

Chapter 34: pp. 633 - 648

# Digestive Systems & Nutrition

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# OUTLINE

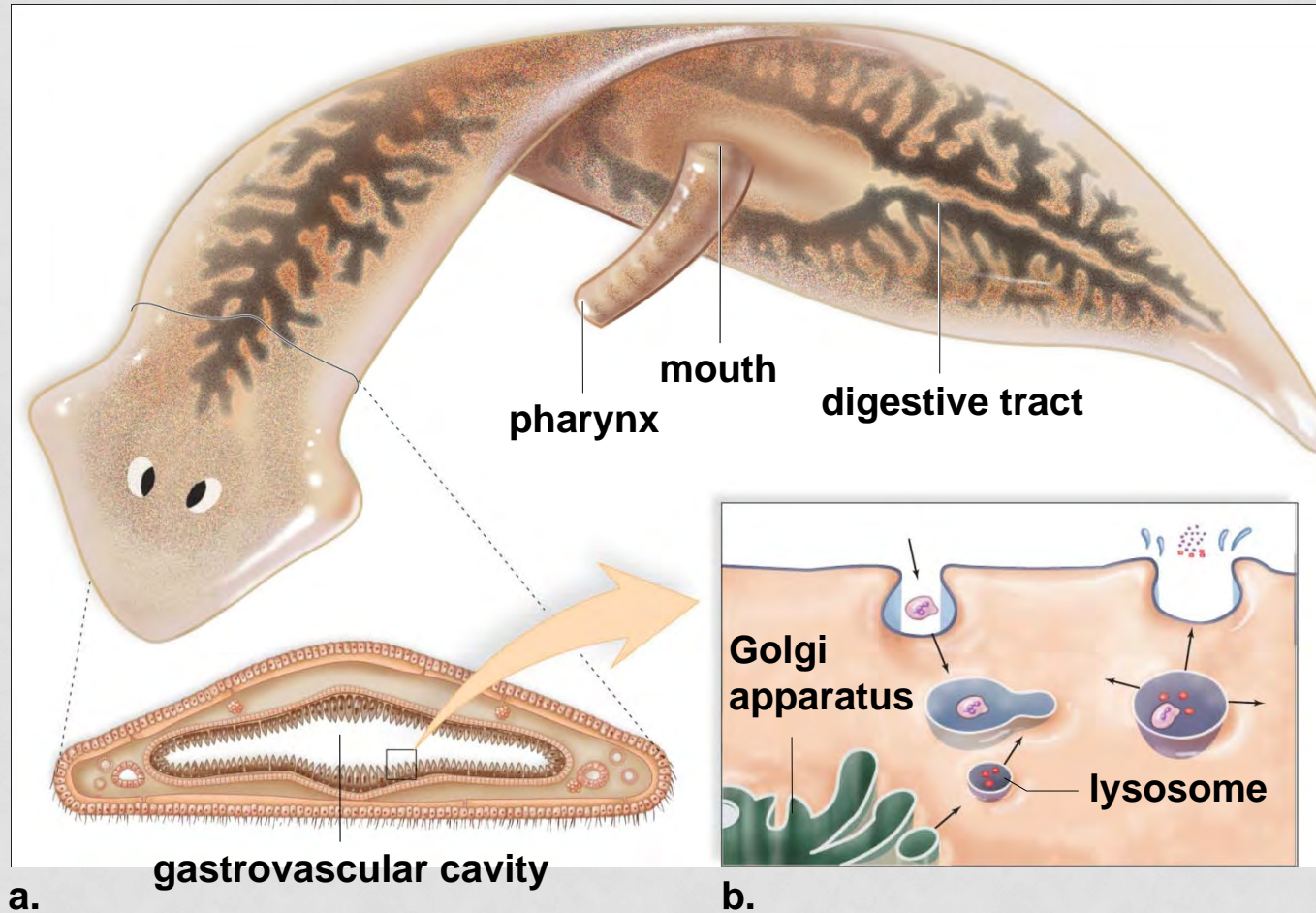
- Digestive Tracts
  - Incomplete versus Complete Tracts
  - Continuous versus Discontinuous Feeders
  - Dentition Among Mammals
- Human Digestive Tract
  - Mouth
  - Stomach
  - Small Intestine
  - Large Intestine
  - Accessory Organs
- Digestive Enzymes
- Nutrition

# DIGESTIVE TRACTS

- Incomplete versus Complete Tracts
  - Incomplete tract has a single opening
  - Ex: Planarian
    - Food enters through mouth and muscular pharynx
    - Wastes exit through mouth and muscular pharynx
    - Lacks specialized parts
  - Complete Tract has two openings
  - Ex: Earthworm
    - Food enters through mouth
    - Wastes exit through anus

# INCOMPLETE DIGESTIVE TRACT OF A PLANARIAN

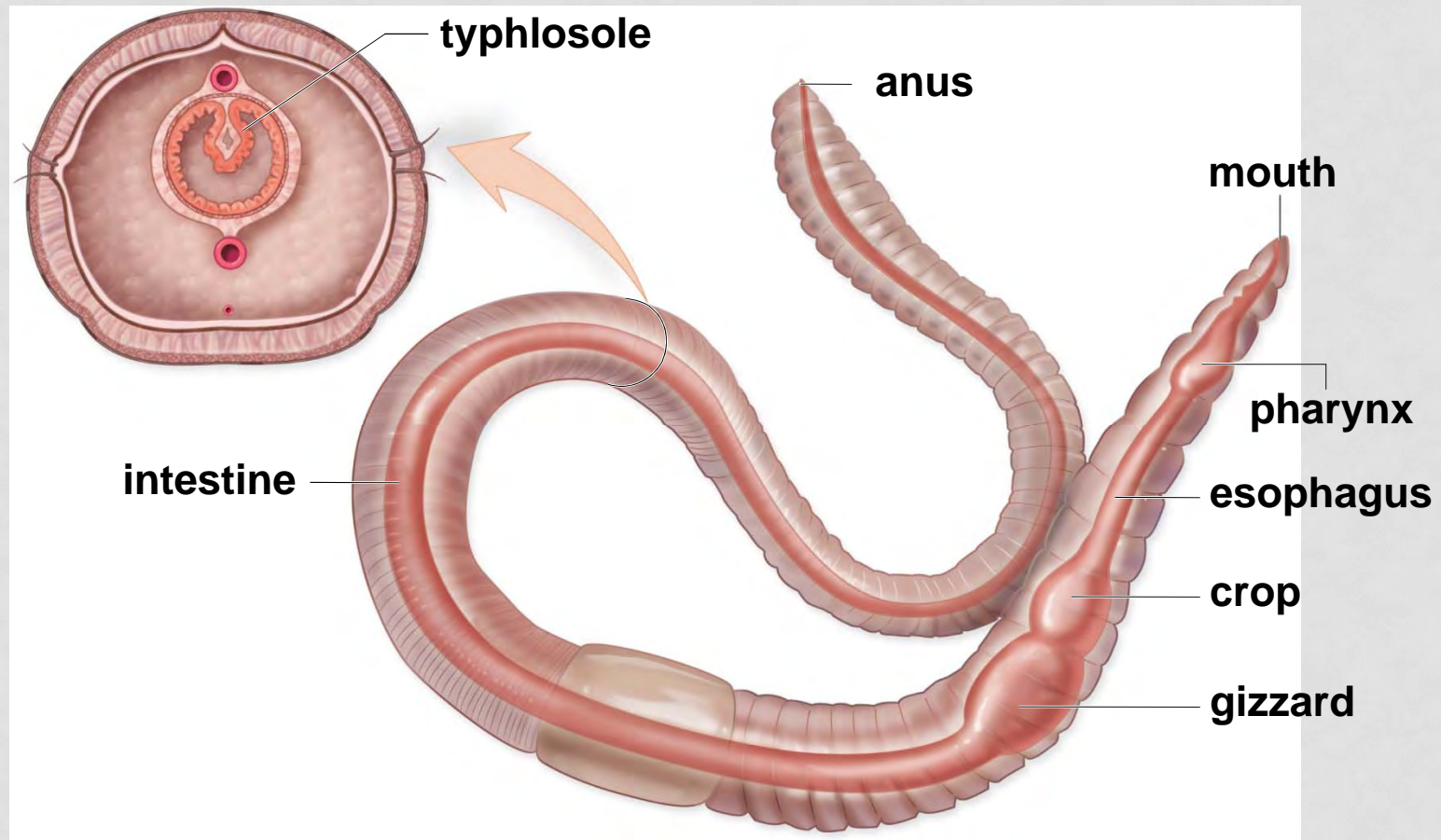
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# COMPLETE DIGESTIVE TRACT OF AN EARTHWORM

