The Digestive System 1

Learning Outcomes

- Identify the organs of the digestive system and their basic functions.
- Describe the four layers that form the wall of the gastrointestinal tract.
- Identify the locations of the salivary glands, and describe the functions of their secretions.
- Describe the location, structure, and functions of the pharynx and esophagus.
- Describe the location, structure, and functions of the stomach.
- Describe the location, structure, and functions of the pancreas.
- Describe the location, structure, and functions of the liver and gallbladder.

Learning Outcomes

- Describe the location, structure, and functions of the small intestine.
- Describe the location, structure, and functions of the large intestine.
- Describe the three phases of digestion.
- Describe the major hormones that regulate digestive activities

Functions of the Digestive System

- Ingestion: eating
- Digestion: breakdown of foods
  - Mechanically: by mixing and propulsion of digestive organs along GI tract
  - Chemically: by enzymes, hormones and buffers
- Absorption: transport products of digestion into the body
- Defecation: excrete solid waste products

Organs of the Digestive System

- Gastrointestinal (GI) tract
  - A tube through which foods pass and where digestion and absorption occur.
  - Includes: mouth, pharynx, esophagus, stomach, small intestine, large intestine
- Accessory organs:
  - Organs that help in digestion but through which food never passes.
  - Includes: teeth, tongue, salivary glands, liver, gallbladder, and pancreas

Organs of the Digestive System

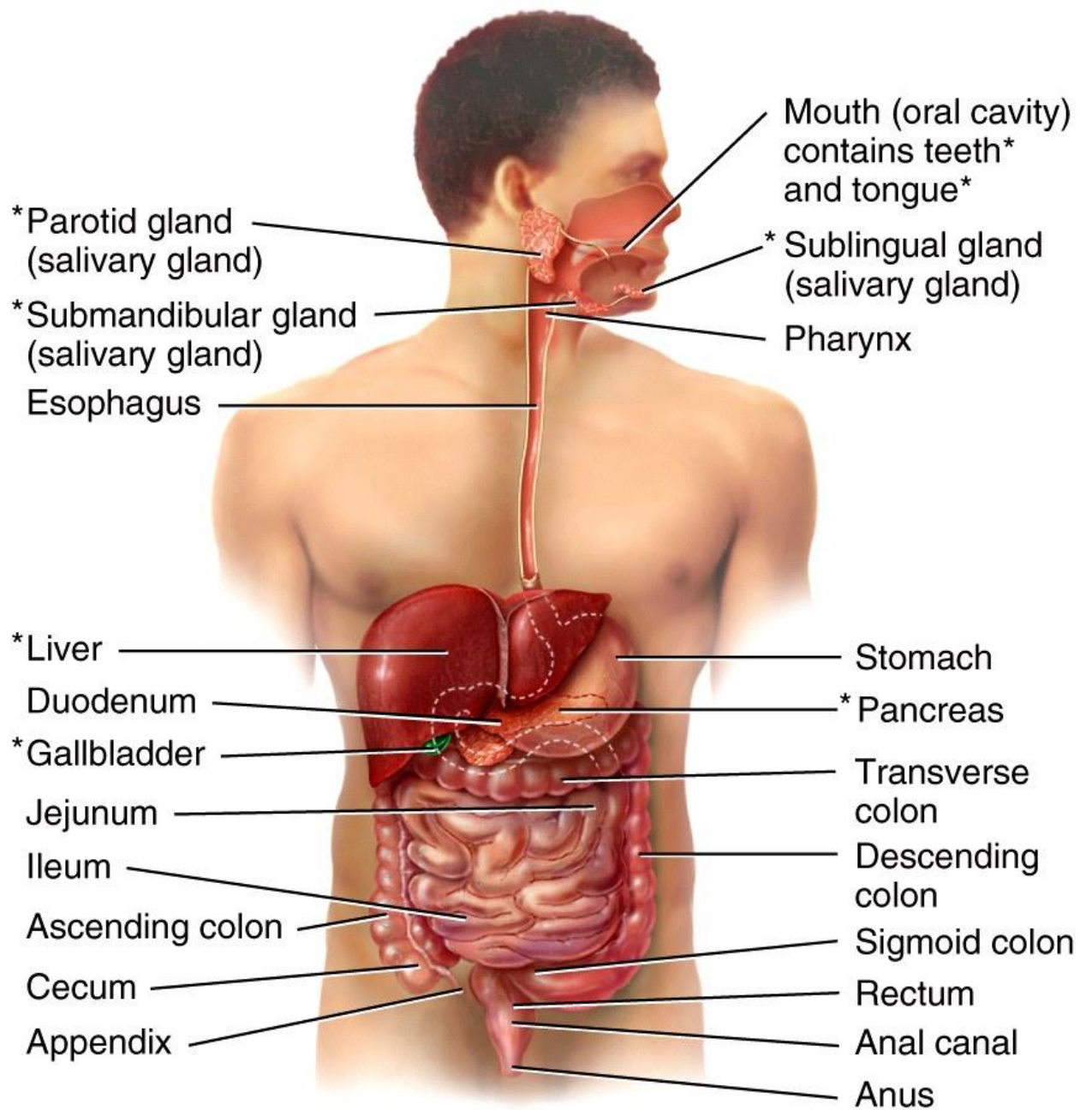


Diagram of right lateral view of head and neck and anterior view of trunk

ACCESSORY ORGANS

Salivary glands
Secrete saliva, which contains enzymes that initiate breakdown of carbohydrates

Liver
Produces bile, which emulsifies fat

Gallbladder
Stores bile and introduces it into small intestine

Pancreas
Produces and secretes pancreatic juice, containing digestive enzymes and bicarbonate ions, into small intestine

ALIMENTARY CANAL

Mouth
Mechanical breakdown of food; begins chemical digestion of carbohydrates

Pharynx
Connects mouth with esophagus

Esophagus
Peristalsis pushes food to stomach

Stomach
Secretes acid and enzymes; mixes food with secretions to begin enzymatic digestion of proteins

Small intestine
Mixes food with bile and pancreatic juice; final enzymatic breakdown of food molecules; main site of nutrient absorption

Large intestine
Absorbs water and electrolytes to form feces

Rectum
Regulates elimination of feces

Anus

.5 meter (from tongue to duodenum)

Tongue
Esophagus
Stomach
Gallbladder
Duodenum
Pancreas

1.0 m

5.5 – 6.0 meters (small intestine)

Jejunum (2.2 – 2.4 m)
Ileum (3.3 – 3.6 m)

1.5 meters (large intestine)

Appendix
Cecum
Large intestine
Anus

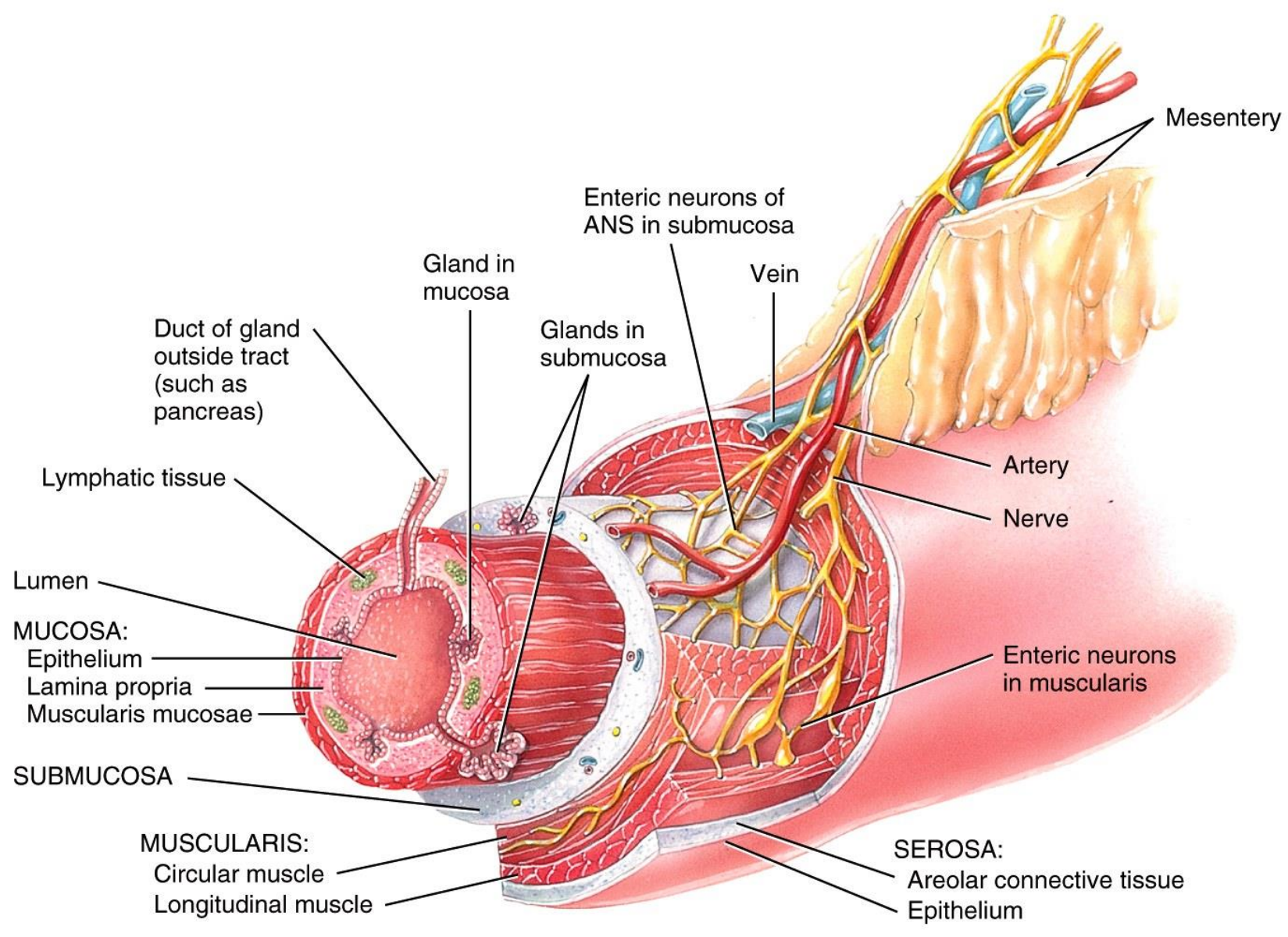
Layers of the Gastrointestinal (GI) Wall

