contract. Sphincters can go into spasm and fail to open as a result of intense pain.

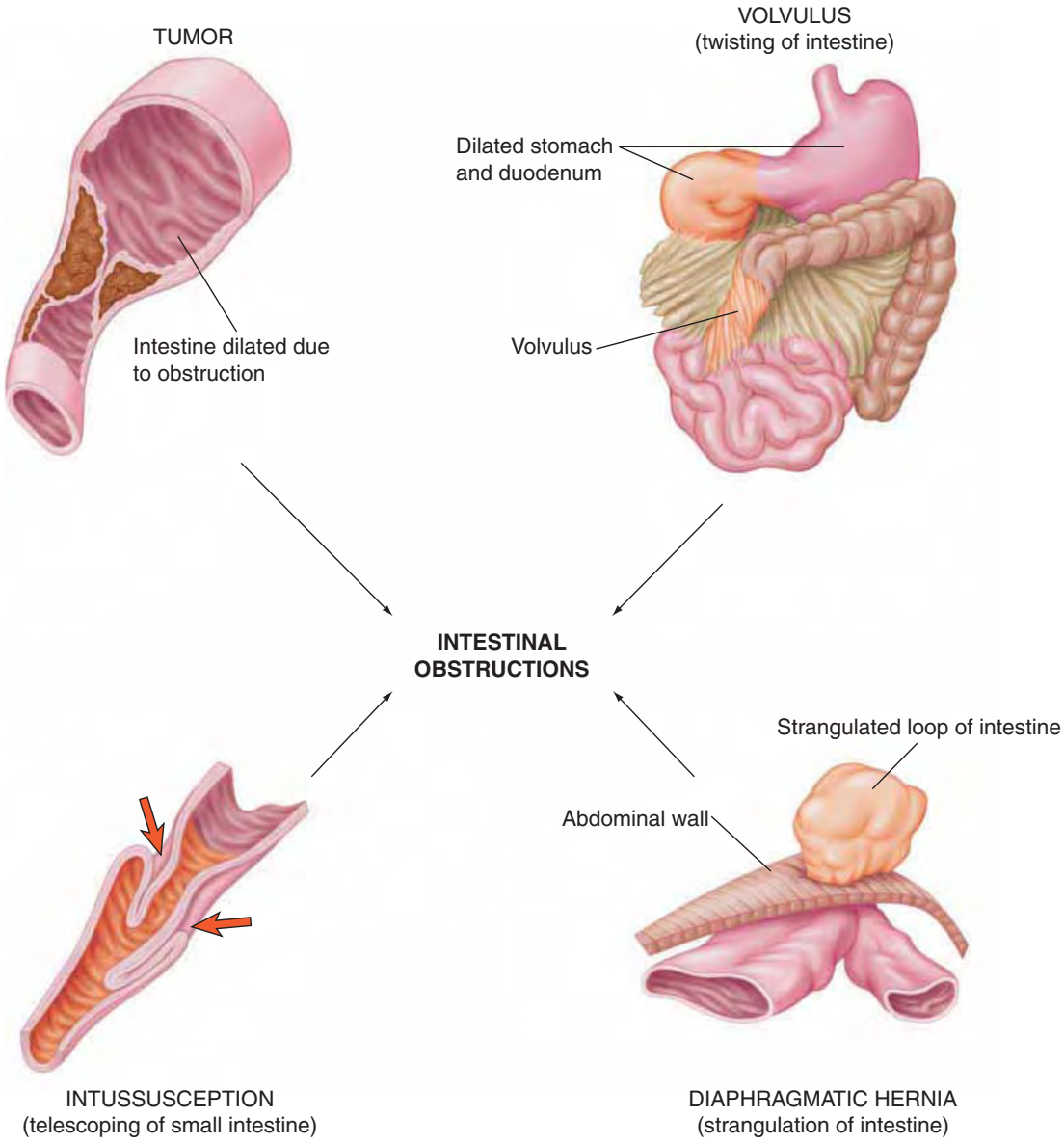


Figure 9–8 ► Organic obstructions of the intestinal tract.

ISBN 0-558-59446-8

Prevention PLUS!

Cancer Prevention through Detection

Early detection of colorectal cancer is the key to survival. Death rates are low for patients whose colorectal cancer is detected at an early localized stage; about 9% die within 5 years. Death rates are much higher, however, when the diagnosis occurs at an advanced stage; about 92% die within 5 years. Screening remains underused even though its benefits seem clear. Regular screening should be done for adults aged 50 years and over. This includes an annual fecal occult blood test, a flexible sigmoidoscopy every 5 years, and a colonoscopy every 10 years. These tests can identify precancerous polyps that can be removed, or they can detect cancer in the early localized stage, which can be treated before the cancer has a chance to spread.

Spastic Colon (Irritable Bowel Syndrome)

Irritable bowel syndrome or **spastic colon** is relatively common, occurring in 20% of American adults and affecting more women than men. Irritable bowel is marked by diarrhea, constipation, abdominal pain, and gas. The difference between a spastic or **irritable colon** and the diseases already discussed is that the spastic colon has no lesion, no tumor, or ulceration. It is a functional disorder of motility, the movement of the colon. The pain is probably caused by muscle spasms in the wall of the intestine.

Abuse of laxatives and consumption of certain foods and beverages, particularly caffeine, alcohol, spicy foods, fatty foods, and concentrated orange juice, can irritate the bowel. Foods such as beans and cabbage, which contain carbohydrates fermented by colon bacteria, promote gas production and should be avoided. Laxatives should be avoided as well. Adding fiber to the diet helps prevent constipation. Emotional stress has an adverse effect on the digestive system, because the nerves of the autonomic nervous system affect digestion. If stressful situations can be alleviated, the colon will function more normally. Tension-relieving activities, sports, hobbies, or regular exercise may help.

Dysentery

The terms *dysentery* and *diarrhea* are often incorrectly used interchangeably. Dysentery is an infectious disease; diarrhea is a symptom. **Dysentery** is an acute inflammation of the colon. The major symptom of dysentery is diarrhea containing pus, blood, and mucus accompanied by severe abdominal pain. Bacteria, parasitic worms, and other microorganisms can cause dysentery. The protozoan *Entamoeba histolytica*, which is transmitted in feces-contaminated food and water, causes amebiasis, also called amoebic dysentery. Amoebic dysentery is uncommon in the United States and is usually found among immigrants arriving from countries with poor water quality and sanitary procedures. American travelers acquire amoebic dysentery when drinking contaminated water abroad. *E. histolytica* invade the wall of the colon and cause numerous ulcerations, which account for the pus and blood in the stools. Bacillary dysentery is caused by various species of gram-negative bacteria in the genus *Shigella.* Antibiotics can be effective for bacillary dysentery, and amebicides are used for amoebic dysentery.

▶ Diseases Indicated by Stool Characteristics

Microscopic examination of stool may identify the cause of food poisoning, gastroenteritis, or dysentery. Other information can also be obtained from stool samples. Signs of several of the diseases discussed include blood in the stools. Blood appears differently, however, depending upon the site of bleeding.

If the blood in the stools is bright red, the bleeding originated from the distal end of the colon, the rectum. Streaks of red blood can indicate bleeding hemorrhoids. This symptom can also indicate cancer of the rectum. Dark blood

ISBN 0-558-59446-8

may appear in the stools, giving them a dark, tarry appearance, the condition of **melena**. This blood was altered as it passed through the digestive tract, so it originated from the stomach or duodenum. A bleeding ulcer or cancer of the stomach may be indicated by melena. Certain medications (those containing iron, for instance) can also give this tarry appearance to the stools. Blood may not be apparent to the naked eye, but a chemical test can show its presence. This is referred to as **occult blood**. It can indicate bleeding ulcers or a malignancy in the digestive tract.