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# CONTINUOUS VERSUS DISCONTINUOUS FEEDERS

## ● Continuous filter feeders

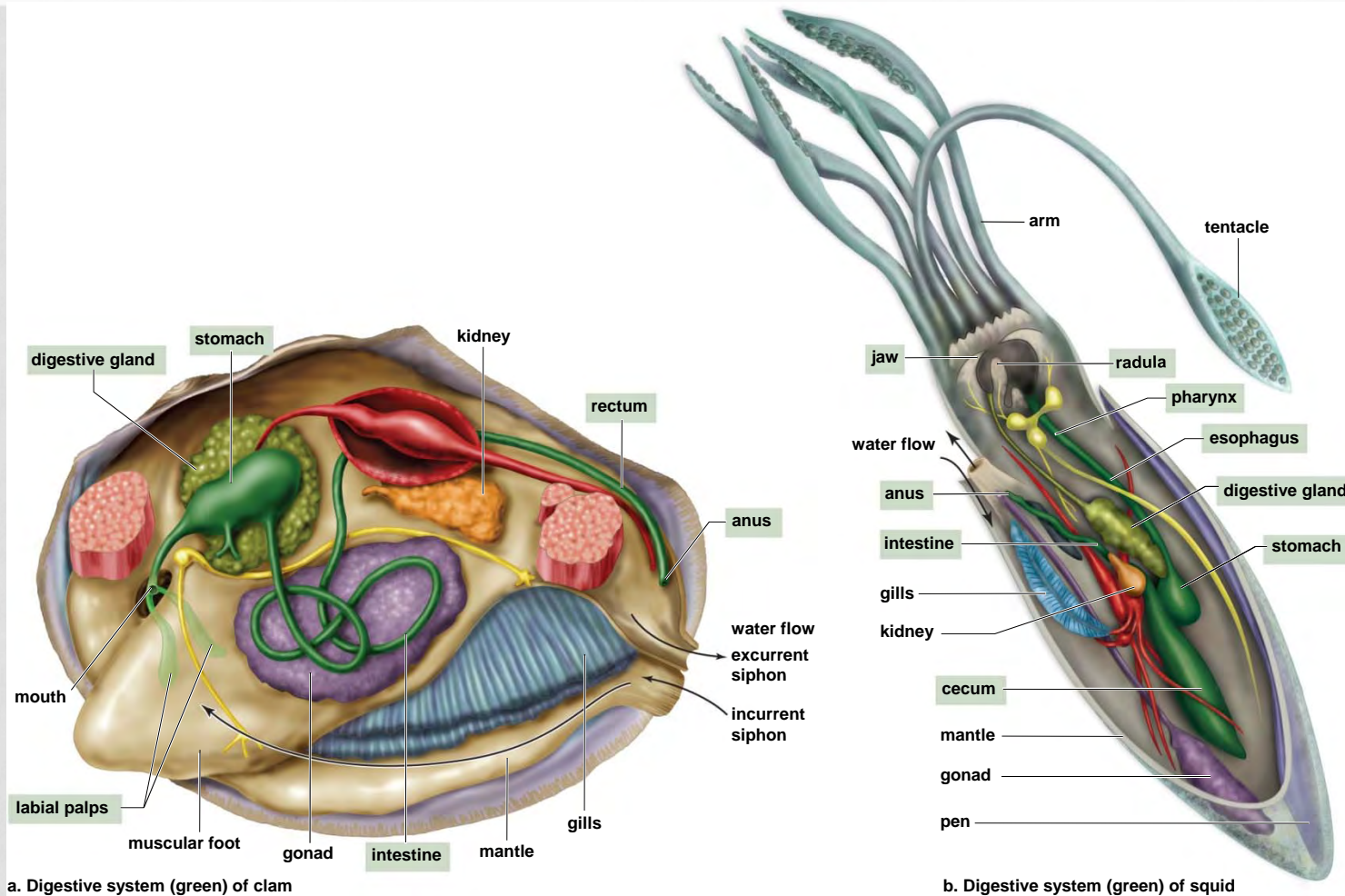
- Ex: Clams
  - Always have water moving into the mantle cavity via incurrent siphon
  - Particles deposited on gills
- Do not need food storage area

## ● Discontinuous feeders

- Ex: Squid
  - Uses tentacles to seize prey
  - Allows the beaklike jaws to pull pieces into the mouth with the radula
- Food storage area needed

# NUTRITIONAL MODE OF A CLAM COMPARED TO A SQUID

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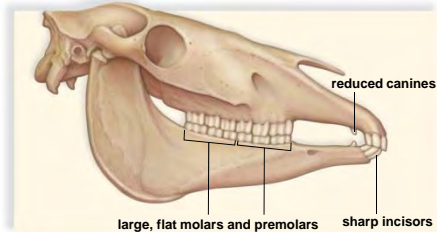
# ADAPTATIONS TO DIET

- Dentition differs with mode of nutrition
  - Omnivores
    - Variety of specializations
    - Accommodate both vegetation and meat
  - Herbivores
    - Incisors for clipping
    - Premolars and molars for grinding
  - Carnivores
    - Pointed incisors and enlarged canines
    - Shear off pieces small enough to swallow

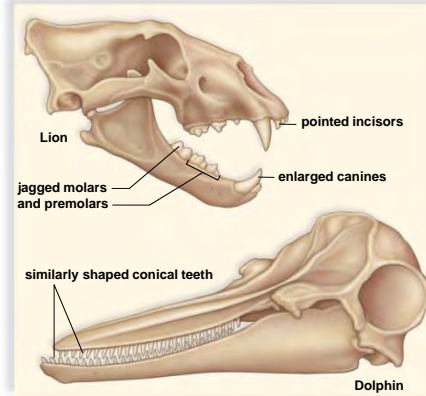


# DENTITION AMONG MAMMALS

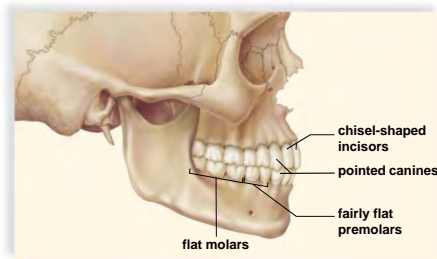
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a. Horses are herbivores.



b. Lions and dolphins are carnivores.



c. Humans are omnivores.