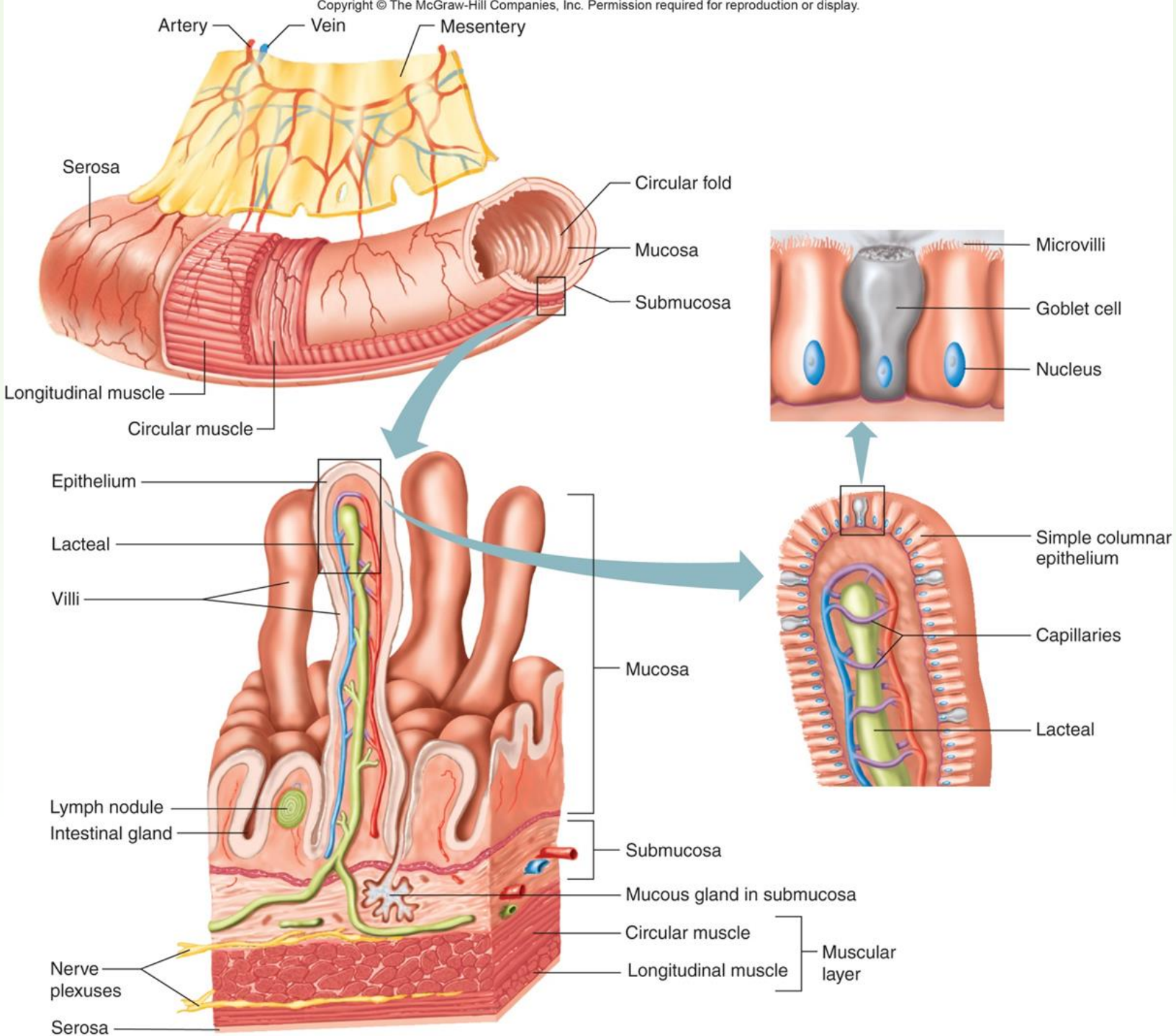
- Four layers from lower esophagus to anus
  1. Mucosa: epithelium in direct content with food; made of connective tissue, glands, and thin muscularis mucosae
  2. Submucosa: connective tissue, blood vessels, lymphatic vessels, and enteric nervous system (ENS)

Layers of the Gastrointestinal (GI) Wall

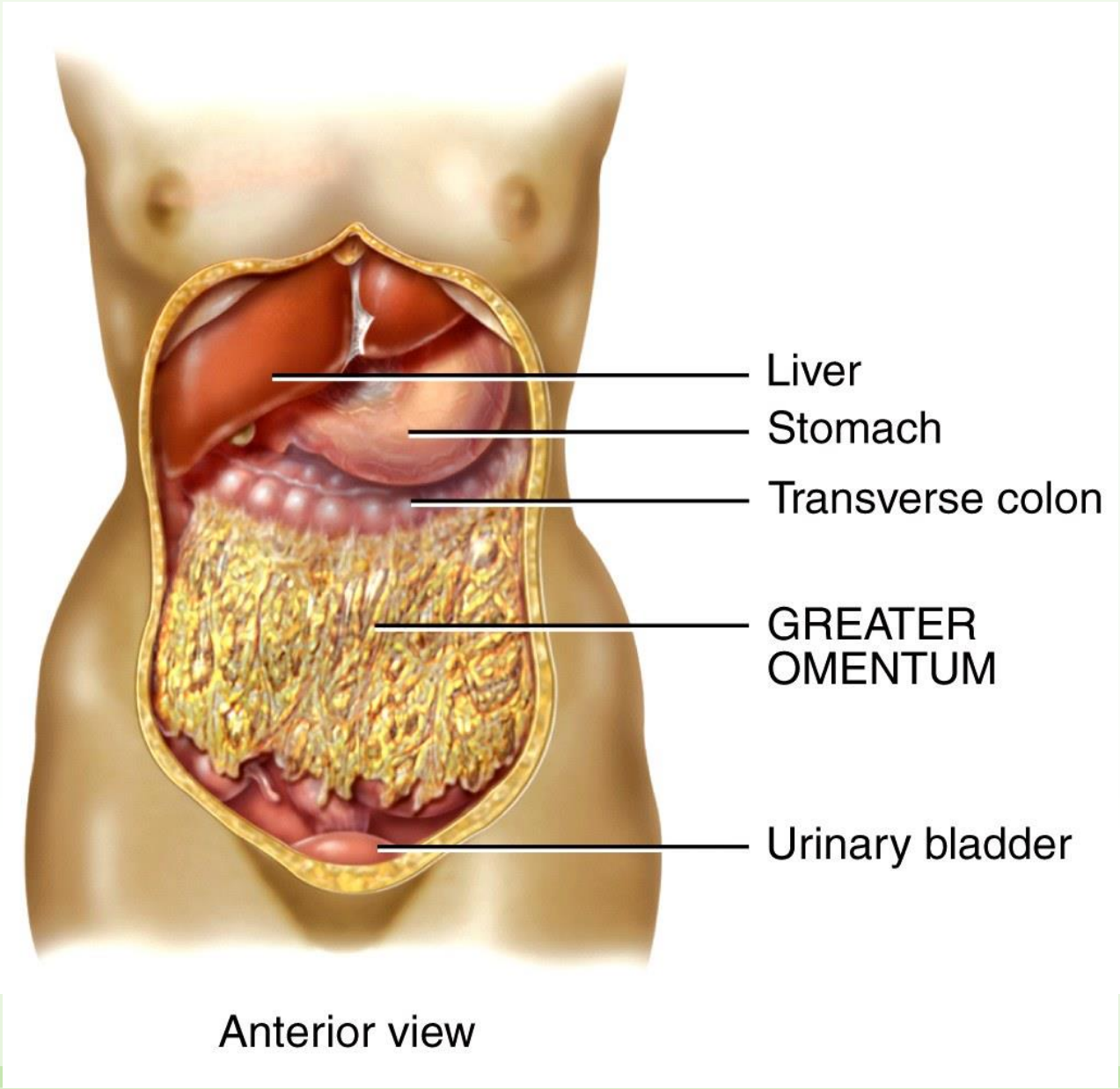
3. Muscularis: inner circular layer, outer longitudinal layer
   - Smooth muscle in most of GI tract
   - Except skeletal (voluntary muscle) in mouth, pharynx, upper esophagus, and external anal sphincter
4. Serosa: visceral layer of peritoneum
   - Also forms extensions: greater omentum and mesentery

