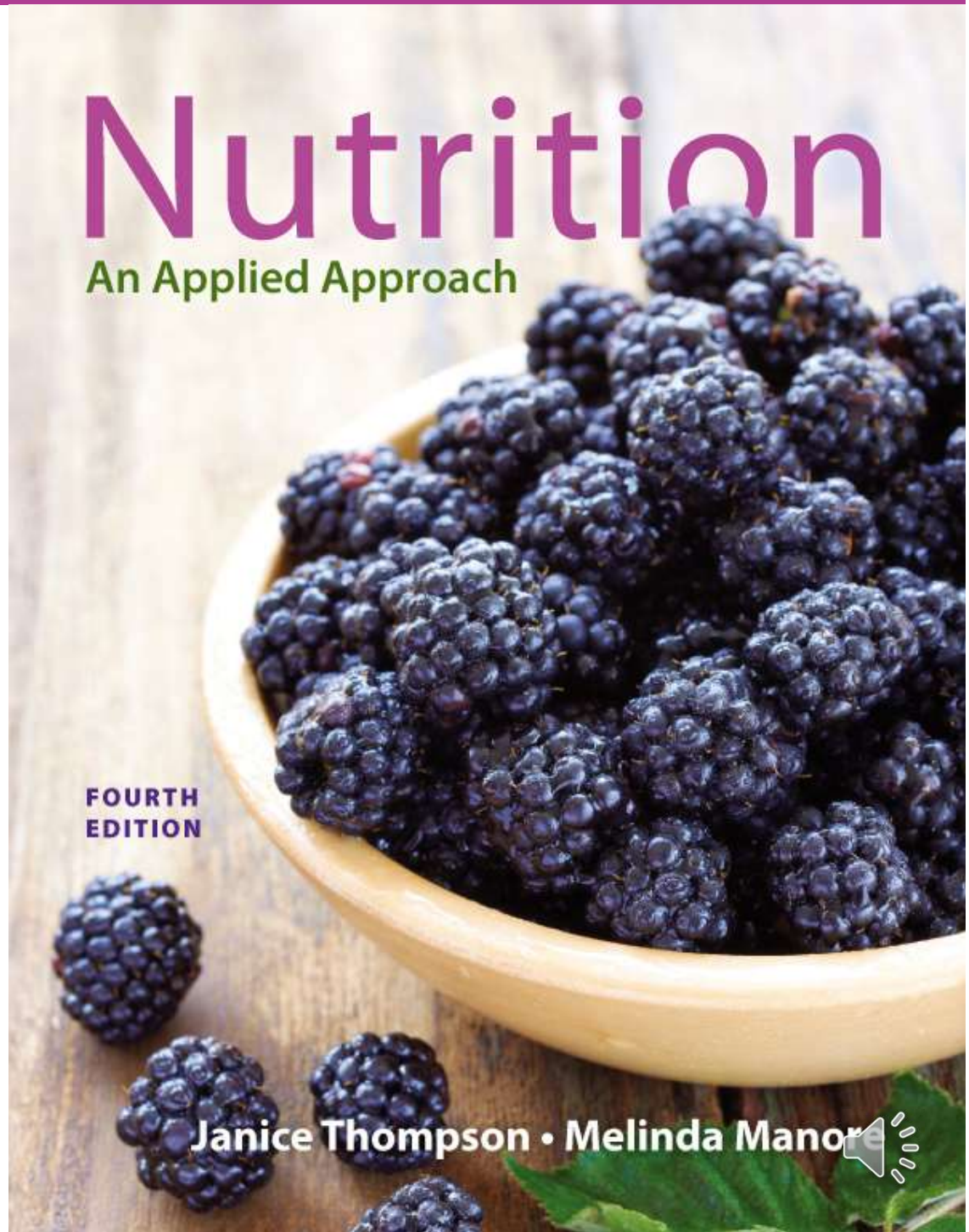
Chapter 3: The Human Body: Are We Really What We Eat? and In Depth 3.5, Disorders Related to Specific Foods



Outline

- Digestive system
- Process of digestion
- Absorption
- Nutrient transport
- Diseases of the GI tract

Organization of the Body

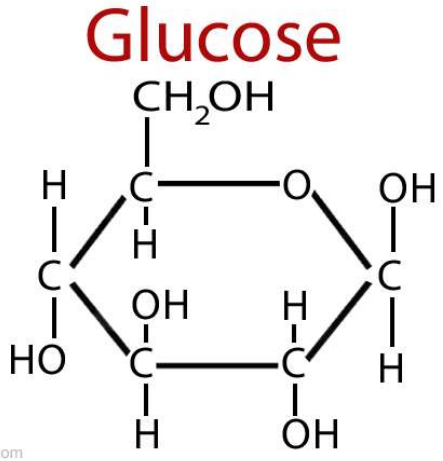
Atoms: the smallest units of matter

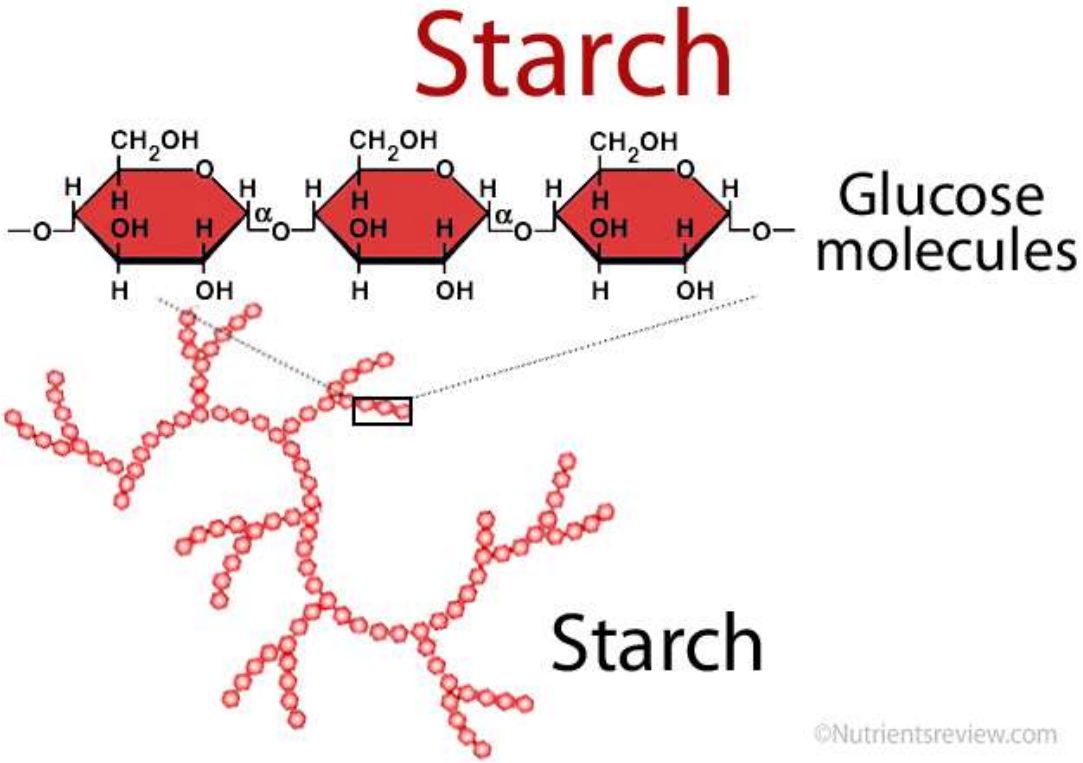
- Atoms bond to each other to form molecules

