

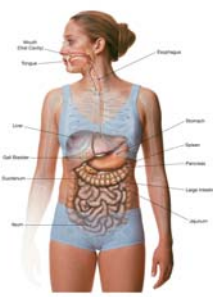
Chapter 6
Digestion, Absorption, and
Metabolism
Part 1
The Link Between Food and Energy

Hewlings/Medeiros

PowerPoint presentation created by
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The Digestive System



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Movement Along the Intestine

- Peristalsis
 - A ring of contraction propelling material along the GI tract
- Segmentation
 - A back-and-forth action that breaks food apart
- Mass movement
 - Peristaltic wave that contracts over a large area of the large intestine to help eliminate waste

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Functions of the Sphincters

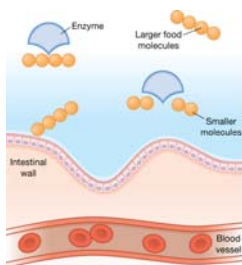
- Prevent reflux of stomach content that causes heartburn and ulcers
- Control the amount of stomach content into the small intestine
- Control the amount of bile into the small intestine
- Prevent large intestine content (bacteria) from backing up into the small intestine

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Absorption



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The Nose Knows

- Five primary tastes
- Salty, sweet, sour, bitter, and umami

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The Mouth and the Esophagus

- Mouth
 - Mechanically digests all food
 - Begins chemical digestion of carbohydrates
- Esophagus
 - Passes food from the mouth to the stomach

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The Stomach

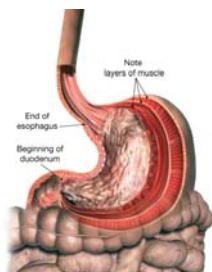
- Lower esophageal sphincter and pyloric sphincter
- Capacity of 1–4 liters
- Greater musculature to “churn” food
- Secretion of acid and enzymes and intrinsic factor
 - HCl begins digestion (denaturation)
 - Sterilizes food
- Holds food for 2–4 hours
- Absorbs alcohol only
- Results in the formation of chyme
- Mucus layer prevents autodigestion

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Physiology of the Stomach




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The Small Intestine


- Duodenum
 - ~10 inches in length
 - Primary site of digestion
 - Release of bile and pancreatic enzymes
- Jejunum
 - ~4 feet in length
 - Some digestion
- Ileum
 - ~5 feet in length
 - Little digestion
 - Immune function



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Physiology of the Small Intestine

- The wall is folded and branches out on many levels.
 - Villi projections are located on the folds.
 - Absorptive cells (enterocytes) are located on the villi.
 - Microvilli are located on the villi.
 - Glycocalyxes are located on the microvilli.
- Increases intestinal surface area by a factor of 600



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In the Small Intestine

- Bile acid from the liver via the gallbladder
- Bicarbonate ions from the pancreas
- Muscle contractions to mix the food with digestive juices
- Digestive enzymes from wall of intestine and microvilli
- Food remains 3–10 hours in the small intestine.
- ~95 percent of digestion takes place here.

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The Large Intestine

- ~3 1/2 feet in length
- Cecum, ascending, transverse, descending, and sigmoid
- Little digestion occurs here
- Indigestible food stuff
- Absorption of water, some minerals, vitamins, electrolytes, some fatty acids
- Formation of feces for elimination

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The Liver and Gallbladder

- Nutrients are released into the portal vein to the liver.
- Hepatic veins release nutrients to the general circulation.
- Production and storage of bile (gallbladder stores)
- CCK stimulates release of bile and pancreatic secretions via common bile duct (sphincter of Oddi at end).
- Enterohepatic circulation
- Unwanted substances released into the duodenum
- Detoxification by the liver

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Pancreas

- Produces glucagon and insulin
- Secretes bicarbonate and digestive enzymes

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Digestion and Absorption: from Tongue to Blood



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Digestion of Carbohydrate in the Mouth

- Saliva contains **amylase**.
- Starch is broken down to **dextrins** and **maltose**.
- Taste the sweetness with prolonged chewing.

