- I. Unit 14: The Digestive System and Body Metabolism
  - A. The Digestive System Functions
    - 1. Ingestion - taking in food
    - 2. Digestion - breaking food down both physically and chemically
      - a) mechanical
      - b) chemical
    - 3. Absorption - movement of nutrients into the bloodstream
    - 4. Propulsion
      - a) deglutition
      - b) peristalsis
    - 5. Defecation - rids the body of indigestible waste
  - B. Organs of the Digestive System
    - 1. Two main groups
      - a) Alimentary canal (gastrointestinal or GI tract) - continuous coiled
      - b) Accessory digestive organs
    - 2. Organs of the Alimentary Canal
      - a) Mouth
        - (1) Lips (labia) - protect the anterior opening
        - (2) Cheeks - form the lateral walls
        - (3) Hard palate - forms the anterior roof
        - (4) Soft palate - forms the posterior roof
        - (5) Uvula - fleshy projection of the soft palate
        - (6) Vestibule - space between lips externally and teeth and gums internally
        - (7) Oral cavity proper - area contained by the teeth
        - (8) Tongue - attached at hyoid bone and styloid processes of the skull, and by the lingual frenulum to the floor of the mouth
        - (9) Tonsils
          - (a) Palatine
          - (b) Lingual
        - (10) Mouth Physiology

- [ ] (a) Mastication (chewing) of food
- [ ] (b) Mixing masticated food with saliva
- [ ] (c) Initiation of swallowing by the tongue
- [ ] (d) Allows for the sense of taste

- [ ] b) Pharynx
  - [ ] (1) Nasopharynx - not part of the digestive system
  - [ ] (2) Oropharynx - posterior to oral cavity
  - [ ] (3) Laryngopharynx - below the oropharynx and connected to
  - [ ] (4) Pharynx Physiology
    - [ ] (a) Serves as a passageway for air and food
    - [ ] (b) Food is propelled to the esophagus by two muscle layers
      - [ ] (i) Longitudinal inner layer
      - [ ] (ii) Circular outer layer
    - [ ] (c) Food movement is by alternating contractions of the muscle layers (peristalsis)
- [ ] c) Esophagus
  - [ ] (1) Anatomy
    - [ ] (a) About 10 inches long
    - [ ] (b) Runs from pharynx to stomach through the diaphragm
  - [ ] (2) Physiology
    - [ ] (a) Conducts food by peristalsis (slow rhythmic squeezing)
    - [ ] (b) Passageway for food only (respiratory system branches off after the pharynx)
- [ ] d) Stomach
  - [ ] (1) Stomach Anatomy
    - [ ] (a) Located on the left side of the abdominal cavity
    - [ ] (b) Food enters at the cardioesophageal sphincter
    - [ ] (c) Food empties into the small intestine at the pyloric sphincter (valve)
    - [ ] (d) Regions of the stomach
      - [ ] (i) Cardiac region - near the heart

- [ ] (ii) Fundus - expanded portion lateral to the cardiac region
- [ ] (iii) Body - midportion
- [ ] (iv) Pylorus - funnel-shaped terminal end
- [ ] (e) Rugae - internal folds of the mucosa
- [ ] (f) External regions
  - [ ] (i) Lesser curvature - concave medial surface
  - [ ] (ii) Greater curvature - convex lateral surface
- [ ] (g) Layers of peritoneum attached to the stomach
  - [ ] (i) Lesser omentum - attaches the liver to the lesser curvature
  - [ ] (ii) Greater omentum - attaches the greater curvature to the posterior body wall
    - [ ] (a) Contains fat to insulate, cushion, and protect
    - [ ] (b) Has lymph nodules containing macrophages

- [ ] (2) Stomach Physiology
  - [ ] (a) Temporary storage tank for food
  - [ ] (b) Site of food breakdown
  - [ ] (c) Chemical breakdown of protein begins
  - [ ] (d) Delivers chyme (processed food) to the small intestine
- [ ] (3) Structure of the Stomach Mucosa
  - [ ] (a) Mucosa is simple columnar epithelium
  - [ ] (b) Mucous neck cells - produce a sticky alkaline mucus
  - [ ] (c) Gastric glands - situated in gastric pits and secrete gastric juice
  - [ ] (d) Chief cells - produce protein-digesting enzymes (pepsinogens)
  - [ ] (e) Parietal cells - produce hydrochloric acid
  - [ ] (f) Enteroendocrine cells - produce gastrin

