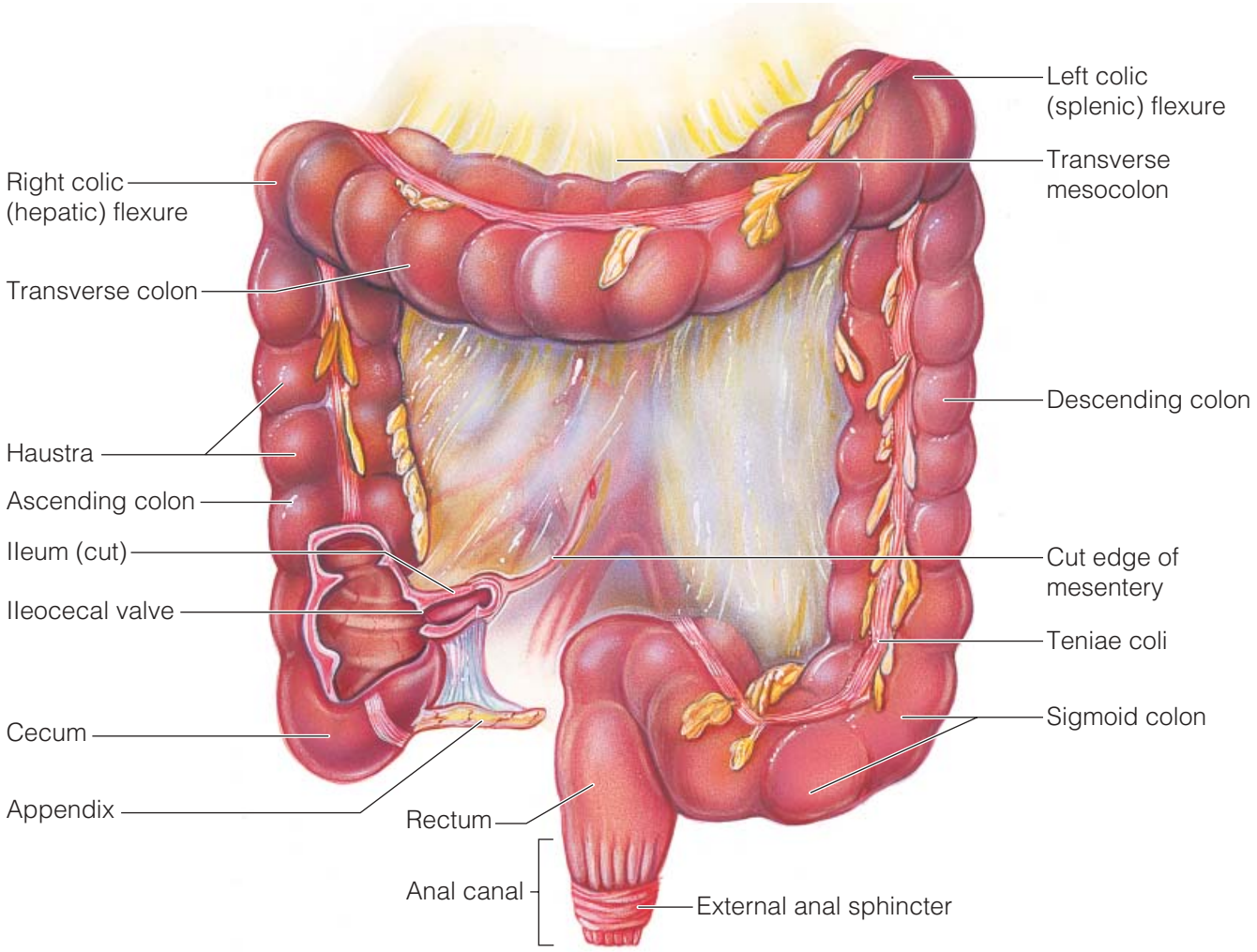

FIGURE 14.8 The large intestine. A section of the cecum is removed to show the ileocecal valve.