# HUMAN DIGESTIVE TRACT

- Humans digestive tract is complete
- Part of a tube-within-a-tube body plan
- Begins with a mouth and ends in an anus
- Digestion entirely extracellular
  - Digestive enzymes are secreted by
  - The wall of the digestive tract, or
  - By nearby glands

# THE HUMAN DIGESTIVE TRACT

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## Accessory organs

**Salivary glands**  
secrete saliva: contains digestive enzyme for carbohydrates

**Liver**  
major metabolic organ:  
processes and stores nutrients;  
produces bile for emulsification of fats

**Gallbladder**  
stores bile from liver; sends it to the small intestine

**Pancreas**  
produces pancreatic juice: contains digestive enzymes, and sends it to the small intestine; produces insulin and secretes it into the blood after eating

## Digestive tract organs

**Mouth**  
teeth chew food; tongue tastes and pushes food for chewing and swallowing  
**Pharynx**  
passageway where food is swallowed

**Esophagus**  
passageway where peristalsis pushes food to stomach

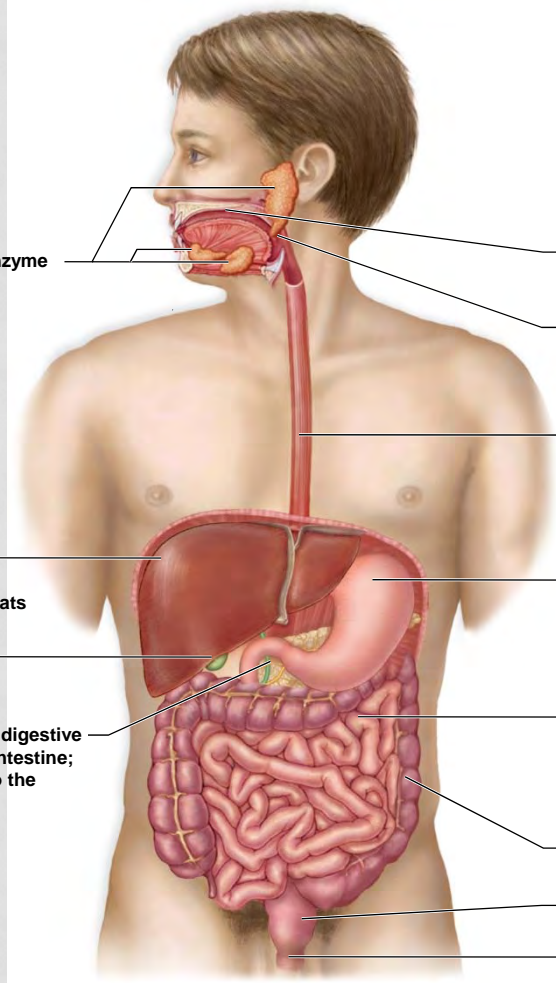
**Stomach**  
secretes acid and digestive enzyme for protein; churns, mixing food with secretions, and sends chyme to small intestine

**Small intestine**  
mixes chyme with digestive enzymes for final breakdown; absorbs nutrient molecules into body; secretes digestive hormones into blood

**Large intestine**  
absorbs water and salt to form feces

**Rectum**  
stores and regulates elimination of feces

**Anus**



# HUMAN DIGESTIVE TRACT

- Mouth
  - Three major pairs of salivary glands
    - Saliva contains salivary amylase
    - Salivary amylase initiates starch digestion
  - Tongue is composed of striated muscle
    - Mixes chewed food with saliva
    - Forms mixture into bolus



# PHARYNX AND ESOPHAGUS

## ● Pharynx

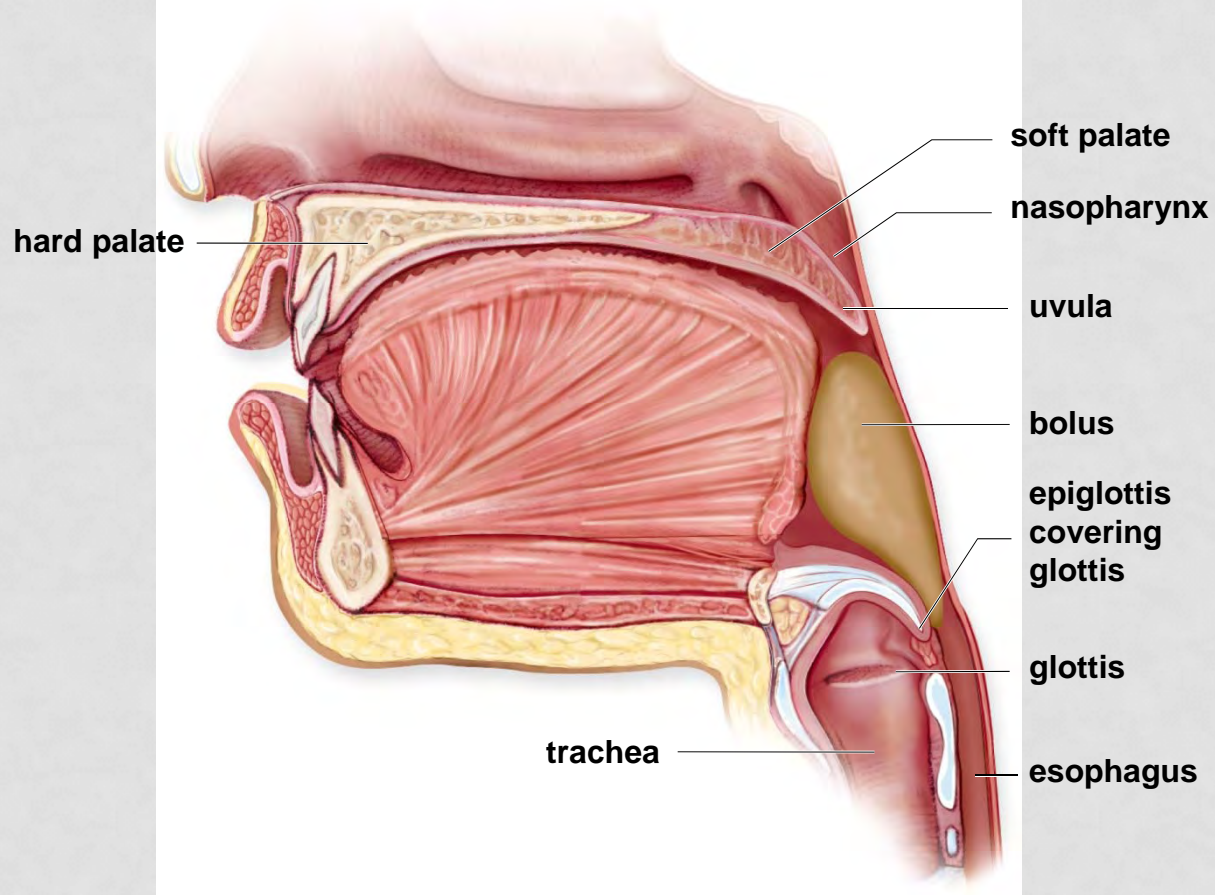
- Where digestive and respiratory passages come together
- Soft palate closes off nasopharynx
- Epiglottis
  - Covers opening into trachea
  - Keeps food from air passages (most of the time)

