General Aspects of Digestion

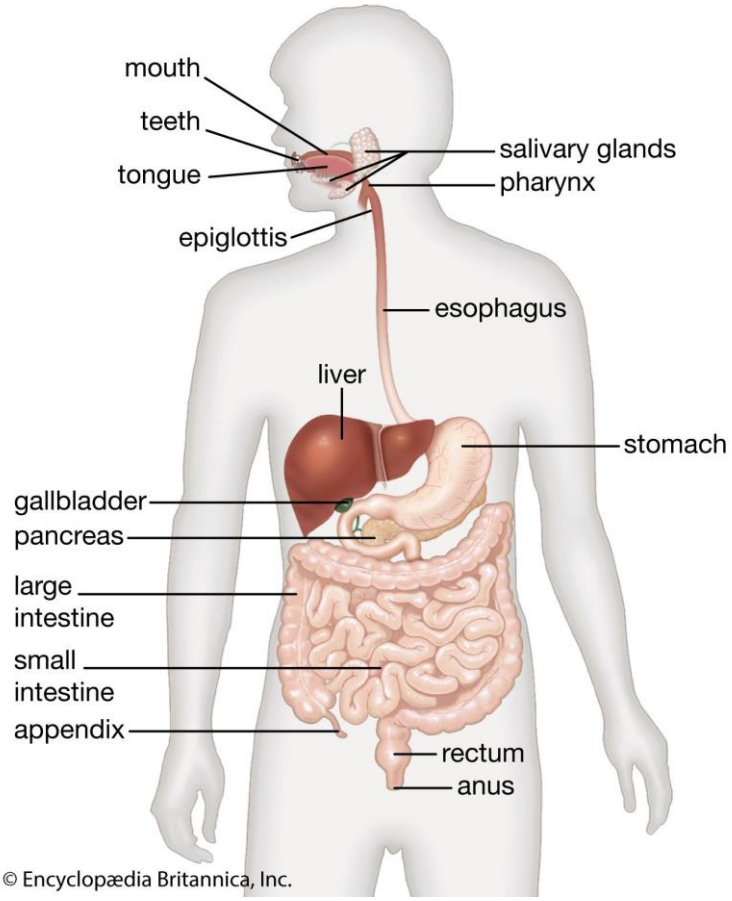
The primary function of the **digestive** (**gastrointestinal** or **GI**) **system** is to transfer nutrients, water, and electrolytes from the food we eat into the body's internal environment. Ingested food is essential as an energy source, or fuel, from which the cells can generate adenosine triphosphate (ATP) to carry out their activities, such as active transport, contraction, synthesis, and secretion. Food is also a source of building supplies for the renewal and addition of body tissues.

Food first must be digested, or chemically broken down, into small, simple molecules that can be absorbed from the digestive tract into the circulatory system for distribution to the cells. Normally, about 95% of the ingested food is made available for the body's use.

The digestive tract and accessory digestive organs make up the digestive system.

The digestive system consists of the digestive tract plus the accessory digestive organs. The **accessory digestive organs** include the *salivary glands*, the *exocrine pancreas*, and the *biliary system*, which is composed of the *liver* and *gallbladder*. These exocrine organs lie outside the digestive tract and empty their secretions through ducts into the digestive tract lumen.

The **digestive tract** is essentially a tube includes the following organs: *mouth*, *pharynx* (throat), *esophagus*, *stomach*, *small intestine* (consisting of the *duodenum*, *jejunum*, and *ileum)*, *large intestine* (the *cecum*, *appendix*, *colon*, and *rectum)*, and *anus* .



Mouth

The oral cavity is the entrance to the digestive tract.

Entry to the digestive tract is through the **mouth**, or **oral cavity**. The opening is formed by the muscular **lips**.

The **tongue**, which forms the floor of the oral cavity, is composed of voluntarily controlled skeletal muscle. The tongue guides food within the mouth during chewing and swallowing and also plays an important role in speech. Furthermore, the major **taste buds** are located on the tongue

The teeth mechanically break down food.

The first step in the digestive process is **mastication**, or **chewing**, the mouth motility that involves the slicing, tearing, grinding, and mixing of ingested food by the **teeth**.

Saliva begins carbohydrate digestion

Saliva, the secretion associated with the mouth, is produced largely by three major pairs of salivary glands that lie outside the oral cavity and discharge saliva through short ducts into the mouth .