(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,

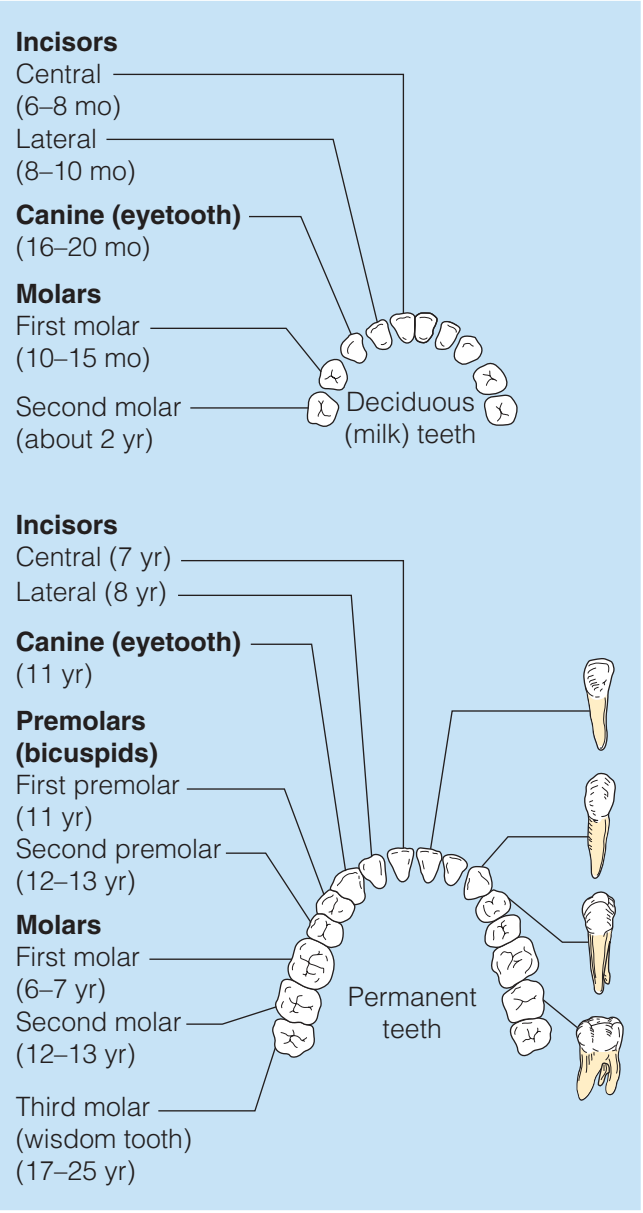

FIGURE 14.9 Human deciduous and permanent teeth. Approximate time of tooth eruption is shown in parentheses. Since the same number and arrangement of teeth exist in both upper and lower jaws, only the lower jaw is shown in each case. The shapes of individual teeth are shown on the right.

where it becomes the S-shaped **sigmoid** (sig′moid) **colon.** The sigmoid colon, rectum, and anal canal lie in the pelvis. The anal canal ends at the **anus** (a′nus), which opens to the exterior. The anal canal has an external *voluntary sphincter* (the **external anal sphincter**) composed of skeletal muscle and an internal *involuntary sphincter* formed by smooth muscle. These sphincters, which act rather like purse strings to open and close the anus, are ordinarily closed except during defecation, when feces are eliminated from the body.

Because most nutrient absorption has occurred before the large intestine is reached, no villi are seen in the large intestine, but there are tremendous numbers of *goblet cells* in its mucosa that produce an alkaline (HCO_3^--rich) mucus. The mucus acts as a lubricant to ease the passage of feces to the end of the digestive tract.

In the large intestine, the longitudinal muscle layer of the muscularis externa is reduced to three bands of muscle called *teniae coli* (ten′ne-e ko′li; "ribbons of the colon"). Since these muscle bands usually display some degree of tone (are partially contracted), they cause the wall to pucker into small pocketlike sacs called **haustra** (haws′trah).

Accessory Digestive Organs

Salivary Glands

Three pairs of **salivary glands** empty their secretions into the mouth. The large **parotid** (pah-rot′id) **glands** lie anterior to the ears. *Mumps,* a common childhood disease, is an inflammation of the parotid glands. If you look at the location of the parotid glands in Figure 14.1, you can readily understand why people with mumps complain that it hurts to open their mouth or chew.

The **submandibular glands** and the small **sublingual** (sub-ling′gwal) **glands** empty their secretions into the floor of the mouth through tiny ducts. The product of the salivary glands, **saliva,** is a mixture of mucus and serous fluids. The mucus moistens and helps to bind food together into a mass called a **bolus** (bo′lus), which makes chewing and swallowing easier. The clear serous portion contains an enzyme, **salivary amylase** (am′ĭ-lās), in a bicarbonate-rich (alkaline) juice that begins the process of starch digestion in the mouth. Saliva also contains substances such as lysozyme and antibodies (IgA) that inhibit bacteria; therefore, it has a protective function as well. Last but not least, saliva dissolves food chemicals so they can be tasted.

Teeth

The role of the teeth in food processing needs little introduction. We **masticate,** or *chew,* by opening and closing our jaws and moving them from side to side while continually using our tongue to move the food between our teeth. In the process, the teeth tear and grind the food, breaking it down into smaller fragments.

