The Digestive System -

Accessory organs

Salivary glands
secrete saliva and digestive enzyme

parotid

sublingual

submandibular

Digestive tract organs

Mouth
tooth 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

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

Spleen
stores blood cells; helps fight infections

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

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

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

Villus
absorbs nutrients from the chyme

Large intestine
absorbs water and salt to form feces

Rectum
stores and regulates elimination of feces

Anus

verniform appendix

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.
Anatomy of the Digestive System

- Alimentary canal -__________

- Digestion includes both _____ and ______ processes that reduce food into _________________

- Functions of the digestive system:
  - Ingest
  - Break food
  - Absorb
  - Eliminate
Mouth (oral cavity) receives _____ & begins _______ & _________ digestion

- Tongue is composed of ______________________________
  - Papillae-_______________________________________
    - Help it ______________________________________
    - Contain_____________________________________
  - Frenulum attaches it to the floor of the mouth
- Roof separates it _________________________________
  - Hard palate - ______________________
  - Soft palate- _________________________
- Salivary glands-_______________________________
  - Parotid- _________________________________
  - Sublingual – ______________________________
  - Submandibular – _________________________
  - Saliva- solution of _________________________
    - Salivary amylase – ___________________________
    - ____________________________ and prepares it for swallowing
    - Antibacterial lysozyme and secretory
Pharynx- transports

Three parts
- Nasopharynx-
- Oropharynx-
- Laryngopharynx-
  - Palatine tonsils
  - Lingual tonsils
  - Pharyngeal tonsil (adenoids)

Swallowing- normally food enters the

because
  - Voluntary phase
  - _________ – once food or drink is pushed back to the oropharynx
  - Bolus-
Wall of the gut- 4 layers cover the entire digestive tract.

- **Mucosa (mucous membrane layer)**
  - Layer of epithelium
  - Glandular epithelial cells secrete
  - Goblet cells

- **Submucosa (submucosal layer)**
  - Loose connective tissue
  - Contains
  - Peyer’s patches are scattered throughout the submucosa

- **Muscularis (smooth muscle layer)**
  - Inner, circular layer
  - Outer, longitudinal layer

- **Serosa (serous membrane layer)**
  - Thin, 
  - Secretes
Esophagus - ________________

- pushes food along the alimentary canal

- Function is to ________________________

- Esophageal sphincter marks the __________

- Heartburn occurs when ________________
- thick walled J-shaped organ

Continuous with the ________ and _________ of the small intestine

Rugae – ____________________

______ and __________________

Starts the ____________________

---

Regions of the Stomach

- Cardiac- ______________
- Fundic- temporary ______
- ______________________
- _______ - main part
- _______ – leads to pyloric sphincter
Digestive functions of the stomach

• Acts on food both _______________ and __________________
• Muscular wall churns and mixes food with __________________
• Chyme-_______________________________________
• Gastric glands produce gastric juice:
  ▪ 1. ____________________________
    - Secrete pepsinogen
    - Pepsinogen becomes the protein-digesting enzyme ____________
  ▪ 2. Parietal cells
    - _________________ – kills bacteria and activates pepsin
    - Produces intrinsic factor – binds to vitamin $B_{12}$ and prevents it from being destroyed in the acidic environment
  ▪ 3. Enteroendocrine cells produce _________________________
  ▪ 4. ____________________________ secrete protective mucus
Peritoneum -

- **Parietal** -
  
  __________________

- **Visceral** -
  
  __________________

- __________________ -- double layer that supports the viseral organs

  - _______ and _______
    
    the abdominal cavity

  - Contains ______________

  - Can wall off portions of the alimentary wall
    
    ____________________
- complete digestion process

- Extends from the pyloric valve of the _________ to the ileocecal valve where it joins the ____________

- Regions of the Small Intestine
  - _________________
    - Glands __________________
    - Receives __________________
  - Jejunum
  - Ileum contains Peyer’s patches
Small intestine wall has 3 features to increase surface area

1. ___________ - transverse folds
2. ___________ - finger-like projections
3. ___________ - microscopic projections of villi increase surface area
Functions of the small intestine

- Digestion of _______________________________

- Bile-____________________________________

- Absorption of nutrients
  - Greater the __________________ greater __________
  - Movement of ______________________________