If the stools are large and pale, appear greasy, and float on water, they contain fat. This is a symptom of malabsorption syndrome. It may also indicate a diseased liver, gallbladder, or pancreas. Diseases of these organs are discussed next.

Functions of the Liver and the Gallbladder

The liver is located below the diaphragm, in the upper right quadrant of the abdominal region. The liver is the largest glandular organ of the body, and it is unique in that it has great powers of regeneration; it can replace damaged or diseased cells. Still, chronic liver disease may cause irreversible damage and loss of function.

The liver has a dual blood supply: It receives oxygenated blood from the hepatic artery and blood rich in nutrients from the portal vein. The blood reaching the liver through the portal vein comes from the stomach, intestines, spleen, and pancreas. Blood from the small intestines carries absorbed nutrients such as simple sugars and amino acids. One of the functions of the liver is to store any excess of these substances. The liver plays an important role in maintaining the proper level of glucose in the blood. It takes up excess glucose, storing it as **glycogen**. When the level of circulating glucose falls below normal, the liver converts glycogen into glucose, which is then released into the blood. The liver also stores iron and vitamins.

The liver synthesizes various proteins, including enzymes necessary for cellular activities. One means of evaluating liver function is to determine the level of these enzymes in the blood. The liver also synthesizes plasma proteins. Albumin is the plasma protein that has a water-holding power within the blood vessels. If the albumin level is too low, plasma seeps out of the blood vessels and into the tissue spaces, causing edema. Other essential plasma proteins synthesized by the liver are those required for blood clotting: fibrinogen and prothrombin. If the liver is seriously diseased or injured and cannot make these proteins, hemorrhaging may occur.

The liver can detoxify various substances; that is, it can make poisonous substances harmless. Ammonia, which results from amino acid metabolism, is converted to urea by the liver. The urea then enters the bloodstream and is excreted by the kidneys. Certain drugs and chemicals are also detoxified by the liver. Specialized cells called **Kupffer cells** line the blood spaces within the liver. These cells engulf and digest bacteria and other foreign substances, thus cleansing the blood.

Bile, necessary for fat digestion, is secreted by the liver. Bile is an emulsifier, acting on fat in such a way that the lipid enzymes can digest it. The products of lipid digestion are then absorbed by the walls of the small intestine. In the absence of bile, the fat-soluble vitamins A, D, E, and K cannot be absorbed. Bile consists of water, bile salts, cholesterol, and bilirubin, which is a colored substance resulting from the breakdown of hemoglobin. It is bilirubin that gives bile its characteristic color of yellow or orange.

The gallbladder is a small, saclike structure on the underside of the liver. Bile is secreted continuously by the liver into the hepatic duct, which carries bile to the gallbladder for storage and concentration (Figure 9–9▸). The gallbladder releases the bile through the cystic duct to the common hepatic duct, which carries the bile to the duodenum. Release of bile is coordinated with the appearance of fats in the duodenum.

Diseases of the Liver

Liver disease manifests itself when chronic damage to liver cells cannot be repaired. When fibrous tissue replaces liver cells, the normal functions of the liver become impaired.

ISBN 0-558-59446-8

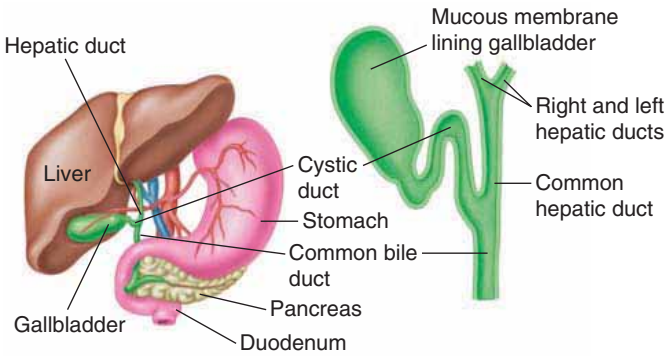


Figure 9–9 ► Bile duct system of the liver and gallbladder.

Jaundice

One sign frequently associated with liver disease is jaundice. **Jaundice**, or **icterus**, is a yellow or orange discoloration of the skin, tissues, and the whites of the eyes. It is caused by a build-up of bilirubin, a pigment that is normally secreted in the bile and removed from the body in the feces.

Jaundice has several causes. The normal flow of bile from the gallbladder to the duodenum may be obstructed by a tumor, a gallstone in the duct system, or a congenital defect. Because the bile cannot move forward, it leaks into the blood, with bilirubin coloring the plasma. When the blood reaches the kidneys, the bile appears in the urine, giving it a dark color. Because bile is unable to reach the duodenum, the stools are light in color. They are usually described as clay colored. Complications can result from this blockage to bile flow. Infection or inflammation of the gallbladder or bile ducts could occur. Lack of bile interferes with fat digestion and absorption, which means that the fat-soluble vitamins are not being absorbed. In the absence of vitamin K, bleeding tendencies may develop. The obstruction can also cause liver damage. Jaundice can also indicate liver disease, such as hepatitis or cirrhosis.

Hemolytic jaundice has an entirely different etiology. This type of jaundice accompanies the hemolytic anemias explained in Chapter 7. In these anemias, the red blood cells hemolyze, and an excess of bilirubin results from the breakdown of released hemoglobin. Abnormal discoloration follows.

Viral Hepatitis

Hepatitis, or inflammation of the liver, is caused by a number of factors, including several viruses. Important causes are hepatitis virus A, hepatitis virus B, hepatitis virus C, and hepatitis virus D. Hepatitis E is uncommon in the United States.

Hepatitis virus A, formerly called *infectious hepatitis,* is the least serious form and can develop as an isolated case or in an epidemic. In the United States, as many as 30,000 people per year had hepatitis A infection until the vaccine was introduced, and since the 1990s this number has dropped dramatically. Still, in large crowded urban areas and in rural areas with poor sanitation, the rate of infection can exceed 20 per 100,000. The incubation period, the time from exposure to the development of symptoms, is from 2 to 6 weeks. The symptoms include anorexia, nausea, and mild fever. The urine becomes dark in color, and jaundice appears in some cases. On examination, the liver may be found to be enlarged and tender. Contaminated water or food is the usual source of the infection, which spreads under conditions of poor sanitation. The virus is excreted in the stools and urine, infecting soil and water. Hepatitis virus type A is usually mild in children; it is sometimes more severe in adults. Prognosis is usually good, with no permanent liver damage resulting. **Immunoglobulin** injections provide temporary protection against hepatitis virus type A for people exposed to it. A vaccine now in use has proven to be effective. Exposure to hepatitis A gives lifetime immunity.

Hepatitis virus B, formerly called *serum hepatitis,* is a more serious and common disease, affecting more than 60,000 Americans per year. In fact, 1.25 million American are chronically infected with hepatitis B, 25% of whom will die from cirrhosis. The symptoms are similar to those of hepatitis virus A but develop more slowly. The incubation period is long, lasting from 2 to 6 months. The severity of the disease varies greatly. Those with poor nutritional status, for example, will be more adversely affected by hepatitis. Occasionally, a **fulminating** form of hepatitis virus B develops, and it is fatal. This form has a sudden onset and progresses

ISBN 0-558-59446-8

rapidly. Delirium is followed by a coma and death. Hepatitis virus B can be transmitted by donated blood or serum transfusions that contain the virus. It also is transmitted sexually and through contaminated needles or syringes used by drug addicts. Physical condition at the onset of the disease makes a difference in the seriousness of the infection. Blood and plasma are screened for hepatitis, but hospital personnel still must be well informed of the hazards that can lead to acquiring hepatitis. Precautions must be taken by nurses, laboratory technicians, dialysis workers, and blood bank personnel to prevent becoming infected. Vaccination provides immunity to the virus, and it should be administered to personnel who handle or come in close contact with blood or other bodily fluids (see Chapter 3).