Molecules: groups of atoms bonded in specific configurations

- Examples
  - Water is H_2O
  - Carbon dioxide is CO_2

Atoms and Molecules





Glucose:

$C_6H_{12}O_6$

Atoms in a glucose molecule:

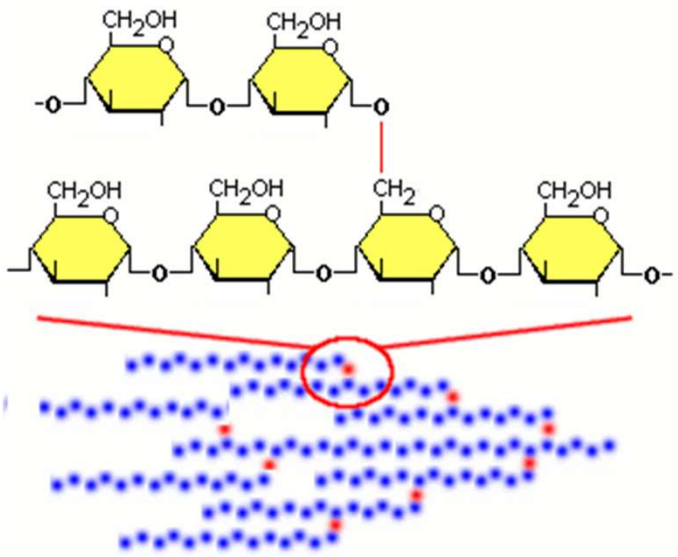
6 carbon atoms

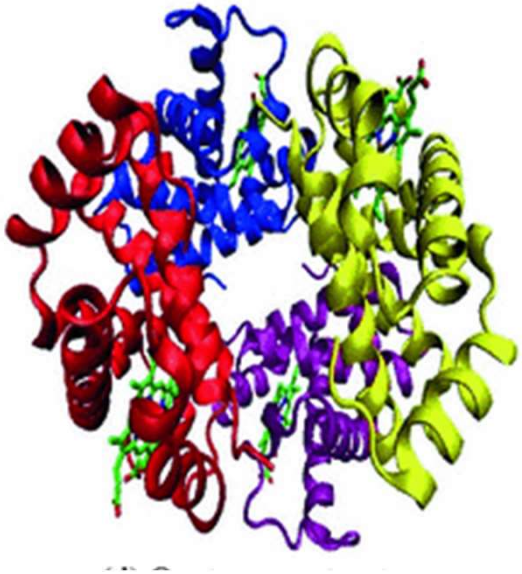
12 hydrogen atoms

6 oxygen atoms

Organization of the Body (cont.)

- Carbohydrates, proteins, fats, and vitamins are usually very large molecules

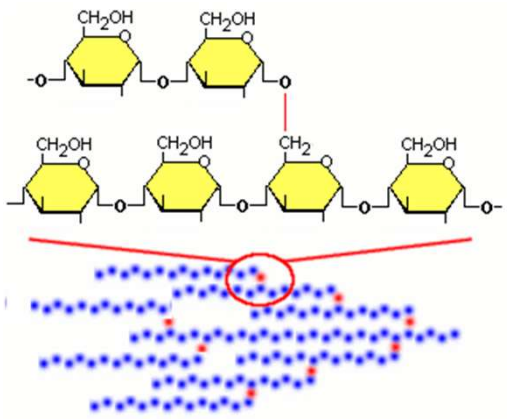


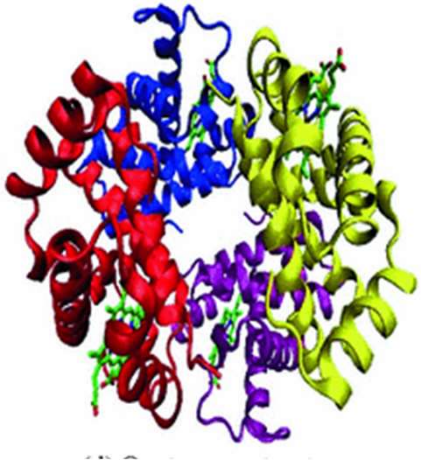


- **Amylose:** 500 to 20,000 alpha-D-glucose monomers linked together through glycosidic bonds.

Organization of the Body (cont.)