Ordinarily, by the age of 21, two sets of teeth have been formed (Figure 14.9). The first set is the **deciduous** (de-sid′u-us) **teeth,** also called **baby teeth** or **milk teeth.** The deciduous teeth begin to erupt around six months, and a baby has a full set (20 teeth) by the age of 2 years. The first teeth to appear are the lower central incisors, an event that is usually anxiously awaited by the child's parents.

As the second set of teeth, the deeper **permanent teeth,** enlarge and develop, the roots of the milk teeth are reabsorbed, and between the ages of 6 and 12 years they loosen and fall out. All of the permanent teeth but the third molars have erupted by the end of adolescence. The third molars, also called *wisdom teeth,* emerge later, between the ages of 17 and 25. Although there are 32 permanent teeth in a full set, the wisdom teeth often fail to erupt; sometimes they are completely absent.

Homeostatic Imbalance

When teeth remain embedded in the jawbone, they are said to be *impacted.* Impacted teeth exert pressure and cause a good deal of pain and must be removed surgically. Wisdom teeth are the most commonly impacted.

The teeth are classified according to shape and function as incisors, canines, premolars, and molars (see Figure 14.9). The chisel-shaped **incisors** are adapted for cutting; the fanglike **canines** (eyeteeth) are for tearing or piercing. The **premolars** (bicuspids) and **molars** have broad crowns with rounded cusps (tips) and are best suited for grinding.

A tooth consists of two major regions, the **crown** and the **root,** as shown in Figure 14.10. The enamel-covered crown is the exposed part of the tooth above the **gingiva** (jin-ji′vah), or **gum. Enamel** is the hardest substance in the body and is fairly brittle because it is heavily mineralized with calcium salts. The portion of the tooth embedded in the jawbone is the root; the root and crown are connected by the tooth region called the **neck.** The outer surface of the root is covered by

Q *What substance forms the bulk of the tooth?*

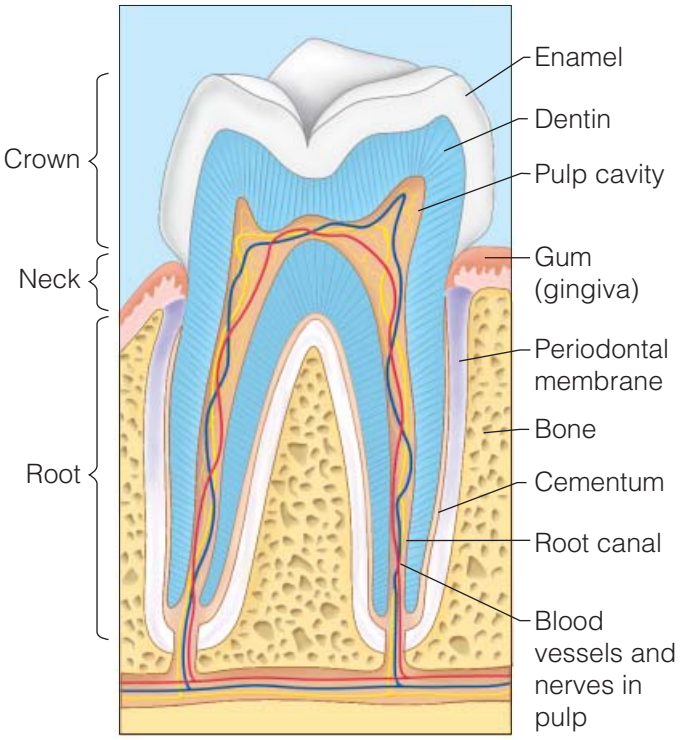

FIGURE 14.10 Longitudinal section of a molar.

a substance called **cementum,** which attaches the tooth to the **periodontal** (per″e-o-don′tal) **membrane (ligament).** This ligament holds the tooth in place in the bony jaw. **Dentin,** a bonelike material, underlies the enamel and forms the bulk of the tooth. It surrounds a central **pulp cavity,** which contains a number of structures (connective tissue, blood vessels, and nerve fibers) collectively called **pulp.** Pulp supplies nutrients to the tooth tissues and provides for tooth sensations. Where the pulp cavity extends into the root, it becomes the **root canal,** which provides a route for blood vessels, nerves, and other pulp structures to enter the pulp cavity of the tooth.

Pancreas

The **pancreas** is a soft, pink, triangular gland that extends across the abdomen from the spleen to the duodenum (see Figures 14.1 and 14.6).