Hepatitis C infections have declined in the United States to approximately 26,000 per year, somewhat fewer than hepatitis B, but hepatitis C remains the leading viral cause of chronic liver disease and cirrhosis and is now the most common reason for liver transplants. Because of the very high rates of infection seen in the 1980s, over 4 million Americans are infected today, 3.2 million of whom are chronically infected. The initial symptoms are nonspecific and similar to those of hepatitis A or B, but the disease persists for months, even years. About 20% of those infected develop cirrhosis, and a number of these cases can lead to end-stage liver disease. The virus is transmitted mostly through blood transfusions, although transmission has been traced to intravenous drug use, and epidemiologic studies show a risk associated with sexual contact with someone with hepatitis and with having had more than one sex partner in a year. Treatments of hepatitis C include interferon injections and oral ribavirin. Treatment for end-stage cirrhosis may include liver transplant.

Hepatitis D virus is described as a defective virus because it cannot reproduce in a cell unless the cell is also infected with hepatitis B. The resulting disease is more serious and more frequently progresses to chronic liver disease. Rates of hepatitis D are not known because surveillance is not systematically conducted; however, hepatitis D is quite uncommon but its transmission is known to be similar to that of hepatitis B.

Hepatitis E is very rare in the United States, but worldwide it is the leading cause of epidemics of infectious hepatitis. Major epidemics occur in Africa, Asia, and Mexico, where it is transmitted primarily through fecal-contaminated drinking water. Nearly every case in the United States occurs in travelers to areas where the disease is endemic. No effective treatment or vaccine exists. Fortunately, there is no evidence that type E progresses to chronic disease.

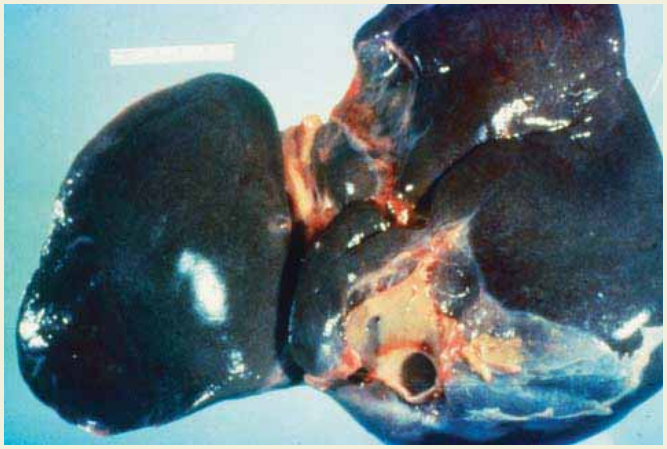
Cirrhosis of the Liver

Cirrhosis is chronic destruction of liver cells and tissues with a nodular, bumpy regeneration. Cirrhosis is the twelfth leading cause if death in the United States, killing about 26,000 people each year. Alcoholic cirrhosis, the most common type of cirrhosis, is described in detail. This disease is also called portal, Laennec, or fatty nutritional cirrhosis (an accumulation of fat often develops within the liver). The exact effect of excessive alcohol on the liver is not known, but it may be related to the malnutrition that frequently accompanies chronic alcoholism, or the alcohol itself may be toxic. In the normal liver, there is a highly organized arrangement of cells, blood vessels, and bile ducts. A cirrhotic liver loses this organization and, as a result, the liver cannot function. Liver cells die and are replaced by fibrous connective tissue and scar tissue. This tissue has none of the liver cell functions. At first, the liver is generally enlarged due to regeneration but then becomes smaller as the fibrous connective tissue contracts. The surface acquires a nodular appearance. This is sometimes called a “hobnailed” liver.

In cirrhosis, circulation through the liver is impaired. As a result, high pressure builds in vessels of the abdomen and in other areas. The esophageal veins swell, forming esophageal varices. Abdominal organs like the spleen, pancreas, and stomach also swell. These organs and vessels may hemorrhage, causing hemorrhagic shock. Hemorrhage of vessels in the stomach or intestines may cause vomiting of blood, **hematemesis**. A characteristic symptom of cirrhosis is distention of the abdomen caused by

ISBN 0-558-59446-8

SIDE by SIDE ■ Cirrhosis



▲ Normal human liver.

▲ Cirrhosis of the liver from chronic alcoholism.

the accumulation of fluid in the peritoneal cavity. This fluid is called **ascites** and develops as a result of liver failure. The pressure within the obstructed veins forces plasma into the abdominal cavity. This fluid often has to be drained. When the liver fails to produce adequate amounts of albumin, an albumin deficiency, **hypoalbuminemia**, develops and fluid leaks out of the blood vessels, causing edema. Because the necrotic cells of the cirrhotic patient fail to produce albumin, ascitic fluid develops, as does edema, particularly in the ankles and legs.

Blockage of the bile ducts, like that of the blood vessels, follows the disorganization of the liver. Bile accumulates in the blood, leading to jaundice and, because bile is not secreted into the duodenum, stools are clay colored. The excess of bile, carried by the blood to the kidneys, imparts a dark color to urine.

Other signs are related to the fact that the diseased liver cannot perform its usual biochemical activities. Normally, the liver inactivates small amounts of female sex hormones secreted by the adrenal glands in both males and females. Estrogens then have no effect on the male, but the cirrhotic liver does not inactivate estrogens. They accumulate and have a feminizing effect on males. The breasts enlarge, a condition known as **gynecomastia**, and the palms of the hands become red because of the estrogen

Prevention PLUS!

Know Your Viruses

The more you know about how a virus is transmitted, the better prepared you can be to prevent infection. Hepatitis A is transmitted primarily through contaminated food and water. Workers in the food-service industry must use sanitary procedures when handling food, including the simple task of washing their hands. You can protect yourself at home by thoroughly cooking meat and seafood. Hepatitis B and C are transmitted through blood transfusions, contaminated needles and syringes, and sexual intercourse. Healthcare workers receive vaccination against hepatitis B, and blood is screened for contamination by hepatitis B and C.

ISBN 0-558-59446-8

level. Hair on the chest is lost, and a female-type distribution of hair develops. Atrophy of the testicles can also occur.

The damaged liver cells are unable to carry out their normal function of detoxification, so ammonia and other poisonous substances accumulate in the blood and affect the brain, causing various neurologic disorders. Confusion and disorientation, even to the point of stupor, and a characteristic tremor or shaking develop. This shaking is called "liver flap." Somnolence or abnormal sleepiness are symptoms of cirrhosis. **Hepatic coma** is a possible cause of death in cirrhosis.

Although chronic alcoholism is the leading cause of cirrhosis, other diseases can also cause cirrhosis. Severe chronic hepatitis, chronic inflammation of the bile ducts, and certain drugs and toxins can cause necrosis of the liver cells, which is the first step in the development of cirrhosis.

There is no effective treatment for cirrhosis. Liver damage can not be reversed, but further damage can be prevented by treating alcoholism or liver infections that are at the root of cirrhosis. Symptoms of cirrhosis may be treated. For example, edema is treated with diuretics and portal hypertension is remedied with beta blockers to reduce blood pressure. Liver transplant is the only way to restore liver function.