## ● Esophagus

- Takes food to stomach by peristalsis
- Peristalsis - Rhythmical contraction to move contents in tubular organs

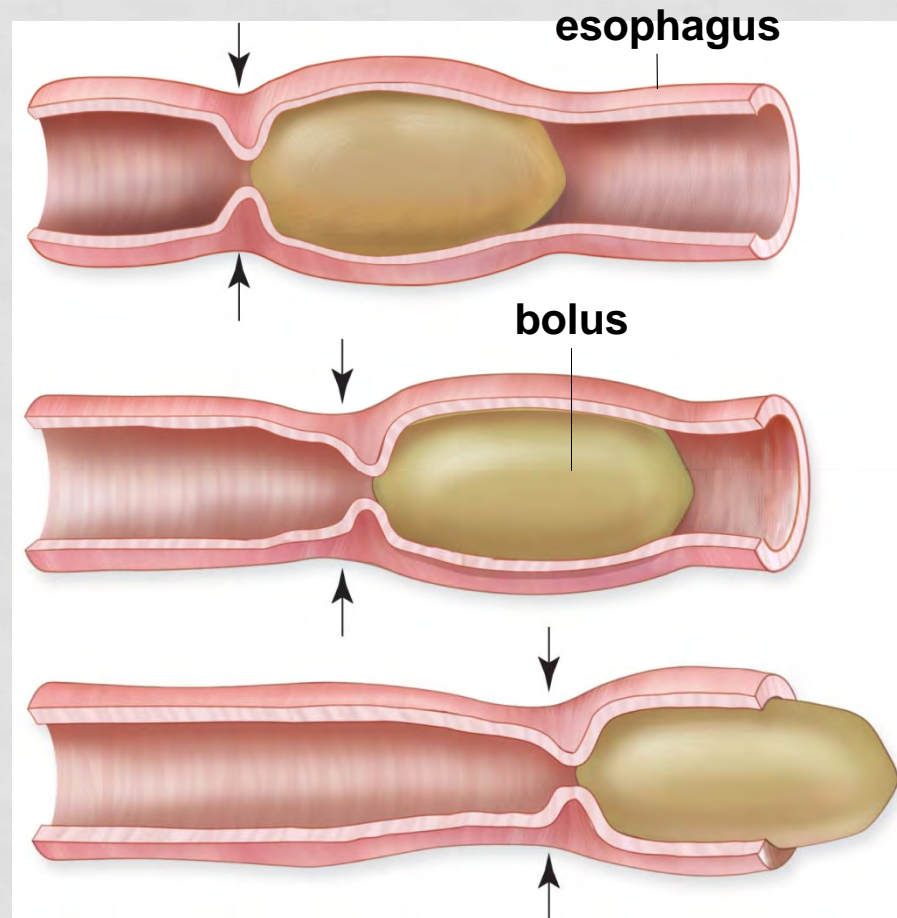
# SWALLOWING

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# PERISTALSIS IN THE DIGESTIVE TRACT

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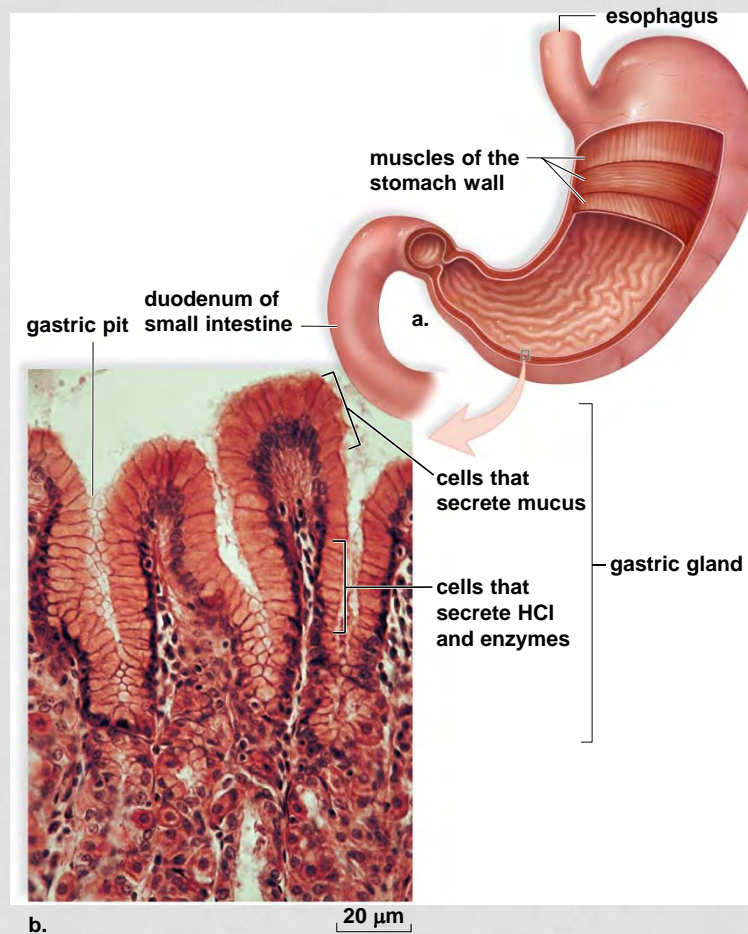
# STOMACH

- Stomach
  - Stomach wall has deep folds
  - Folds disappear as the stomach fills to an approximate volume of one liter
  - Epithelial lining of the stomach has millions of gastric pits, which drain gastric glands
    - Pepsin is a hydrolytic enzyme that acts on protein to produce peptides