Layers of the Gastrointestinal (GI) Wall

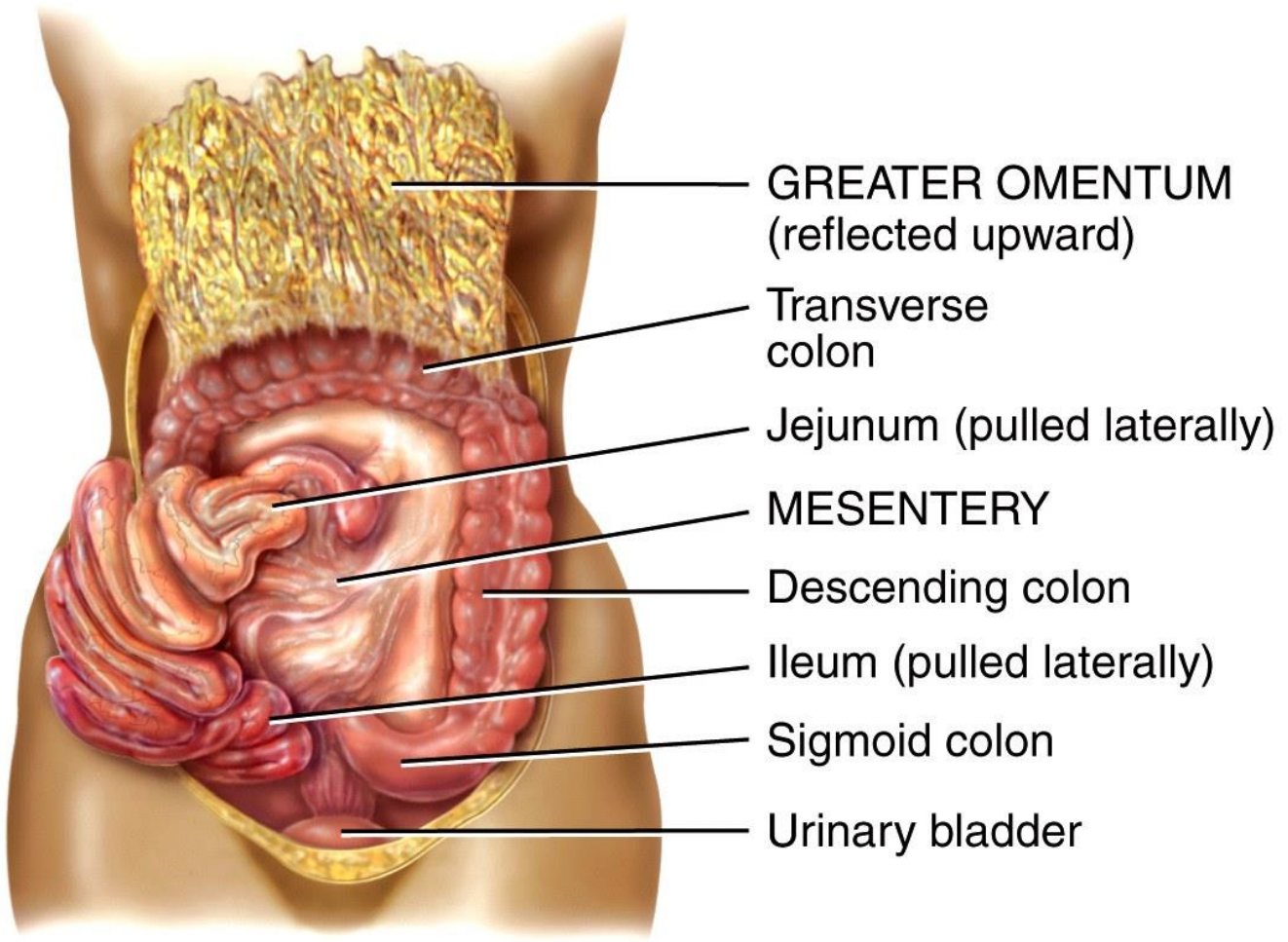




Layers of the Gastrointestinal (GI) Wall



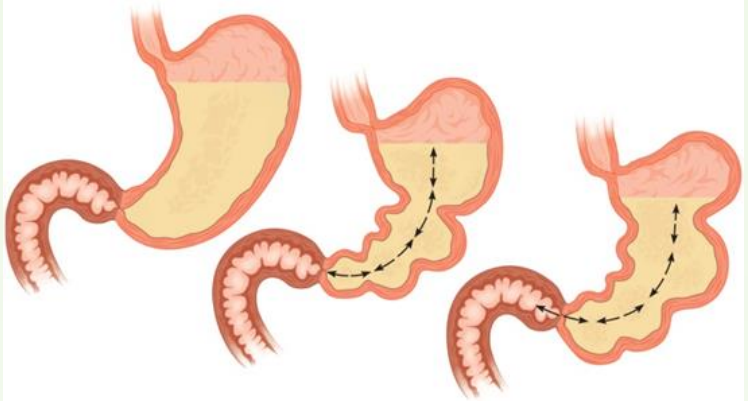
Layers of the Gastrointestinal (GI) Wall



Anterior view (greater omentum lifted and small intestine reflected to right side)

TABLE 17.1 | Layers of the Wall of the Alimentary Canal

Layer	Composition	Function
Mucosa	Epithelium, connective tissue, smooth muscle	Protection, secretion, absorption
Submucosa	Loose connective tissue, blood vessels, lymphatic vessels, nerves	Nourishes surrounding tissues, transports absorbed materials
Muscular layer	Smooth muscle fibers in circular and longitudinal groups	Movements of the tube and its contents
Serosa	Epithelium, connective tissue	Protection, lubrication



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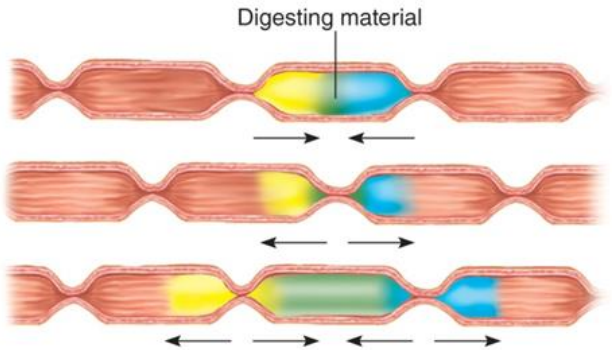

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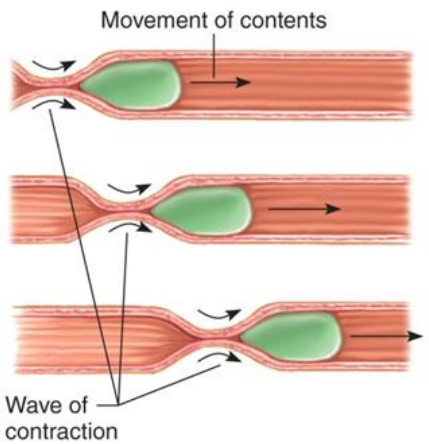


(c)

