

Digestion

- Digestion is the process of breaking down foods into nutrients to prepare for absorption while overcoming 7 challenges.

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Digestion

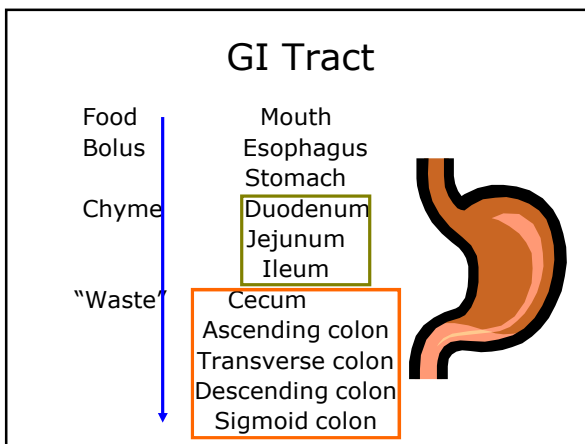
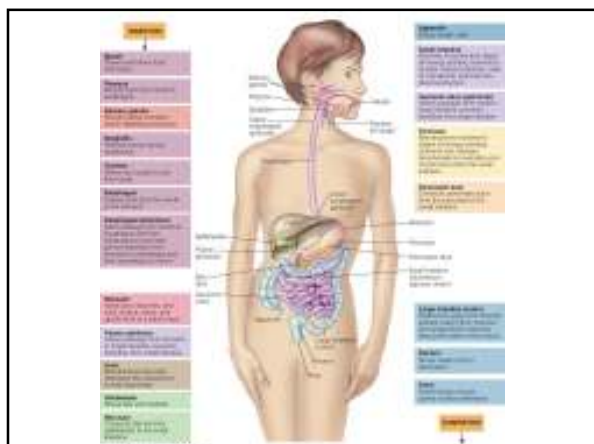
- Anatomy of the Digestive Tract – The gastrointestinal (GI) tract is the flexible muscular tube from mouth to anus. The lumen is the inner space of the tract.
 - ✓ The mouth is the beginning of the digestive system. Digestion in the mouth involves mastication (chewing), the stimulation of taste buds, and swallowing. The epiglottis closes to prevent food from entering the pharynx. After swallowing the food is called a bolus.
 - ✓ The esophagus is the tube that leads the bolus to the stomach. There is a sphincter at the upper and lower (also known as the cardiac sphincter) ends of the esophagus.

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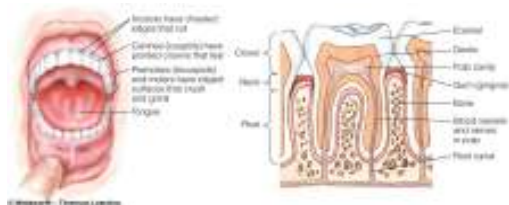
Digestion

- Anatomy of the Digestive Tract
 - ✓ The stomach adds juices and grinds the bolus to a semiliquid mass called chyme. The pyloric sphincter regulates the flow of partially digested food into the small intestine.
 - ✓ The small intestine receives digestive juices from the gallbladder and the pancreas. The three segments of the small intestine are the duodenum, the jejunum and the ileum.
 - ✓ The large intestine (colon) begins at the ileocecal valve and ends at the rectum and anus. The chyme passes by the opening of the appendix.

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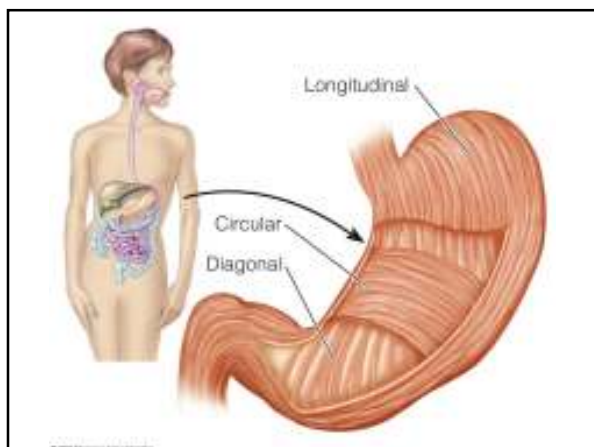
Mastication