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Digestion of Carbohydrate in the Stomach

- The acidic environment stops the action of salivary amylase.
- No further starch digestion occurs.
- Empty quickly from stomach, especially if simple sugar

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Digestion of Carbohydrate in the Small Intestine

- **Pancreatic amylase** breaks down dextrins into maltose.
- Intestinal cells release **maltase, sucrase, and lactase**
Maltose + maltase → glucose + glucose
Sucrose + sucrase → glucose + fructose
Lactose + lactase → glucose + galactose
- Monosaccharides are absorbed.

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Fate of Absorbed Carbohydrates

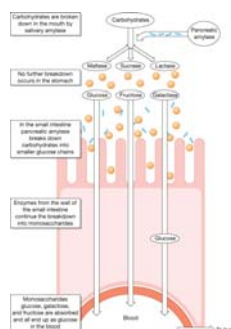
- **Villi**
 - Monosaccharides are absorbed through the cell layer of villi.
 - Enter a capillary in the villi
 - Capillary drains into a vein going to liver
 - Portal vein
- **Liver**
 - Galactose and fructose are taken up.
 - Fructose slower
 - Much of the glucose is taken up.
 - Remaining glucose circulates.
- **Blood Glucose**

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Summary of Carbohydrate Absorption



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Digestion of Fat in the Stomach

- **Gastric and lingual lipase**
- Work only in an acidic environment
- Act on triglycerides containing short- and medium-chain fatty acids
 - Break to free fatty acids and diglycerides, which then enter portal vein
- Longer-chain fatty acids not affected by the stomach

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Digestion of Fat in the Small Intestine

- Primary site of fat digestion
- **CCK** released from duodenal cells stimulates pancreas to release **pancreatic lipase**.
- **CCK** stimulates the release of **bile**.
 - Bile helps emulsify fat, which increases surface area of food to aid action of lipase.
- Pancreatic **colipase** is released to help facilitate lipase enzyme action.
- Fat is broken down to **monoglycerides** and **fatty acids**.
- Lecithin from gall bladder and protein colipase (aids lipase's attachment to lipid)

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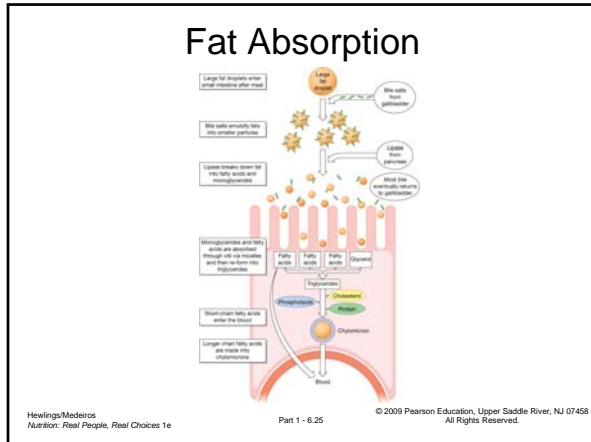
Transportation of Absorbed Fat

- If chain is less than 12 C, portal vein to liver
 - Then packaged to VLDL
- If long, re-formed into triglycerides
 - Packaged into chylomicrons transported via lymphatic system with fat-soluble vitamins and cholesterol
- Lipoprotein lipase from wall of vessel breaks down triglycerides in the chylomicrons.
 - Fatty acids are absorbed by cells.
 - Takes 2–10 hours to clear chylomicron

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Digestion of Protein in the Stomach

- Proteins are denatured by cooking and stomach acid (from parietal cells).
- **Gastrin** (a hormone) stimulates the release of **pepsinogen** from the chief cells in the stomach and release of HCl.
 - **Pepsinogen** is converted to pepsin by the acid in the stomach.
- **Pepsin** (an enzyme produced in the stomach) breaks down proteins into peptones.
- **Pancreas releases sodium bicarbonate to neutralize acid at top of small intestine.**
 - This is stimulated by **secretin** (which also will slow gastric emptying).

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Digestion of Protein in the Small Intestine

- Stimulates the release of **GIP, CCK (stimulates pancreas and gallbladder)**
 - Slow emptying, too
 - Also occurs in fat digestion = fullness
- Pancreas releases the protein-splitting enzymes in inactive form: **trypsin, chymotrypsin, and carboxypeptidase** into the duodenum.
 - Break peptones into smaller peptides and amino acids
- Peptides and amino acids are ready for absorption.

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