- Carbohydrates, proteins, fats, and vitamins are usually very large molecules

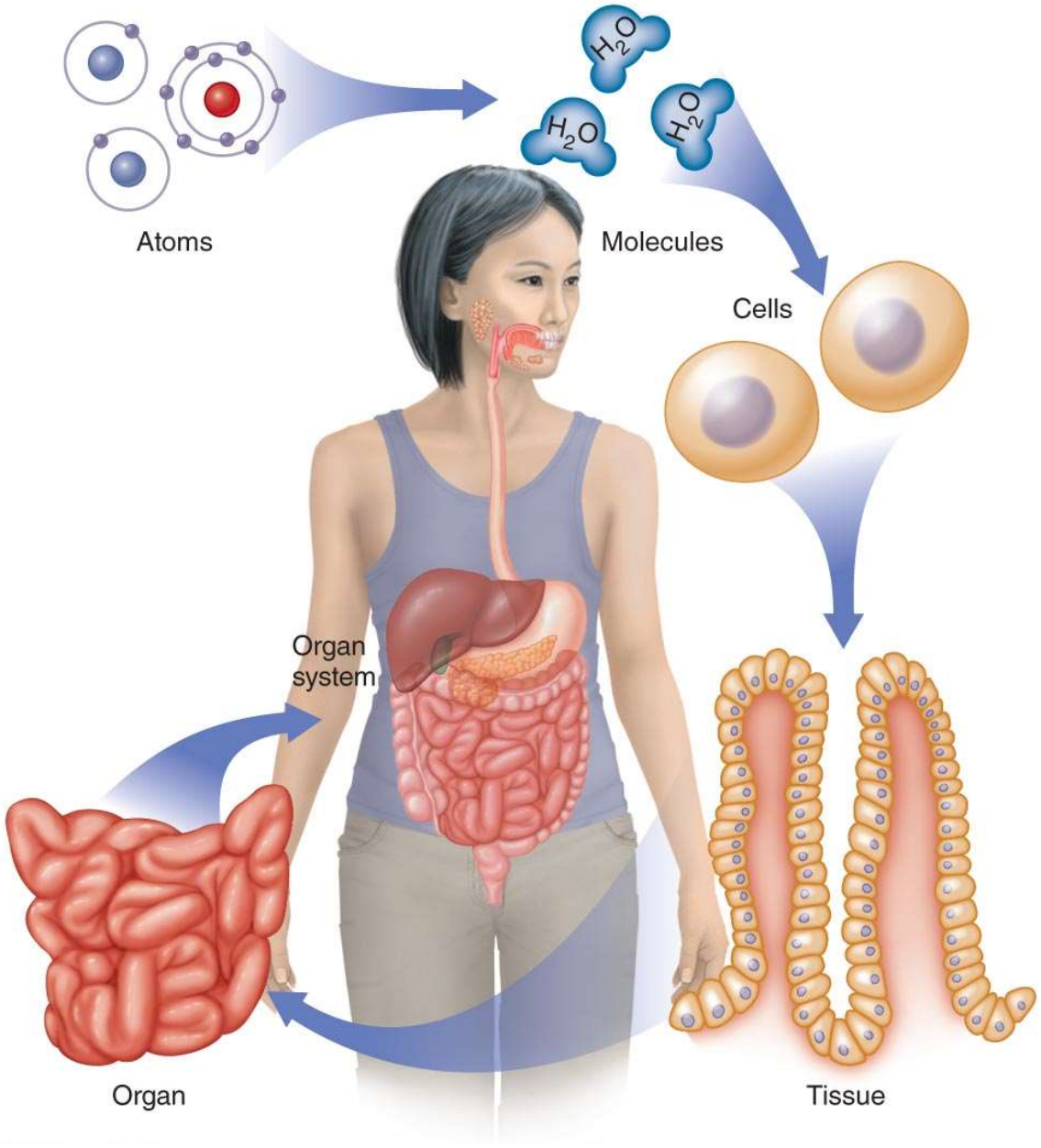




- **Amylose:** 500 to 20,000 alpha-D-glucose monomers linked together through glycosidic bonds.

- **<u>The goals of digestion</u>**:
  - Break these large molecules down into smaller molecules and absorb them into the cells of the body

Organization of the Body (cont.)



Organization of the Body

- Cells join together to form tissues

- Tissue: group of cells acting together to perform a common function
  - Examples:
    - Muscle tissue
    - Nervous tissue

Organization of the Body (cont.)

- Different tissues combine to form organs
- Organ: a sophisticated organization of tissues that performs a specific function
  - Examples:
    - Stomach
    - Heart
    - Brain
- Organ systems: groups of organs working together for a particular function
  - Example:
    - Gastrointestinal system

Why Do We Want to Eat?

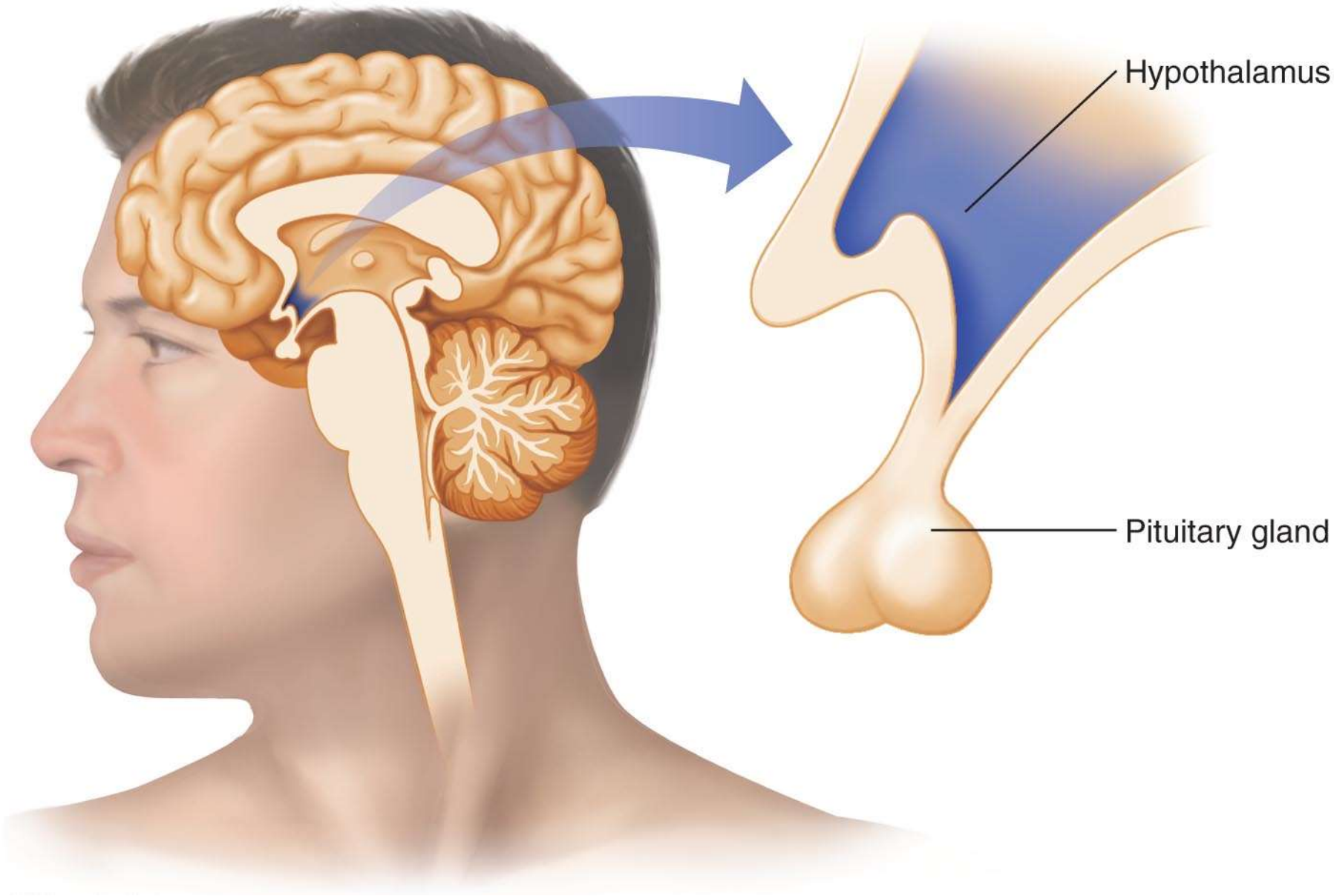
Appetite Vs Hunger

1. Appetite is a psychological desire to eat that is stimulated by
   - Sight
   - Smell
   - Thought of food
2. Hunger is a **physiologic drive** to eat that occurs when our body senses that we need food

Why Do We Want to Eat? (cont.)