Digestion

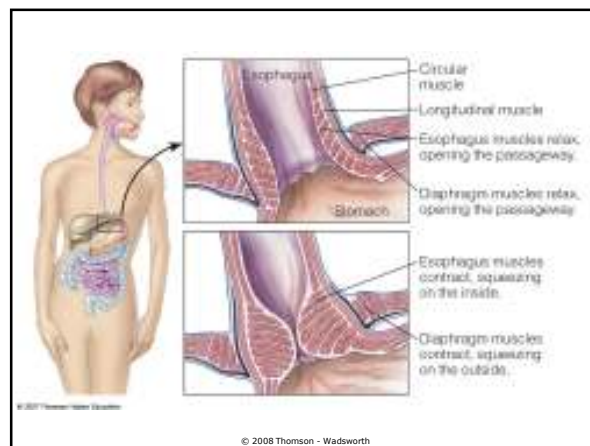
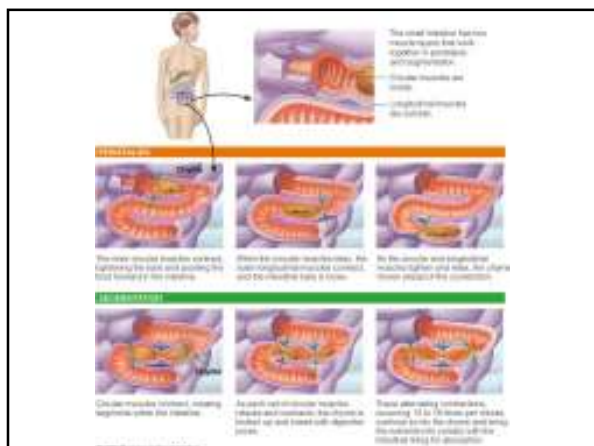
- The Muscular Action of Digestion – under autonomic control
 - ✓ Peristalsis pushes the digestive contents along.
 - ✓ Stomach action involves circular, longitudinal, and diagonal muscles.
 - ✓ Segmentation is contractions by circular muscles that contract and squeeze contents to promote mixing with digestive juices.
 - ✓ Sphincter contractions open and close passageways. This prevents reflux and controls the passage of contents.

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The Small Intestine

- Duodenum
 - ✓ ~10 inches in length
 - ✓ Primary site of digestion
- Jejunum
 - ✓ ~4 feet in length
 - ✓ Some digestion
- Ileum
 - ✓ ~5 feet in length
 - ✓ Little digestion



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Digestion

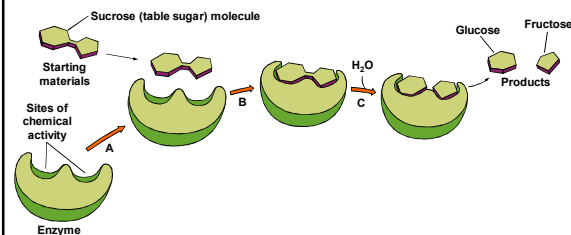
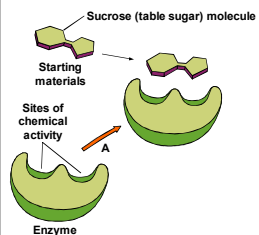
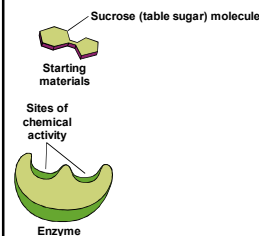
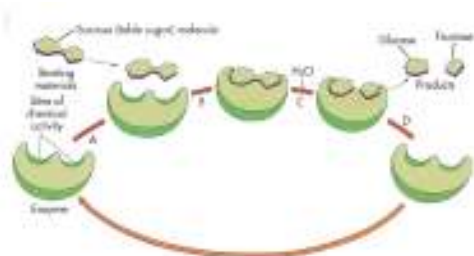
- The Secretions of Digestion
 - ✓ Includes digestive enzymes that act as catalysts in hydrolysis reactions
 - ✓ Saliva from the salivary glands moistens foods
 - ✓ Gastric juice from the gastric glands includes hydrochloric acid. The goblet cells of the stomach wall secrete mucus to protect the walls of the stomach from the high acidity levels that are measured by pH units.
 - ✓ Pancreatic juice contains intestinal enzymes (carbohydrase, lipase, protease) and bicarbonate.
 - ✓ Bile is produced by the liver, stored in the gall bladder, and acts as an emulsifier to suspend fat.

