I. Nutrition

A. Nutrient - chemical substance that is needed by the body for normal growth, maintenance & repair. Two categories

1. Macronutrient - needed in large amounts. Carbohydrates, Lipids & Proteins (& Water)

B. Carbohydrates
1. Includes starches, sugars & cellulose
2. Sources - grains, legumes, potatoes, fruits & vegetables
3. Three categories
   a. Monosaccharide - simple sugars. Glucose, fructose, & galactose. Glucose is the only form that the cells of the body can utilize.
   b. Disaccharide - two monosaccharides bonded together. Lactose, maltose & sucrose.
4. Function - to provide energy for all the cells of the body.

C. Lipids
1. Composed of 3 fatty acid chains and 1 glycerol molecule.
2. Two categories
3. Functions - 1) to serve as a reserve energy supply 2) essential in cell membranes
4. Diet - should be less than 30% (saturated fats less than 10%)
D. Proteins
1. Chains of amino acids bonded together with peptide bonds.
2. Sources - meat, beans, eggs, milk, nuts
3. Amino acids
   a. 20 different AA
   b. The body can manufacture 12.
      8 must be obtained through the food that we eat - Essential Amino Acids.
4. Functions - 1) structural material for growth and repair of cells.
   2) enzymes regulate chemical reaction
   
E. Minerals
1. Inorganic molecules that function as integral parts of enzymes and hormones.
2. Ca, P, K, S, Na, Cl, Mg, Fe

F. Vitamins
1. Organic molecules essential for growth & development.
2. Two types
   a. fat soluble - A, D, E, K
   b. water soluble - B complex and C
II. Overview of the Digestive System
   A. Alimentary canal (gastrointestinal tract) - muscular digestive tube that runs through the body.
   B. Alimentation - the combined processes of ingestion, digestion, absorption, assimilation, & egestion through which food substances are chemically changed into forms that can be taken into and used by cells.
      1. Ingestion - eating. The taking of food into the digestive tract.
      2. Propulsion - the movement of food along the alimentary canal.
         a. peristalsis - wave-like muscular contractions
      3. Digestion - the breaking down of food into usable molecules.
         a. physical
         b. chemical
      4. Absorption - process by which food molecules move into the bloodstream to be carried to the cells of the body.
      5. Assimilation - incorporation of food molecules into the cells of the body to be used as energy or structural materials.

C. Digestive system is divided into 2 parts
   1. Alimentary canal - organs through which food passes. Oral cavity, pharynx, esophagus, stomach, small intestine, large intestine.
D. Layers of the alimentary canal

1. Mucosa - innermost layer.
   Composed of epithelium & functions in protection, secretion & absorption.

2. Submucosa - composed of loose connective tissue, blood vessels & nerves. Functions in nourishment of the mucosa & carries away absorbed materials.


4. Serosa - visceral peritoneum. Functions to secrete fluid to keep outer surface moist and lubricated.

III. Organs of the Alimentary Canal

A. Oral cavity / Buccal cavity / Mouth

1. The mechanical digestion of all foods and the chemical digestion of carbohydrates.


3. Tongue
   a. Functions: taste, movement of food, & speech
   b. Lingual frenulum - fold of tissue that attaches tongue to floor of mouth.
   c. Papillae - projections on the surface of the tongue that aid in licking foods and provides friction for manipulation of food.
   d. Taste buds - specialized papillae mostly found at the tip and along the sides of the tongue. Four tastes
      1) sweet - tip
      2) salty - front sides
      3) sour - sides
      4) bitter - back
4. Teeth - mechanically digest food
   a. Mastication - the chewing of food to increase its surface area for the chemical digestion of enzymes.
   b. Teeth structure - pulp (blood vessels & nerves), dentine (bony material) & enamel (hardest substance in the body)
   c. Teeth types
      1) Incisors - flat, chisel teeth for cutting
      2) Canines - sharp, pointed teeth for ripping & tearing
      3) Bicuspids (premolar) - flat teeth for grinding & crushing
      4) Molars - flat teeth for grinding or crushing
   d. Two sets of teeth in your life
      1) deciduous teeth (milk or baby teeth) - 20
         I - 8, C - 4, M - 4, M2 - 4
      2) permanent teeth - 32 (including wisdom (M3) teeth)
         I - 8, C - 4, B - 4, B2 - 4, M - 4, M2 - 4, M3 - 4
5. Salivary Glands - secrete saliva (1000 - 1500 ml per day)
   a. Saliva composed of water, mucous, ions, & amylase
   b. Saliva functions in digestion of carbo's (amylase), lubrication of food (mucous), maintains pH in mouth, washes teeth, and neutralizes acids in mouth. 
   c. Amylase breaks down starches into disaccharides.
   d. 3 sets of salivary glands
      1) Parotid - anterior and inferior to the ear. Largest salivary glands
      2) Submandibular
      3) Sublingual

   a. Food is chewed (mastication) & mixed with saliva.
   b. It is rolled into a ball (bolus) using the tongue and soft palate and forced into the pharynx.
   c. The bolus triggers sensory receptors in the pharynx that causes the swallowing reflex.
   d. The tongue blocks the mouth, the uvula blocks the nasopharynx, and the epiglottis blocks the larynx.
   e. Peristaltic contractions of the esophagus carry the food to the stomach.
B. Esophagus

1. 10 inch tube that carries food from the mouth to the stomach.
2. Has a thick muscularis to force food along.
3. Esophageal Hiatus - hole in the diaphragm through which the esophagus passes (hiatus hernia).
4. Cardiac Sphincter - circular muscle at the opening to the stomach. It prevents the back flow of food and digestive juices into the esophagus.
   a. Heartburn - stomach juices (acid) is splashed up into the esophagus causing a burning sensation.
**C. Stomach**