Regulation of contraction & secretion in the digestive tract

- Enteric Nervous system

- 3 phases occur in sequence as your meal begins

- Sight or smell of food causes nervous stimulation of gastric secretion

- Gastric phase

- Intestinal phase – stretch of the causes and in the
Hormone regulation of digestive system

- Gastrin - causes ____________
  ____________________________
  ____________________________

- ____________ – causes bicarbonate release from pancreas

- Gastric inhibitory peptide – ____________
  ____________________________

- Cholecystokinin – ____________
  ____________________________

- _______ – from adipocytes, causes full feeling

- Ghrelin – ____________
  ____________________________
Large intestine

- Stores
- Absorbs

Rectum

- Sigmoid colon
- Descending colon
- Store form

Feces

Ascending colon

Four portions

- Cecum
- Vermiform appendix
- Blind end

Parts of the large intestine

Cecum

Large intestine - absorbs

Anal canal

Rectum

Sigmoid colon

Colon

Ascending colon
Elimination by the large intestine

- **Feces**
  - 75% ______________
  - 25% ______________
    - ______________
    - ______________

- **Constipation**
  - Feces is dry and hard
  - Chronic constipation is associated with ______________ - enlarged & inflamed blood vessels in the anus

- **Major causes of diarrhea**
  - Infection _____________________________
  - _____________________________
Other disorders of the large intestine

- **Polyps**
  - Can be benign or cancerous (colon cancer)

- **Diverticulosis**
  - **Diverticulitis**
    - Cramps or steady pain
    - Fever
    - Loss of appetite, nausea, and vomiting
Accessory Organs of Digestion

- **Salivary glands**

- **Teeth**

- **Pancreas**
  - **Endocrine function** – __________secrete and __________
  - **Exocrine function** acinar cells produce __________
    - Sodium bicarbonate
    - __________for all types of foods
      - **Amylase digests**
      - Three protein-digesting enzymes – inactive forms – activated by enterokinase
        - Trypsin
        - Chymotrypsin
        - Carboxypeptidase
      - **Lipase digests**
      - __________break down nucleic acids
- largest organ of the body

- Two main lobes
- Each lobe is divided into many ________________________
  - Serve as its ________ and ________ unit of the liver
- Portal triads are located between the lobules
  - bile duct-______________________________________
  - A branch of the hepatic artery-________________________
  - A branch of the hepatic portal vein-______________
  - Bile ducts merge to form the common ____________
Liver functions

- Detoxifies
- Stores and vitamins
- Makes
- Maintains concentrations
  - Excess in the blood is removed & stored as by the liver
- Produces after breaking down
- and bile
  - Stored in
- Helps regulate the level
Liver disorders lead to 2 common conditions

- **Jaundice** - yellowish tint to eyes and skin
  - Hemolytic jaundice
  - Obstructive jaundice
  - Hepatitis –__________________________________________

- **Cirrhosis** –__________________________________________
  - Hinder liver’s ability to__________________________
- stores excess bile

- When needed, bile leaves the gallbladder via the cystic duct

- **Function of bile salts**
  - Emulsification of fats-
  - Enhance absorption of ___________, ________________, and ________________
Chemical Digestion

Digestive enzymes are _______________________

- _____________________________
- Introduce ______________________ at specific bonds

Starch

- Salivary amylase
- Pancreatic amylase
- Disaccharases (brush border enzymes) ______________________

Proteins

- Pepsin
- Three pancreatic proteinases
  - Trypsin
  - Chymotrypsin
  - Carboxypeptidase
- Peptidases (brush border enzymes) ______________________