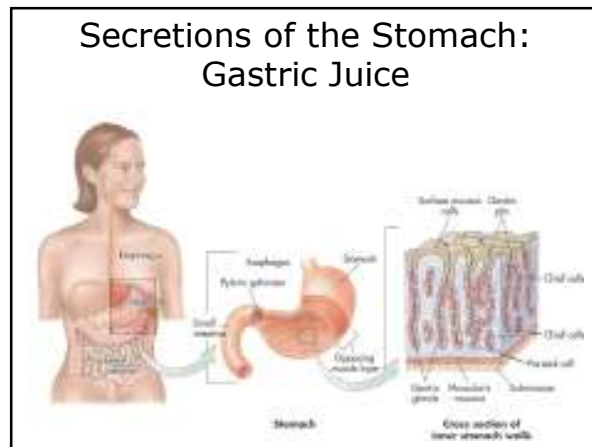
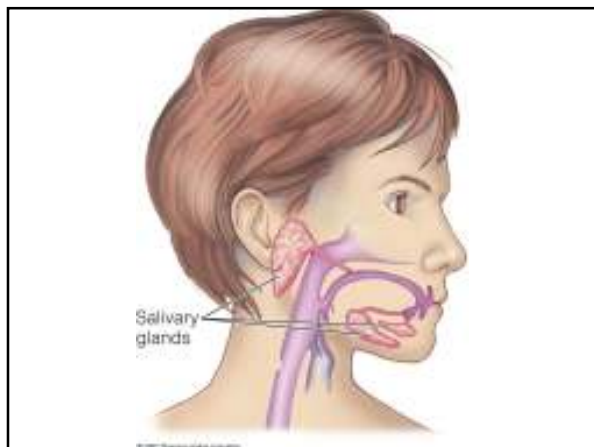
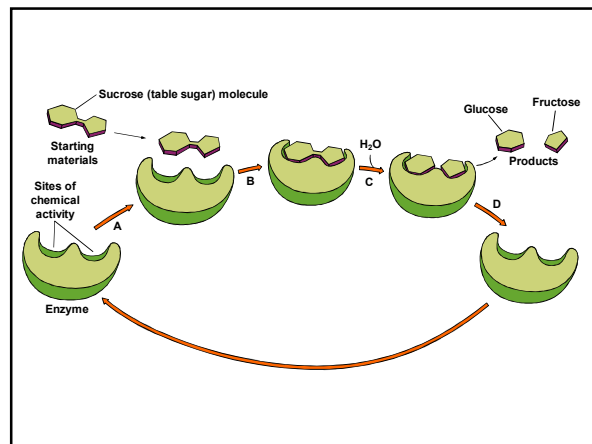
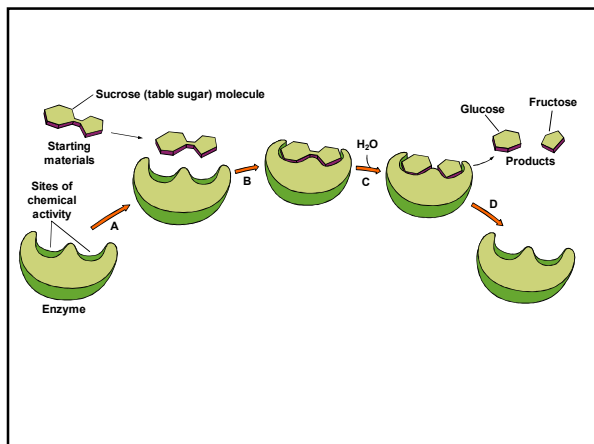
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Digestive Enzymes