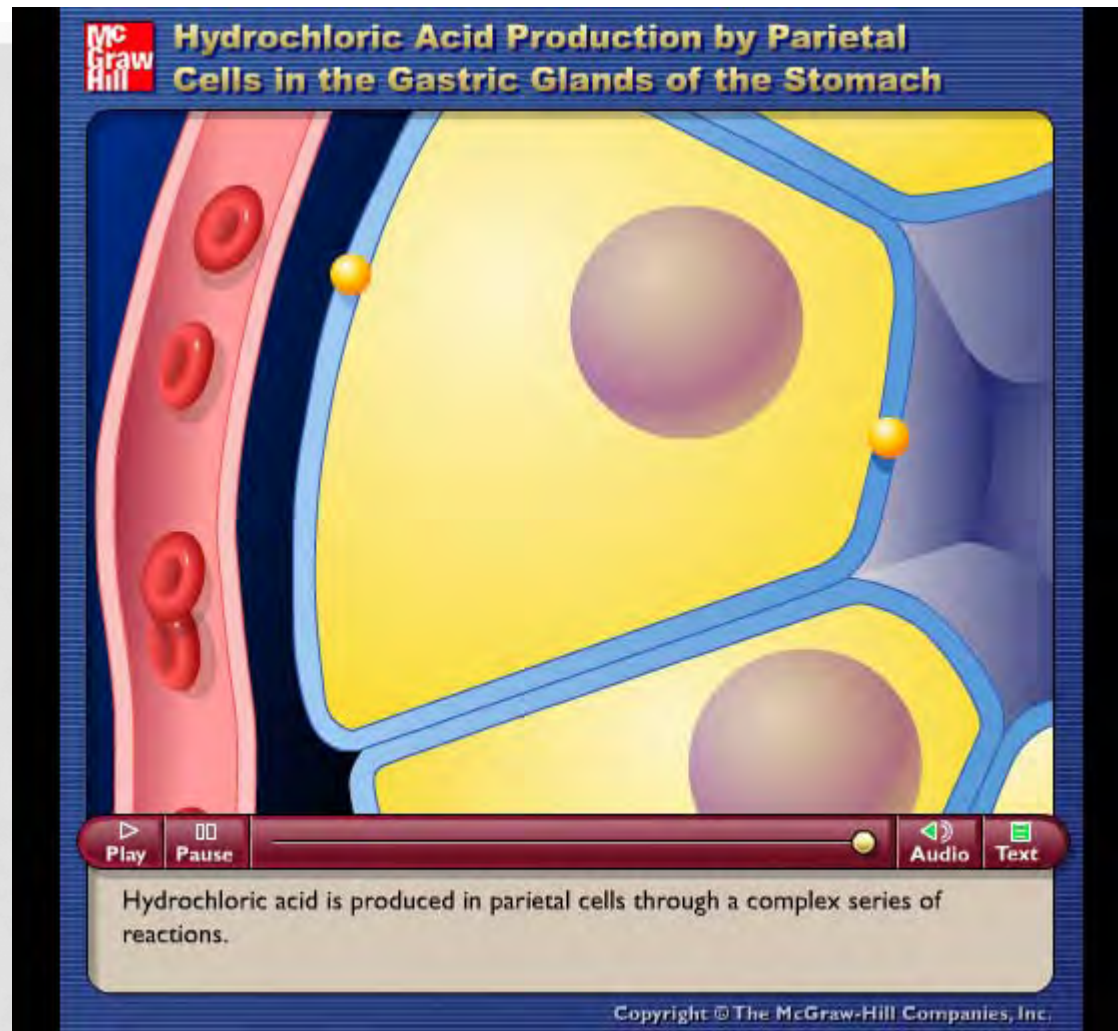
# ANATOMY OF THE STOMACH

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b: © Ed Reschke/Peter Arnold, Inc.

# ANIMATION



# STOMACH

- Food mixing with gastric juices becomes chyme
  - Junction between stomach and small intestine controlled by a sphincter
  - When the sphincter relaxes, a small quantity of chyme passes into the small intestine

# ANIMATION

**McGraw Hill** **Hormones and Gastric Secretion**



▶ Play    ⏸ Pause    ⏮ ⏭ ⏪ ⏩ ⏴ ⏵ ⏶ ⏷ ⏸ ⏹ ⏺ ⏻ ⏼ ⏽ ⏾ ⏿ ⏴ ⏵ ⏶ ⏷ ⏸ ⏹ ⏺ ⏻ ⏼ ⏽ ⏾ ⏿

Audio    Text

The taste, smell, touch sensation, or thought of food sends nervous impulses to the brain. These impulses cause neurons to stimulate secretion of hydrochloric acid and pepsin in the stomach.

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# SMALL INTESTINE

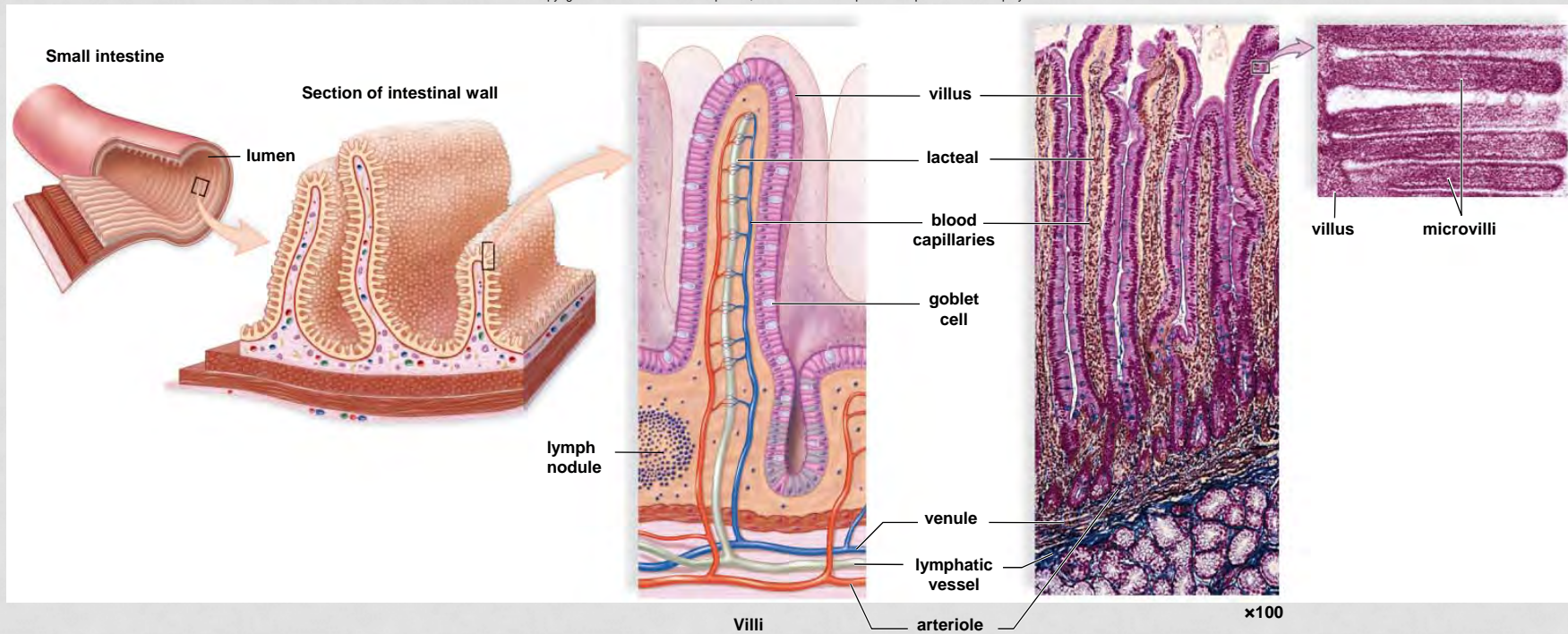
- First segment is duodenum
- Chyme from stomach enters the duodenum
- Mixes with secretions from the liver and pancreas
  - Liver
    - Produces bile, which is stored in gallbladder
    - Bile contains bile salts which break up fat into fat droplets via emulsification
    - Helps maintain glucose concentration in blood by converting excess into glycogen