- [ ] e) Small intestine
  - [ ] (1) The body’s major digestive organ
  - [ ] (2) Site of nutrient absorption into the blood
  - [ ] (3) Muscular tube extending from the pyloric sphincter to the
  - [ ] (4) Suspended from the posterior abdominal wall by the mesentery

- (5) Subdivisions of the Small Intestine
  - (a) Duodenum
    - (i) Attached to the stomach
    - (ii) Curves around the head of the pancreas
  - (b) Jejunum
    - (i) Attaches anteriorly to the duodenum
  - (c) Ileum
    - (i) Extends from jejunum to large intestine
- (6) Chemical Digestion in the Small Intestine
  - (a) Chemical digestion begins in the small intestine
    - (i) Enzymes are produced by
      - (a) Intestinal cells
      - (b) Pancreas
        - (i) Pancreatic ducts carry enzymes to the small intestine
  - (b) Bile, formed by the liver, enters via the bile duct
- (7) Small Intestine Anatomy
  - (a) Three structural modifications that increase surface area
    - (i) Microvilli - tiny projections of the plasma membrane (create a brush border appearance)
    - (ii) Villi - fingerlike structures formed by the mucosa
    - (iii) Circular folds (plicae circulares) - deep folds of mucosa and submucosa

f) Large intestine

- (1) Larger in diameter, but shorter in length, than the small intestine
- (2) Frames the internal abdomen
- (3) Large Intestine Anatomy
  - (a) Cecum - saclike first part of the large intestine
  - (b) Appendix
    - (i) Accumulation of lymphatic tissue that sometimes becomes inflamed (appendicitis)
    - (ii) Hangs from the cecum

- (ii) Hangs from the cecum
- (c) Colon
  - (i) Ascending - travels up right side of abdomen
  - (ii) Transverse - travels across the abdominal cavity
  - (iii) Descending - travels down the left side
  - (iv) Sigmoid - enters the pelvis
    - (a) Rectum and anal canal - also in pelvis
- (4) No villi present
- (5) Goblet cells produce alkaline mucus which lubricates the passage
- (6) Muscularis externa layer is reduced to three bands of muscle called teniae coli
- (7) These bands cause the wall to pucker into haustra (pocketlike sacs)

g) Anus

- (1) Anus - opening of the large intestine
  - (a) External anal sphincter - formed by skeletal muscle and under voluntary control
  - (b) Internal involuntary sphincter - formed by smooth muscle
  - (c) These sphincters are normally closed except during defecation

3. Layers of Alimentary Canal Organs

a) Four layers

- (1) Mucosa
  - (a) Innermost, moist membrane consisting of
    - (i) Surface epithelium
    - (ii) Small amount of connective tissue (lamina propria)
    - (iii) Small smooth muscle layer
- (2) Submucosa
  - (a) Just beneath the mucosa
  - (b) Soft connective tissue with blood vessels, nerve endings, and lymphatics
- (3) Muscularis externa - smooth muscle

- [ ] (a) Inner circular layer
- [ ] (b) Outer longitudinal layer
- [ ] (4) Serosa - outermost layer of the wall contains fluid-producing cells
  - [ ] (a) Visceral peritoneum - outermost layer that is continuous with the innermost layer
  - [ ] (b) Parietal peritoneum - innermost layer that lines the abdominopelvic cavity

- [ ] 4. Alimentary Canal Nerve Plexuses
  - [ ] a) Two important nerve plexuses serve the alimentary canal
  - [ ] b) Both are part of the autonomic nervous system
    - [ ] (1) Submucosal nerve plexus
    - [ ] (2) Myenteric nerve plexus
  - [ ] c) Function is to regulate mobility and secretory activity of the GI tract organs
- [ ] 5. Accessory Digestive Organs
  - [ ] a) Teeth
    - [ ] (1) Function is to masticate (chew) food
    - [ ] (2) Humans have two sets of teeth
      - [ ] (a) Deciduous (baby or “milk”) teeth
      - [ ] (b) 20 teeth are fully formed by age two
    - [ ] (3) Permanent teeth
      - [ ] (a) Replace deciduous teeth between the ages of 6 and 12
      - [ ] (b) A full set is 32 teeth, but some people do not have wisdom teeth (third molars)
      - [ ] (c) If they do emerge, the wisdom teeth appear between ages of 17 and 25
    - [ ] (4) Classification of Teeth
      - [ ] (a) Incisors - cutting
      - [ ] (b) Canines - tearing or piercing
      - [ ] (c) Premolars - grinding
      - [ ] (d) Molars - grinding
    - [ ] (5) Regions of a Tooth