- All enzymes are proteins
- Enzymes speed up chemical reactions
- Enzymes lower the amount of energy needed for the action to proceed
- Each enzyme acts on a specific substrate
 - ✓ i.e. carb, protein, lipid
- Enzymes convert substrates into products

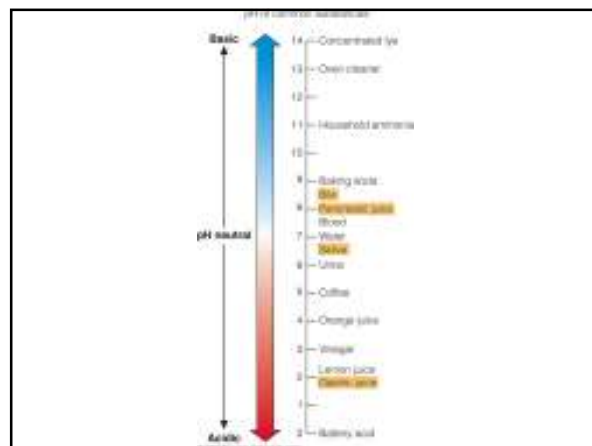
Enzyme Action





Cells of the Stomach

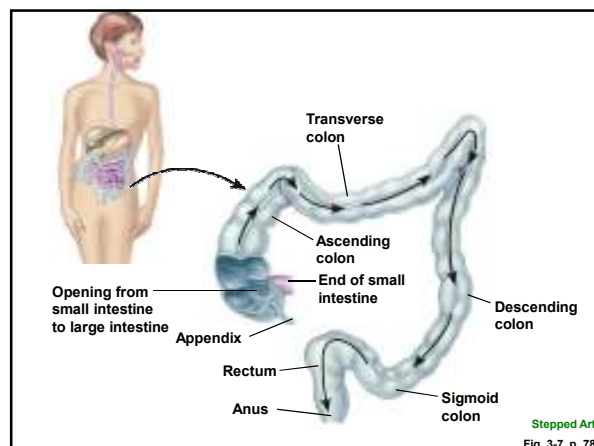
- *Parietal cells* produce hydrochloric acid (HCl)
- *Goblet cells* produce mucus
- *Chief cells* produce pepsinogen
- Secretion of the *intrinsic factor*



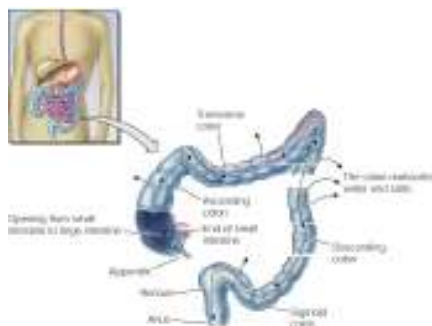
Digestion

- The Final Stage
 - ✓ Energy-yielding nutrients are disassembled for absorption.
 - ✓ Vitamins, minerals and water can be absorbed.
 - ✓ Undigested residues, including some fibers, continue through the digestive tract and form stool.
 - ✓ Recycling of usable materials

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Propulsion or Mass Movement



Movement Along the Intestine

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

Stomach Acid

- Partially digests dietary protein
- Destroys activity of salivary enzyme
- Converts pepsinogen to pepsin
- Assists in calcium absorption
- Destroys bacteria



Production of Stomach Acid

- Produced in parietal cells of stomach
- Hydrochloric acid ($H^+ + Cl^- \leftrightarrow HCl$)
- Proton pump (H^+ is a proton)
- Excess acid production
 - ✓ Genetics, smoking, medical conditions
 - ✓ Histamine
 - ✓ Dietary factors

Pancreatic Secretions

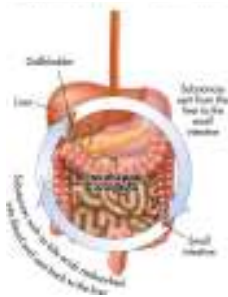
- Sodium bicarbonate (Na_2CO_3) to neutralize stomach acid
- Enzymes:
 - ✓ Proteases
 - ✓ Lipases
 - ✓ Carbohydrases