- The hypothalamus region of the brain contains a cluster of nerve cells known as the ***feeding center*** and another cluster of cells known as the ***satiety center***
  1. **Nerve cells** in the stomach and small intestine sense food and send message to hypothalamus
  2. **Hormones** relay messages to the hypothalamus
  3. **Amount and type of food** consumed influence satiety

The Hypothalamus Triggers Hunger



Why Do We Want to Eat? (cont.)

The signals that prompt us to eat include

- **Nerve receptors in the stomach**, which send signals to the hypothalamus to indicate if the stomach is full or empty
- **Blood glucose levels**, which trigger the release of hormones called insulin and glucagon

Why Do We Want to Eat? (cont.)

Hormones:

Chemicals produced in specialized glands that travel in the bloodstream to target organs in other parts of the body

- Some hormones stimulate hunger
  - Ghrelin
- Some hormones produce a feeling of satiety
  - Cholecystokinin (CCK)
  - Leptin

Why Do We Want to Eat? (cont.)

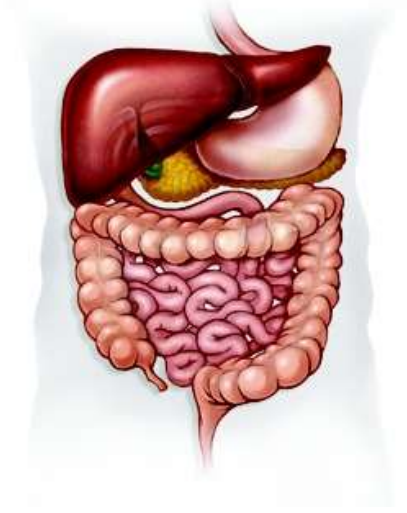
Amount and type of food:

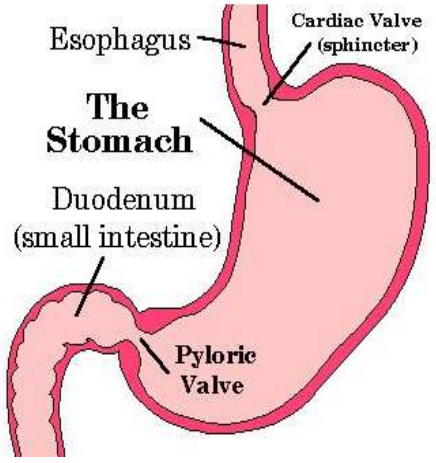
- Foods have differing effects on our feelings of hunger and satiety
  - Proteins have the highest satiety value
  - Carbohydrates have a lower satiety value than fats
  - Bulky foods provide a sense of satiety
  - Solid foods are more filling than semisolid foods or liquids

Digestion

Gastrointestinal (GI) tract

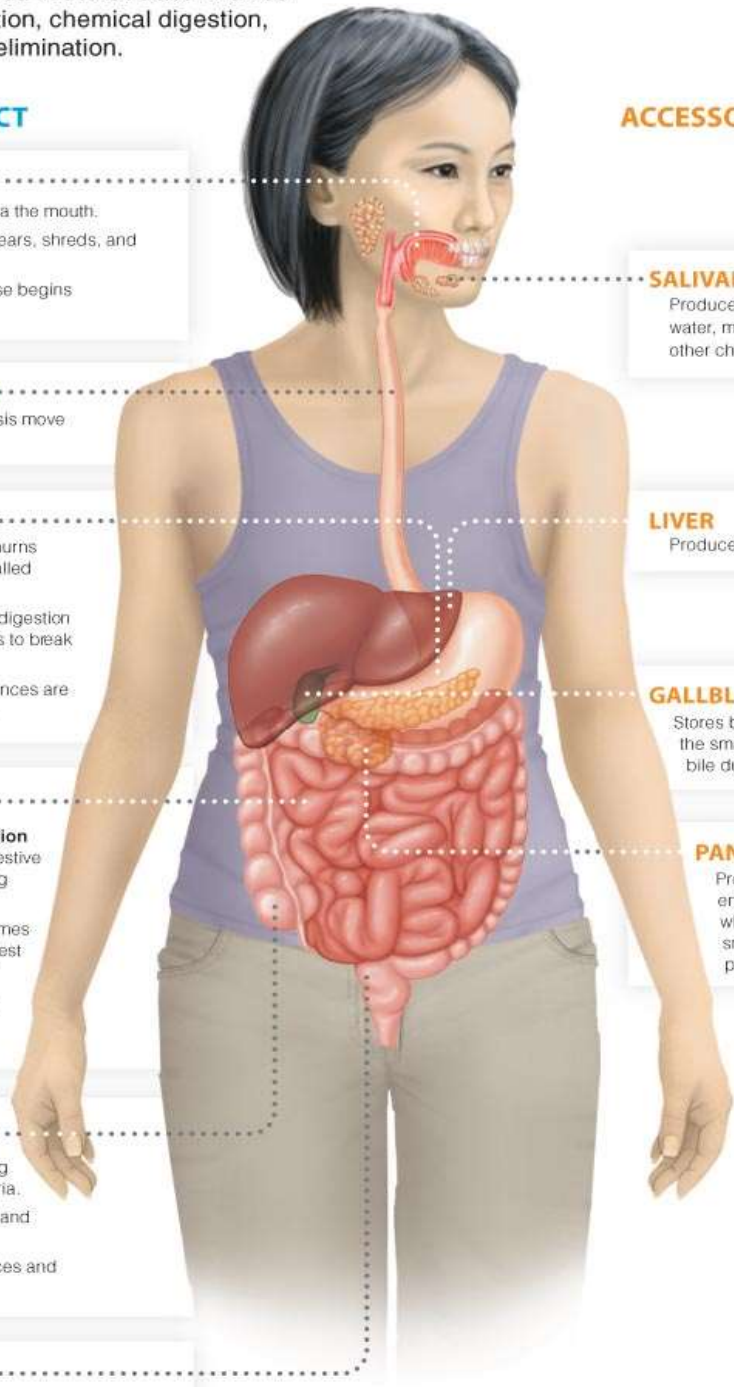
- series of organs arranged as a long tube through which the food passes
- **The GI tract includes**
  - Organs such as the stomach and intestines
  - Sphincters: muscles that control the passage of material from one organ to the next





Digestive System

The digestive system consists of the organs of the gastrointestinal (GI) tract and associated accessory organs. The processing of food in the GI tract involves ingestion, mechanical digestion, chemical digestion, propulsion, absorption, and elimination.



