

## Chapter 2 – The Digestive System: Mechanism for Nourishing the Body

### Multiple-Choice

<u>Key</u>	<u>Page(s)</u>	
b	34	1. Within the lamina propria, lying just below the epithelium, is the mucosa-associated lymphoid tissue, which <ol style="list-style-type: none"> <li>a. controls secretions from the mucosal glands.</li> <li>b. contains white blood cells and protects against ingested microorganisms.</li> <li>c. initiates peristalsis.</li> <li>d. secretes mucus, hormones and digestive juices into the lumen.</li> </ol>
c	34, 56	2. Which structural component of the gastrointestinal tract is within the muscularis externa and controls the contractions that cause motility? <ol style="list-style-type: none"> <li>a. muscularis mucosae</li> <li>b. submucosal plexus</li> <li>c. myenteric plexus</li> <li>d. lumen</li> </ol>
d	34, 47	3. Which of the following is NOT considered an accessory organ? <ol style="list-style-type: none"> <li>a. pancreas</li> <li>b. liver</li> <li>c. gallbladder</li> <li>d. spleen</li> </ol>
c	34, 49	4. Bile is most important for the digestion and absorption of _____. <ol style="list-style-type: none"> <li>a. carbohydrates</li> <li>b. proteins</li> <li>c. fats</li> <li>d. vitamins</li> </ol>
b	35	5. What is the most probable problem if the function of the parotid glands is decreased? <ol style="list-style-type: none"> <li>a. lack of triglyceride digestion</li> <li>b. hard to form bolus</li> <li>c. saliva that is too thin – a high water to mucus ratio</li> <li>d. diarrhea due to malabsorption</li> </ol>
c	36	6. What is the name of the digestive enzyme in saliva that digests starch? <ol style="list-style-type: none"> <li>a. lipase</li> <li>b. synthetase</li> <li>c. amylase</li> <li>d. lactase</li> </ol>

- d 36 7. Which is NOT a component of saliva?  
a. mucus  
b. enzymes  
c. water  
d. proteases
- b 37 8. Which stage of swallowing moves structures of the mouth and throat to avoid the aspiration of food?  
a. oral stage  
b. pharyngeal stage  
c. esophageal stage
- d 38 9. The volume of a normal stomach ranges from 50 mL (~2 oz) when empty to \_\_\_\_\_ when full.  
a. 100 mL (~4 oz)  
b. 250 mL (~1 cup)  
c. 750 mL (~3 cups)  
d. 1.5 L (~ 6 cups)
- d 38, 39 10. What product produced by neck cells in the oxyntic gland of the stomach protects the epithelium from mechanical and chemical damage?  
a. amylase  
b. pepsin  
c. gastrin  
d. mucus
- b 38 11. What cells found both in oxyntic glands and pyloric glands of the stomach secrete hydrochloric acid and intrinsic factor?  
a. neck cells  
b. parietal cells  
c. chief cells  
d. enteroendocrine cells
- c 38 12. What cells found in oxyntic glands in the body of the stomach secrete pepsinogens?  
a. neck cells  
b. parietal cells  
c. chief cells  
d. enteroendocrine cells
- d 38 13. Which specialized cell of the gastric epithelium secretes a hormone?  
a. neck  
b. parietal  
c. chief  
d. G-cell