Secretions: Bile

- Made in the liver
- Stored in the gallbladder
- Released into the small intestine
- Emulsifies fats (like soap)



Bile is Recycled



Colon: Intestinal Flora



- Produces vitamins (K and biotin)
- Helps metabolize fiber
- Produces SCFA (acetate, butyrate)
- Maintains healthy colon
- Prevents colonization of harmful bacteria

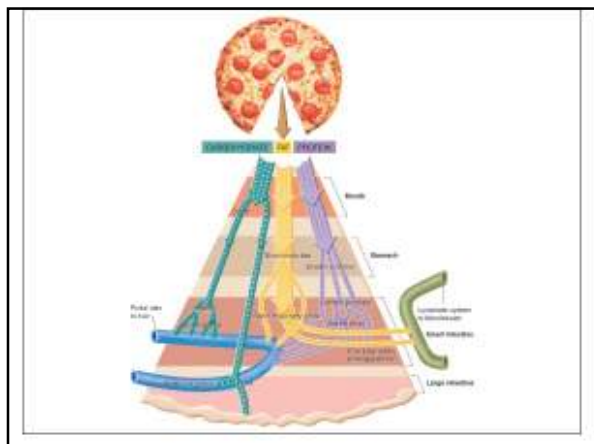
Sphincters

- A muscular and circular valve in the GI tract that controls the flow of food stuff
- Cardiac sphincter (or esophageal sphincter)
- Pyloric sphincter
- Anal sphincters
- Ileocecal valve
- Sphincter of Oddi (hepatopancreatic)



Functions of the Sphincters

- Cardiac sphincter
 - Prevents reflux of stomach content up into esophagus
- Pyloric sphincter
 - Controls the amount of stomach content (chyme) released into the small intestine
- Ileocecal sphincter
 - Prevents large intestine content (bacteria) back up into the small intestine
- Anal sphincters
 - Controls elimination of feces



Absorption

- The enormous surface area of the small intestine facilitates nutrient absorption.
- Nutrients can be absorbed through simple diffusion, facilitated diffusion, or active transport.

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The diagram shows a cross-section of a cell membrane with three transport mechanisms:

- Simple Diffusion:** Small molecules (like water and small lipids) pass directly through the lipid bilayer from the outside cell to the inside cell.
- Facilitated Diffusion:** Larger molecules (like glucose and amino acids) pass through a specific carrier protein in the membrane. The carrier changes shape to move the molecule across.
- Active Transport:** Some nutrients (like glucose and amino acids) are moved against a concentration gradient. This requires energy (ATP) and is done by a carrier protein.

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This diagram provides a more detailed view of the transport mechanisms:

- Simple Diffusion:** Molecules move directly through the membrane.
- Facilitated Diffusion:** A carrier protein binds to a nutrient on the outside, changes shape, and releases it on the inside.
- Active Transport:** A carrier protein uses energy to move a nutrient from the outside to the inside against its concentration gradient.

Some nutrients (such as water and small lipids) are absorbed by simple diffusion. They cross into intestinal cells freely.

Some nutrients (such as the water-soluble vitamins) are absorbed by facilitated diffusion. They need a specific carrier to transport them from one side of the cell membrane to the other. (Alternatively, facilitated diffusion may occur when the carrier changes the cell membrane in such a way that the nutrients can pass through.)

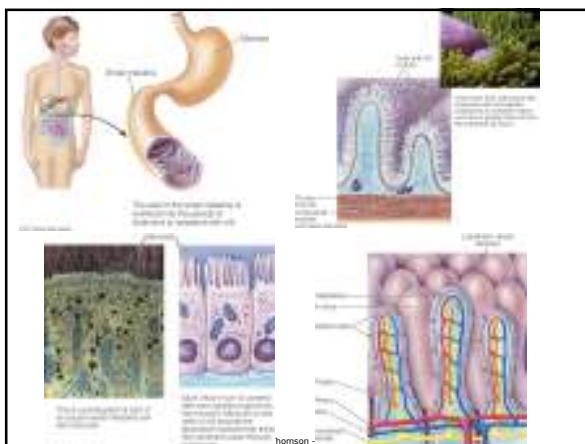
Some nutrients (such as glucose and amino acids) must be absorbed actively. These nutrients move against a concentration gradient, which requires energy.