ORGANS OF THE GI TRACT

MOUTH
Ingestion Food enters the GI tract via the mouth.
Mechanical digestion Mastication tears, shreds, and mixes food with saliva.
Chemical digestion Salivary amylase begins carbohydrate breakdown.

PHARYNX AND ESOPHAGUS
Propulsion Swallowing and peristalsis move food from mouth to stomach.

STOMACH
Mechanical digestion Mixes and churns food with gastric juice into a liquid called chyme.
Chemical digestion Pepsin begins digestion of proteins, and gastric lipase begins to break lipids apart.
Absorption A few fat-soluble substances are absorbed through the stomach wall.

SMALL INTESTINE
Mechanical Digestion and **Propulsion** Segmentation mixes chyme with digestive juices; peristaltic waves move it along tract.
Chemical digestion Digestive enzymes from pancreas and brush border digest most classes of nutrients.
Absorption Nutrients are absorbed into blood and lymph through enterocytes.

LARGE INTESTINE
Chemical digestion Some remaining food residues are digested by bacteria.
Absorption Reabsorbs salts, water, and vitamins.
Propulsion Compacts waste into feces and propels it toward the rectum.

RECTUM
Elimination Temporarily stores feces before voluntary release through the anus.

ACCESSORY ORGANS

SALIVARY GLANDS
Produce saliva, a mixture of water, mucus, enzymes, and other chemicals.

LIVER
Produces bile to emulsify fats.

GALLBLADDER
Stores bile before release into the small intestine through the bile duct.

PANCREAS
Produces digestive enzymes and bicarbonate, which are released into the small intestine via the pancreatic duct.

Digestion:

The Goals of Digestion:

- Break the large food molecules down into smaller molecules
- Absorb the smaller molecules into the cells of the body

1). Digestion: The Mouth

Digestion begins in the mouth:

- Mechanical digestion – Chewing food
- Chemical digestion – Enzymes secreted in the mouth

1). Salivary amylase:

digestion of carbohydrates

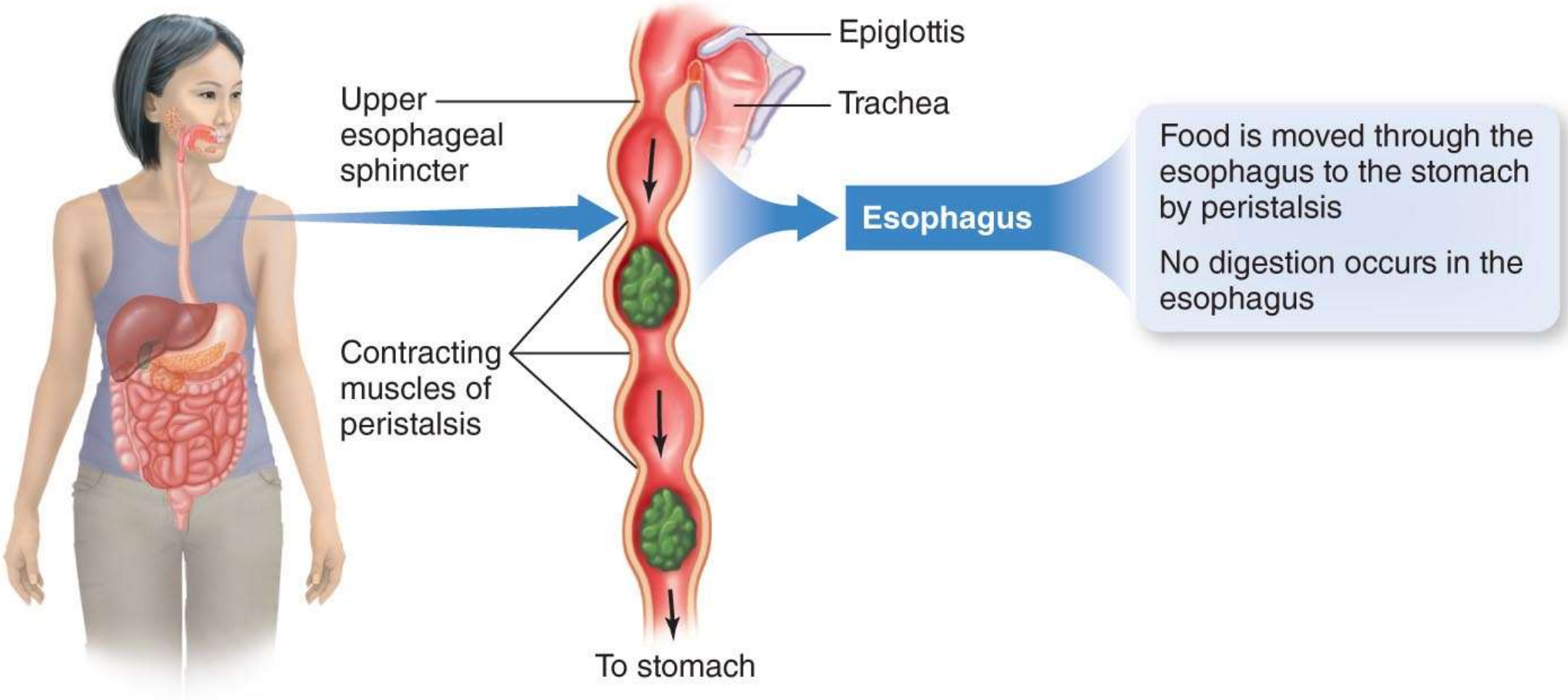
2). Lingual lipase:

digestion of fats

Digestion: The Mouth (cont.)

- The mass of food that has been chewed and moistened in the mouth is referred to as a bolus.
- This bolus moves from the mouth to the pharynx and to the esophagus.
- Then Esophagus Propels food into the stomach
- Peristalsis is the muscular contractions moving food through the GI tract
- The gastroesophageal sphincter separates the esophagus from the stomach

Digestion: Peristalsis



There is no digestion in the esophagus. WHY?

2). Digestion: Stomach

- The stomach mixes, digests, and stores food
- Digestion in the stomach includes
  1. Mechanical digestion: extensive mechanical digestion to mix food with **gastric juice**
  2. Chemical digestion of proteins and fats

No digestion of carbohydrates in the stomach

Digestion: Stomach (cont.)

Gastric juice contains:

1. Hydrochloric acid (HCl): to denature proteins and activate pepsin
2. Intrinsic factor: a protein critical to the absorption of vitamin B_{12}
3. Pepsin: an enzyme to **digest protein**
4. Gastric lipase: an enzyme to **digest fat**

Chyme:

Semisolid product of mechanical and chemical digestion in the stomach- partially digested food.