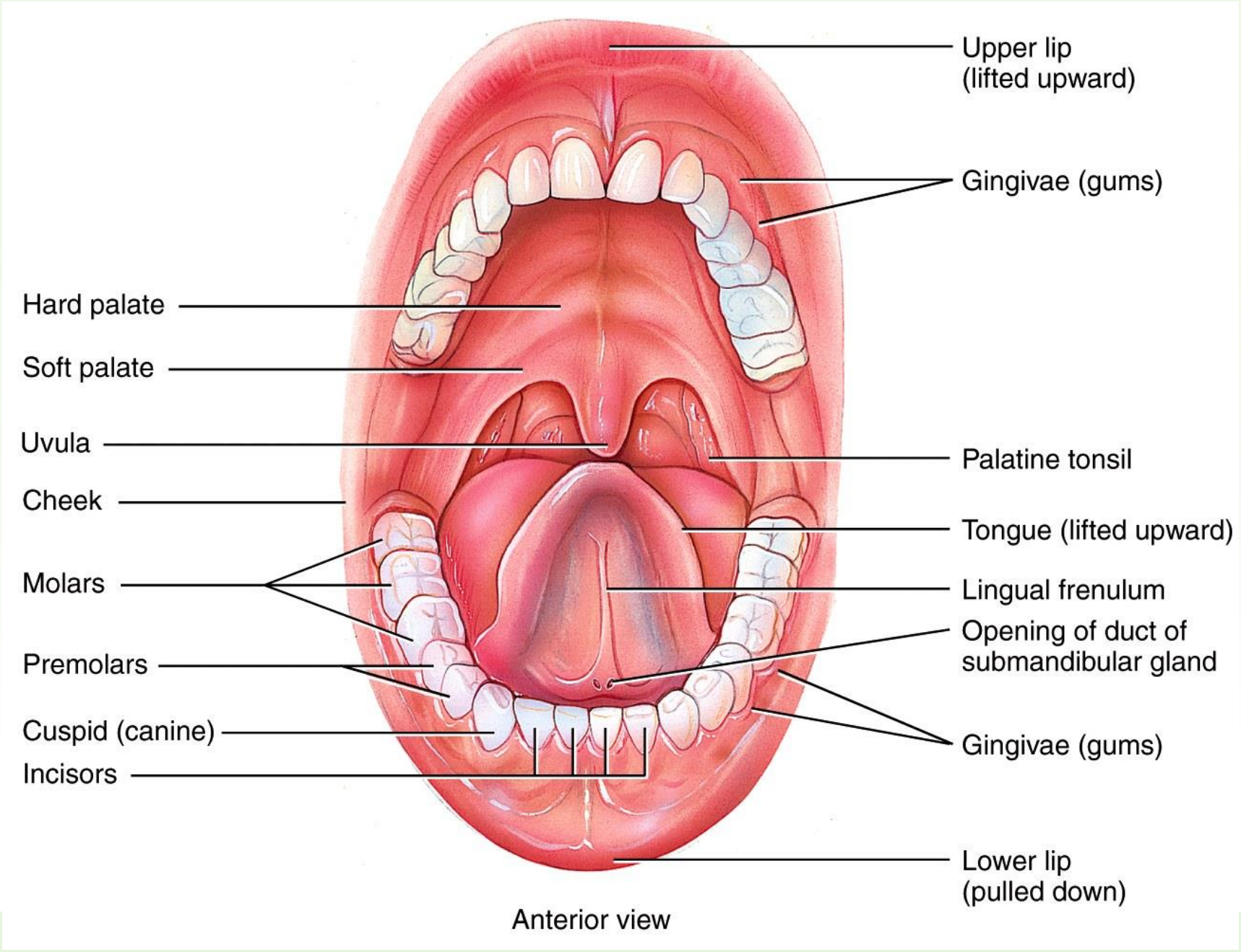
Mouth (Oral Cavity)

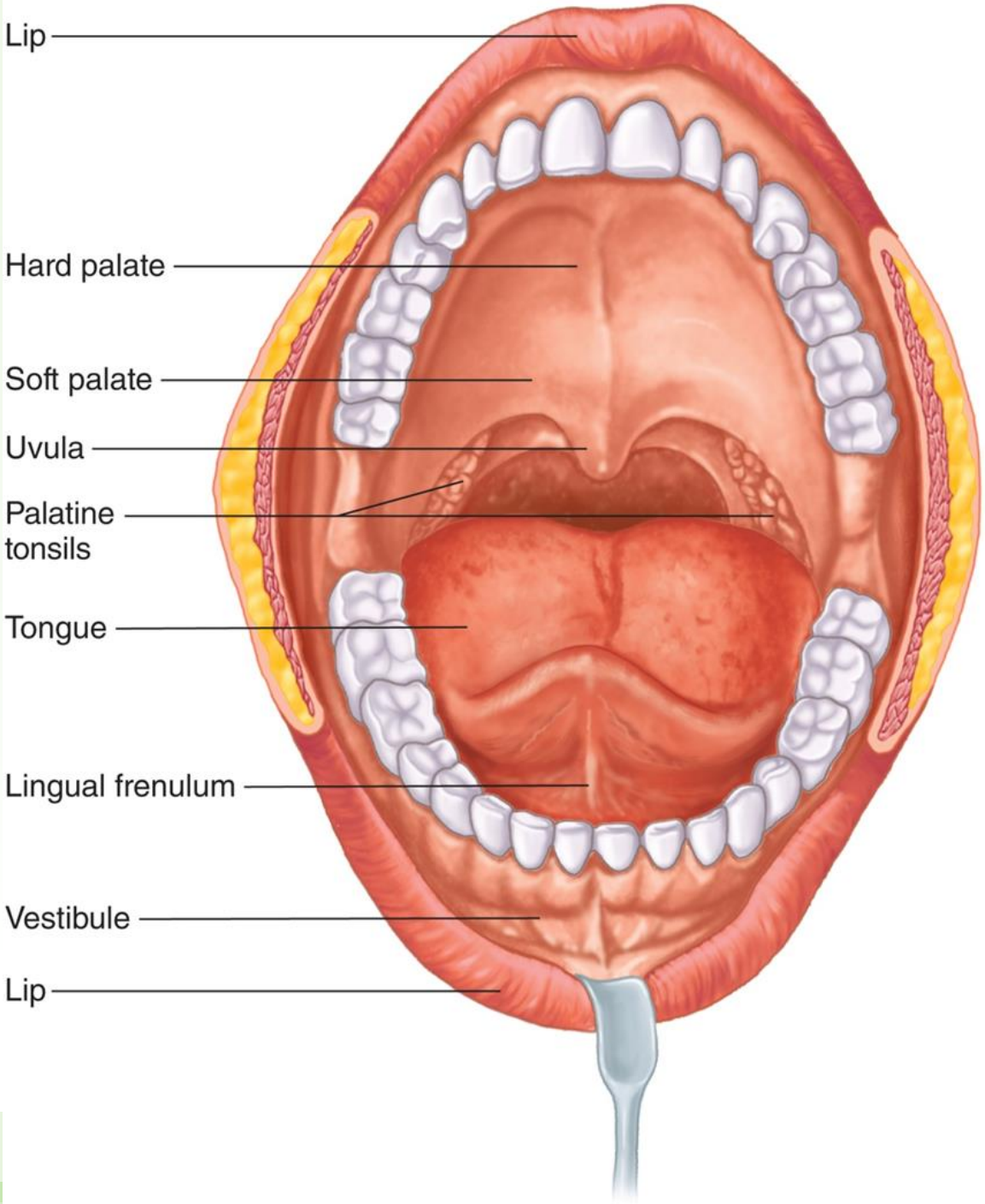
- Formed by
  - Cheeks and tongue
  - Hard palate anteriorly, soft palate posteriorly
- Uvula
  - U-shaped extension of soft palate posteriorly
  - During swallowing, uvula blocks entry of food or drink into nasal cavity
- Tongue: muscular accessory organ
  - Maneuvers food for chewing
  - Adjusts shape for speech and swallowing
- Lingual tonsils at base of tongue