Cancer of the Liver

Hepatocarcinoma, or cancer of the liver, is a primary malignancy of the liver that is rare but has a high mortality rate. While liver cancer comprises 1% of all cancers in the United States, it accounts for 6% and 2% of cancer deaths in men and women, respectively. Liver cancer is most prevalent in men over age 60, and the incidence increases with age. In Africa and parts of Asia, where there is a high incidence of hepatitis B infection, liver cancer comprises 10% to 50% of all cancers. Most cancer found in the liver is secondary, which means it results from metastasis from cancer in other organs, especially the colon, rectum, stomach, pancreas, esophagus, lung, or breast. Primary cancer of the liver is caused chiefly by viral hepatitis and cirrhosis. Other causes of liver cancer may include aflatoxin, a toxin from a mold that grows on peanuts and rice.

The symptoms of hepatocarcinoma vary according to the site of the tumor. If the tumor obstructs the portal vein, ascites develops in the abdominal cavity, as it does in cirrhosis. If the fluid contains blood, a malignancy is indicated. A tumor blocking the bile duct will cause jaundice. General symptoms may include loss of weight and an abdominal mass and pain in the upper right quadrant of the abdomen.

Diagnosis includes serum levels of enzymes that arise from diseased liver tissue, but correct diagnosis depends on needle biopsy or open biopsy. Prognosis for cancer of the liver is poor because usually the malignancy has developed elsewhere and has spread to the liver.

Diseases of the Gallbladder

The gallbladder stores and concentrates bile. Gallbladder disease impairs the storage and delivery of bile to the duodenum.

Gallstones (Cholelithiasis)

Gallstones are precipitated bile components in the gallbladder and bile ducts. Gallstones and gallbladder disorders (cholecystitis, discussed in the following subsection) are common, affecting about 1 million Americans per year. Gallstones affect twice as many women as men. The stones arise in the gallbladder when the bile composition changes or when gallbladder muscle activity reduces, as it may during pregnancy, use of oral contraceptives, diabetes mellitus, obesity, cirrhosis, and pancreatitis. The stones consist principally of cholesterol, bilirubin, and calcium when in excess. Gallstones, also called **biliary calculi**, may be present in the gallbladder and give no symptoms. There may be one gallstone present or several hundred, which can be large or small (Figure 9–10▸). Small stones, referred to as gravel, can enter the common bile duct and cause an obstruction with excruciating pain.

ISBN 0-558-59446-8

Figure 9–10 ► Gallbladder opening showing gallstones. (Martin Rotker/Phototake NYC)

Gallstones can be diagnosed and located by ultrasound and x-ray. The usual treatment for gallstones is surgical removal of the gallbladder, a **cholecystectomy**. The cystic duct is ligated and the common bile duct examined for stones. Occasionally, undetected cholesterol stones are retained in the common bile duct after surgery. Administering a solubilizing agent through a catheter into the bile duct may dissolve the remaining stones, preventing the necessity of repeated surgery.

Cholecystitis

Cholecystitis is an inflammation of the gallbladder usually associated with gallstones (cholelithiasis). Acute cholecystitis is most common in middle age. The gallbladder becomes extremely swollen, causing pain under the right rib cage that radiates to the right shoulder. At this point, the gallbladder can usually be palpated. Chills and fever, nausea and vomiting, belching and indigestion are symptoms; in chronic cholecystitis these symptoms occur especially after eating fatty foods. The presence of fat in the duodenum stimulates the gallbladder to contract and release bile, and the contraction of the inflamed gallbladder causes pain. Prolonged inflammation causes the gallbladder to lose its ability to concentrate bile. The walls of the gallbladder may thicken, making it impossible for the gallbladder to contract properly. Serious complications can result from cholecystitis. Lack of blood flow because of the obstruction brought about by the swelling can cause an infarction. With the death of the tissues, gangrene can set in. The acutely inflamed gallbladder, like an inflamed appendix, may rupture, causing peritonitis. A complication of chronic cholecystitis is that bile accumulates in the bile ducts of the liver. This causes necrosis and fibrosis of the liver cells lining the ducts. This is another form of cirrhosis, **biliary** (bile) **cirrhosis**.

Structure and Function of the Pancreas

The pancreas is a fish-shaped organ extending across the abdomen behind the stomach. The head fits into the curve of the duodenum, where the pancreatic duct empties digestive enzymes from the pancreas. These enzymes include amylase, which breaks down carbohydrates; trypsin and chymotrypsin, which digest protein; and lipase, which breaks down lipid or fat.

Diseases of the pancreas severely interfere with digestion and absorption of nutrients. Also, a diseased pancreas may release enzymes that can damage the pancreas and surrounding tissues. Figure 9–11► shows the structure of the pancreas. Figure 9–12► shows the relationship between the pancreas and other digestive organs.

ISBN 0-558-59446-8

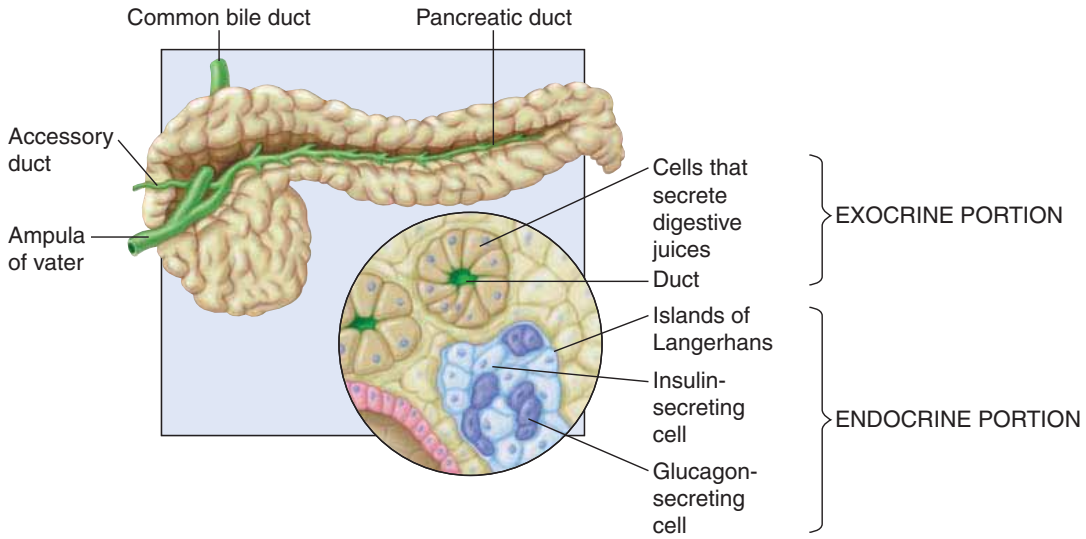


Figure 9–11 ▶ The pancreas: An endocrine and exocrine gland.