3). Digestion: Small Intestine

- Composed of three segments
  - Duodenum, jejunum, and ileum
- From the stomach, chyme is slowly released through the pyloric sphincter to the small intestine
- Chemical digestion continues in the small intestine using pancreatic enzymes and bile

4). Digestion: Large Intestine (Colon)

- Undigested food components move through a sphincter called the ileocecal valve to the large intestine
- In the large intestine
  - Very little digestion takes place
  - Material is stored 12–24 hours prior to elimination
  - Water and some nutrients are absorbed

Digestion: Accessory Organs

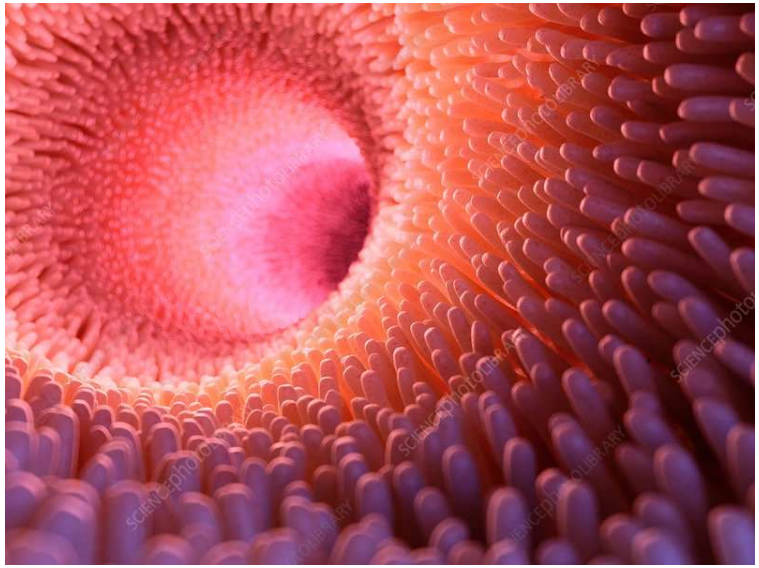
- Surrounding the GI tract are several accessory organs:
  1. Salivary glands: Amylase
  2. Liver: Produces bile, which emulsifies fats
  3. Gallbladder: Stores bile
  4. Pancreas:
     - Produces many digestive enzymes
     - **Produces bicarbonate to neutralize chyme**
  - *Bile is produced by the liver and stored in the gallbladder.*

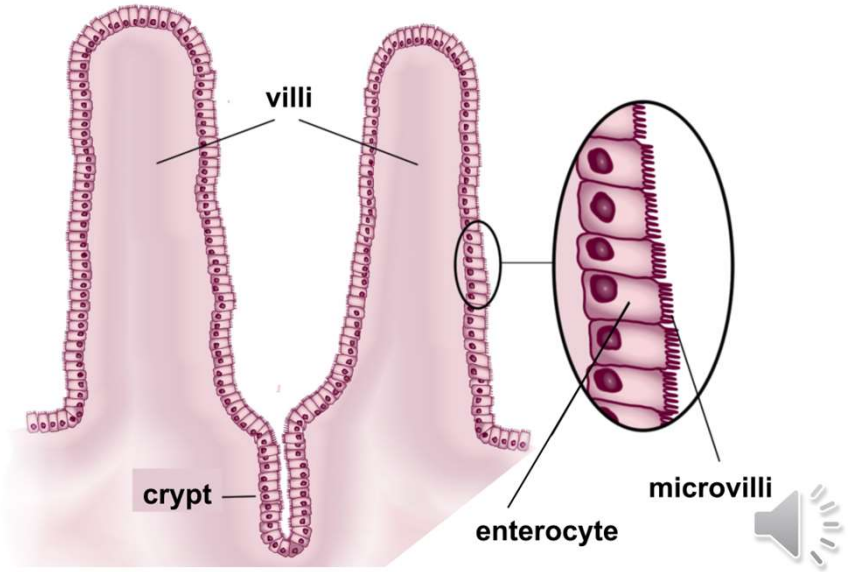
Absorption

- Absorption: the process of taking molecules across a cell membrane and into cells of the body
- A small amount of absorption occurs in the stomach
- **Most absorption of nutrients occurs in the small intestine**

Absorption (cont.)

- The lining of the small intestine has special structures to facilitate absorption
  - Villi: folds in the lining that are in close contact with nutrient molecules
  - Brush border: composed of microvilli that greatly increase the surface area





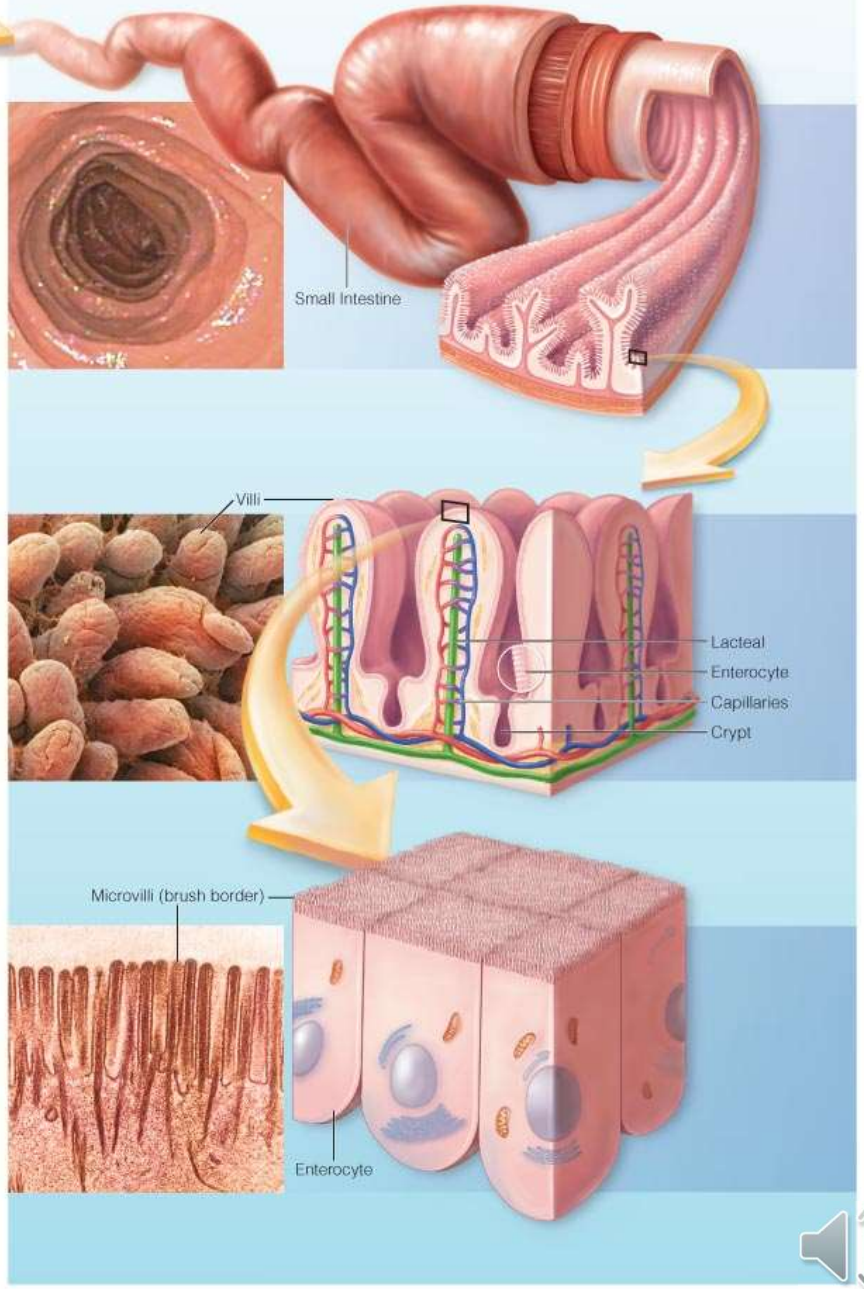
Absorption (cont.)