The most important salivary proteins are *amylase*, *mucus*, and *lysozyme*. They contribute to the functions of saliva, which are as follows:

1. Saliva begins digestion of dietary starches through action of the enzyme **salivary amylase**. The products of digestion include **maltose**, a disaccharide consisting of two glucose molecules
2. Saliva facilitates swallowing by moistening food particles.
3. Saliva exerts some antibacterial action by **lysozyme**, a salivary enzyme that lyses, or destroys, certain bacteria by breaking down their cell walls; second, by salivary *IgA antibodies.*

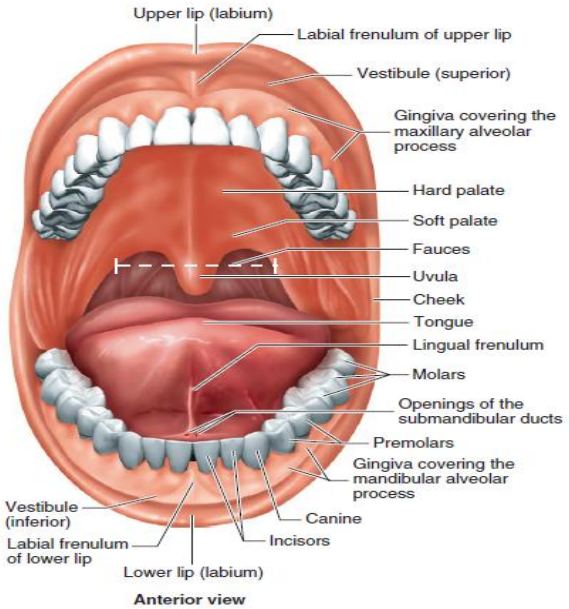


FIGURE 24.6 AP|R Oral Cavity

Pharynx and Esophagus

The **pharynx** is the cavity acts as a common passageway for both the digestive system (by serving as the link between the mouth and esophagus, for food) and the respiratory system (by providing access between the nasal passages and trachea, for air) . Housed within the side walls of the pharynx are the **tonsils**, lymphoid tissues that are part of the body's defense team.

The motility associated with the pharynx and esophagus is swallowing. Most of us think of swallowing as the limited act of moving food out of the mouth into the esophagus. However, **swallowing** is the entire process of moving food from the mouth through the esophagus into the stomach.

The **esophagus** is a fairly straight muscular tube that extends between the pharynx and the stomach.

Lying mostly in the thoracic cavity, it penetrates the diaphragm and joins the stomach in the abdominal cavity a few centimeters below the diaphragm.