▶ Diseases of the Pancreas

Pancreatitis

Acute **pancreatitis** is a serious, painful inflammation of the pancreas. Pancreatitis is more prevalent in women than in men and usually occurs after age 40. In men it is often associated with alcoholism or peptic ulcers. In women it is more commonly associated with gallbladder disease. The prognosis is good if pancreatitis is associated with gallbladder disease but is very poor if it is related to alcoholism. Pancreatitis

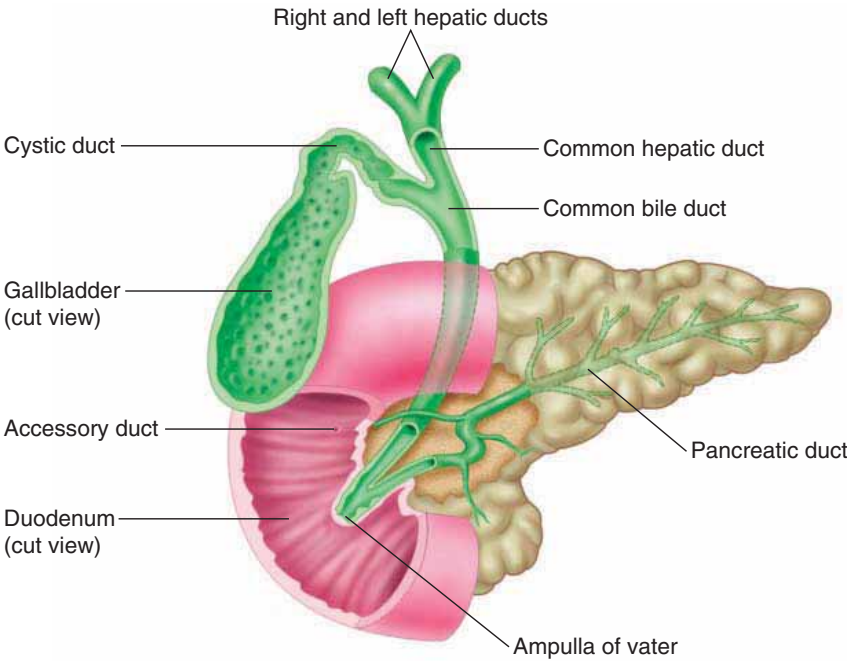


Figure 9–12 ▶ Relationship between the pancreas and the digestive system.

ISBN 0-558-59446-8

may be caused by local swelling, necrosis, hemorrhage, or trauma.

Severe, steady abdominal pain of sudden onset is the first symptom. The intense pain radiates to the back and resembles the sharp pain of a perforated ulcer. Drawing up the knees or assuming a sitting position may provide some relief. There may also be nausea and vomiting. Jaundice sometimes develops if the swelling blocks the common bile duct. If a large area of the pancreas is affected, both endocrine and digestive functions of the gland become impaired. In the absence of lipid enzymes from the pancreas, fat cannot be digested, resulting in greasy stools with a foul odor. Secondary malabsorption syndrome develops because fat that is not digested cannot be absorbed. In pancreatitis, the protein- and lipid-digesting enzymes become activated within the pancreas and begin to digest the organ itself. Severe necrosis and edema of the pancreas result. The digestion can extend into blood vessels, which causes severe internal bleeding and shock. When the condition becomes this severe, it is called acute hemorrhagic pancreatitis.

The most significant diagnostic procedures for pancreatitis are blood and urine tests for amylase. Treatment is aimed at maintaining circulation to the pancreas and surrounding tissues, maintaining blood and fluid volume, and reducing pain.

Cancer of the Pancreas

Cancer of the pancreas, **adenocarcinoma**, has a high mortality rate. It occurs more frequently in males than in females, is most prevalent in men between age 35 and 70, and exhibits the highest prevalence in Israel, the United States, Sweden, and Canada. Pancreatic cancer is linked to cigarette smoking, high-protein and -fat diets, food additives, and exposure to industrial chemicals like beta-naphthalene, benzidine, and urea. Chronic alcohol abuse, chronic pancreatitis, and diabetes mellitus increase the risk of developing pancreatic cancer.

A malignancy in the head of the pancreas can block the common bile duct (Figure 9–13▸), and symptoms are experienced earlier than those of cancer in the body or tail of the pancreas, which can be very advanced before it is discovered. Obstruction of the bile duct causes jaundice and impairs digestion because the pancreatic enzymes and bile cannot enter the duodenum. This causes malabsorption of fat and clay-colored stools; sufficient nutrients and calories cannot be absorbed, and weight loss occurs. Great pain is experienced as the tumor grows, and the cancer usually metastasizes to the surrounding organs: the duodenum, stomach, and liver.

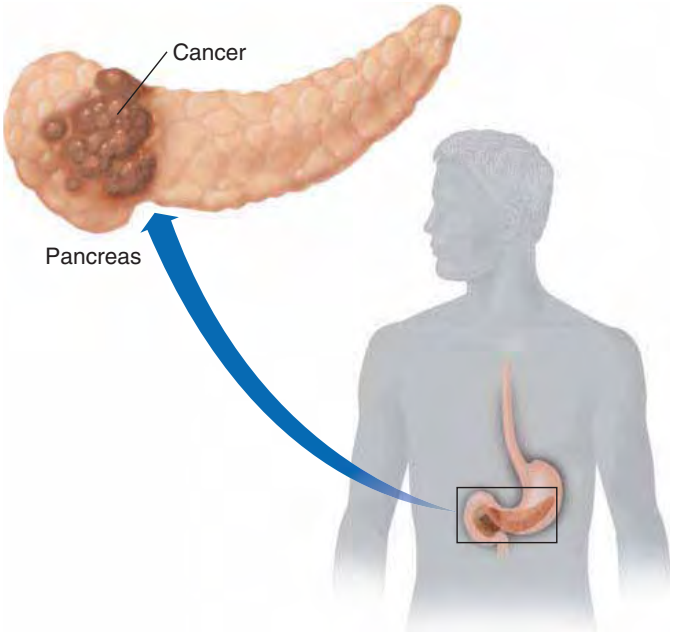


Figure 9–13 ▸ Pancreatic cancer. A common site of pancreatic cancer is in the head of the pancreas within the pancreatic ducts.

Diagnosis depends on laparoscopic biopsy and ultrasound. Prognosis for cancer of the pancreas is poor, and death occurs in a relatively short time. Treatment, which is rarely successful, includes surgery, chemotherapy, and radiation.

▸ Age-Related Diseases

Infants and young children are especially vulnerable to the effects of digestive system disorders and diseases because their growing and developing bodies require substantial fluids,

ISBN 0-558-59446-8

calories, and nutrients. For example, unchecked vomiting and diarrhea can cause dehydration and malnutrition more easily in children than in adults. The digestive system functions fairly well in healthy elderly people, despite normal age-related changes like thinning mucosa and decreased muscle motility. However, some diseases occur with greater frequency with increasing age and thus significantly impact elderly populations.

Mouth and Esophagus

Dental caries (cavities) are more prevalent in children than in adults. After adolescence, the incidence of caries reduces and the risk for gingivitis and periodontal disease increases. Periodontal disease and osteoporosis contribute to tooth loss in elderly people. The number of taste buds decrease, and together with decreased saliva secretion, this may lead to decreased appetite. Esophageal cancer incidence is highest in those over age 60. As stated earlier, this cancer is closely linked with the use of alcohol and tobacco.

Gastrointestinal Tract

Infectious diarrheal diseases are the leading cause of death in children worldwide. Children cannot tolerate the loss of enormous amounts of water, electrolytes, and nutrients associated with diarrhea. Hiatal hernia is a common disorder in elderly people. Peptic ulcers are no more common in elderly than in middle-age people; however, the risk of hemorrhage is greater in old age. Colon cancer incidence increases after age 45, which emphasizes the importance of regular screening and early diagnosis. Diverticula are most common in elderly, and therefore the incidence of diverticulitis rises. Diarrhea poses a great risk of dehydration and malnutrition. Therefore, gastrointestinal infections like food poisoning and dysentery can be serious diseases. Overall, the function of the intestines remains fairly normal, although intestinal motility is slightly decreased. Thus, changes in diet or new medications that affect intestinal motility can more easily lead to constipation or diarrhea.

