Chapter 2 – Digestion and Absorption

Chapter Outline

I. Anatomy of the Digestive Tract
   A. The Digestive Organs
      1. Mouth to the Esophagus
      2. Esophagus to the Stomach
      3. The Small Intestine
      4. The Large Intestine (Colon)
      5. The Rectum
   B. The Involuntary Muscles and the Glands
      1. Gastrointestinal Motility
      2. Peristalsis
      3. Segmentation
      4. Liquefying Process
      5. Stomach Action

II. The Process of Digestion
   A. Digestion in the Mouth
   B. Digestion in the Stomach
   C. Digestion in the Small and Large Intestines
      1. Digestive Enzymes
      2. Bicarbonate
      3. Bile
      4. The Rate of Digestion
      5. Protective Factors
      6. The Final Stage

III. The Absorptive System
   A. The Small Intestine
      1. Villi and Microvilli
      2. Specialization in the Intestinal Tract
      3. The Myth of “Food Combining”
   B. Absorption of Nutrients

IV. Transport of Nutrients
   A. The Vascular System
   B. The Lymphatic System
   C. Transport of Lipids: Lipoproteins
      1. VLDL, LDL, and HDL
      2. Health Implications of LDL and HDL

V. The System at Its Best

VI. Nutrition in Practice – Hunger and Community Nutrition
   A. Why is hunger a problem in developed countries such as the U.S. where food is abundant?
   B. How to Identify Food Insecurity in a U.S. Household
   C. What U.S. food programs are directed at relieving hunger in the U.S.?
   D. How to Plan Healthy, Thrifty Meals
   E. Why do nurses need to know about food assistance programs?
   F. Are there other programs aimed at reducing hunger in the U.S.?
   G. What about local efforts and community nutrition programs?
Multiple Choice

Circle the letter for the best response to each question.

1. The _____ is the major organ responsible for digestion and the _____ is the major site for absorption.
   a. stomach, small intestine  
   b. stomach, large intestine  
   c. small intestine, small intestine  
   d. small intestine, large intestine

2. The function of saliva it to:
   a. moisten each mouthful of food.  
   b. promote fat emulsification.  
   c. trigger the digestion of proteins.  
   d. provide important digestive enzymes for adults.

3. The process within the intestines of forcing food back a few inches, which allows for better food-digestive juice contact, is called:
   a. digestion.  
   b. segmentation.  
   c. peristalsis.  
   d. liquefying process.

4. Certain organs secrete digestive juices. Which organ in the list below does not?
   a. stomach  
   b. small intestine  
   c. pancreas  
   d. esophagus

5. Breaking food down into its nutrient components is the definition for:
   a. chemical digestion.  
   b. metabolism.  
   c. peristalsis.  
   d. absorption.

6. The major digestive activity occurring in the stomach is the:
   a. initial breakdown of proteins.  
   b. breakdown of disaccharides.  
   c. breakdown of triglycerides.  
   d. breakdown of proteins into amino acids.

7. Bicarbonate, which is a constituent of pancreatic juice, performs which function?
   a. emulsifies fat  
   b. attaches intrinsic factor to B₁₂  
   c. neutralizes the acidic chyme  
   d. cleaves protein fragments

8. If a meal is high in _____, the digestive process is fairly rapid.
   a. fiber  
   b. simple sugars  
   c. protein  
   d. fat

9. As a person increases their fiber intake, they should likewise increase their intake of:
   a. protein.  
   b. fat.  
   c. water.  
   d. water-soluble vitamins.

10. Which nutrient is absorbed through the lymphatic system?
    a. water  
    b. amino acids  
    c. simple sugars  
    d. lipids

11. Which organ is the major metabolic organ?
    a. heart  
    b. pancreas  
    c. liver  
    d. small intestine

12. An important role of HDL is to:
    a. carry fat from the liver to tissues.  
    b. carry excess cholesterol to the liver.  
    c. provide fat-soluble vitamins to tissues.  
    d. carry fat to and from the liver and tissues.
13. Which of these factors does not improve the LDL-to-HDL ratio?
   a. quitting alcohol consumption  
   b. soluble fibers  
   c. weight control  
   d. physical activity

14. Chylomicrons, which are large lipoproteins, contain predominantly:
   a. protein.  
   b. triglycerides.  
   c. cholesterol.  
   d. phospholipids.

15. What is the main reason for food poverty in the United States?
   a. lack of resources  
   b. lack of nutrition knowledge  
   c. alcohol abuse  
   d. lack of food assistance programs

16. For those receiving food stamps, coupons can be used on all but:
   a. food-bearing plants.  
   b. fruit punch.  
   c. frozen vegetables.  
   d. cleaning supplies.