Stepped Art
Fig. 3-9, p. 81

Absorption

- Anatomy of the Absorptive System
 - ✓ Villi are the fingerlike projections within the folds of the small intestine that move in a wave-like pattern to trap nutrients.
 - ✓ Microvilli are the microscopic hairlike projections on each villi.
 - ✓ Crypts are the tubular glands that lie between the intestinal villi.
 - ✓ Goblet cells are located between the villi and secrete a protective thick mucus.

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Absorption

- A Closer Look at the Intestinal Cells
 - ✓ Specialization of the cells to absorb different nutrients
 - ✓ "Food combining" which emphasizes separating food for digestive purposes is a myth.
 - ✓ Preparing Nutrients for Transport
 - Water-soluble nutrients and small products of fat digestion are released to the bloodstream.
 - Fat-soluble vitamins and larger fats form chylomicrons and are released to the lymphatic system.

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The Circulatory System

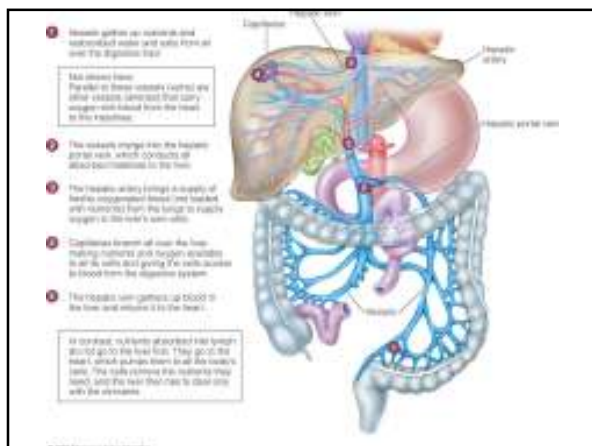
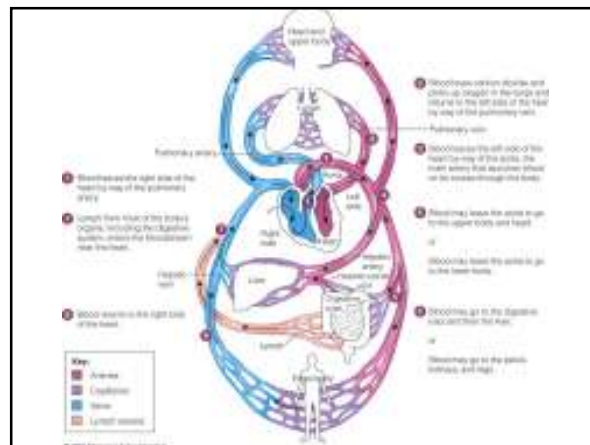
- Water-soluble nutrients and small fats are routed to the liver before being transported to the cells.
- Fat-soluble nutrients, entering from the lymph, bypass the liver at first and eventually enter the vascular system.

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The Circulatory System

- The vascular system consists of arteries, capillaries and veins.
 - ✓ The hepatic portal vein directs blood from the GI tract to the liver.
 - ✓ The hepatic vein takes blood from the liver to the heart.
 - ✓ The liver protects against toxic substances.

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The Circulatory System

- The lymphatic system consists of one-way vessels to transport fluid.
 - ✓ Lymph is a clear, yellowish fluid without red blood cells or platelets that moves through the body by muscle contractions.
 - ✓ The thoracic duct is the lymph's route to the heart.
 - ✓ The subclavian vein provides a return of lymph to the vascular system.
 - ✓ Lacteals are the lymphatic vessels of the intestine that absorb nutrients and pass them to the lymphatic system.

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The Health and Regulation of the GI Tract

- The principle of homeostasis is important in the functioning of the digestive and absorptive systems.
- The body's hormonal and nervous control systems keep conditions normal.