Liver and Gallbladder

Disorders are uncommon in children. In adulthood, liver function diminishes with increasing age, which results in the persistence of high blood levels of medications or toxins. In old age, levels of clotting factors decline, increasing the risk for hemorrhage. The incidence of cholelithiasis is highest in those over age 80.

Pancreas

Disorders in children are uncommon, although insulin-dependent diabetes does have its onset in childhood. (See Chapter 12.) The incidence of pancreatic cancer peaks in the sixties and is most common among older men. Acute pancreatitis is common in the elderly. In younger people, acute pancreatitis is associated with alcoholism, while in the elderly acute pancreatitis is more likely due to gallstones that block the pancreatic duct.

RESOURCES

American Cancer Society: www.cancer.org

American Gastroenterological Association: www.gastro.org

American Liver Society: www.liversociety.org

National Institute of Health, National Digestive Diseases Information Clearinghouse: digestive.niddk.nih.gov

ISBN 0-558-59446-8

DISEASES AT A GLANCE

Digestive System

DISEASE	ETIOLOGY	SIGNS AND SYMPTOMS
Stomatitis	Bacteria, viruses, fungi	Redness, ulcers, patches, bleeding, depending on the cause
Cancer of the mouth	Use of tobacco products, especially in conjunction with consuming alcohol	Abnormal growths, sores, or lesions that don't heal
Cancer of the esophagus	Use of tobacco and alcohol	Dysphagia, vomiting, weight loss
Esophagitis	Acid reflux due to incompetent cardiac sphincter	Burning chest pain (heartburn), especially after eating or while lying down
Esophageal varices	Increased venous pressure; accompanies advanced cirrhosis	Dilated esophageal veins, hemorrhage
Hiatal hernia	Stomach protrudes through weakened diaphragm	Indigestion, heartburn following meals, acid reflux, and esophagitis
Gastritis	Aspirin, coffee, tobacco, alcohol, infection	Stomach pain, hematemesis
Chronic atrophic gastritis	Degeneration of stomach mucosa results in no HCl secretion and no intrinsic factor secretion	Gastritis, poor digestion and absorption of nutrients, weight loss
Peptic ulcer	Infection with *H. pylori* and erosion of mucosa by stomach acid	Upper abdominal pain, hemorrhage, blood in stool
Gastroenteritis	Food- and water-borne infection by bacteria, viruses, protozoa	Nausea, vomiting, diarrhea, abdominal discomfort or pain, and possibly fever, depending on the pathogen

ISBN 0-558-59446-8

DIAGNOSIS	TREATMENT	PREVENTION	LIFESPAN
Physical exam, immunodiagnostic tests, and pathogen culture	Antibiotics, antivirals, or antifungals, depending on the pathogen	Good oral hygiene; do not use antibiotics unnecessarily or incorrectly	More common in infants, young children, and older adults with weakened immune systems
Physical exam, biopsy	Surgical excision of tumor, radiation	Avoid tobacco products; use alcohol only in moderation	Occurs in adults; incidence increases with age
Endoscopy and esophageal washings	Surgery, radiation, chemotherapy	Avoid tobacco products; use alcohol only in moderation	Occurs in adults; incidence increases with age
Physical exam	Nonirritating diet, antacids, acid-reducing medications	Take small meals; avoid known irritants	Occurs in adults; incidence increases with age
Endoscopy, physical exam, history of alcoholism	Hemorrhage requires infusion of vasopressin or insertion of inflatable tube to compress veins; surgical bypass of portal veins to reduce intravenous pressure	Treat underlying alcoholism or liver disease	Occurs in adults; incidence increases with age
X-ray	Avoid irritating foods, eat frequent small meals, surgery to repair diaphragm	Avoid spicy food, caffeine; eat small meals	Occurs in adults; incidence increases with age
Gastroscopy	Avoid irritants, drink ice water, take antacid medications; surgery to control bleeding	Avoid known irritants	Occurs in adults; incidence increases with age
Analysis of stomach content reveals low levels of HCl and intrinsic factor	Avoid stomach irritants, take vitamin B_{12} supplements	Avoid known irritants	Occurs in adults; incidence increases with age
Gastroscopy, gastric washings, barium x-ray	Antibiotics	Reduce stress	Occurs in adults; incidence increases with age
Stool culture, history	Fluid and electrolyte replacement; antidiarrheal medication; self-limiting in healthy people	Safe food handling, including correct storage, refrigeration, and thorough cooking as needed	Occurs at all ages; especially debilitating in young children and older adults

ISBN 0-558-59446-8

DISEASES AT A GLANCE

Digestive System (*continued*)

DISEASE	ETIOLOGY	SIGNS AND SYMPTOMS
Cancer of the stomach	Idiopathic; associated with salted, cured foods and diet low in vegetables and fruit; associated with prior infections with *H. pylori*	Appetite loss, stomach discomfort, hematemesis, blood in stool, late-stage pain
Appendicitis	Obstruction with fecal material leads to infection, inflammation, and necrosis	Acute lower right quadrant abdominal pain, nausea, fever
Malabsorption syndrome	Congenitally abnormal intestinal mucosa or malabsorption secondary to diseases of pancreas or gallbladder	Malnutrition, failure to absorb fats and fat-soluble vitamins, failure to grow in children and weight loss in adults
Diverticulitis	Diverticula of colon become impacted with fecal material and infected or inflamed	Cramping and pain in lower abdomen
Regional enteritis (Crohn's disease)	Idiopathic; possible link to autoimmune disease	Lower right pain, diarrhea and constipation, emission and exacerbation, weight loss, melena
Chronic ulcerative colitis	Idiopathic; may be autoimmune, stress related, food allergy related	Diarrhea; pus, blood, mucus in stool; cramping in lower abdomen
Cancer of colon and rectum	Genetic; associated with familial polyposis and chronic ulcerative colitis	Change in bowel habits, diarrhea or constipation, blood in stool
Spastic colon/irritable bowel syndrome	Abuse of laxatives; irritating foods; stress	Diarrhea, pain, gas, constipation
Dysentery	Food- or water-borne intestinal infection by bacteria or protozoa	Abdominal pain, bloody diarrhea with pus and mucus
Viral hepatitis A (infectious hepatitis)	Food- or water-borne infection with hepatitis A virus	Anorexia, nausea, mild fever, jaundice, enlarged tender liver

ISBN 0-558-59446-8

DIAGNOSIS	TREATMENT	PREVENTION	LIFESPAN
Gastroscopy, biopsy, gastric fluid analysis (low HCl), barium x-ray	Surgery, chemotherapy	Reduce intake of salt and cured meat	Occurs in adults; incidence increases with age
Blood count, physical exam	Surgery	Maintain good bowel habits	Most prevalent puberty through 20s
Stool analysis and history	Manage diet and take vitamin supplements	Treat underlying diseases	Onset around age 1 as gluten introduced in solid meals
Endoscopy	Antibiotics, manage diet	Good bowel habits	Occurs in young adults; incidence increases with age
Stool analysis, endoscopy, patchy thickening of intestinal wall	Corticosteroids, occasionally surgery	None	Occurs in young adults; incidence increases with age
Stool analysis, endoscopy, diffuse thickening of colon (pipestem colon)	Corticosteroids, stress reduction, diet management, colostomy	Reduce stress	Occurs in young adults; incidence increases with age
Endoscopy, biopsy, barium x-ray, stool analysis	Surgery, radiation, chemotherapy	Regular screening to include endoscopy and biopsy if at risk	Occurs in adults; incidence increases with age
History and physical exam; no lesions present	Avoid caffeine, alcohol, spicy food, fat; increase fiber in diet; reduce stress	Avoid laxatives	Occurs in young adults; incidence increases with age
Stool culture and history	Antibiotics if bacterial and amebicides if caused by protozoa	Safe food and water handling	Occurs at all ages; especially debilitating for young children and older adults
Physical exam, stool analysis, immunodiagnostics	Immunoglobulin injections for exposures and infections	Vaccine; safe food and water handling	Occurs at all ages; especially debilitating for young children and older adults

