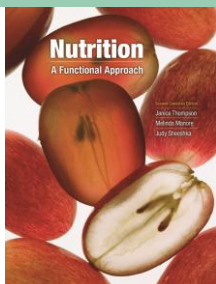


Nutrition: A Functional Approach

Janice Thompson Melinda Manore Judy Sheeshka

3



What Happens to the Food We Eat?

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Why Do We Eat?

Food provides us with:

- Energy for body processes
- Heat for body temperature regulation
- Building blocks for growth and maintenance of body tissues

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Why Do We Want to Eat?

Food is intimately connected to our sense of **taste**, but also stimulates our senses of

- Sight
- Smell
- Touch
- Hearing

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Why Do We Want to Eat?

Appetite: psychological desire to eat certain foods.

- Strong cravings even when we're not hungry are due to appetite.

Hunger: physiological sensation that prompts us to eat.

Satiety: the feeling of being full.

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Why Do We Want To Eat?

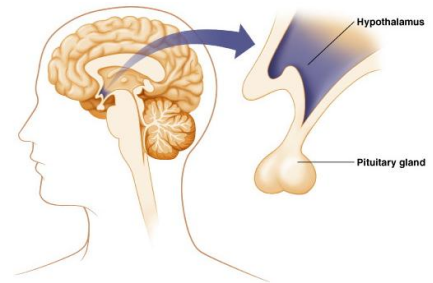
The signals that prompt us to eat include:

- Nerve receptors in the stomach send signals to the brain to indicate if the stomach is full or empty.
- Blood glucose levels trigger the release of hormones called insulin and glucagon
- The **hypothalamus** region of the brain receives these signals.

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Why Do We Want To Eat?



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Why Do We Want To Eat?

Hormones: chemicals produced in specialized glands that travel in the bloodstream to target organs in other parts of the body.

- Some hormones stimulate food intake.
- Some hormones produce a feeling of satiety.

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Why Do We Want To Eat?

Foods have differing effects on our feelings of hunger:

- Proteins have the highest satiety value
- Carbohydrates have the lowest satiety value
- Bulky foods (fibre) provide a sense of satiety
- Solid foods are more filling than semi-solid foods or liquids

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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.

- E.g., H₂O (water), CO₂ (carbon dioxide)

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Organization of the Body

Carbohydrates, proteins, fats and vitamins are usually very large **molecules**.

The goals of digestion:

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

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Organization of the Body

Molecules are the building blocks of cells.

Cells: the smallest unit of life.

Molecules that result from the digestion of food are used to build the cells of the body.

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Organization of the Body

Cell membrane: outer layer enclosing each cell of the body.

- Composed of 2 layers of phospholipids
- Phospholipid “tails” face each other toward the interior of the membrane
- Phospholipid “heads” line the interior and exterior surfaces of the membrane
- Cholesterol is embedded in the membrane

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Organization of the Body

The cell membrane is **selectively permeable** allowing it to control the passage of materials into and out of the cell.

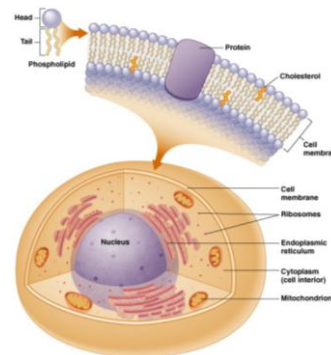
The cell membrane encloses

- **cytoplasm** – the liquid within the cell
- **organelles** – tiny structures that perform many different cellular functions

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Organization of the Body



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Organization of the Body

Cells join together to form tissues.

Tissue: group of cells acting together to perform a common function.

- For example: muscle tissue, nerve tissue

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Organization of the Body

Different tissues combine to form organs.

Organ: a sophisticated organization of tissues that perform a specific function

- For example: stomach, heart, brain

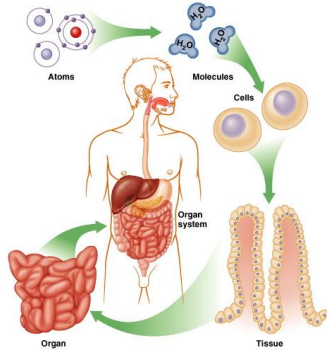
Organ systems are groups of organs working together for a particular function.