Fats

- Emulsified by _____________
- Digested by _____________
# Chemical Digestion

## TABLE 15.2 Major Digestive Enzymes

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Produced By</th>
<th>Site of Action</th>
<th>Optimum pH</th>
<th>Digestion Process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CARBOHYDRATE-DIGESTING ENZYMES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salivary amylase</td>
<td>Salivary glands</td>
<td>Mouth</td>
<td>Neutral</td>
<td>Starch + H₂O → maltose</td>
</tr>
<tr>
<td>Pancreatic amylase</td>
<td>Pancreas</td>
<td>Small intestine</td>
<td>Basic</td>
<td>Starch + H₂O → maltose</td>
</tr>
<tr>
<td>Maltraze</td>
<td>Small intestine</td>
<td>Small intestine</td>
<td>Basic</td>
<td>Maltose → glucose + glucose</td>
</tr>
<tr>
<td>Sucrase</td>
<td>Small intestine</td>
<td>Small intestine</td>
<td>Basic</td>
<td>Sucrose → glucose + fructose</td>
</tr>
<tr>
<td>Lactase</td>
<td>Small intestine</td>
<td>Small intestine</td>
<td>Basic</td>
<td>Lactose → glucose + galactose</td>
</tr>
<tr>
<td><strong>PROTEIN-DIGESTING ENZYMES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pepsin</td>
<td>Stomach</td>
<td>Stomach</td>
<td>Acidic</td>
<td>Protein + H₂O → peptides</td>
</tr>
<tr>
<td>Trypsin</td>
<td>Pancreas</td>
<td>Small intestine</td>
<td>Basic</td>
<td>Peptides + H₂O → smaller peptides + amino acids</td>
</tr>
<tr>
<td>Chymotrypsin</td>
<td>Pancreas</td>
<td>Small intestine</td>
<td>Basic</td>
<td>Peptides + H₂O → smaller peptides + amino acids</td>
</tr>
<tr>
<td>Carboxypeptidase</td>
<td>Pancreas</td>
<td>Small intestine</td>
<td>Basic</td>
<td>Peptides + H₂O → smaller peptides + amino acids</td>
</tr>
<tr>
<td>Peptidases</td>
<td>Small intestine</td>
<td>Small intestine</td>
<td>Basic</td>
<td>Small peptides → amino acids</td>
</tr>
<tr>
<td><strong>LIPID-DIGESTING ENZYMES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pancreatic lipase</td>
<td>Pancreas</td>
<td>Small intestine</td>
<td>Basic</td>
<td>Fat droplet + H₂O → glycerol + fatty acids</td>
</tr>
<tr>
<td><strong>NUCLEIC ACID-DIGESTING ENZYMES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuclease</td>
<td>Pancreas</td>
<td>Small intestine</td>
<td>Basic</td>
<td>RNA or DNA + H₂O → nucleotides</td>
</tr>
<tr>
<td>Nucleotidase</td>
<td>Small intestine</td>
<td>Small intestine</td>
<td>Basic</td>
<td>Nucleotide + H₂O → base + sugar + phosphate</td>
</tr>
</tbody>
</table>
Effects of Aging

- Incidence of ____________________________

- Periodontitis-

- Esophageal hiatal hernia- portion of _________ protrudes into __________________________

- __________________________

- Peristalsis slows __________________________

- __________________________ may occur more frequently

- __________________________ and __________________________

- The liver __________________________

- Gallbladder difficulties occur
  - ____________
  - ____________
interaction between food & living organism

- Nutrient – ________________________________
- A balanced diet contains ________________________________
- Nutrients enter the ______ and is distributed to the ________________
- Essential molecules must be present in food because ________________________________
Nutrition

- Glucose is the body’s ____________________________
- Fats are a ____________________________
- Amino acids
  - Used by the cells to ____________________________
  - Nine essential amino acids
Vitamins-