17. Once nutrients have been absorbed, which organ do they travel to first?
   a. kidney  
   b. liver  
   c. heart  
   d. pancreas

18. When chyme enters the small intestine, bile is secreted by the gallbladder to:
   a. emulsify fats.  
   b. aid in the breakdown of proteins.  
   c. neutralize the chyme.  
   d. promote water absorption.

19. In the GI tract, water is absorbed from the:
   a. mouth.  
   b. stomach.  
   c. small intestine.  
   d. large intestine.

20. Which organ acts as a churn to mix fat, water and acids?
   a. mouth  
   b. stomach  
   c. small intestine  
   d. large intestine

21. In the stomach, salivary enzyme activity is:
   a. enhanced.  
   b. directed to digesting proteins.  
   c. not affected.  
   d. halted.

22. The collecting of wholesome food for distribution to low-income people who are hungry refers to:
   a. an emergency kitchen.  
   b. a food bank.  
   c. food recovery.  
   d. a food pantry.

23. Which nutrient is not digested in the small intestine?
   a. fiber  
   b. fat  
   c. protein  
   d. disaccharides

24. Which digestive organ has the thickest and strongest digestive muscles?
   a. esophagus  
   b. stomach  
   c. small intestine  
   d. large intestine

25. Which nutrient is digested in the large intestine by bacteria?
   a. fiber  
   b. fat  
   c. protein  
   d. carbohydrates

26. Stomach acid (HCl) acts on which mineral to make it more absorbable?
   a. sodium  
   b. phosphorus  
   c. iron  
   d. magnesium
27. The surface space of the small intestine is enhanced by:
   a. villi, microvilli and sphincters.  
   b. villi, microcilli, and epiglottis.  
   c. villi, pharynx and trachea.  
   d. villi, microvilli, and folds.

28. _____ branch all over the liver, delivering nutrients and oxygen from the lungs and providing access to nutrients from the GI tract to the liver cells.
   a. Arteries  
   b. Capillaries  
   c. Veins  
   d. Lymph nodes

29. The function of the sphincter muscle is to:
   a. move food along the GI tract.  
   b. mix and churn food.  
   c. prevent reflux of mixed food.  
   d. prevent food from entering the lungs.

30. The _____ produces bile.
   a. stomach  
   b. small intestine  
   c. gallbladder  
   d. liver

**Fill-in-the-Blank Exercises**

A. Try to fill in the missing words/phrases from memory to complete the chapter summary:

Food enters the 1.____________________ and travels down the 2.____________________ and through the lower esophageal 3.____________________ to the 4.____________________, then through the 5.____________________ to the 6.____________________, on through the 7.____________________ valve to the 8.____________________, past the appendix to the 9.____________________, ending at the 10.____________________. The wavelike contractions of 11.____________________ and the periodic squeezing of 12.____________________ keep things moving at a reasonable pace.

To digest food, the 13.____________________ glands, stomach, pancreas, liver (via the 14.____________________), and small intestine deliver fluids and digestive 15.____________________.

The many 16.____________________ and 17.____________________ of the small intestine dramatically increase its surface area, facilitating nutrient 18.____________________. Nutrients pass through the 19.____________________ of the villi and enter either the 20.____________________ (if they are water 21.____________________ or small fat fragments) or the 22.____________________ (if they are fat 23.____________________).

24.____________________ leaving the digestive system via the 25.____________________ are routed directly to the 26.____________________ before being transported to the body’s 27.____________________. Those leaving via the 28.____________________ eventually enter the 29.____________________ but bypass the 30.____________________ at first. Within the 31.____________________ system, lipids travel bundled with 32.____________________ as 33.____________________. Different types of lipoproteins include 34.____________________, 35.____________________ (VLDL), 36.____________________ (LDL), and 37.____________________ (HDL). Elevated blood concentrations of LDL are associated with a high risk of 38.____________________. Elevated 39.__________ are associated with a low risk of heart disease.
B. Complete the table by filling in the steps in digestion/absorption of each type of nutrient (listed across the top) that occur within each section of the GI tract (listed down the left side).

<table>
<thead>
<tr>
<th>Fiber</th>
<th>Carbohydrate</th>
<th>Fat</th>
<th>Protein</th>
<th>Vitamins</th>
<th>Minerals and Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouth</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Stomach</td>
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<tr>
<td>Small intestine</td>
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<td></td>
</tr>
<tr>
<td>Large intestine (colon)</td>
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</tbody>
</table>

Word Problems

Try to solve the following problems. See the answer key for solutions and explanations.