- [ ] (a) Crown - exposed part
  - [ ] (i) Enamel - hardest substance in the body
  - [ ] (ii) Dentin - found deep to the enamel and forms the bulk of
  - [ ] (iii) Pulp cavity - contains connective tissue, blood vessels, and nerve fibers
  - [ ] (iv) Root canal - where the pulp cavity extends into the root
- [ ] (b) Neck
  - [ ] (i) Region in contact with the gum
  - [ ] (ii) Connects crown to root
- [ ] (c) Root
  - [ ] (i) Cementum - covers outer surface and attaches the tooth to the periodontal membrane

- [ ] b) Salivary glands
  - [ ] (1) Three pairs of salivary glands empty secretions into the mouth
    - [ ] (a) Parotid glands
    - [ ] (b) Submandibular glands
    - [ ] (c) Sublingual glands
  - [ ] (2) Saliva
    - [ ] (a) Mixture of mucus and serous fluids
    - [ ] (b) Helps to form a food bolus
    - [ ] (c) Contains salivary amylase to begin starch digestion
    - [ ] (d) Dissolves chemicals so they can be tasted
- [ ] c) Pancreas
  - [ ] (1) Found posterior to the parietal peritoneum
  - [ ] (2) Extends across the abdomen from spleen to duodenum
  - [ ] (3) Produces a wide spectrum of digestive enzymes that break down all categories of food
  - [ ] (4) Enzymes are secreted into the duodenum
  - [ ] (5) Alkaline fluid introduced with enzymes neutralizes acidic chyme coming from stomach
  - [ ] (6) Hormones produced by the pancreas

- [ ] (a) Insulin
- [ ] (b) Glucagon

- [ ] d) Liver
  - [ ] (1) Largest gland in the body
  - [ ] (2) Located on the right side of the body under the diaphragm
  - [ ] (3) Consists of four lobes suspended from the diaphragm and abdominal wall by the falciform ligament
  - [ ] (4) Connected to the gallbladder via the common hepatic duct
  - [ ] (5) Bile
    - [ ] (a) Produced by cells in the liver
    - [ ] (b) Composition is
      - [ ] (i) Bile salts
      - [ ] (ii) Bile pigments (mostly bilirubin from the breakdown of
      - [ ] (iii) Cholesterol
      - [ ] (iv) Phospholipids
      - [ ] (v) Electrolytes
    - [ ] (c) Function - emulsify fats by physically breaking large fat globules into smaller ones
- [ ] e) Gallbladder
  - [ ] (1) Sac found in hollow fossa of liver
  - [ ] (2) When no digestion is occurring, bile backs up the cystic duct for storage in the gallbladder
  - [ ] (3) When digestion of fatty food is occurring, bile is introduced into the duodenum from the gallbladder
  - [ ] (4) Gallstones are crystallized cholesterol which can cause blockages

- [ ] 6. Functions of the Digestive System
  - [ ] a) Ingestion - getting food into the mouth
  - [ ] b) Propulsion - moving foods from one region of the digestive system
    - [ ] (1) Peristalsis - alternating waves of contraction and relaxation that squeezes food along the GI tract

- (2) Segmentation - moving materials back and forth to aid with mixing in the small intestine
- c) Food breakdown as mechanical digestion
  - (1) Examples:
    - (a) Mixing food in the mouth by the tongue
    - (b) Churning food in the stomach
    - (c) Segmentation in the small intestine
  - (2) Mechanical digestion prepares food for further degradation by enzymes
- d) Food breakdown as chemical digestion
  - (1) Enzymes break down food molecules into their building blocks
  - (2) Each major food group uses different enzymes
    - (a) Carbohydrates are broken to simple sugars
    - (b) Proteins are broken to amino acids
    - (c) Fats are broken to fatty acids and alcohols
- e) Absorption
  - (1) End products of digestion are absorbed in the blood or lymph
  - (2) Food must enter mucosal cells and then into blood or lymph capillaries
- f) Defecation
  - (1) Elimination of indigestible substances from the GI tract in the form