- Play essential roles

- Two groups
  - 1. ___________ - vitamins A, D, E, and K
  - 2. _______________
    - B-complex vitamins and vitamin C
    - Most are ____________________
<table>
<thead>
<tr>
<th>Vitamins</th>
<th>Role in Body</th>
<th>Good Food Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FAT-SOLUBLE VITAMINS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin A</td>
<td>Assists in the formation and maintenance of healthy skin, hair, and mucous membranes; aids in the ability to see in dim light (night vision); is essential for proper bone growth, tooth development, and reproduction</td>
<td>Deep yellow/orange and dark green vegetables and fruits (carrots, broccoli, spinach, cantaloupe, sweet potatoes); cheese, milk, and fortified margarine</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Aids in the formation and maintenance of bones and teeth; assists in the absorption and use of calcium and phosphorus</td>
<td>Milk fortified with vitamin D; tuna, salmon, or cod liver oil; also made in the skin when exposed to sunlight</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>Protects vitamin A and essential fatty acids from oxidation; prevents plasma membrane damage</td>
<td>Vegetable oils and margarine; nuts; wheat germ and whole-grain breads and cereals; green, leafy vegetables</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>Aids in synthesis of substances needed for clotting of blood; helps maintain normal bone metabolism</td>
<td>Green, leafy vegetables, cabbage, and cauliflower; also made by bacteria in intestines of humans, except for newborns</td>
</tr>
<tr>
<td><strong>WATER-SOLUBLE VITAMINS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Is important in forming collagen, a protein that gives structure to bones, cartilage, muscle, and vascular tissue; helps maintain capillaries, bones, and teeth; aids in absorption of iron; helps protect other vitamins from oxidation</td>
<td>Citrus fruits, berries, melons, dark green vegetables, tomatoes, green peppers, cabbage, potatoes</td>
</tr>
<tr>
<td><strong>B-COMPLEX VITAMINS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thiamin</td>
<td>Helps in release of energy from carbohydrates; promotes normal functioning of nervous system</td>
<td>Whole-grain products, dried beans and peas, sunflower seeds, nuts</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>Helps body transform carbohydrates, proteins, and fats into energy</td>
<td>Nuts, yogurt, milk, whole-grain products, cheese, poultry, leafy green vegetables</td>
</tr>
<tr>
<td>Niacin</td>
<td>Helps body transform carbohydrates, proteins, and fats into energy</td>
<td>Nuts, poultry, fish, whole-grain products, dried fruit, leafy greens, beans; can be formed in the body from tryptophan, an essential amino acid found in protein</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>Aids in the use of fats and amino acids; aids in the formation of protein</td>
<td>Sunflower seeds, beans, poultry, nuts, bananas, dried fruit, leafy green vegetables</td>
</tr>
<tr>
<td>Folic acid</td>
<td>Aids in the formation of hemoglobin in red blood cells; aids in the formation of genetic material</td>
<td>Nuts, beans, whole-grain products, fruit juices, dark green leafy vegetables</td>
</tr>
<tr>
<td>Pantothenic acid</td>
<td>Aids in the formation of hormones and certain nerve-regulating substances; helps in the metabolism of carbohydrates, proteins, and fats</td>
<td>Nuts, beans, seeds, poultry, dried fruit, milk, dark green leafy vegetables</td>
</tr>
<tr>
<td>Biotin</td>
<td>Aids in the formation of fatty acids; helps in the release of energy from carbohydrates</td>
<td>Occurs widely in foods, especially eggs; made by bacteria in the human intestine</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>Aids in the formation of red blood cells and genetic material; helps in the functioning of the nervous system; requires intrinsic factor from the stomach to be absorbed</td>
<td>Milk, yogurt, cheese, fish, poultry, eggs; not found in plant foods unless fortified (as in some breakfast cereals)</td>
</tr>
</tbody>
</table>

Minerals-

- Macronutrients -
  - Sodium
  - Magnesium
  - Phosphorus
  - Chlorine
  - Potassium
  - Calcium

- Micronutrients-
# TABLE 15.4 Minerals: Their Role in the Body and Food Sources

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Role in Body</th>
<th>Good Food Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MACRONUTRIENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>Is used for building bones and teeth and for maintaining bone strength; also involved in muscle contraction, blood clotting, and maintenance of plasma membranes</td>
<td>All dairy products; dark green, leafy vegetables; beans, nuts, sunflower seeds, dried fruit, molasses, canned fish</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Is used to build bones and teeth; to release energy from carbohydrates, proteins, and fats; and to form genetic material, plasma membranes, and many enzymes</td>
<td>Beans, sunflower seeds, milk, cheese, nuts, poultry, fish, lean meats</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Is used to build bones, to produce proteins, to release energy from muscle carbohydrate stores (glycogen), and to regulate body temperature</td>
<td>Sunflower and pumpkin seeds, nuts, whole-grain products, beans, dark green vegetables, dried fruit, lean meats</td>
</tr>
<tr>
<td>Sodium</td>
<td>Regulates body-fluid volume and blood acidity; aids in transmission of nerve impulses</td>
<td>Most of the sodium in the U.S. diet is added to food as salt (sodium chloride) in cooking, at the table, or in commercial processing; animal products contain some natural sodium</td>
</tr>
<tr>
<td>Chloride</td>
<td>Is a component of gastric juice and aids in acid-base balance</td>
<td>Table salt, seafood, milk, eggs, meats</td>
</tr>
<tr>
<td>Potassium</td>
<td>Assists in muscle contraction, the maintenance of fluid and electrolyte balance in the cells, and the transmission of nerve impulses; aids in the release of energy from carbohydrates, proteins, and fats</td>
<td>Widely distributed in foods, especially fruits and vegetables, beans, nuts, seeds, and lean meats</td>
</tr>
</tbody>
</table>