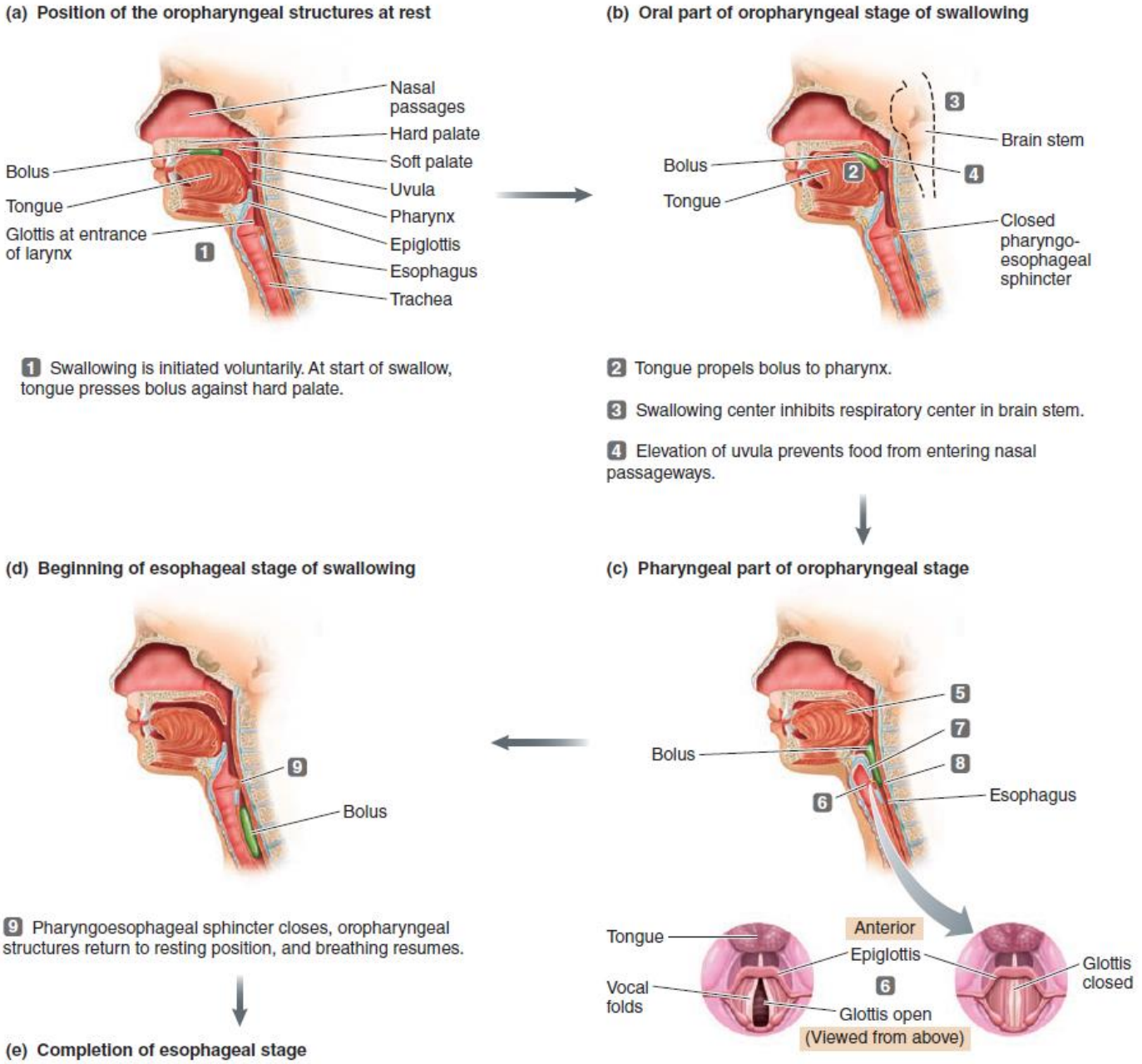
The esophagus is guarded at both ends by sphincters. A sphincter is a ringlike muscular structure that, when closed, prevents passage through the tube it guards. The upper esophageal sphincter is the *pharyngoesophageal sphincter*, and the lower esophageal sphincter is the *gastroesophageal sphincter*.

The gastroesophageal sphincter prevents reflux of gastric contents.

Except during swallowing, the **gastroesophageal sphincter**, which is smooth muscle in contrast to the upper esophageal sphincter, stays tonically contracted by means of myogenic activity .

If gastric contents do flow backward despite the sphincter, the acidity of these contents irritates the esophagus, causing the esophageal discomfort known as **heartburn**. (The heart itself is not involved.)

As the peristaltic wave sweeps down the esophagus, the gastroesophageal sphincter relaxes so that the bolus can pass into the stomach. After the bolus has entered the stomach, the swallow is complete and this lower esophageal sphincter again contracts.



1 Swallowing is initiated voluntarily. At start of swallow, tongue presses bolus against hard palate.

2 Tongue propels bolus to pharynx.

3 Swallowing center inhibits respiratory center in brain stem.

4 Elevation of uvula prevents food from entering nasal passageways.

5 Position of tongue prevents food from reentering mouth.

6 Tight alignment of vocal cords prevents food from entering trachea.

7 Epiglottis folds over closed glottis.

8 Contraction of pharyngeal muscles pushes bolus through opened pharyngoesophageal sphincter into esophagus.

9 Pharyngoesophageal sphincter closes, oropharyngeal structures return to resting position, and breathing resumes.

10 Peristalsis propels bolus down length of esophagus.

11 Gastroesophageal sphincter relaxes as peristalsis pushes bolus into stomach. Swallow is complete. Sphincter again contracts.

Figure 16-5 Oropharyngeal and esophageal stages of swallowing.
FIGURE FOCUS: *On occasion, vomit may accidentally be inhaled, or aspirated. Follow the route by which vomit leaves the stomach and enters the trachea.*

Stomach

The **stomach** is a J-shaped saclike chamber lying between the esophagus and the small intestine. It is divided into three sections based on structural and functional distinctions .

The **fundus** is the part of the stomach that lies above the esophageal opening. The middle or main part of the stomach is the **body**. The smooth muscle layers in the fundus and body are relatively thin, but the lower part of the stomach, the **antrum**, has heavier musculature.

The terminal portion of the stomach is the **pyloric sphincter**, which acts as a barrier between the stomach and the upper part of the small intestine, the duodenum.