7. Control of Digestive Activity

- a) Mostly controlled by reflexes via the parasympathetic division
- b) Chemical and mechanical receptors are located in organ walls that trigger reflexes
- c) Stimuli include
  - (1) Stretch of the organ
  - (2) pH of the contents
  - (3) Presence of breakdown products
- d) Reflexes include
  - (1) Activation or inhibition of glandular secretions
  - (2) Smooth muscle activity

- [ ] 8. Digestive Activities of the Mouth
  - [ ] a) Mechanical breakdown
    - [ ] (1) Food is physically broken down by chewing
  - [ ] b) Chemical digestion
    - [ ] (1) Food is mixed with saliva
    - [ ] (2) Starch is broken down into maltose by salivary amylase
- [ ] 9. Activities of the Pharynx and Esophagus
  - [ ] a) These organs have no digestive function
  - [ ] b) Serve as passageways to the stomach
- [ ] 10. Deglutition (Swallowing)
  - [ ] a) Buccal phase
    - [ ] (1) Voluntary
    - [ ] (2) Occurs in the mouth
    - [ ] (3) Food is formed into a bolus
    - [ ] (4) The bolus is forced into the pharynx by the tongue
  - [ ] b) Pharyngeal-esophageal phase
    - [ ] (1) Involuntary transport of the bolus
    - [ ] (2) All passageways except to the stomach are blocked
      - [ ] (a) Tongue blocks off the mouth
      - [ ] (b) Soft palate (uvula) blocks the nasopharynx
      - [ ] (c) Epiglottis blocks the larynx
    - [ ] (3) Peristalsis moves the bolus toward the stomach
    - [ ] (4) The cardioesophageal sphincter is opened when food presses against it
- [ ] 11. Food Breakdown in the Stomach
  - [ ] a) Gastric juice is regulated by neural and hormonal factors
  - [ ] b) Presence of food or rising pH causes the release of the hormone gastrin
  - [ ] c) Gastrin causes stomach glands to produce
    - [ ] (1) Protein-digesting enzymes
    - [ ] (2) Mucus
    - [ ] (3) Hydrochloric acid

- [ ] d) Hydrochloric acid makes the stomach contents very acidic
  - [ ] (1) Acidic pH
    - [ ] (a) Activates pepsinogen to pepsin for protein digestion
    - [ ] (b) Provides a hostile environment for microorganisms
- [ ] 12. Digestion and Absorption in the Stomach
  - [ ] a) Protein digestion enzymes
    - [ ] (1) Pepsin - an active protein-digesting enzyme
    - [ ] (2) Rennin - works on digesting milk protein in infants, not adults
  - [ ] b) Alcohol and aspirin are the only items absorbed in the stomach
- [ ] 13. Propulsion in the Stomach
  - [ ] a) Food must first be well mixed
  - [ ] b) Rippling peristalsis occurs in the lower stomach
  - [ ] c) The pylorus meters out chyme into the small intestine (30 mL at a time)
  - [ ] d) The stomach empties in 4–6 hours
- [ ] 14. Digestion in the Small Intestine
  - [ ] a) Enzymes from the brush border function to
    - [ ] (1) Break double sugars into simple sugars
    - [ ] (2) Complete some protein digestion
  - [ ] b) Pancreatic enzymes play the major digestive function
    - [ ] (1) Help complete digestion of starch (pancreatic amylase)
    - [ ] (2) Carry out about half of all protein digestion
    - [ ] (3) Digest fats using lipases from the pancreas
    - [ ] (4) Digest nucleic acids using nucleases
  - [ ] c) Alkaline content neutralizes acidic chyme
- [ ] 15. Regulation of Pancreatic Juice Secretion
  - [ ] a) Release of pancreatic juice into the duodenum is stimulated by
    - [ ] (1) Vagus nerve
    - [ ] (2) Local hormones
      - [ ] (a) Hormones travel the blood to stimulate the pancreas to release enzymeand bicarbonate-rich product