- For example: gastrointestinal system

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Organization of the Body



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What Happens to the Food We Eat?

The food we eat undergoes three processes:

1. Digestion
2. Absorption
3. Elimination

These processes occur in the gastrointestinal tract.

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What Happens to the Food We Eat?

Gastrointestinal (GI) tract: series of organs arranged as a long tube.

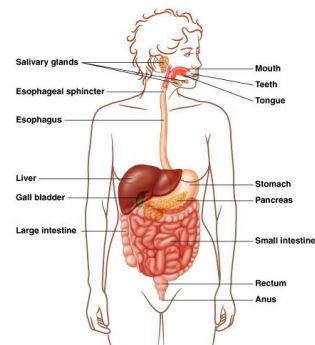
The GI tract includes:

- Organs such as the stomach, intestines
- **Sphincters:** muscles that control the passage of material from one organ to the next

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What Happens to the Food We Eat?



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Digestion

Digestion: the process of breaking large food molecules down to smaller molecules.

Digestion includes:

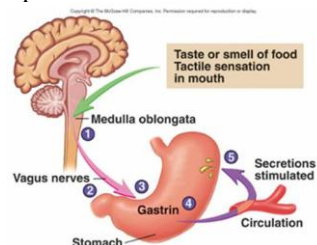
- **Mechanical digestion:** the physical breakdown of food.
- **Chemical digestion:** enzymatic reactions that break down large food molecules.

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Digestion

Cephalic phase: earliest phase of digestion in which the brain prepares the digestive organs for the consumption of food.



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Digestion: The Mouth

Digestion begins in the mouth.

- Chewing is the mechanical digestion that breaks food into smaller pieces
- Some chemical digestion takes place
 - **Salivary amylase** is an enzyme produced by the salivary glands that begins the chemical digestion of carbohydrates.

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Digestion: The Mouth

The **epiglottis** covers the opening to the trachea during swallowing.

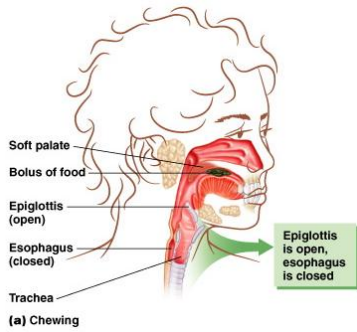
Food travels from the mouth to the stomach through the **esophagus**.

Peristalsis is the muscular contractions moving food through the GI tract.

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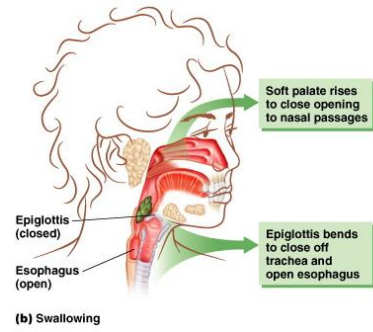
Digestion: Chewing



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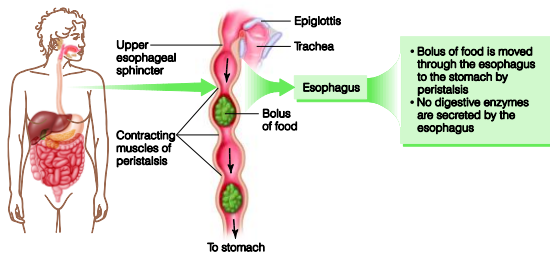
Digestion: Swallowing



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Digestion: Swallowing



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Digestion: Stomach

The **gastroesophageal (cardiac) sphincter** separates the esophagus from the stomach.