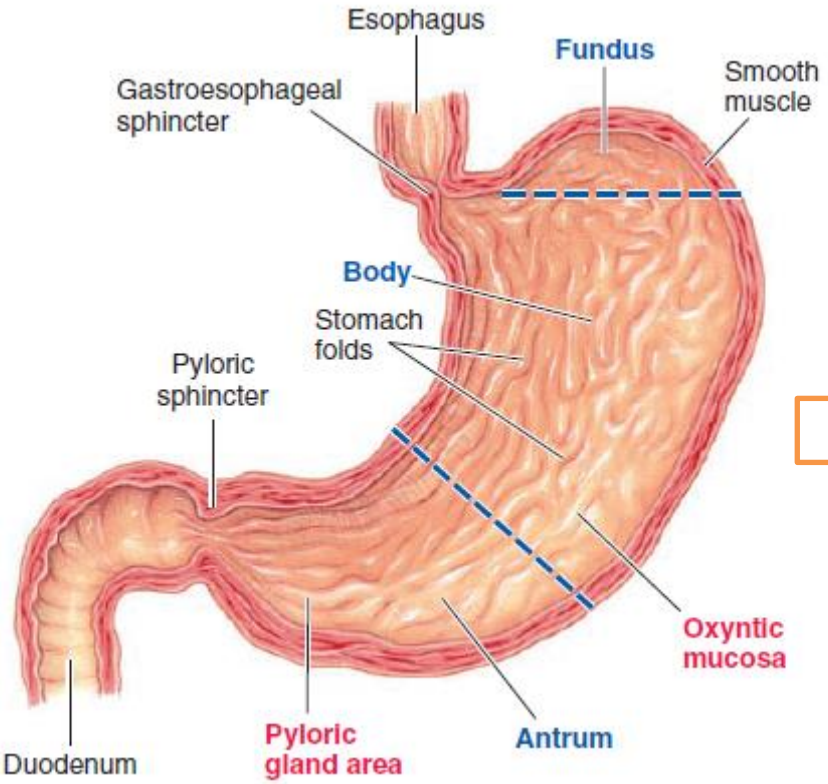


Figure : The stomach

The stomach stores food and begins protein digestion.

The stomach performs three main functions:

1. The stomach's most important function is to store ingested food until it can be emptied into the small intestine at a rate appropriate for optimal digestion and absorption.
2. The stomach secretes hydrochloric acid (HCl) and enzymes that begin protein digestion.
3. Through the stomach's mixing movements, the ingested food is pulverized and mixed with gastric secretions to produce a thick liquid mixture known as **chyme**.

The stomach contents must be converted to chyme before they can be emptied into the duodenum.

Three types of gastric exocrine secretory cells in the walls of stomach :

1. **Mucous cells** secrete a thin, watery *mucus.*
2. **chief cells** secrete the enzyme precursor *pepsinogen.*
3. The **parietal** (or **oxyntic**) **cells** secrete *HCl* and *intrinsic factor*

HCl performs specific functions that aid digestion:

1. HCl activates the enzyme precursor pepsinogen to an active enzyme, *pepsin*, and provides an acid environment optimal for pepsin action.
2. It aids in the breakdown of connective tissue and muscle fibers, reducing large food particles into smaller particles.
3. It denatures protein.
4. Along with salivary lysozyme, HCl kills most of the microorganisms in food.

Pepsinogen is activated to pepsin, which begins protein digestion.

The major digestive constituent of gastric secretion is **pepsinogen**, an inactive enzymatic molecule produced by the chief cells. Pepsinogen, once activated to the enzyme **pepsin**, begins protein digestion.

Mucus is protective.

The surface of the gastric mucosa is covered by a layer of mucus is a protective barrier against mechanical injury. And it helps protect the stomach wall from self-digestion because pepsin is inhibited when it comes in contact with the layer of mucus coating the stomach lining.

Intrinsic factor is essential for absorption of vitamin B12.

Intrinsic factor, another secretory product of the parietal cells in addition to HCl, is necessary for absorption of vitamin B12. Binding of intrinsic factor with vitamin B12 triggers receptormediated endocytosis of this complex in the terminal ileum, the last part of the small intestine . Vitamin B12 is essential for normal formation of red blood cells.

In the absence of intrinsic factor, vitamin B12 is not absorbed, so erythrocyte production is defective and *pernicious anemia* results . Pernicious anemia is typically caused by an autoimmune attack against the parietal cells.