- [ ] (b) Secretin
  - [ ] (i) Secretin causes the liver to increase bile output
- [ ] (c) Cholecystokinin (CCK)
  - [ ] (i) CCK causes the gallbladder to release stored bile
    - [ ] (a) Bile is necessary for fat absorption and absorption of fat-soluble vitamins (K, D, A)

- [ ] 16. Absorption in the Small Intestine
  - [ ] a) Water is absorbed along the length of the small intestine
  - [ ] b) End products of digestion
    - [ ] (1) Most substances are absorbed by active transport through cell membranes
    - [ ] (2) Lipids are absorbed by diffusion
  - [ ] c) Substances are transported to the liver by the hepatic portal vein or lymph
- [ ] 17. Propulsion in the Small Intestine
  - [ ] a) Peristalsis is the major means of moving food
  - [ ] b) Segmental movements
    - [ ] (1) Mix chyme with digestive juices
    - [ ] (2) Aid in propelling food
- [ ] 18. Food Breakdown and Absorption in the Large Intestine
  - [ ] a) No digestive enzymes are produced
  - [ ] b) Resident bacteria digest remaining nutrients
    - [ ] (1) Produce some vitamin K and B
    - [ ] (2) Release gases
  - [ ] c) Water and vitamins K and B are absorbed
  - [ ] d) Remaining materials are eliminated via feces
  - [ ] e) Feces contains
    - [ ] (1) Undigested food residues
    - [ ] (2) Mucus
    - [ ] (3) Bacteria
    - [ ] (4) Water

- [ ] 19. Propulsion in the Large Intestine
  - [ ] a) Sluggish peristalsis
  - [ ] b) Mass movements
    - [ ] (1) Slow, powerful movements
    - [ ] (2) Occur three to four times per day
  - [ ] c) Presence of feces in the rectum causes a defecation reflex
    - [ ] (1) Internal anal sphincter is relaxed
    - [ ] (2) Defecation occurs with relaxation of the voluntary (external)
- [ ] C. Nutrition
  - [ ] 1. Nutrient - substance used by the body for growth, maintenance, and repair
  - [ ] 2. Major nutrients
    - [ ] a) Carbohydrates
    - [ ] b) Lipids
    - [ ] c) Proteins
    - [ ] d) Water
  - [ ] 3. Minor nutrients
    - [ ] a) Minerals
    - [ ] b) Vitamins
  - [ ] 4. Five Basic Food Groups and Some of Their Major Nutrients
    - [ ] a) Dietary Sources of Major Nutrients
      - [ ] (1) Carbohydrates
        - [ ] (a) Most are derived from plants
        - [ ] (b) Exceptions: lactose from milk and small amounts of glycogens from meats
      - [ ] (2) Lipids
        - [ ] (a) Saturated fats from animal products
        - [ ] (b) Unsaturated fats from nuts, seeds, and vegetable oils
        - [ ] (c) Cholesterol from egg yolk, meats, and milk products
      - [ ] (3) Proteins
        - [ ] (a) Complete proteins - contain all essential amino acids

- (i) Most are from animal products
- (b) Legumes and beans also have proteins, but are incomplete
- (4) Vitamins
  - (a) Most vitamins are used as coenzymes
  - (b) Found in all major food groups
- (5) Minerals
  - (a) Play many roles in the body
  - (b) Most mineral-rich foods are vegetables, legumes, milk, and some meats

- D. Metabolism
  - 1. Chemical reactions necessary to maintain life
    - a) Catabolism - substances are broken down to simpler substances; energy is released
    - b) Anabolism - larger molecules are built from smaller ones
  - 2. Carbohydrate Metabolism
    - a) Carbohydrates are the body's preferred source to produce cellular energy (ATP)
    - b) Glucose (blood sugar) is the major breakdown product and fuel to
  - 3. Cellular Respiration
    - a) Oxygen-using events take place within the cell to create ATP from ADP
    - b) Carbon leaves cells as carbon dioxide (CO_2)
    - c) Hydrogen atoms are combined with oxygen to form water
    - d) Energy produced by these reactions adds a phosphorus to ADP to produce ATP
    - e) ATP can be broken down to release energy for cellular use
  - 4. Metabolic Pathways Involved in Cellular Respiration
    - a) Glycolysis - energizes a glucose molecule so it can be split into two pyruvic acid molecules and yield ATP
    - b) Krebs cycle
      - (1) Produces virtually all the carbon dioxide and water resulting from cell respiration