ISBN 0-558-53446-8

DISEASES AT A GLANCE

Digestive System (*continued*)

DISEASE	ETIOLOGY	SIGNS AND SYMPTOMS
Hepatitis B (serum hepatitis)	Blood-borne or sexually transmitted infection with hepatitis B virus	2–6-month incubation period followed by anorexia, nausea, mild fever, jaundice, enlarged tender liver; may lead to chronic hepatitis and cirrhosis
Hepatitis C	Blood-borne or sexually transmitted infection with hepatitis C virus	Symptoms as for hepatitis A and hepatitis B following incubation period of months to decades; commonly results in cirrhosis and end-stage liver disease
Hepatitis D	Rare blood-borne or sexually transmitted co-infection with hepatitis D virus and hepatitis B virus	Same as for hepatitis B; more serious and frequently progresses to chronic liver diseases
Hepatitis E	Water-borne infection with hepatitis E virus rare in United States	As for hepatitis A
Cirrhosis	Alcohol-induced damage to liver; hepatitis	Jaundice, abdominal distension, ascites, bleeding tendencies, edema, malabsorption of fats, gynecosmastia, delerium tremens, hepatic coma
Cancer of the liver	Primary carcinoma is complication of cirrhosis; more common is secondary or metastatic	Bile duct obstruction, jaundice, impaired clotting, ascites, weight loss
Cholecystitis	Obstruction by infection/inflammation or by tumor	Upper right abdominal pain especially following a meal of fatty food; nausea, indigestion, belching
Cholelithiasis	Related to obesity; higher incidence in pregnancy and among women	None, or upper right abdominal pain especially following a meal
Pancreatitis	Idiopathic, commonly associated with excessive alcohol consumption or with gallstones	Acute, severe, sharp, radiating abdominal pain; risk of hemorrhage; jaundice; vomiting; malabsorption
Cancer of the pancreas	Linked to cigarette smoking, alcohol abuse, chemical carcinogens, chronic pancreatitis, diabetes mellitus	Malabsorption, jaundice, upper abdominal pain

ISBN 0-558-59446-8

DIAGNOSIS	TREATMENT	PREVENTION	LIFESPAN
Physical exam, stool analysis, immunodiagnostics	Immunoglobulin injections for exposures and infections, antiviral medications, vaccine for prevention	Vaccine	Occurs at all ages; especially debilitating for young children and older adults
Physical exam, stool analysis, immunodiagnostics	Ribavarin, interferon, liver transplant	Safe sex, avoid injection drug abuse	Occurs at all ages; especially debilitating for young children and older adults
Physical exam, stool analysis, immunodiagnostics	Immunoglobulin injections, antiviral	Safe sex, avoid injection drug abuse	Occurs at all ages; especially debilitating for young children and older adults
Physical exam, stool analysis, immunodiagnostics	No treatment, no vaccine	Safe food and water handling	Occurs at all ages; especially debilitating for young children and older adults
Patient history, physical exam, serum liver enzyme levels	No specific treatment; symptomatic treatment for edema and portal hypertension or bleeding; improved diet, liver transplant	Treat underlying alcoholism or liver disease	Occurs in adults
Ultrasound, CT scan, needle biopsy	Chemotherapy (prognosis poor)	None	Rare; occurs in adults and occasionally children
Ultrasound, CT scan, fecal fat test	Cholecystectomy	None	Occurs in young adults and prevalence increases with age
Ultrasound, CT scan, fecal fat test	Cholecystectomy, administration of solubilizing agent into bile duct	Reduce weight	Occurs in young adults and prevalence increases with age
Ultrasound, CT scan, serum pancreatic enzymes	No specific treatment; analgesics, fluid replacement, IV nutrients	Treat underlying alcoholism	Occurs in young adults and prevalence increases with age
Ultrasound, CT scan, needle biopsy	Chemotherapy (prognosis poor)	Stop tobacco use, alcohol abuse, treat underlying diabetes	Occurs in young adults and prevalence increases with age

ISBN 0-558-59446-8

Interactive Exercises

Cases for Critical Thinking

1. A 45-year-old woman experiences frequent heartburn, difficulty swallowing, and sharp pains below her sternum. At night, she experiences gastric reflux, or a regurgitation of stomach acid into the esophagus, a condition that is extremely painful. What could produce these symptoms? What diagnostic procedures could be used? How should she be treated?
2. T. W. experiences sharp pain in his upper right abdomen after eating a high-fat meal. Also, he has noted that his feces are grayish white instead of brown. What disease is the likely cause of his symptoms? Explain why each of these symptoms occurs with this disease.
3. Explain how cirrhosis leads to each of these signs and symptoms: jaundice, malnutrition, hemorrhage, esophageal varices.

Multiple Choice

1. Which of the following is a sign of gastritis?
   a. constipation
   b. inflammation of stomach mucosa
   c. achlorhydria
   d. diarrhea
2. Recurrent bloody diarrhea may be a symptom of _____.
   a. gastric ulcer
   b. ulcerative colitis
   c. hiatal hernia
   d. esophagitis
3. Which disease is characterized by the destruction of intestinal villi, leading to inability to absorb fats and other nutrients?
   a. ulcerative colitis
   b. celiac disease/malabsorption syndrome
   c. Crohn's disease
   d. peptic ulcer
4. Small pouches of the large intestine become inflamed during which disease?
   a. Crohn's disease
   b. gastritis
   c. hemorrhoids
   d. diverticulitis
5. Which statement about pancreatic cancer is FALSE?
   a. It is characterized by abdominal pain, weakness, weight loss.
   b. It has a higher incidence with age.
   c. Most cancers are diagnosed after the cancer has metastasized.
   d. The prognosis is good with an 85% cure rate.
6. Which statement about cirrhosis is FALSE?
   a. Irreversible degenerative changes occur in the liver.
   b. The normal liver tissue is replaced with fibrous scar tissue.
   c. It is most often caused by diabetes.
   d. It is associated with esophageal varices.
7. Acute pancreatitis is most closely associated with _____.
   a. hepatitis C virus infection
   b. chronic alcoholism
   c. bile duct obstruction
   d. complication of cirrhosis
8. Esophageal varices arise in which disease?
   a. cirrhosis
   b. pancreatic cancer
   c. cholecystitis
   d. cholelithiasis
9. Oral thrush is caused by _____.
   a. *Candida albicans*
   b. herpes simplex virus type 1
   c. *Treponema pallidum*
   d. *Streptococcus pyogenes* virus type 1
10. Pain in the upper right quadrant, especially after eating, could be a sign of _____.
    a. appendicitis
    b. pancreatitis
    c. cholecystitis
    d. colitis

ISBN 0-558-59446-8

True or False

_____ 1. Hemorrhoids are caused by infection with *E. coli*.
_____ 2. Oral and esophageal cancers are linked to tobacco and alcohol use.
_____ 3. Drinking too much water causes diarrhea.
_____ 4. Dark stools are known as melena.
_____ 5. Neurologic disorders can accompany liver disease.
_____ 6. Hepatitis A is acquired through blood products.
_____ 7. Most cancer in the liver is primary liver cancer.
_____ 8. Gallstones are made of undigested food particles too large to pass.
_____ 9. There is no vaccine for hepatitis B.
_____ 10. Gastric ulcers are caused by infection with *Helicobacter pylori*.