# SMALL INTESTINE

- Pancreas
  - Exocrine gland
  - Produces pancreatic juice and digestive enzymes into the duodenum
    - Pancreatic amylase digests starch to maltose
    - Trypsin digests protein to peptides
    - Lipase digests fat droplets to glycerol and fatty acids
- Epithelial cells intestine also produce enzymes
  - These complete digestion of peptides and sugars

# ANATOMY OF THE SMALL INTESTINE

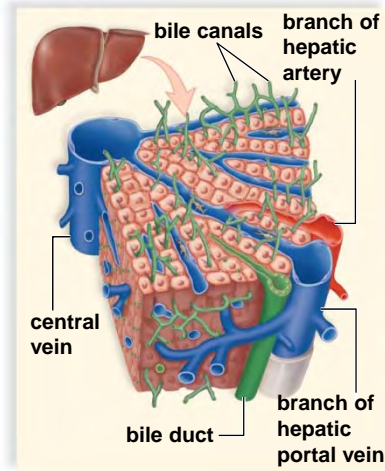
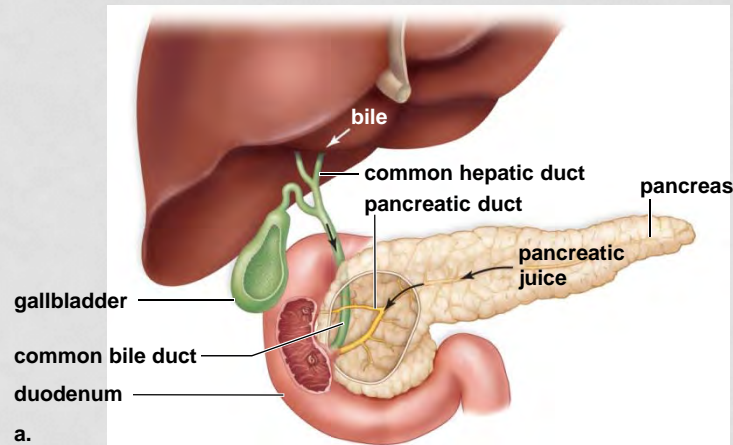
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(Villi): © Manfred Kage/Peter Arnold, Inc.; (Microvilli): Photo by Susumu Ito, from Charles Flickinger, *Medical Cellular Biology*, W.B. Saunders, 1979

# LIVER, GALLBLADDER, AND PANCREAS

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# ABSORPTION BY VILLI

- Mucous membrane of small intestine
  - Has ridges and furrows that give it a corrugated surface
  - Villi are ridges on the surface, which contain even smaller ridges, microvilli
    - Greatly increase absorptive area
    - Each villus contains blood capillaries and a lymphatic capillary (lacteal)

# ANIMATION

**McGraw Hill** **Organs of Digestion**



Go to interactive

Play Pause

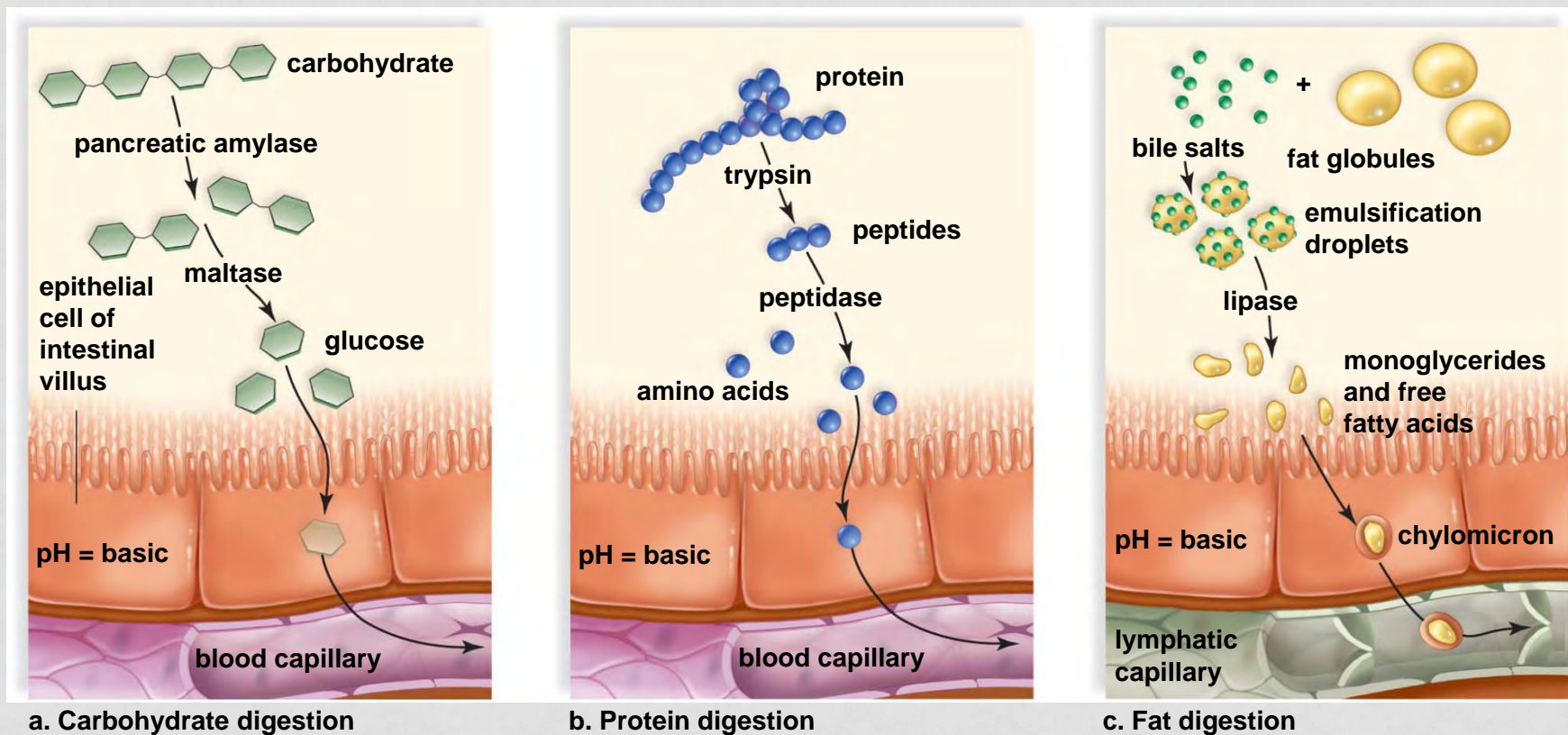
Audio Text

The primary functions of the digestive system are the breakdown of food (called digestion) and absorption of nutrients.