The small intestine is highly adapted for absorbing nutrients. Its length—about 20 feet—provides a huge surface area, and its wall has three structural features—circular folds, villi, and microvilli—that increase its surface area by a factor of more than 600.

CIRCULAR FOLDS
The lining of the small intestine is heavily folded, resulting in increased surface area for the absorption of nutrients.

VILLI
The folds are covered with villi, thousands of finger-like projections that increase the surface area even further. Each villus contains capillaries and a lacteal for picking up nutrients absorbed through the enterocytes and transporting them throughout the body.

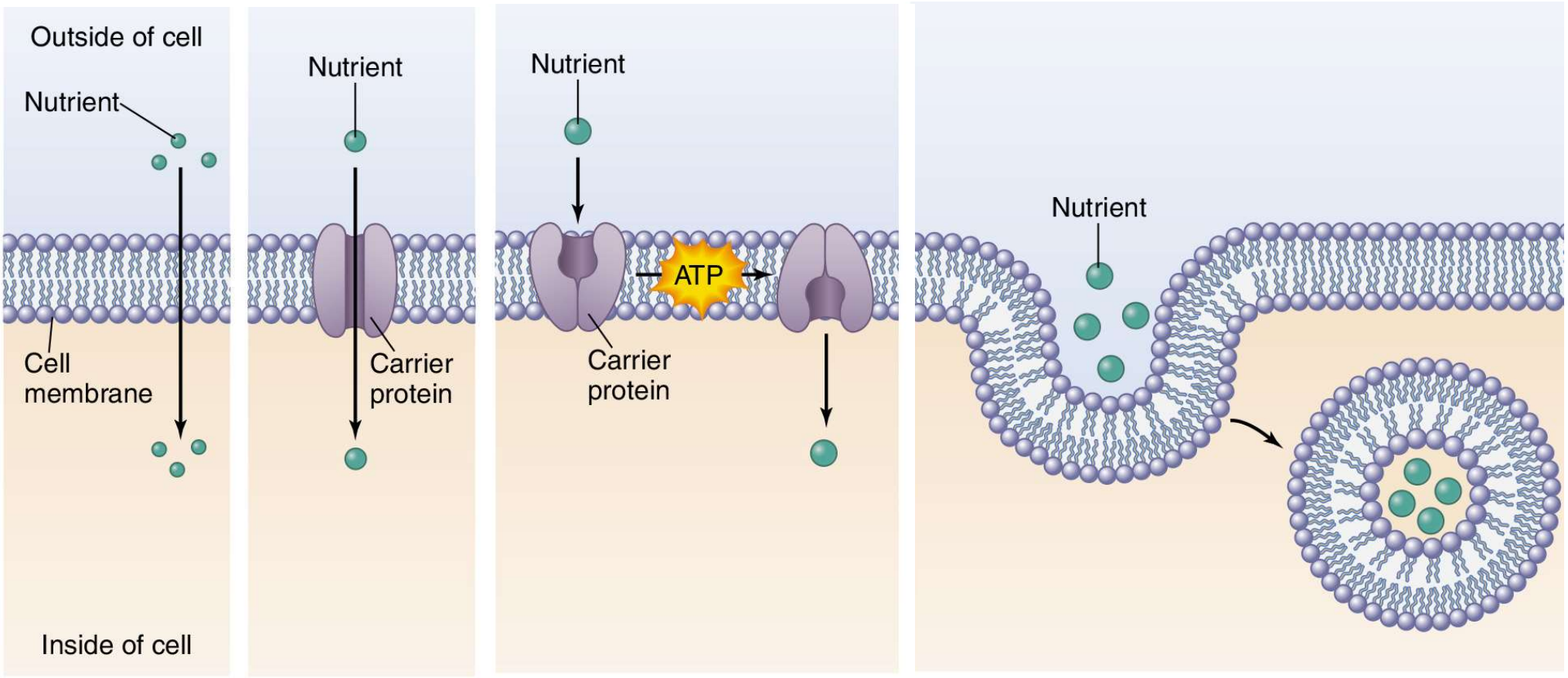
MICROVILLI
The cells on the surface of the villi, enterocytes, end in hairlike projections called microvilli that together form the brush border through which nutrients are absorbed.



Absorption (cont.)

- Nutrients are absorbed across the mucosal membrane and into the blood stream or lymph by:
  1. Passive diffusion
  2. Facilitated diffusion
  3. Active transport
  4. Endocytosis

Absorption (cont.)



(a) Passive diffusion

(b) Facilitated diffusion

(c) Active transport

(d) Endocytosis

Transport (cont.)

1. Water-soluble nutrients:

- Carbohydrate, protein, minerals, and some vitamins enter the portal vein
- The portal vein transports these nutrients to the liver
- Liver processes nutrients and then releases into circulation through hepatic vein