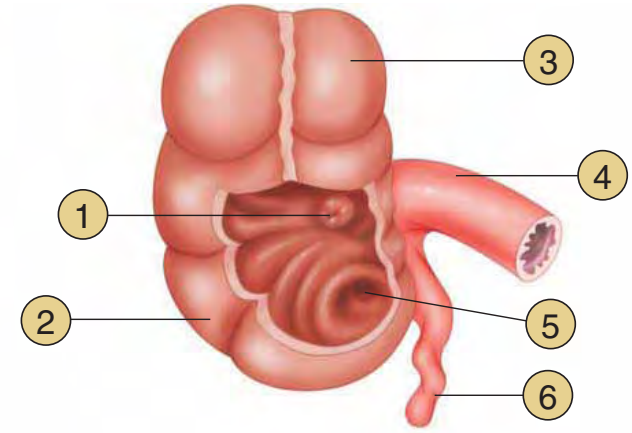
Fill-Ins

1. *Entamoeba histolytica* is the cause of _____ _____.
2. Thickened intestinal walls, leading to obstruction and abdominal pain, are found in _____ _____.
3. An abdominal _____ is protrusion of an organ through abdominal wall muscles.
4. An instrument called a(n) _____ is used to view the lining of the esophagus or other organs of the digestive tract.
5. Hepatitis type _____ is the major viral cause of cirrhosis.
6. Cholecystectomy is used to treat _____.
7. Biliary cirrhosis arises if there is obstruction of the _____ _____.
8. Accumulation of fluid in the abdomen is called _____.
9. Stomatitis refers to inflammation of the _____.
10. The primary function of the _____ _____ is to absorb water.

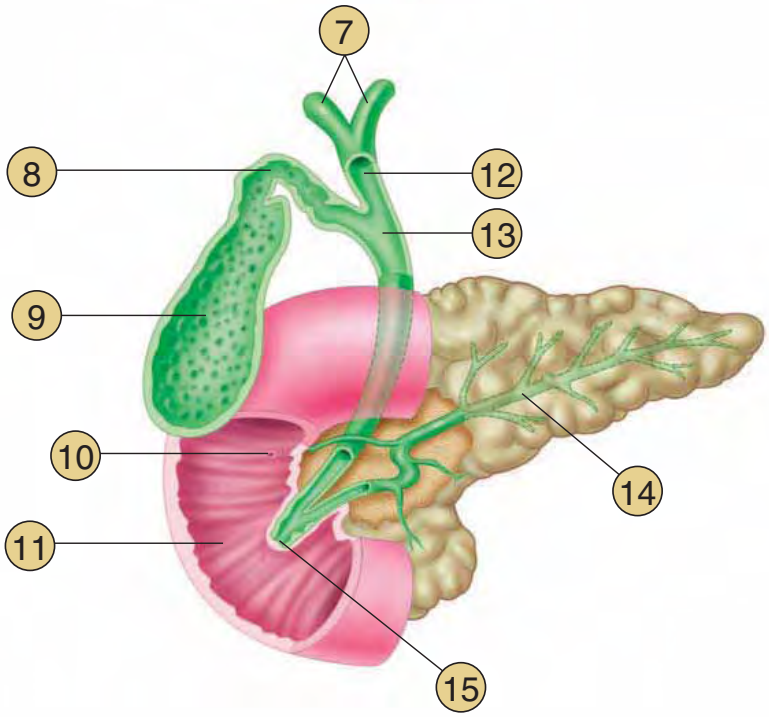
ISBN 0-558-59446-8

Labeling Exercise

Use the blank lines on the right to label the following images.



1 _____
2 _____
3 _____
4 _____
5 _____
6 _____



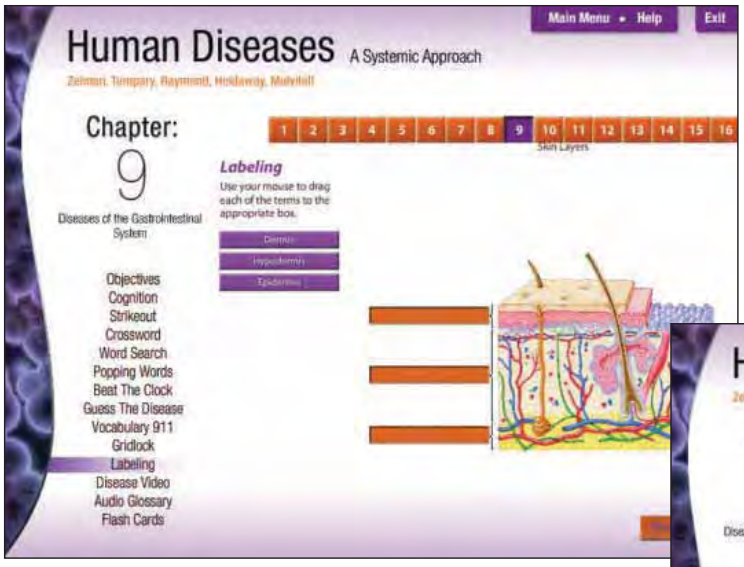
7 _____
8 _____
9 _____
10 _____
11 _____
12 _____
13 _____
14 _____
15 _____

ISBN 0-558-59446-8

Multimedia Preview

Additional interactive resources and activities for this chapter can be found on the Companion Website. For videos, audio glossary, and review, access the accompanying DVD-ROM in this book.

DVD-ROM Highlights



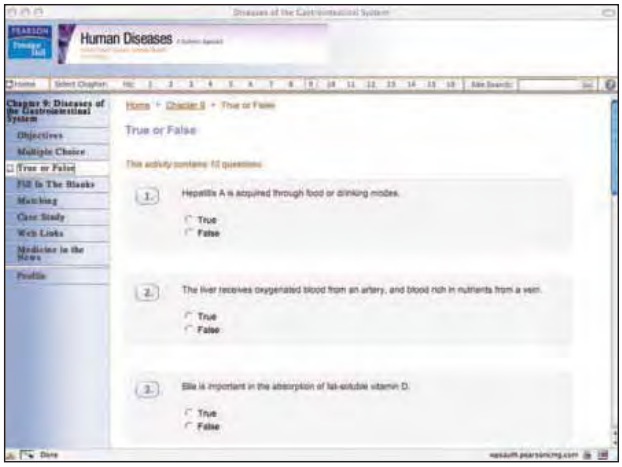
Labeling Exercise

A picture is worth a thousand words, but only if it's labeled correctly. Review pathology by clicking and dragging the terms that correlate to a figure from this chapter. The correct labels will lock into place beside the picture.

Gridlock

Are you a *Jeopardy!* champ? Prove your quiz show smarts by clicking the tiles to answer the human diseases questions hidden beneath. Get them all right to clear the grid.

Website Highlights—www.pearsonhighered.com/zelman



True or False Quiz

Take advantage of the free-access online study guide that accompanies your textbook. You'll find a true or false quiz that provides instant feedback and allows you to check your score to see what you got right or wrong. By clicking on this URL you'll also access links to current news articles and an audio glossary.

ISBN 0-558-59446-8