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# DIGESTION AND ABSORPTION OF NUTRIENTS

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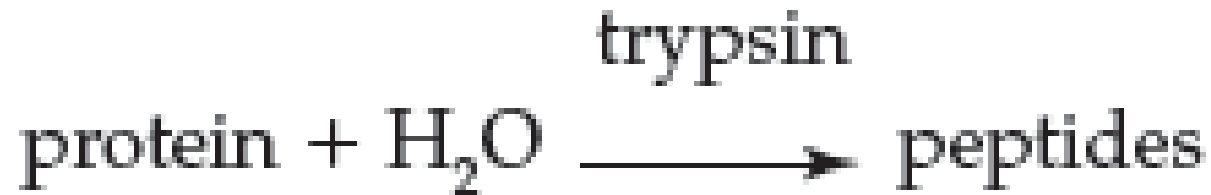


# DIGESTIVE ENZYMES





# DIGESTIVE ENZYMES




# LARGE INTESTINE

- Includes cecum, colon, rectum, and anal canal
  - Larger in diameter, but shorter in length than small intestine
    - Absorbs water, salts, and some vitamins
  - Cecum has small projection - appendix
  - Colon subdivided into ascending, transverse, descending, and sigmoid colon
  - Opening to anal canal - Anus

# ANIMATION

**McGraw Hill** **Reflexes in the Colon**



The diagram illustrates the human digestive system, specifically the stomach, duodenum, and colon. The stomach is shown at the top, with the duodenum (small intestine) below it. The colon (large intestine) is depicted as a long, segmented tube with a cecum at the bottom left and a sigmoid colon at the bottom right. The entire system is rendered in a realistic, reddish-brown color.

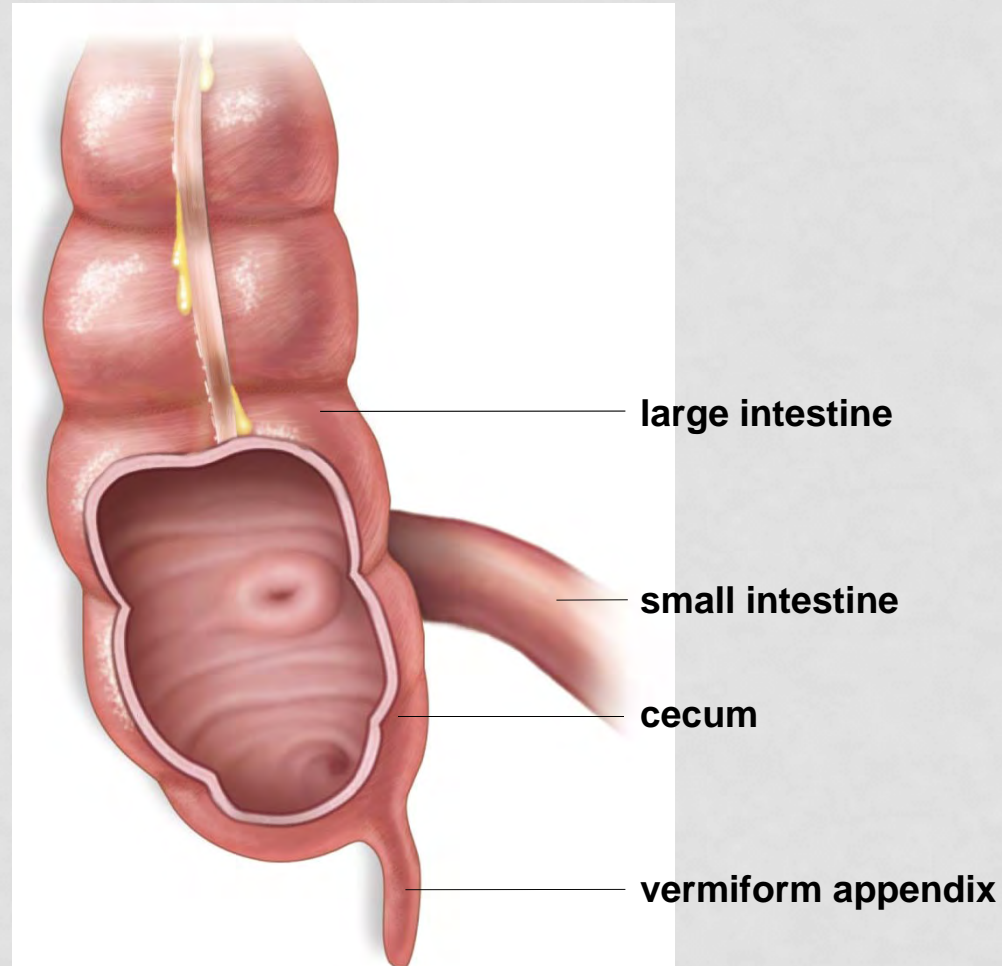
▶ Play    ⏸ Pause    🔊 Audio    📄 Text

The presence of food in the stomach and chyme in the duodenum stimulates mass movements in the colon.

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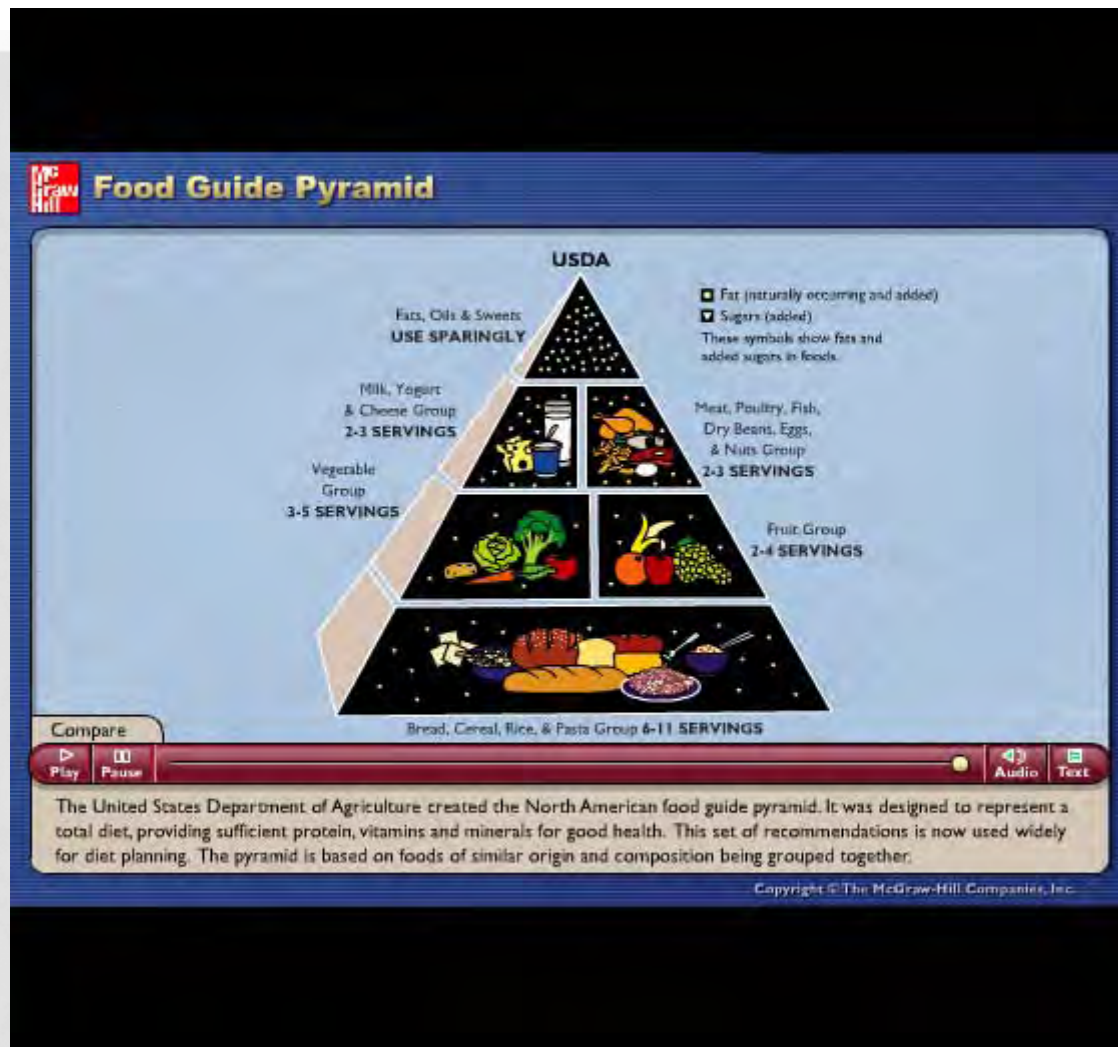
# JUNCTION OF THE SMALL INTESTINE AND THE LARGE INTESTINE