**MICRONUTRIENTS (TRACE ELEMENTS)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Role in Body</th>
<th>Good Food Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>Is involved in the formation of hemoglobin in the red blood cells of the blood and myoglobin in muscles; also is a part of several enzymes and proteins</td>
<td>Molasses, seeds, whole-grain products, fortified breakfast cereals, nuts, dried fruits, beans, poultry, fish, lean meats</td>
</tr>
<tr>
<td>Zinc</td>
<td>Is involved in the formation of protein (growth of all tissues), in wound healing, and in prevention of anemia; is a component of many enzymes</td>
<td>Whole-grain products, seeds, nuts, poultry, fish, beans, lean meats</td>
</tr>
<tr>
<td>Iodine</td>
<td>Is an integral component of thyroid hormones</td>
<td>Table salt (fortified), dairy products, shelfish, and fish</td>
</tr>
<tr>
<td>Fluoride</td>
<td>Is involved in maintenance of bone and tooth structure</td>
<td>Fluoridated drinking water is the best source; also found in tea, fish, wheat germ, kane, cottage cheese, soybeans, almonds, onions, milk</td>
</tr>
<tr>
<td>Copper</td>
<td>Is vital to enzyme systems and in manufacturing red blood cells; is needed for utilization of iron</td>
<td>Nuts, oysters, seeds, crab, wheat germ, dried fruit, whole grains, legumes</td>
</tr>
<tr>
<td>Selenium</td>
<td>Functions in association with vitamin E; may assist in protecting tissues and plasma membranes from oxidative damage; may also aid in preventing cancer</td>
<td>Nuts, whole grains, lean pork, cottage cheese, milk, molasses, squash</td>
</tr>
<tr>
<td>Chromium</td>
<td>Is required for maintaining normal glucose metabolism; may assist insulin function</td>
<td>Nuts, prunes, vegetable oils, green peas, corn, whole grains, orange juice, dark green vegetables, legumes</td>
</tr>
<tr>
<td>Manganese</td>
<td>Is needed for normal bone structure, reproduction, and the normal functioning of the central nervous system; is a component of many enzyme systems</td>
<td>Whole grains, nuts, seeds, pineapple, berries, legumes, dark green vegetables, tea</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>Is a component of enzymes; may help prevent dental caries</td>
<td>Tomatoes, wheat germ, lean pork, legumes, whole grains, strawberries, winter squash, milk, dark green vegetables, carrots</td>
</tr>
</tbody>
</table>

Eating disorders

- **Obesity**
  - 28% of women and 10% of men in the U.S. are overweight

- **Bulimia Nervosa**
  - Can coexist with either obesity or anorexia nervosa
  - Bingeing then purging
  - Alters blood ________________
  - Stomach acids can ________________
Persons with bulimia nervosa have
- recurrent episodes of binge eating characterized by consuming an amount of food much higher than normal for one sitting and a sense of lack of control over eating during the episode.
- an obsession about their body shape and weight.
- increase in fine body hair, halitosis, and gingivitis.

Body weight is regulated by
- a restrictive diet, excessive exercise.
- purging (self-induced vomiting or misuse of laxatives).

Persons with anorexia nervosa have
- a morbid fear of gaining weight; body weight no more than 85% normal.
- a distorted body image so that person feels fat even when emaciated.
- in females, an absence of a menstrual cycle for at least three months.

Body weight is kept too low by either/or
- a restrictive diet, often with excessive exercise.
- binge eating/purging (person engages in binge eating and then self-induces vomiting or misuses laxatives).
morbid fear of gaining weight

- Individuals have a distorted self-image
- **Individuals have all the symptoms of starvation**
  - Low __________________________
  - Irregular ______________________
  - ______________________________
  - Constant _______________________
  - Bone density ___________________
  - ______________________ stops in females
  - Internal organs do not ___________
  - Skin __________________________