1. Identify the major digestive secretions produced by the pancreas, and describe the action of each.
2. Compare and contrast LDL and HDL, including fat composition, role in the body and health implications.

3. State whether each of the following foods has a slower or faster rate of digestion and why that is so.

- ½ cup oatmeal
- 3 oz fried chicken
- 1 piece angel food cake

**Matching**

**A. Write the letter for the appropriate definition beside each term.**

1. _____ bolus  a. all the organs and glands associated with the ingestion and digestion of food.
2. _____ chyme  b. the portion of food swallowed at one time.
3. _____ digestive system  c. a circular muscle surrounding, and able to close, a body opening.
4. _____ gastrointestinal motility  d. the semiliquid mass of partly digested food expelled by the stomach into the duodenum.
5. _____ glands  e. single cells or groups of cells that secrete materials for special uses in the body.
6. _____ intestinal flora  f. spontaneous motion in the digestive tract accomplished by involuntary muscular contractions.
7. _____ microvilli  g. successive waves of involuntary muscular contractions passing along the walls of the GI tract that push the contents along.
8. _____ peristalsis  h. a periodic squeezing or partitioning of the intestine by its circular muscles that both mixes and slowly pushes the contents along.
9. _____ segmentation  i. the bacterial inhabitants of the GI tract.
10. _____ sphincter  j. fingerlike projections from the folds of the small intestine.
11. _____ villi  k. tiny, hairlike projections on each cell of every villus that can trap nutrient particles and transport them into the cells.

**B. Write the letter for the appropriate description beside each term.**

1. _____ artery  a. a loosely organized system of vessels and ducts that conveys the products of digestion toward the heart.
2. _____ capillaries  b. the body fluid found in lymphatic vessels.
3. _____ lymphatic system  c. a vessel that carries blood away from the heart.
4. _____ lymph  d. small vessels that branch from an artery.
5. _____ vein  e. a vessel that carries blood back to the heart.
Discussion

Answer the following questions on a separate sheet of paper. See the answer key for correct responses or examples.

1. An elderly client of yours who lives alone has recently been identified as being undernourished. What strategies can you suggest that might help to correct the problem?

2. Describe how lipid absorption differs from the absorption of carbohydrates and proteins.

3. The digestive process begins in the mouth; describe what happens there.

4. What function do bacteria play in the GI tract?

5. How might a public health nurse identify food insecurity within a household?
Answer Key

Multiple Choice

1. c (pp. 46-48) 9.  c (p. 47) 17. b (p. 50) 25. a (p. 47)
2. a (p. 39) 10. d (p. 50) 18. a (p. 46) 26. c (p. 41)
3. b (p. 44) 11. c (p. 50) 19. d (p. 47) 27. d (p. 48)
4. d (p. 45) 12. b (p. 52) 20. b (pp. 44-45) 28. b (p. 50)
5. a (p. 45) 13. a (p. 52) 21. d (p. 46) 29. c (p. 42)
6. a (p. 46) 14. b (p. 50) 22. c (p. 58) 30. d (p. 46)
7. c (p. 46) 15. a (p. 56) 23. a (p. 47)
8. b (p. 47) 16. d (p. 57) 24. b (p. 44)

Fill-in-the-Blank Exercises

A. Fill-in summary

1. mouth 14. gallbladder 28. lymphatic system
2. esophagus 15. enzymes 29. vascular system
3. sphincter 16. folds 30. liver
4. stomach 17. villi 31. circulatory
5. pyloric sphincter 18. absorption 32. proteins
6. small intestine 19. cells 33. lipoproteins
7. ileocecal 20. blood 34. chylomicrons
8. large intestine 21. soluble 35. very-low-density
9. rectum 22. lymph lipoproteins
10. anus 23. soluble 36. low-density lipoproteins
11. peristalsis 24. Nutrients 37. high-density lipoproteins
12. segmentation 25. blood 38. heart disease
13. salivary 26. liver 39. HDL
18
B. Fill-in table