A *Dentin.*

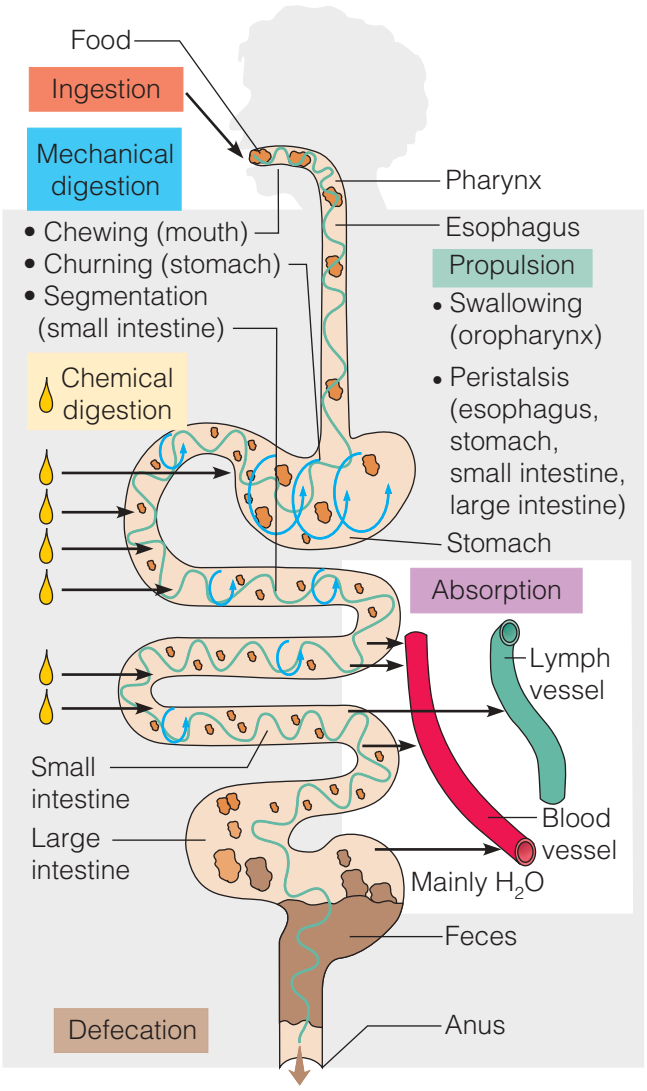

FIGURE 14.11 Schematic summary of gastrointestinal tract activities. Gastrointestinal tract activities include ingestion, mechanical digestion, chemical (enzymatic) digestion, propulsion, absorption, and defecation. Sites of chemical digestion are also sites that produce enzymes or that receive enzymes or other secretions made by accessory organs outside the alimentary canal. The mucosa of virtually the entire GI tract secretes mucus, which protects and lubricates.

Most of the pancreas lies posterior to the parietal peritoneum; hence its location is referred to as *retroperitoneal*.

The pancreas produces enzymes (described later) that break down all categories of digestible foods. The pancreatic enzymes are secreted into the duodenum in an alkaline fluid, which neutralizes the acidic chyme coming in from the stomach. The pancreas also has an endocrine function; it produces the hormones insulin and glucagon, as explained in Chapter 9.

Liver and Gallbladder

The **liver** is the largest gland in the body. It is located under the diaphragm, more to the right side of the body (see Figures 14.1 and 14.5). As described earlier, the liver overlies and almost completely covers the stomach. The liver has four lobes and is suspended from the diaphragm and abdominal wall by a delicate mesentery cord, the **falciform** (fal′si-form) **ligament.**

There is no question that the liver is one of the body's most important organs. It has many metabolic and regulatory roles; however, its digestive function is to produce **bile.** Bile leaves the liver through the **common hepatic duct** and enters the duodenum through the *bile duct* (see Figure 14.6).

Bile is a yellow-to-green, watery solution containing bile salts, bile pigments (chiefly bilirubin, a breakdown product of hemoglobin), cholesterol, phospholipids, and a variety of electrolytes. Of these components, only the bile salts (derived from cholesterol) and phospholipids aid the digestive process. Bile does not contain enzymes, but its bile salts *emulsify* fats by physically breaking large fat globules into smaller ones, thus providing more surface area for the fat-digesting enzymes to work on.

The **gallbladder** is a small, thin-walled green sac that snuggles in a shallow fossa in the inferior surface of the liver (see Figures 14.1 and 14.6). When food digestion is not occurring, bile backs up the **cystic duct** and enters the gallbladder to be stored. While being stored in the gallbladder, bile is concentrated by the removal of water. Later, when fatty food enters the duodenum, a hormonal stimulus prompts the gallbladder to contract and spurt out stored bile, making it available to the duodenum.

Homeostatic Imbalance

If bile is stored in the gallbladder for too long or too much water is removed, the cholesterol it contains may crystallize, forming *gallstones.* Since gallstones tend to be quite sharp, agonizing pain may occur when the gallbladder contracts (the typical *gallbladder attack*).