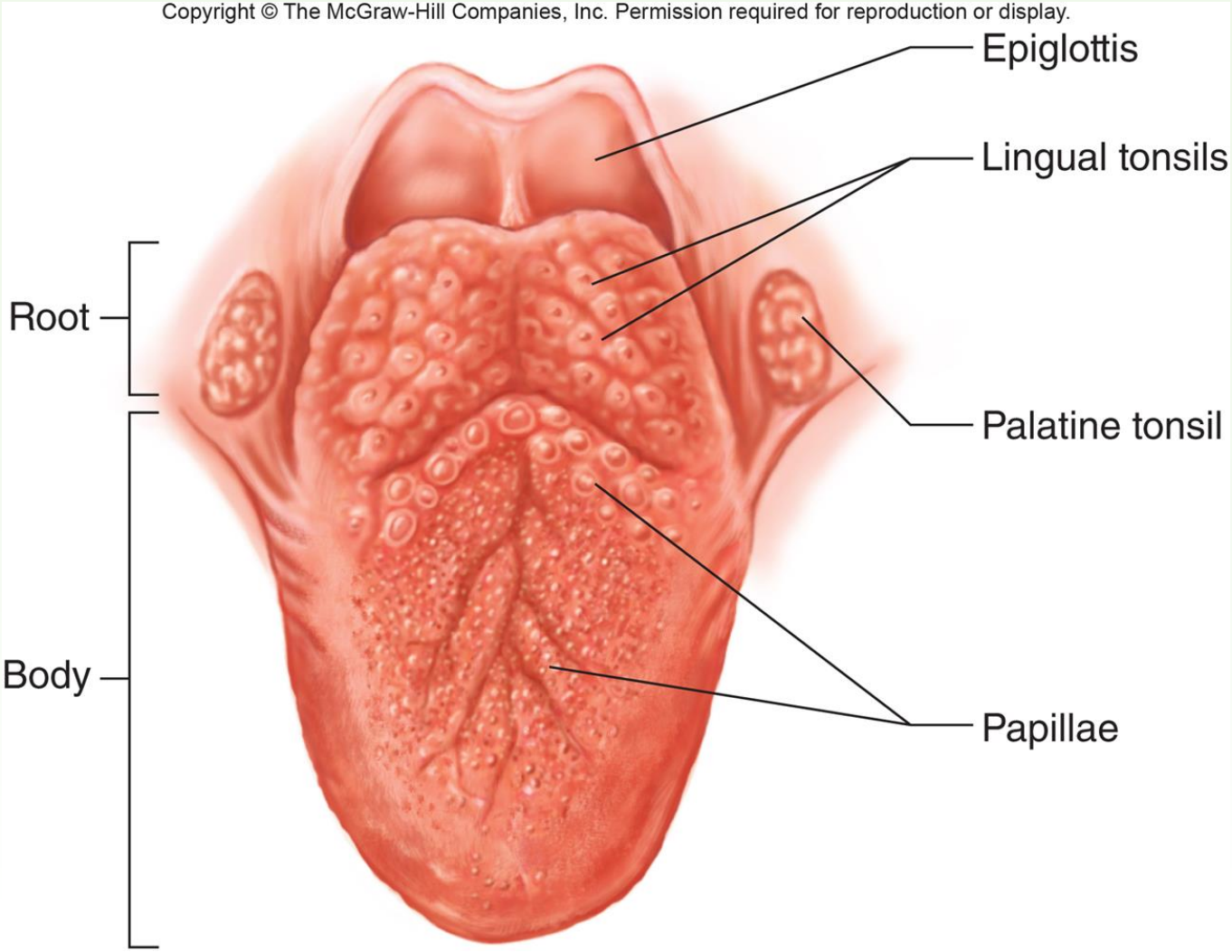
Salivary Glands

- Exocrine glands with ducts that empty into oral cavity
- Three pairs of salivary glands
  - Parotid
    - Largest; inferior and anterior to ears
  - Submandibular
    - In floor of mouth; medial and inferior to mandible
  - Sublingual
    - Inferior to tongue and superior to submandibular
- Saliva: 99.5% water, salivary amylase, mucus and other solutes
  - Dissolves food and starts digestion of starches

Salivary Glands







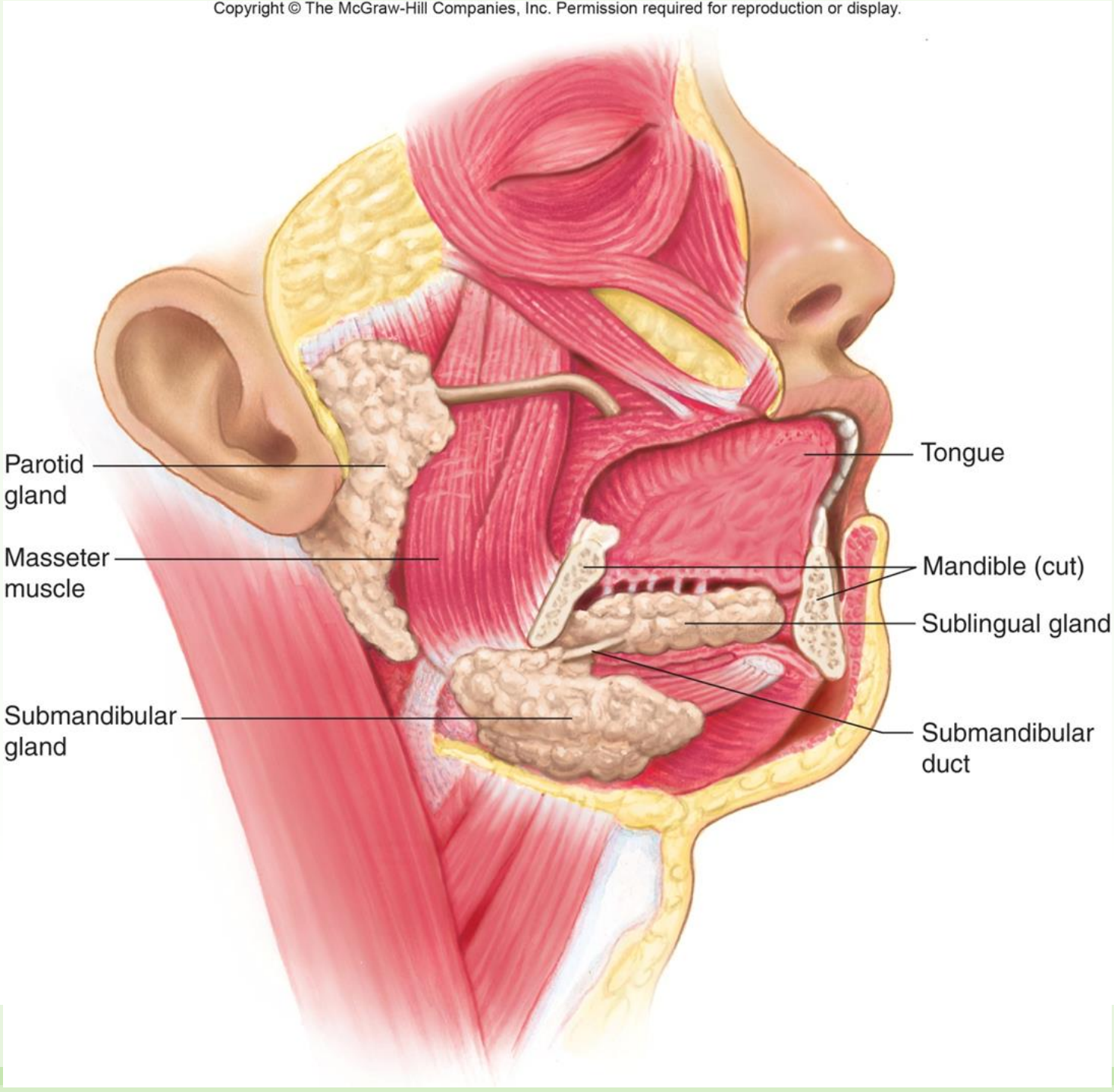
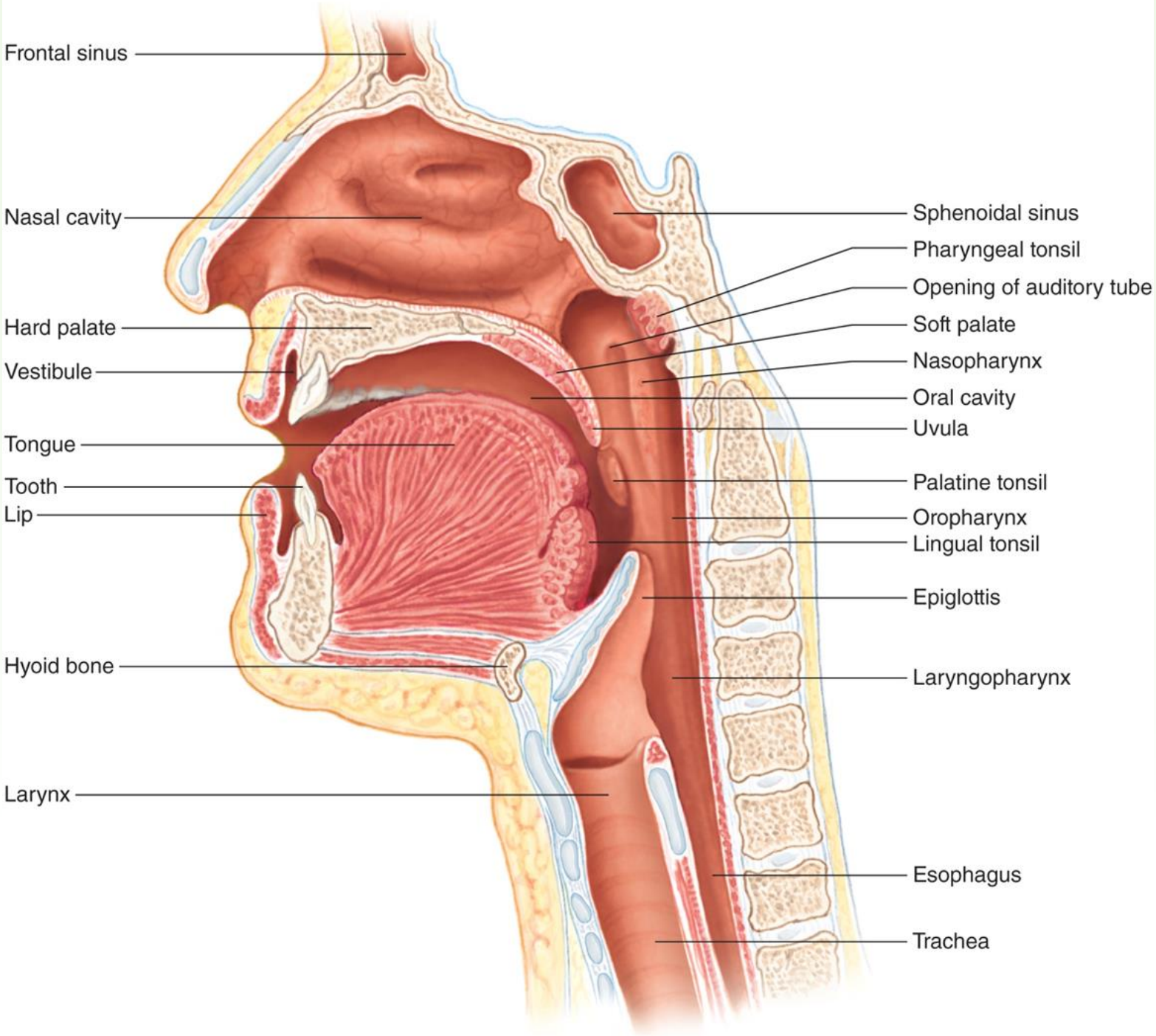