- [ ] (2) Yields a small amount of ATP
- [ ] c) Electron transport chain
  - [ ] (1) Hydrogen atoms removed during glycolysis and the Krebs cycle are delivered to protein carriers
  - [ ] (2) Hydrogen is split into hydrogen ions and electrons in the mitochondria
  - [ ] (3) Electrons give off energy in a series of steps to enable the production of ATP
- [ ] 5. Metabolism of Carbohydrates
  - [ ] a) Hyperglycemia - excessively high levels of glucose in the blood
    - [ ] (1) Excess glucose is stored in body cells as glycogen
    - [ ] (2) If blood glucose levels are still too high, excesses are converted to fat
  - [ ] b) Hypoglycemia - low levels of glucose in the blood
    - [ ] (1) Liver breaks down stored glycogen and releases glucose into the blood
- [ ] 6. Fat Metabolism
  - [ ] a) Handled mostly by the liver
    - [ ] (1) Uses some fats to make ATP
    - [ ] (2) Synthesizes lipoproteins, thromboplastin, and cholesterol
    - [ ] (3) Releases breakdown products to the blood
  - [ ] b) Body cells remove fat and cholesterol to build membranes and steroid hormones
  - [ ] c) Fats must first be broken down to acetic acid
  - [ ] d) Within mitochondria, acetic acid is completely oxidized to produce water, carbon dioxide, and ATP
  - [ ] e) Acidosis (ketoacidosis) results from incomplete fat oxidation in which acetoacetic acid and acetone accumulate in the blood
    - [ ] (1) Breath has a fruity odor
    - [ ] (2) Common with
      - [ ] (a) “No carbohydrate” diets
      - [ ] (b) Uncontrolled diabetes mellitus
      - [ ] (c) Starvation
- [ ] 7. Protein Metabolism

- [ ] a) Proteins are conserved by body cells because they are used for most cellular structures
- [ ] b) Ingested proteins are broken down to amino acids
- [ ] c) Cells remove amino acids to build proteins
  - [ ] (1) Synthesized proteins are actively transported across cell membranes
- [ ] d) Amino acids are used to make ATP only when proteins are overabundant or there is a shortage of other sources
- [ ] e) Production of ATP from Protein
  - [ ] (1) Amine groups are removed from proteins as ammonia
  - [ ] (2) The rest of the protein molecule enters the Krebs cycle in mitochondria
  - [ ] (3) The liver converts harmful ammonia to urea which can be eliminated in urine

- [ ] 8. Role of the Liver in Metabolism
  - [ ] a) Several roles in digestion
    - [ ] (1) Manufactures bile
    - [ ] (2) Detoxifies drugs and alcohol
    - [ ] (3) Degrades hormones
    - [ ] (4) Produces cholesterol, blood proteins (albumin and clotting proteins)
    - [ ] (5) Plays a central role in metabolism
  - [ ] b) Can regenerate if part of it is damaged or removed
  - [ ] c) Metabolic Functions of the Liver
    - [ ] (1) Glycogenesis - “glycogen formation”
      - [ ] (a) Glucose molecules are converted to glycogen
      - [ ] (b) Glycogen molecules are stored in the liver
    - [ ] (2) Glycogenolysis - “glucose splitting”
      - [ ] (a) Glucose is released from the liver after conversion from glycogen
    - [ ] (3) Gluconeogenesis - “formation of new sugar”
      - [ ] (a) Glucose is produced from fats and proteins
    - [ ] (4) Fats and fatty acids are picked up by the liver
      - [ ] (a) Some are oxidized to provide energy for liver cells

- [ ] (b) The rest are broken down into simpler compounds and released into the blood
- [ ] (5) Cholesterol Metabolism
  - [ ] (a) Cholesterol is not used to make ATP
  - [ ] (b) Functions of cholesterol
    - [ ] (i) Serves as a structural basis of steroid hormones and vitamin D
    - [ ] (ii) Is a major building block of plasma membranes
  - [ ] (c) Most cholesterol is produced in the liver (85%) and is not from diet (15%)
- [ ] (6) Cholesterol Transport
  - [ ] (a) Cholesterol and fatty acids cannot freely circulate in the
  - [ ] (b) They are transported by lipoproteins (lipid-protein complexes)
  - [ ] (c) Low-density lipoproteins (LDLs) transport to body cells
  - [ ] (d) Rated “bad lipoproteins” since they can lead to artherosclerosis
  - [ ] (e) High-density lipoproteins (HDLs) transport from body cells to