2. Functions: 1) receive food, 2) mix food with gastric juices, 3) initiate the chemical digestion of proteins, 4) limited absorption, 5) pass food into the small intestines.
3. Stomach parts - cardiac sphincter, cardiac region, fundus, body, pyloric region, pyloric sphincter.
4. Rugae - folds in the lining of the stomach that allow for the stomach to stretch (distend).
5. Chyme - food, and gastric juice mixture.
6. Mucosa of stomach contains gastric pits with three cells
   a. Mucous cells - secrete mucus that protects the lining of the stomach from its own digestive juices.
   b. Parietal cells - secrete hydrochloric acid that lowers the pH to 1.5 - 3.5. It functions to kill bacteria and activation of the pepsin.
   c. Chief cells - secrete pepsinogen, which is activated by the HCl and becomes pepsin. Pepsin digest proteins.
7. Ulcer - over production of HCl and pepsin that wears away at the stomach wall. Usually due to stress.
8. Vomiting - emesis. Complex muscular reflex controlled by the medulla that expels food from the stomach. Caused by over extension of the stomach, bacteria, alcohol, spicy food, etc.
The small intestine is 21 feet long and 1 inch in diameter. It extends from the pyloric sphincter to the ileocecal valve.

It is the major digestive and absorption organ.

Functions:
1. Receive secretions from the pancreas, gall bladder, & liver,
2. Digestion of carbs, proteins, & lipids,
3. Absorption of carbs, proteins, & lipids,
4. Produce & secrete various enzymes,
5. Transport undigested food to the colon.

Three segments:
- Duodenum - 10 inches long. Receives chyme through the pyloric sphincter. Mixes chyme with pancreatic juice and bile.
- Jejunum - 8 feet long. Most absorption of nutrients occurs here.
- Ileum - 12 feet long. Joins the small intestine to the large intestine at the ileocecal valve.

Villi - finger-like projections on the surface of the mucosa:
- They increase the surface area of the small intestine some 600 times.
- Each villus has microvilli on its surface, which increases the absorptive surface area even more.
- Inside the villi are capillaries (which absorb nutrient molecules) and lacteal (lymphatic capillaries).

Brunner's glands - secrete mucus that functions to 1) lubricate the small intestine and 2) neutralize the stomach acid in the chyme.
7. **Mesentary** - fan-shaped tissue that supports the small intestine as well as the blood vessels that carry blood to and from the intestines

8. **Intestinal Juice** - enzymes produced and secreted by the mucosa of the small intestine (1-2 L/day). They aid in the digestion of all macronutrients.
E. Large Intestine (Colon)
1. 5 feet long tube that extends from the ileocecal valve to the anus.
2. Functions: 1) reabsorbs water, 2) reabsorbs electrolytes, 3) stores and forms feces.
3. Has no digestive functions
4. Colon parts - ileocecal valve, cecum, ascending colon, transverse colon, descending colon, sigmoid colon, rectum, and anus.
5. Vermiform appendix - finger-like projection attached to the bottom of the cecum. Part of the lymphatic system although it is considered to be a vestigial organ. Infection can occur (appendicitis) and without surgical removal (appendectomy) it can burst and allow chyme to flow into & infect the abdominal cavity (peritonitis).
6. Haustra - pocket-like sacs that segment the large intestine.
7. Escherichia coli - bacteria that live in the large intestine. They digest feces and produce vitamin K & several B's.
8. Flatulation - farting. The bacteria also produce methane gas, which has to be released periodically.
IV. Accessory Organs

A. Liver

1. Largest organ in the body. Located in the upper right quadrant of the abdominal cavity.

2. Functions
   a. produces bile
   b. detoxifies blood
   c. destroys worn out red blood cells (RBC’s)
   d. converts glucose to glycogen & stores it
   e. converts non-carbohydrates to glucose
   f. deamination of amino acids
   g. formation of urea
   h. stores vitamins A, D, B12, & iron
   i. many, many other functions

3. Structure of the Liver
   a. Divided into 4 major lobes
   b. Lobes are divided into lobules
   c. The lobules are composed of hepatic cells that radiate outward from a central vein

4. Bile - greenish-yellow liquid produced by the hepatic cells.
   a. Composed of water, bile salts, bile pigments, & cholesterol
   b. The main bile pigment, bilirubin, is produced from the breakdown of heme from the hemoglobin of worn out RBC’s
   c. Bile is an emulsifier (like soap) that breaks down fat globules into smaller fat globules. This increases the surface area of the fat upon which the enzymes may work & speeds up the digestion of fats.

5. Cirrhosis - chronic deterioration of the hepatic cells of the liver. Due to alcoholism or hepatitis. Impaired liver function can eventually lead to death. Liver transplants are the best option.
B. Gall Bladder
1. Pear-shaped sac attached to the ventral surface of the liver.
2. Bile produced in the liver travels up the cystic duct to the gall bladder.
3. Bile is stored and concentrated in the gall bladder.
4. When fats enter the duodenum, the gall bladder & liver are stimulated to secrete bile.
5. The cystic duct merges with the hepatic duct to form the common bile duct.
6. The common bile duct releases the bile into the duodenum.
7. The circular muscle called the sphincter of Oddi controls the release of bile.
8. The gall bladder absorbs water out of bile in order to make it more concentrated. Too much reabsorption of water causes the cholesterol to crystallize into gallstones. The removal of the gall bladder due to gallstones is a cholecystectomy.
C. Pancreas

1. Gland located slightly below and behind the stomach.
2. It has both digestive (exocrine) and hormonal (endocrine) functions.
3. Pancreatic juice contains enzymes that digest carbo’s, lipids, & proteins.
4. The secretions are carried down the pancreatic duct to the common bile duct, which releases the secretions into the duodenum.