TABLE 17.4 | The Major Salivary Glands

Gland	Location	Duct	Type of Secretion
Parotid glands	Anterior to and somewhat inferior to the ears between the skin of the cheeks and the masseter muscles	Parotid ducts pass through the buccinator muscles and enter the mouth opposite the upper second molars	Clear, watery serous fluid, rich in salivary amylase
Submandibular glands	In the floor of the mouth on the inside surface of the mandible	Ducts open inferior to the tongue near the frenulum	Some serous fluid with some mucus; more viscous than parotid secretion
Sublingual glands	In the floor of the mouth inferior to the tongue	Many separate ducts	Primarily thick, stringy mucus

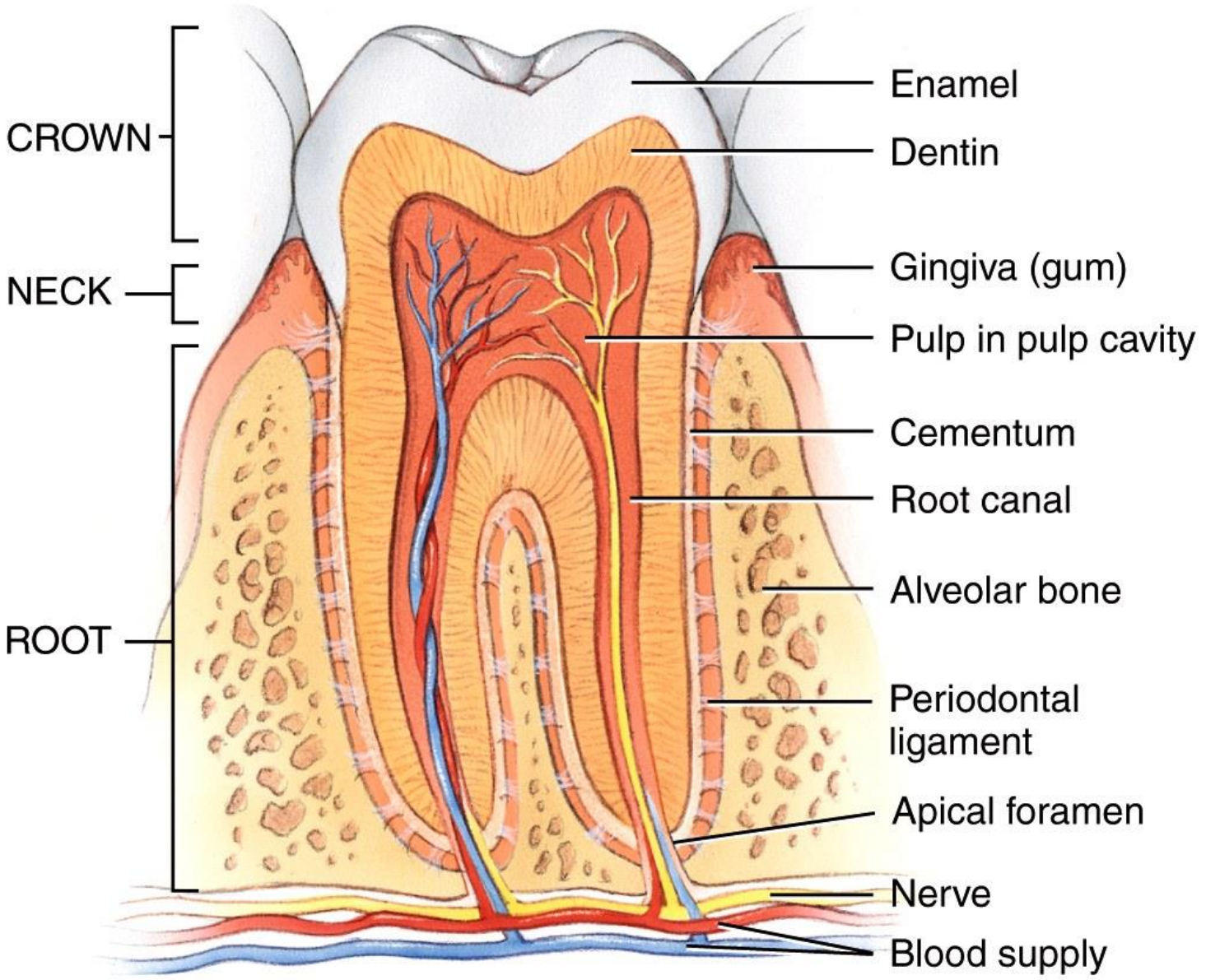


Teeth

- Accessory organs in bony sockets of mandible and maxilla
- Three external regions
  - Crown: above gums
  - Root: part(s) embedded in socket
  - Neck: between crown and root near gum line
- Three layers of material
  - Enamel: hardest substance in body; over crown
  - Dentin: majority of interior of tooth
  - Pulp cavity: nerve, blood vessel, and lymphatics

Teeth

Sagittal plane



Sagittal section of a mandibular (lower) molar

Teeth

- Humans have two sets of teeth
  - The 20 deciduous teeth are replaced by the permanent teeth between ages 6 and 12 years.
  - The 32 permanent teeth appear between 6 years and adulthood.
- Four types of teeth
  - Incisors (8): used to cut food
  - Cuspids (canines) (4): used to tear food
  - Premolars (8): for crushing and grinding food
  - Molars (12): used for crushing and grinding food

TABLE 17.2 | Primary and Secondary Teeth

Primary Teeth (Deciduous)		Secondary Teeth (Permanent)	
Type	***Number***	***Type***	***Number***
Incisor		Incisor	
Central	4	Central	4
Lateral	4	Lateral	4
Canine (cuspid)	4	Canine (cuspid)	4
		Premolar (bicuspid)	
		First	4
		Second	4
Molar		Molar	
First	4	First	4
Second	4	Second	4
		Third	4
Total	20	**Total**	32