Digestion in the stomach includes

- Extensive mechanical digestion to mix food with gastric juice
- Chemical digestion of proteins and fats

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Digestion: Stomach

Gastric juice contains

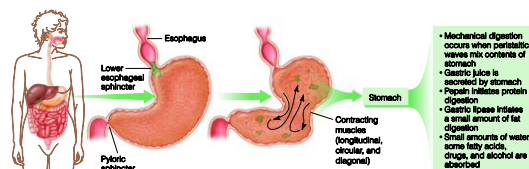
- **Hydrochloric acid (HCl)** – to denature proteins and activate pepsin
- **Pepsin** – an enzyme to digest protein
- **Gastric lipase** – an enzyme to digest fat
- **Mucus** – to protect the stomach lining

Chyme: semi-solid product of mechanical and chemical digestion in the stomach.

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Digestion: The Stomach



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Digestion: Small Intestine

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.

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Digestion: Accessory Organs

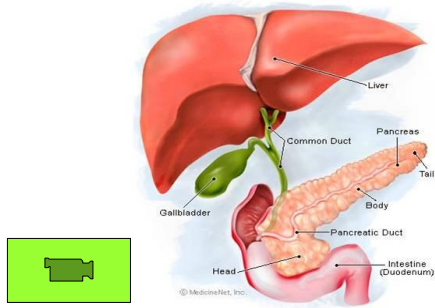
Accessory organs of the GI tract include

- **Liver** – produces **bile** which emulsifies fats
- **Pancreas**
 - produces pancreatic amylase
 - produces pancreatic lipase
 - produces proteases
 - produces bicarbonate to neutralize chyme
- **Gall bladder** – stores bile

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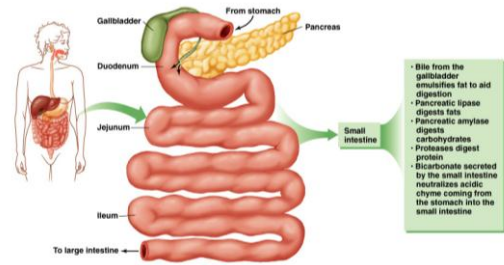
Digestion: Accessory Organs



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Digestion: Accessory Organs



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Digestion: Enzymes

Enzyme	Where it is Found	What it Does
Salivary amylase	Mouth	Breaks starch into smaller carbohydrate molecules
Renin	Stomach	Causes casein to curdle
Pepsin		Breaks proteins into polypeptides and amino acids
Trypsin	Pancreas	Breaks proteins and polypeptides into shorter polypeptides
Chymotrypsin		Breaks proteins and polypeptides into shorter polypeptides
Carboxypeptidase		Breaks polypeptides into amino acid
Pancreatic lipase		Breaks triglycerides into monoglycerides, fatty acids, and glycerol
Pancreatic amylase		Breaks starch into shorter glucose chains and maltose
Carboxypeptidase, aminopeptidase, dipeptidase	Small intestine	Breaks polypeptides into amino acids
Lipase		Breaks monoglycerides into fatty acids
Sucrase		Breaks sucrose into glucose and fructose
Lactase		Breaks lactose into glucose and galactose
Maltase		Breaks maltose into glucose
Dextrinase		Breaks shorter chains of glucose into individual glucose molecules

Digestion: Hormone Functions

Hormone	Where it Comes From	What it Does
Gastrin	Stomach mucosa	Stimulate secretion of HCl and pepsinogen by gastric glands in the stomach and increases gastric motility and emptying
Somatostatin	Stomach and duodenal mucosa	Inhibits the following: stomach secretion, motility, and emptying; pancreatic secretion; absorption in the small intestine; gall bladder contraction; and bile release
Secretin	Duodenal mucosa	Inhibits gastric secretion and motility; increases output of water and bicarbonate from the pancreas; increases bile output from the liver
Cholecystokinin (CCK)		Stimulates contraction of the gallbladder to expel bile; increases output of pancreatic juice
Gastric inhibitory peptide		Inhibits gastric secretion and motility

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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, e.g. water, alcohol
- Most absorption of nutrients occurs in the small intestines.

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Absorption

The lining of the GI tract has special structures to facilitate absorption.