- [ ] 9. Body Energy Balance
  - [ ] a) Energy intake = total energy output
    - [ ] (1) (heat + work + energy storage)
  - [ ] b) Energy intake is liberated during food oxidation
  - [ ] c) Energy output
    - [ ] (1) Heat is usually about 60%
    - [ ] (2) Storage energy is in the form of fat or glycogen
- [ ] 10. Regulation of Food Intake
  - [ ] a) Body weight is usually relatively stable
    - [ ] (1) Energy intake and output remain about equal
  - [ ] b) Mechanisms that may regulate food intake
    - [ ] (1) Levels of nutrients in the blood
    - [ ] (2) Hormones
    - [ ] (3) Body temperature
    - [ ] (4) Psychological factors

- [ ] 11. Metabolic Rate and Body Heat Production
  - [ ] a) Basic metabolic rate (BMR) - amount of heat produced by the body per unit of time at rest
  - [ ] b) Average BMR is about 60 to 72 kcal/hour
  - [ ] c) Kilocalorie (kcal) is the unit of measure for the energy value of foods and the amount of energy used by the body
- [ ] 12. Metabolic Rate and Body Heat Production
  - [ ] a) Factors that influence BMR
    - [ ] (1) Surface area - a small body usually has a higher BMR
    - [ ] (2) Gender - males tend to have higher BMRs
    - [ ] (3) Age - children and adolescents have higher BMRs
    - [ ] (4) The amount of thyroxine produced is the most important control factor
      - [ ] (a) More thyroxine means a higher metabolic rate
  - [ ] b) Factors Determining BMR
  - [ ] c) Total Metabolic Rate (TMR)
    - [ ] (1) Total amount of kilocalories the body must consume to fuel ongoing activities
    - [ ] (2) TMR increases with an increase in body activity
    - [ ] (3) TMR must equal calories consumed to maintain homeostasis and maintain a constant weight
- [ ] 13. Body Temperature Regulation
  - [ ] a) Most energy is released as foods are oxidized
  - [ ] b) Most energy escapes as heat
  - [ ] c) The body has a narrow range of homeostatic temperature
    - [ ] (1) Must remain between 35.6°C to 37.8°C (96°F to 100°F)
    - [ ] (2) The body’s thermostat is in the hypothalamus
      - [ ] (a) Initiates heat-loss or heat-promoting mechanisms
  - [ ] d) Heat-promoting mechanisms
    - [ ] (1) Vasoconstriction of blood vessels
      - [ ] (a) Blood is rerouted to deeper, more vital body organs

- (2) Shivering - contraction of muscles produces heat
- e) Heat-loss mechanisms
  - (1) Heat loss from the skin via radiation and evaporation
    - (a) Skin blood vessels and capillaries are flushed with warm blood
    - (b) Evaporation of perspiration cools the skin
- f) Fever - controlled hyperthermia
  - (1) Results from infection, cancer, allergic reactions, CNS injuries
  - (2) If the body thermostat is set too high, body proteins may be denatured and permanent brain damage may occur

14. Developmental Aspects of the Digestive System

- a) The alimentary canal is a continuous tube by the fifth week of development
- b) Digestive glands bud from the mucosa of the alimentary tube
- c) The developing fetus receives all nutrients through the placenta
- d) In newborns, feeding must be frequent, peristalsis is inefficient, and vomiting is common

E. Developmental Aspects of the Digestive System

1. Newborn reflexes
   - a) Rooting reflex helps the infant find the nipple
   - b) Sucking reflex helps the infant hold on to the nipple and swallow
2. Teething begins around age six months
3. Problems of the digestive system
   - a) Gastroenteritis - inflammation of the gastrointestinal tract
   - b) Appendicitis - inflammation of the appendix
4. Metabolism decreases with old age
5. Middle-age digestive problems
   - a) Ulcers
   - b) Gallbladder problems
6. Activity of the digestive tract in old age
   - a) Fewer digestive juices
   - b) Peristalsis slows

- [ ] c) Diverticulosis and cancer are more common