- c 38, 39 14. The chief cells secrete \_\_\_\_\_.  
a. gastrin  
b. mucus  
c. zymogens  
d. hydrochloric acid
- a 38, 39 15. The parietal cells secrete \_\_\_\_\_.  
a. hydrochloric acid and intrinsic factor  
b. intrinsic factor and gastrin  
c. gastrin and zymogens  
d. zymogens and hydrochloric acid
- d 39 16. A function of hydrochloric acid in the gastric juice is to  
a. digest protein, functioning as an endopeptidase.  
b. protect the stomach lining from damage.  
c. inhibit secretion of gastrin and CCK.  
d. act as a bactericide agent.
- b 39 17. When the pH of the stomach is increased to avoid GERD, over time the stomach may not be acidic enough. Which of the following might occur?  
a. lack of carbohydrate digestion  
b. decreased protein digestion  
c. destruction of bacterial in the stomach  
d. gastric ulcer
- a 40 18. Which of the following digestive fluids is the most alkaline?  
a. bile  
b. pancreatic juice  
c. saliva  
d. gastric juice
- d 40 19. The product(s) of pepsin's action is/are \_\_\_\_\_.  
a. disaccharides  
b. amylose  
c. short-chain fatty acids  
d. hydrolyzed proteins
- d 42 20. Pepcid, a drug that is classified as a H<sub>2</sub> receptor antagonist, acts by \_\_\_\_\_.  
a. inhibiting the secretion of hydrogen ions by the parietal cells  
b. inhibiting the release of acetylcholine by the vagus nerve  
c. inhibiting the binding of gastrin to the parietal cells  
d. inhibiting the binding of histamine to the parietal cells

- b 42 21. Which medication inhibits hydrogen release into the gastric juice, which reduces GI mucosal irritation?
- Pepcid
  - Nexium
  - Tums
  - Tagamet
- b 43 22. Approximately how much chyme per minute is allowed to enter the duodenum from the stomach?
- 1-5 mL
  - 6-10 mL
  - 11-15 mL
  - 16-20 mL
- c 44 23. Most of the digestive enzymes produced by the intestinal enterocytes function
- in the stomach.
  - in the intestinal lumen.
  - at the brush border.
  - within the cytoplasm of the enterocytes.
- c 45 24. Choose the phrase that best describes the function of the crypt of Lieberkühn.
- mucus secretion
  - glucose oxidation
  - cellular differentiation
  - amylase secretion
- c 47 25. The pancreas is a digestive system accessory organ with two types of active tissue, the ductless endocrine cells that secrete insulin and glucagon and the
- liver-like cells that produce bile.
  - ductless absorptive tissue that controls bicarbonate.
  - acinar exocrine cells that produce digestive enzymes.
  - erythropoietic cells that produce red blood cells.
- b 47 26. Pancreatic juice that enters the duodenum through the sphincter of Oddi contains all of the following EXCEPT \_\_\_\_.
- digestive enzymes
  - intrinsic factor
  - anions such as bicarbonate and chloride
  - cations such as sodium, potassium, and calcium
- b 47 27. The majority of the pancreatic tissue is \_\_\_\_.
- endocrine in function
  - exocrine in function

- c 48 28. In what organ are enzymes produced that are responsible for digestion of 50% of carbohydrate and protein and 90% of fat?
- liver
  - esophagus
  - pancreas
  - gallbladder
- b 48, 57 29. The hormone whose major action is to alkalize intestinal contents by stimulating secretion of bicarbonate from the pancreas and by inhibiting gastric acid secretion and gastric emptying is \_\_\_\_.
- gastrin
  - secretin
  - cholecystokinin
  - GRP
- c 48 30. Which enzyme or zymogen is secreted from the pancreas?
- pepsinogen
  - enterokinase
  - procarboxypeptidases
  - maltase
  - acyl-CoA synthetase
- c 49, 57 31. The hormone primarily responsible for contraction of the gallbladder and release of bile into the duodenum is \_\_\_\_.
- gastrin
  - secretin
  - cholecystokinin
  - GRP
- c 49 32. Bile salts are synthesized from cholesterol in the \_\_\_\_.
- canaliculi
  - common bile duct
  - hepatocytes
  - gallbladder
- a 49 33. Conjugation of bile acids with glycine and taurine improves their ability to
- ionize and form micelles.
  - undergo enterohepatic recirculation.
  - be excreted in the feces, thus keeping serum cholesterol normal.
  - promote the formation of bile salts.
- d 49 34. The total bile acid pool in the human body is 2.5 to 5 g. What percentage of bile is reabsorbed in the ileum?
- 10%
  - 30%
  - 65%
  - 90%