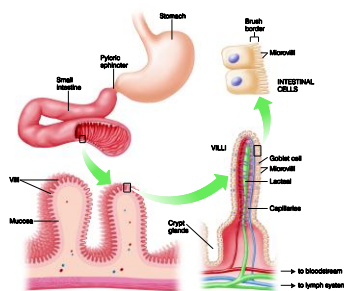
Villi are projections whose movement helps to trap nutrient molecules

The **brush border** is composed of microvilli which greatly increase the surface area.

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Absorption



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Absorption

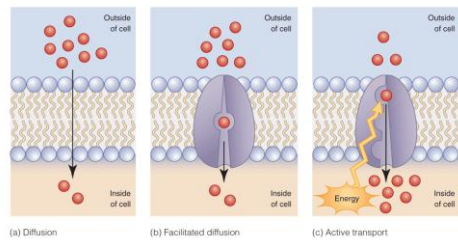


Figure 3.11 Nutrient absorption by (a) simple diffusion, (b) facilitated diffusion, and (c) active transport.

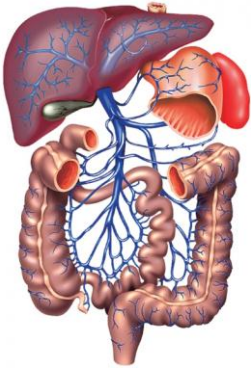
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Simple diffusion examples: vitamins, minerals
 Facilitated diffusion examples: B vitamins and vitamin C
 Active transport examples: glucose, amino acids

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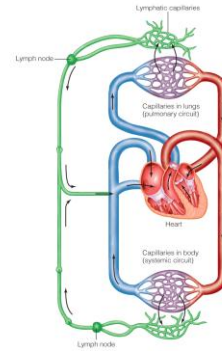
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Hepatic Portal Circulation



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Transport of Nutrients and Fluids



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Figure 3.12 Blood travels through the cardiovascular system to transport nutrients and fluids and pick up waste products. Lymph travels through the lymphatic system and transports most fats and fat-soluble vitamins.

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Elimination

Undigested food components move through a sphincter called the **ileocecal valve** to the large intestine.

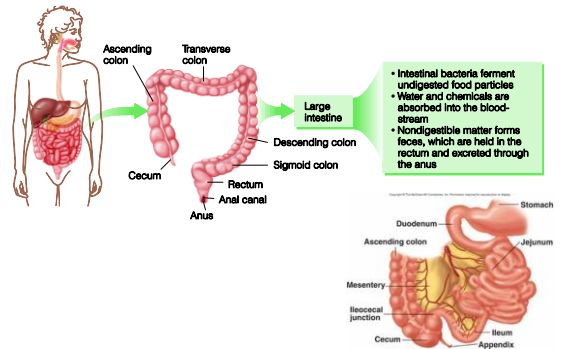
In the large intestine:

- Bacteria ferment undigested food particles
- Material is stored 12-24 hours prior to elimination while water and some nutrients are absorbed

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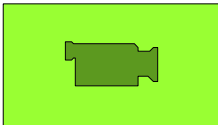
Elimination



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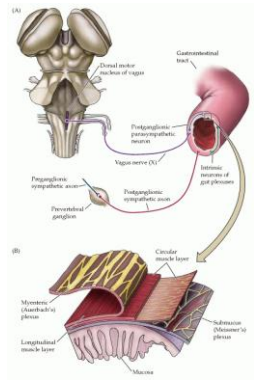
Overview of Digestion



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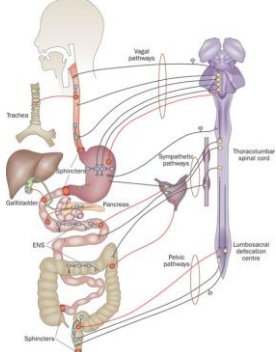
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Enteric Nervous System



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Enteric Nervous System



Furness, J.B. 2012. *Nature Reviews Gastroenterology & Hepatology* 9, 286-294

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