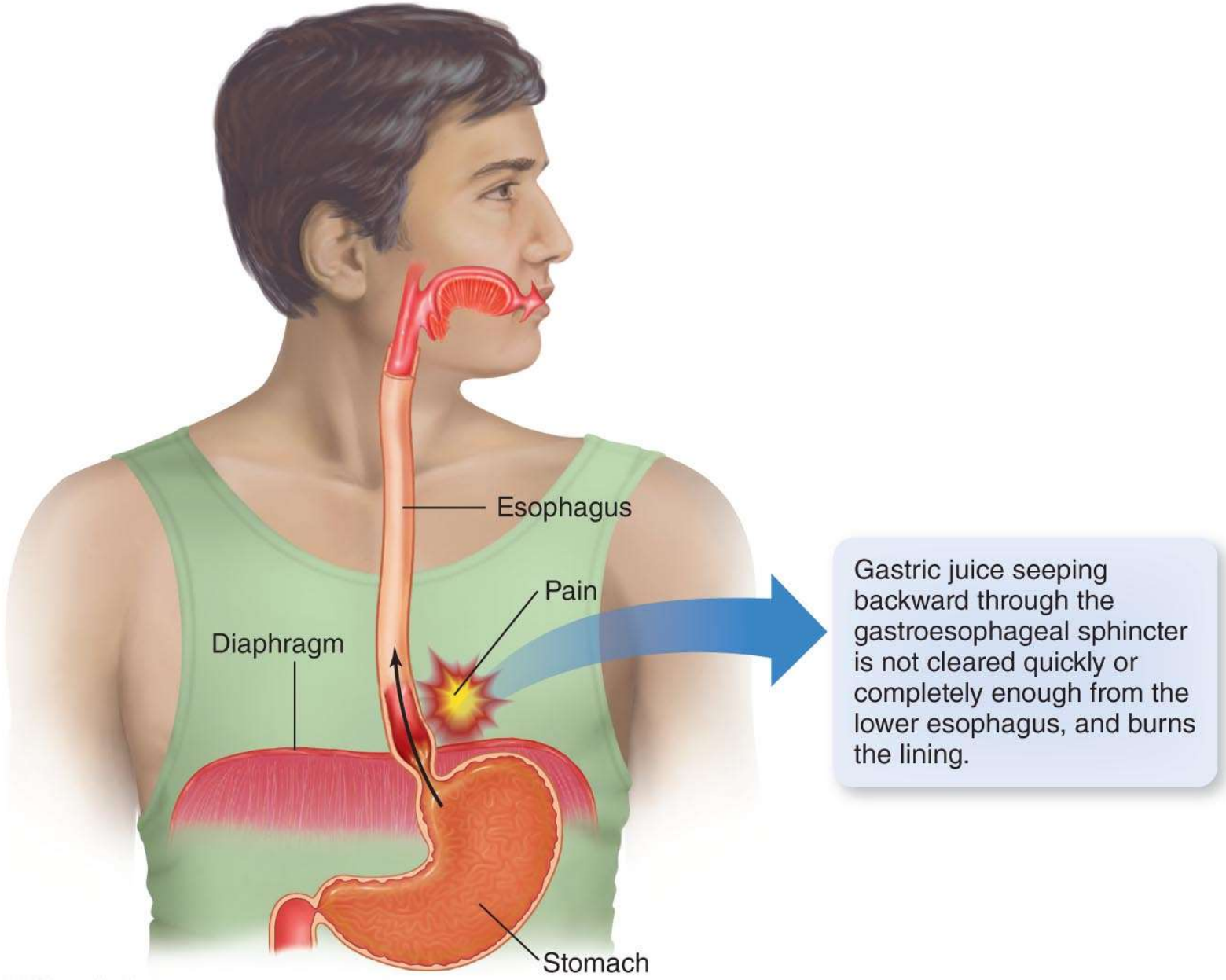
2. Fat-soluble nutrients:

- Lipids and some vitamins enter the lymphatic vessels
- Lymphatic vessels transport these nutrients directly to the bloodstream

GI Tract Disorders

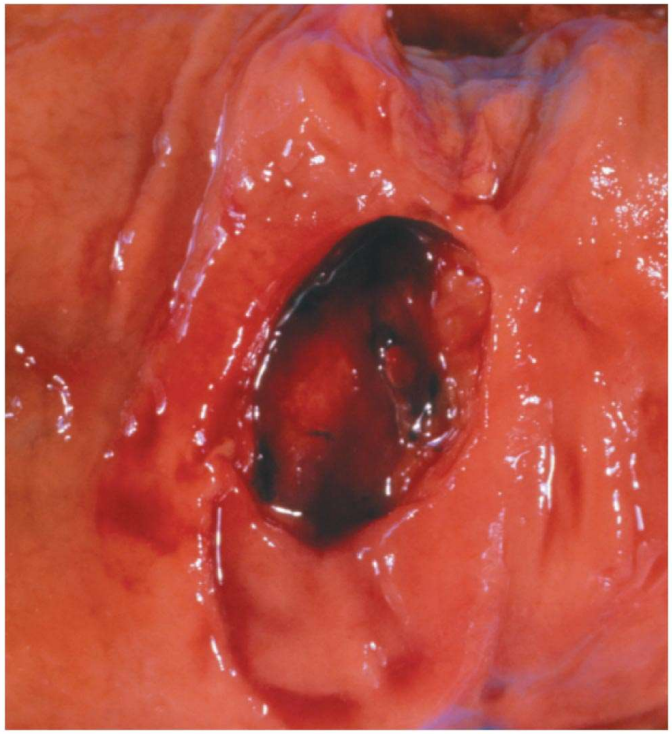
- Gastroesophageal reflux disease (GERD) is a chronic disease for which painful, persistent heartburn is the most common symptom
- Heartburn is caused by hydrochloric acid in the esophagus
- The lining of the stomach is designed to cope with hydrochloric acid, but other regions of the GI tract are not

Heartburn



GI Tract Disorders (cont.)

- Peptic ulcers are regions of the GI tract that have been eroded by HCl and pepsin
- The bacterium *Helicobacter pylori* contributes to the production of both gastric and duodenal ulcers



GI Tract Disorders (cont.)

- Irritable bowel syndrome (IBS) is a disorder that interferes with normal colon function
- Symptoms of IBS include:
  - Abdominal cramps and bloating
  - Either diarrhea or constipation
- IBS is more common in women than in men

In Depth: Disorders Related to Foods

Food intolerance:

- a particular food causes numerous unpleasant symptoms, including gas, pain and diarrhea. *The immune system is not involved*
  - *Ex: Lactose intolerance*

Food allergy:

- hypersensitivity reaction of the immune system to a component in a food
  - *Ex: Peanut allergy*

In Depth: Disorders Related to Foods (cont.)

Celiac Disease:

- is an autoimmune disease that is also considered a genetic disorder
  - Complete intolerance for gluten, a protein found in wheat, rye, barley, and triticale
  - Can damage the small intestine, leading to poor absorption of nutrients

In Depth: Disorders Related to Foods (cont.)

Non-Celiac Gluten Sensitivity:

- Some individuals may have a negative GI reaction when consuming gluten, but do not have Celiac Disease
  - Bloating
  - Abdominal pain
  - Diarrhea
  - Possible joint pain
- Symptoms improve by following a gluten free diet

Chapter 3- Summary

- Organization of the human body
  - cells- organ systems
- Digestive system
  - organs, accessary organs, enzymes
- Absorption
- Nutrient transport
- Diseases of the GI tract
- Food intolerance Vs Food allergy
- Celiac disease
- Non-celiac gluten sensitivity