Digestion in the Mouth

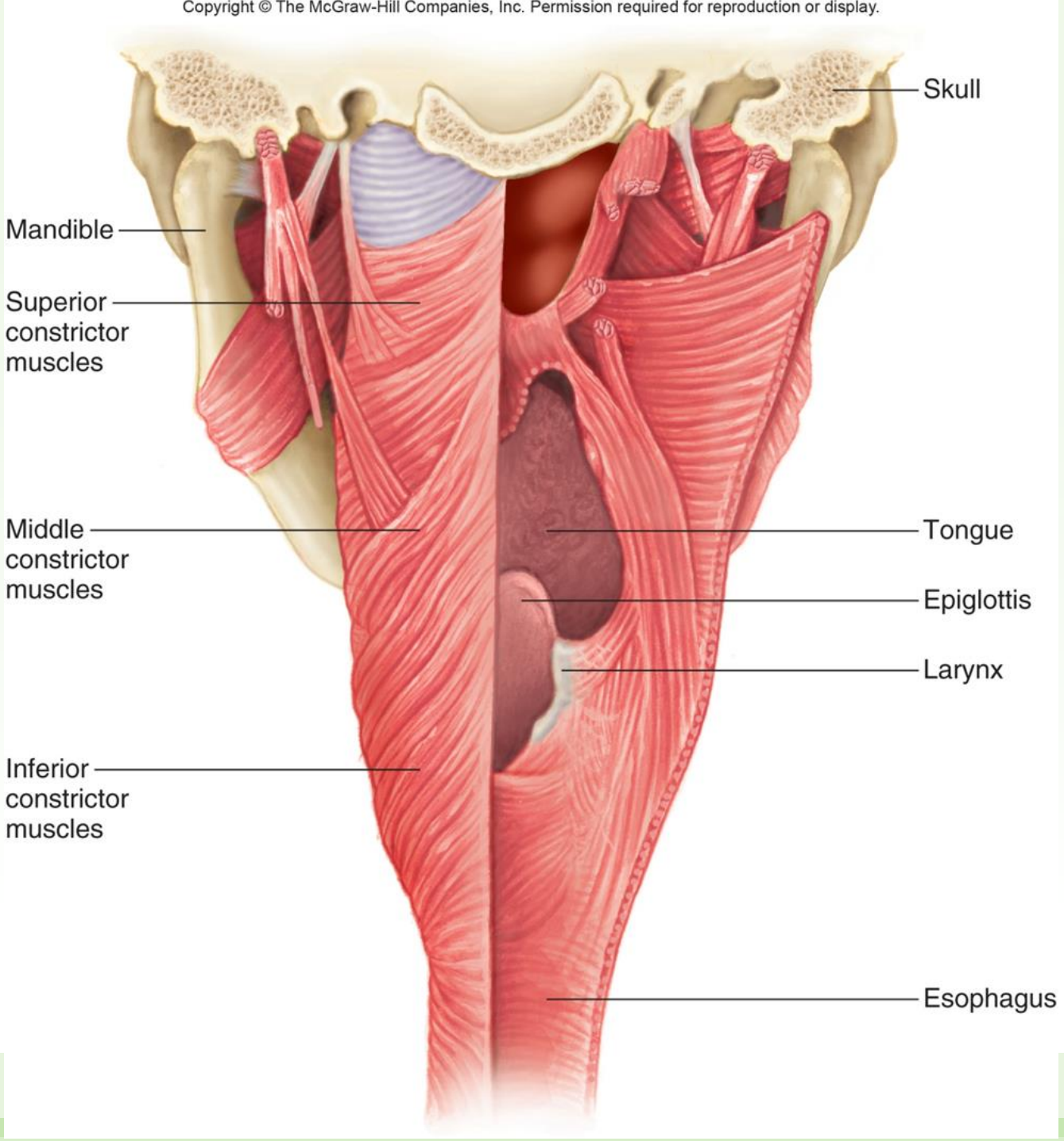
- Mechanical digestion
  - Chewing mixes food with saliva
  - Rounds up food into a soft bolus for swallowing
- Chemical digestion
  - Salivary amylase (enzyme) breaks down polysaccharides (starch) → maltose and larger fragments
  - Continues in the stomach for about an hour until acid inactivates amylase

TABLE 17.3 | Mouth Parts and Their Functions in Digestion

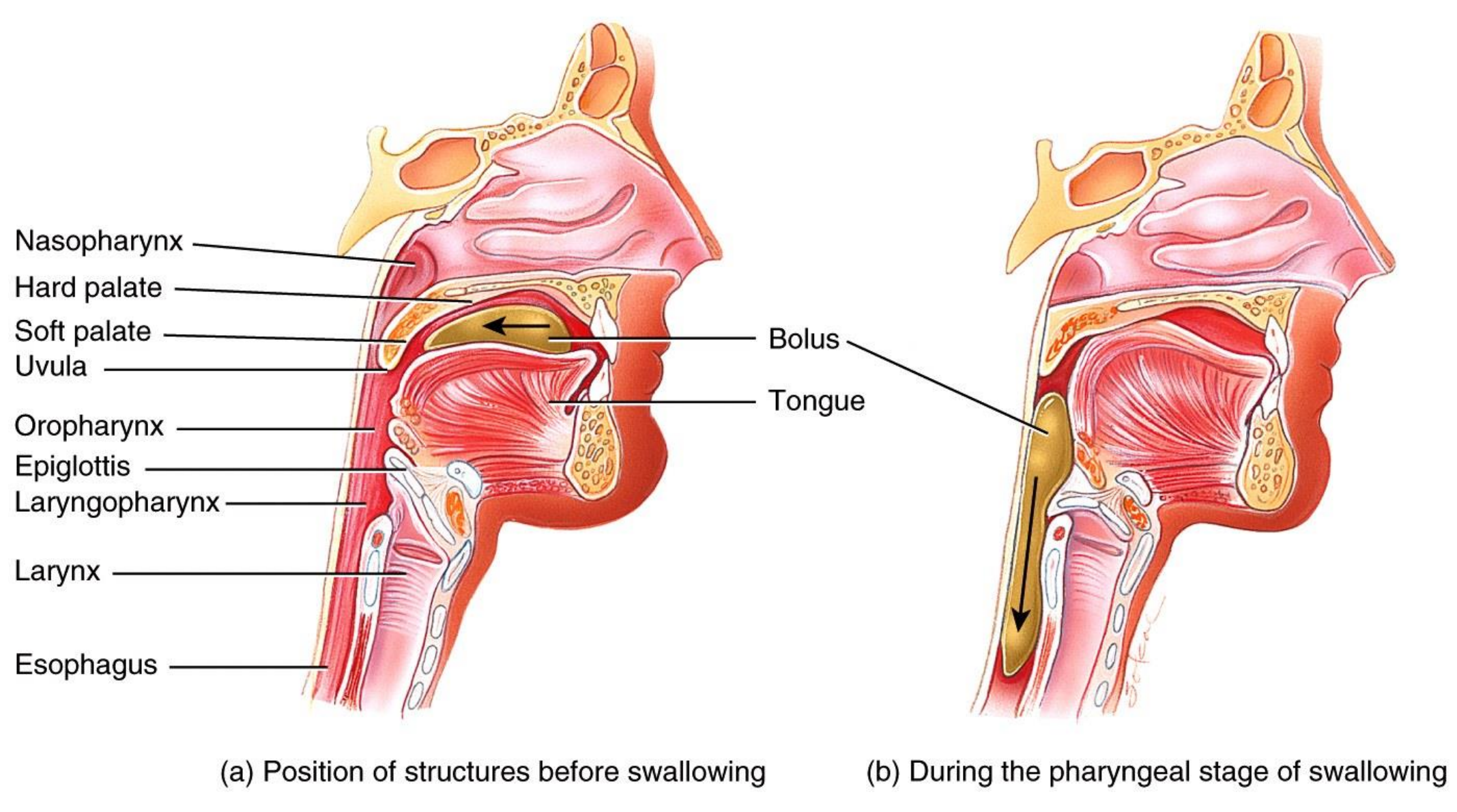
Part	Location	Function
Cheeks	Form lateral walls of mouth	Hold food in mouth; muscles chew food
Lips	Surround mouth opening	Contain sensory receptors used to judge characteristics of foods
Tongue	Floor of mouth	Mixes food with saliva; moves food toward pharynx; contains taste receptors
Palate	Forms roof of mouth	Holds food in mouth; directs food to pharynx
Teeth	In sockets of mandibular and maxillary bones	Break food particles into smaller pieces; help mix food with saliva during chewing