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The Health and Regulation of the GI Tract

- Gastrointestinal Bacteria
 - ✓ A healthy GI tract has many different non-disease-causing bacteria known as flora or microflora.
 - ✓ Probiotics are bacteria found in the GI tract that can be beneficial to health. An example is the bacteria found in yogurt.
 - ✓ Prebiotics are foods that are used as food by intestinal bacteria.

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The Health and Regulation of the GI Tract

- Gastrointestinal Hormones and Nerve Pathways
 - ✓ Hormones act as messengers, and those involved in the GI tract are known as enterogastrones.
 - ✓ Gastrin is secreted by the stomach.
 - ✓ Pyloric sphincter
 - ✓ Secretin is secreted by the duodenum.

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The Health and Regulation of the GI Tract

- Gastrointestinal Hormones and Nerve Pathways
 - ✓ Pancreatic secretions change based on the content of the diet.
 - ✓ The pancreas is protected against enzymes by creating enzyme precursors called proenzymes or zymogen.
 - ✓ Cholecystokinin targets the gall bladder.
 - ✓ Motility slows for foods that take longer to be digested.

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The Health and Regulation of the GI Tract

- The System at Its Best
 - ✓ A healthy digestive tract is essential.
 - ✓ Balance, moderation, variety and adequacy of meals are important.

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Common Digestive Problems

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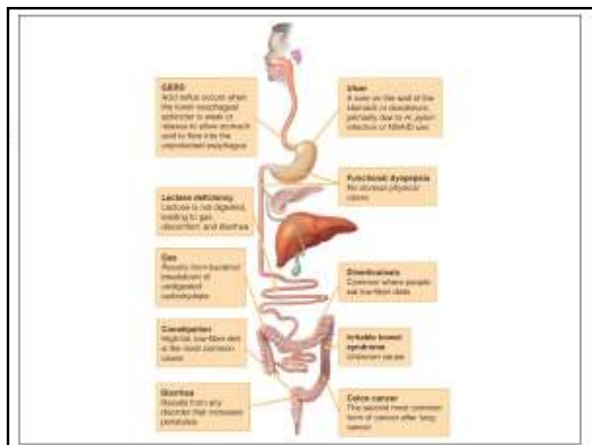
Nutrition and GI Disorders

- Constipation
 - ✓ Hard, dry, infrequent stools
 - ✓ Reduced by high fiber, fluid intake, exercise
- Diarrhea
 - ✓ Loose, watery, frequent stools
 - ✓ Symptom of diseases/infection
 - ✓ Can cause dehydration
- Diverticulosis
 - ✓ Pouches along colon
 - ✓ High fiber diet reduces formation



Nutrition and GI Disorders

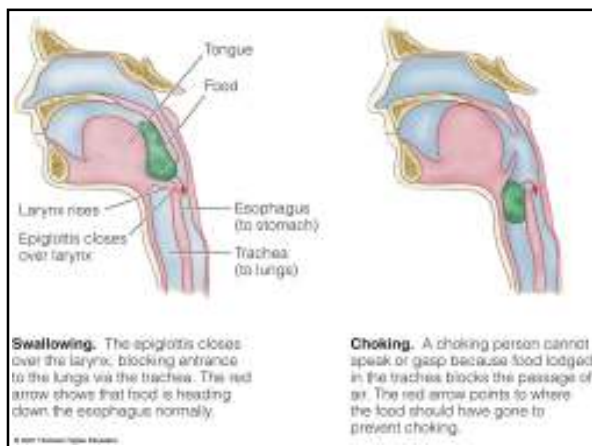
- Gastroesophageal Reflux Disease (GERD)
 - ✓ Reduced by smaller meals, less fat
- Irritable Bowel Syndrome (IBS)
- Colorectal cancer
 - ✓ Antioxidants may reduce risk
- Gas
- Ulcers
 - ✓ Bacterial cause
- Functional dyspepsia



Choking

- Food becomes lodged in the trachea.
- The larynx cannot make sounds.
- The Heimlich maneuver may need to be used.
- Strategies
 - ✓ Small bites
 - ✓ Chew thoroughly.
 - ✓ Don't talk or laugh with food in the mouth.
 - ✓ Don't eat when breathing hard.