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# ANIMATION



# NUTRITION: CARBOHYDRATES

- Carbohydrates are present in food in the form of sugars, starch, and fiber.
- Fruits, vegetables, milk, and honey are natural sources of sugars.
- Monosaccharides:
  - Glucose
  - Fructose
- Disaccharides:
  - Lactose (milk sugar)
  - Sucrose (table sugar)

# NUTRITION: CARBOHYDRATES

- After being absorbed from the digestive tract all sugars are converted to glucose
  - Glucose is the preferred direct energy source in cells.
- Plants store glucose as starch,
- Animals store glucose as glycogen

# NUTRITION: FIBER

- Includes various undigestible carbohydrates derived from plants
- Food sources rich in fiber include beans, peas, nuts, fruits, and vegetables
- Technically, fiber is not a nutrient for humans
  - Cannot be digested
  - Soluble fiber combines with bile acids and cholesterol in the small intestine and prevents them from being absorbed



# FIBER RICH FOOD

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# NUTRITION: PROTEINS

- Adequate protein formation requires 20 different types of amino acids
- Adults require 8 from the diet, children require 9
  - Essential amino acids
  - Some foods, such as meat, milk, and eggs, provide all 20 (complete)
  - Vegetables supply one or more essential amino acids, but are deficient in at least one
  - Vegetarians should combine plant products to provide all the essential amino acids

# NUTRITION: LIPIDS

- Fat, oils, and cholesterol
- Saturated fats (solids at room temperature) usually come from animals
  - Exceptions are palm oil and coconut oil
  - Contain mostly saturated fats
- Butter and meats, such as marbled red meats and bacon, contain saturated fats



# FOOD HIGH IN TRANS-FAT

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# DIET AND OBESITY

- Too many calories from any source contributes to body fat.
  - Increases risk of obesity and associated illnesses
- Type 2 diabetes and cardiovascular disease are often seen in people who are obese.

# ANIMATION

**McGraw Hill** **Calories in a Sandwich**

Top bun

Mayonnaise

Mustard

Ketchup

Pickle

Tomato

Onion

Lettuce

Cheese

Chicken breast

Burger patty

Bottom bun

Drag Here

	Ingredient	Total
Calories	<input type="text"/>	<input type="text"/>
Protein (g)	<input type="text"/>	<input type="text"/>
Carbs. (g)	<input type="text"/>	<input type="text"/>
Fat (g)	<input type="text"/>	<input type="text"/>
	<input type="button" value="Reset"/>	

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# EXERCISE FOR GOOD HEALTH

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# NUTRITION: VITAMINS

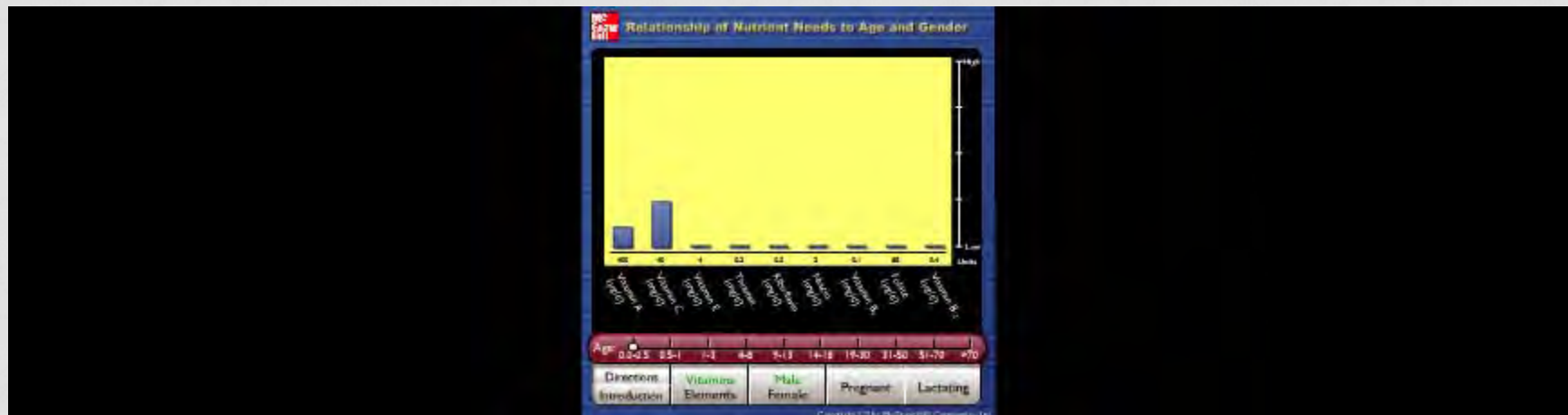
- Vitamins
  - Organic compounds the body is unable to produce, but are required for metabolic purposes
  - Must be obtained externally
  - Antioxidants
    - Cellular metabolism generates free radicals that carry extra electron
    - Vitamins C, E, and A are believed to defend the body against free radicals



# NUTRITION: VITAMINS

- Vitamin D
  - Skin cells contain precursor cholesterol molecule
  - Converted to vitamin D after UV exposure
  - Activated into calcitriol that regulates calcium uptake and metabolism

# ANIMATION



# REVIEW

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