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Mouth</strong></td>
<td></td>
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</tr>
<tr>
<td>Crushes and tears fiber in food and mixes it with saliva to moisten it.</td>
<td>The salivary enzyme amylase begins digestion.</td>
<td>Glands in the base of the tongue secrete lingual lipase. Some hard fats begin to melt.</td>
<td>Chewing and crushing moisten protein-rich foods and mix them with saliva.</td>
<td>No action.</td>
<td>The salivary glands add water.</td>
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<tr>
<td><strong>Stomach</strong></td>
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<tr>
<td>Fiber is unchanged.</td>
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<td></td>
<td>Stomach acid and enzymes start to digest salivary enzymes, halting starch digestion. Stomach acid hydrolyzes maltose and sucrose.</td>
<td>Lingual lipase splits one bond of triglycerides to produce diglycerides and fatty acids. A gastric lipase accesses and hydrolyzes a very small amount of fat.</td>
<td>Stomach acid uncoils protein strands and activates stomach enzymes.</td>
<td>Intrinsic factor attaches to vitamin B12.</td>
<td>Stomach acid (HCl) acts on iron to reduce it. The stomach secretes watery fluid to create chyme.</td>
</tr>
<tr>
<td><strong>Small intestine</strong></td>
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<tr>
<td>Fiber is unchanged.</td>
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<td></td>
<td>Pancreatic enzymes are released through the pancreatic duct. Enzymes on the surfaces of the small intestinal cells break disaccharides into monosaccharides, and the cells absorb them.</td>
<td>Bile flows in from the liver and gallbladder. Pancreatic lipase flows in from the pancreas; broken down to monoglycerides, glycerol, fatty acids and absorbed.</td>
<td>Broken down to amino acids and absorbed.</td>
<td>Bile emulsifies fat-soluble vitamins and aids in their absorption with other fats. Water-soluble vitamins are absorbed.</td>
<td>Fluid is added. Many minerals are absorbed. Vitamin D aids in the absorption of calcium.</td>
</tr>
<tr>
<td><strong>Large intestine</strong></td>
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</tr>
<tr>
<td>(colon) Bacterial enzymes digest some fiber.</td>
<td>Some fat and cholesterol, trapped in fiber, exit in feces.</td>
<td>Bacteria produce vitamin K, which is absorbed.</td>
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</tbody>
</table>

Word Problems

1. Pancreatic lipase facilitates the breakdown of polysaccharides to disaccharides
   Pancreatic lipase facilitates the breakdown of emulsified fats to monoglycerides, glycerol and fatty acids
   Bicarbonate neutralizes chyme

2. LDL
   Composition: greater amount of overall fat, especially cholesterol, and less protein
   Role: carries cholesterol and triglycerides from the liver to body cells
   Health implications: elevated levels increase the risk of cardio-vascular disease
HDL

- Composition: lesser amount of overall fat, cholesterol is the predominant fat, greater amount of protein
- Role: carries cholesterol from the cells back to the liver
- Health implications: lower blood values increase the risk of cardiovascular disease, higher levels lower risk

3. ½ cup oatmeal: slower due to fiber
   3 oz fried chicken: slower due to fat
   1 piece angel food cake: faster due to simple sugars

Matching

<table>
<thead>
<tr>
<th>Set A</th>
<th>4. f</th>
<th>8. g</th>
<th>Set B</th>
<th>4. b</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. b</td>
<td>5. e</td>
<td>9. h</td>
<td>1. c</td>
<td>5. e</td>
</tr>
<tr>
<td>2. d</td>
<td>6. i</td>
<td>10. c</td>
<td>2. d</td>
<td></td>
</tr>
<tr>
<td>3. a</td>
<td>7. k</td>
<td>11. j</td>
<td>3. a</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

1. I would begin by checking the client’s food storage and preparation facilities. Determine if the client is eligible for food stamps and get them connected with local Meals-on-Wheels (the senior feeding program) or local organizations that host congregate meals for seniors. Discuss with the client the importance of proper nutrient intake and health.

2. To begin with, most lipids are dismantled and then reconstructed to aid in absorption and transportation of fats. They also travel through the lymphatic system before entering the blood flow. Carbohydrates and protein break down to minute, absorbable structures, and are absorbed directly into the blood.

3. Two types of digestion occur in the mouth, mechanical and, to a lesser extent, chemical. Mechanical digestion is the tearing apart of food by the teeth, not only making it softer and easier to swallow but also exposing more of its surface area to the chemical digestion process. Saliva, a secretion from glands in the mouth, contains salivary amylase, which begins the breakdown of starches. There is no additional chemical digestion that occurs in the mouth.

4. They produce various vitamins, including vitamin K and biotin, and protect people from infections by making it difficult for invading bacteria to establish themselves.

5. He/she would need to ask numerous questions related to whether or not family members feel hungry on a regular basis. Questions would include:
   - Do you or any other member of the family go hungry? If so, how often?
   - Do you have times when there’s not enough money to buy food for yourself or the family?