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Vomiting

- Body's adaptive mechanism
- Dehydration is a concern.
- May be self-induced as in eating disorders

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Diarrhea

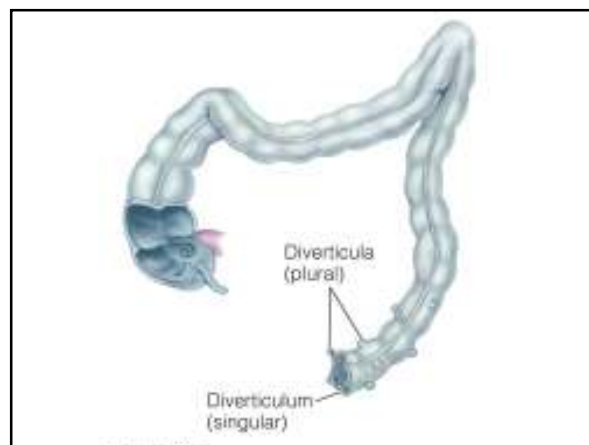
- Frequent, loose, watery stools
- Irritable bowel syndrome or colitis is one of the common GI disorders.
- Strategies
 - ✓ Rest
 - ✓ Drink fluids
 - ✓ Medical help is needed if it persists.

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Constipation

- Defecation habits are different among people.
- Many causes are possible.
- Hemorrhoids may be a problem.
- Diverticulosis is a condition in which the intestinal walls weaken and bulge. The bulging pockets are called diverticula. Diverticulitis is a worsened condition and requires intervention.
- Use of laxatives, enemas and mineral oil may not be necessary with lifestyle changes.

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Constipation

- Colonic irrigation is the internal washing of the large intestine and can be hazardous.
- Strategies
 - ✓ High-fiber diet
 - ✓ Increased fluids
 - ✓ Exercise regularly.
 - ✓ Respond quickly to the urge to defecate.

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Belching and Gas

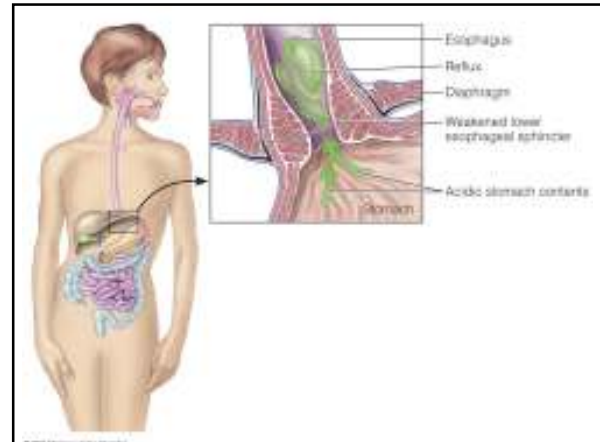
- Strategies
 - ✓ Eat slowly.
 - ✓ Chew thoroughly.
 - ✓ Relax while eating.
 - ✓ Watch bothersome foods.
- Hiccups are triggered by eating or drinking too fast.

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Heartburn and "Acid Indigestion"

- Gastroesophageal reflux is the backward flow of stomach contents into the esophagus.
- Antacids and acid controllers may help indigestion.

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Heartburn and "Acid Indigestion"

- Strategies
 - ✓ Small meals
 - ✓ Liquids between meals
 - ✓ Sit up while eating.
 - ✓ Wait 1 hour after eating before lying down.
 - ✓ Wait 2 hours after eating before exercising.
 - ✓ Refrain from tight-fitting clothing.
 - ✓ Avoid bothersome foods.
 - ✓ Refrain from tobacco use.
 - ✓ Lose weight if overweight.

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Ulcers

- Peptic ulcers can be gastric or duodenal.
- Strategies
 - ✓ Take prescribed medicine.
 - ✓ Avoid caffeine- and alcohol-containing foods.
 - ✓ Minimize aspirin and ibuprofen use.
 - ✓ No smoking.

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