Pharynx and Esophagus

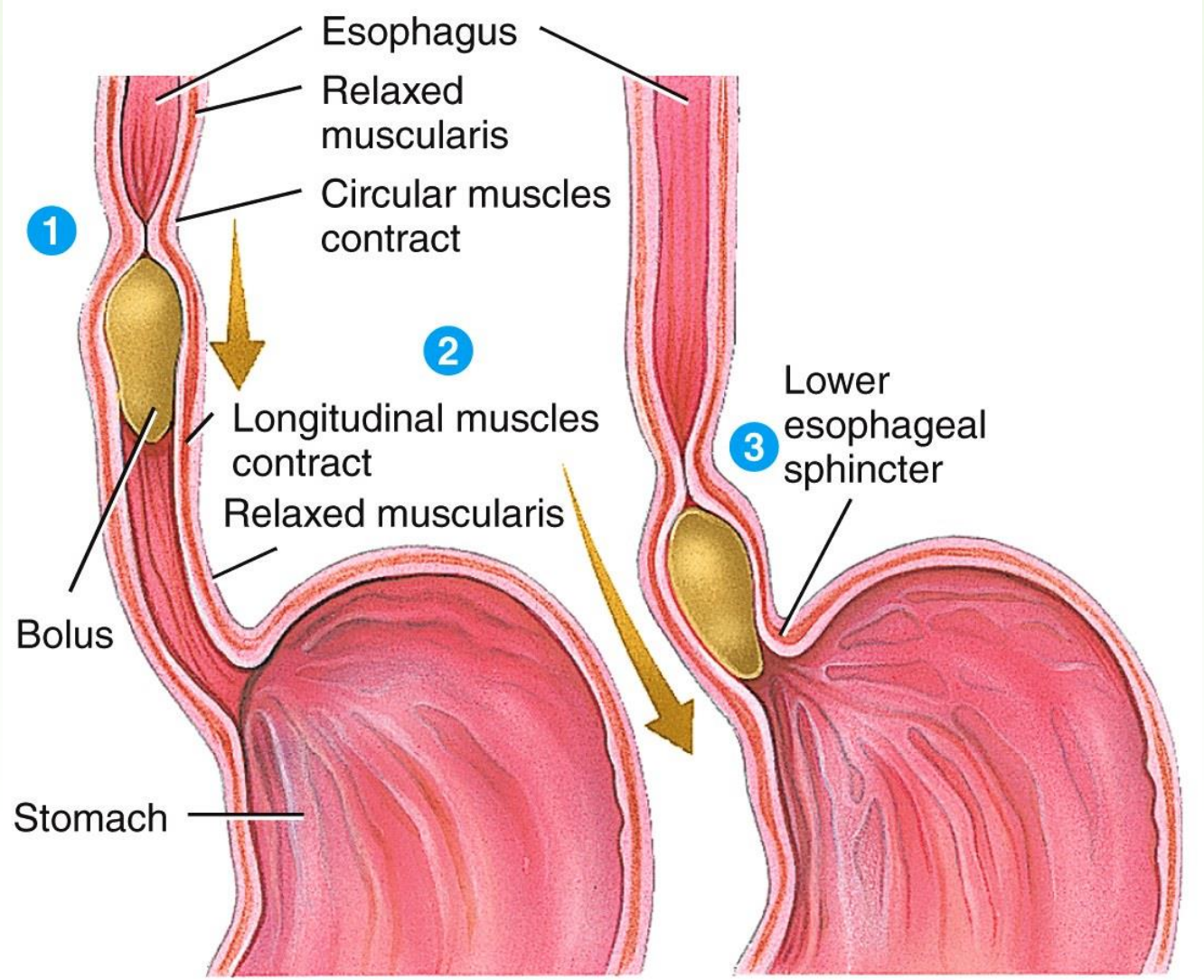
- Food passages from mouth → stomach
- Swallowing: 3 stages
  - Voluntary stage: bolus of food → oropharynx
  - Pharyngeal stage: oropharynx → esophagus
    - Soft palate moves up and epiglottis moves down; prevent food from entering nasopharynx and larynx
  - Esophageal: food → stomach by peristalsis
- Esophageal sphincters:
  - Upper: controls entry → esophagus
  - Lower: controls entry → stomach; GERD affects



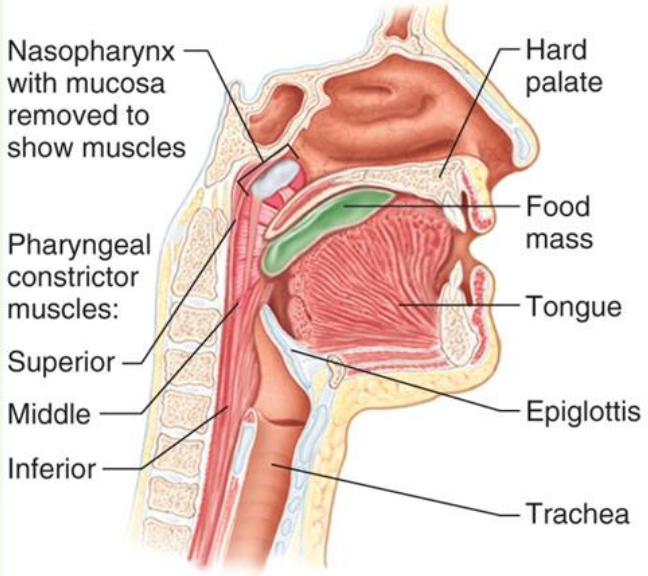
Pharynx and Esophagus



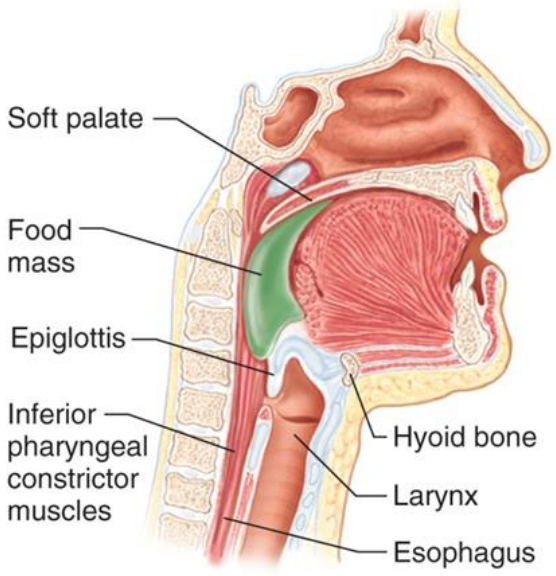
Pharynx and Esophagus



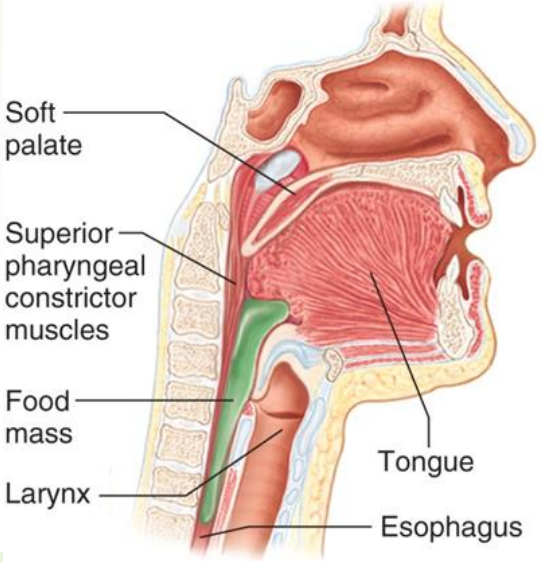
Anterior view of frontal sections of peristalsis in esophagus



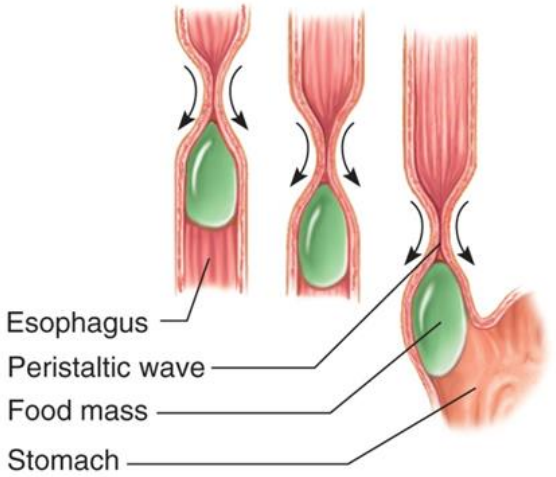
(a) The tongue forces food into the pharynx.



(b) The soft palate, hyoid bone, and larynx are raised, the tongue is pressed against the palate, the epiglottis closes, and the inferior constrictor muscles relax so that the esophagus opens.



(c) Superior constrictor muscles contract and force food into the esophagus.



(d) Peristaltic waves move food through the esophagus to the stomach.