- d 49 35. What percentage of cholesterol in bile is used to form chylomicrons?  
a. none of it  
b. 10%  
c. 25%  
d. 50%
- b 50 36. Which of the following is enterohepatically circulated?  
a. pancreatic enzymes  
b. bile  
c. glucose  
d. CCK
- c 51 37. In general, in which portion of the gastrointestinal tract does most absorption occur?  
a. esophagus  
b. stomach  
c. small intestine  
d. colon
- b 52 38. How long does it take for most of the carbohydrate, protein, and fat to be absorbed from chyme after it enters the small intestine?  
a. 10 minutes  
b. 30 minutes  
c. 1 hour  
d. 2 hours
- c 52 39. Which of the mechanisms responsible for absorption of nutrients into the epithelial cell of the villus requires energy?  
a. diffusion  
b. facilitated diffusion  
c. active transport  
d. pinocytosis
- c 53 40. Which hormone is responsible for decreasing sodium absorption in the colon?  
a. glucocorticoids  
b. mineralcorticoids  
c. vasopressin  
d. glucagon
- d 53 41. One of the major molecules absorbed from the colon is water and one liter of chyme entering the large intestine is normally reduced to \_\_\_\_\_.  
a. 500 g  
b. 400 g  
c. 300 g  
d. 200 g

- a 54 42. Of the 3 short-chain fatty acids created by gut bacteria, which one is the preferred energy source for colonic epithelial cells?
- butyric acid
  - acetic acid
  - propionic acid
  - oleic acid
- c 54 43. Anaerobic bacteria populate the gut in \_\_\_\_\_ greater quantities than aerobic bacteria.
- 2 fold
  - 5 fold
  - 10 fold
  - 100 fold
- b 55 44. What percentage of urea produced in the body is converted to ammonia by bacteria in the colon and reabsorbed?
- 10%
  - 25%
  - 50%
  - 100%
- b 55 45. When diagnosing lactose intolerance, \_\_\_\_\_ is measured in the breath following oral consumption of 50 g lactose.
- methane
  - hydrogen
  - carbon dioxide
  - sulfur
- a 55 46. Lactose intolerance is common in all of the following EXCEPT \_\_\_\_\_.
- European Americans
  - African Americans
  - American Indians
  - Asian Americans
- c 55 47. Prebiotics act as substrates for the growth of beneficial bacteria in the colon and are \_\_\_\_\_.
- certain types of bifidobacteria
  - live cultures of mixed lactobacilli
  - selected fibers
  - antibiotics
- a 56 48. The parasympathetic nervous system affects gastrointestinal motility by
- stimulating peristalsis.
  - constricting sphincters.
  - decreasing muscle contractions.
  - inhibiting peptide production.

- d 56 49. The neuronal network system located in the submucosa (plexus of Meissner) controls:
- peristalsis and local blood flow.
  - ileal secretions and gastric motility.
  - frequency and strength of gastric muscle contractions.
  - gastrointestinal secretions and local blood flow.
- a 56-57 50. Among the regulatory peptide molecules, some are recognized as true hormones. Which of the following is a paracrine rather than a hormone?
- somatostatin
  - secretin
  - cholecystokinin
  - gastrin
- b 57 51. The major role of gastrin in the GI tract is that of \_\_\_\_.
- inhibition
  - stimulation
  - transport
  - no effect
- a 57 52. Secretin is released from the enteroendocrine S-cell in the \_\_\_\_.
- proximal small intestine
  - gastric mucosa
  - esophagus
  - colon
- d 58 53. Which regulatory peptide synthesized in the pancreatic and intestinal cells appears to inhibit release of gastrin, secretin, and motilin?
- neurotensin
  - GRP
  - insulin
  - somatostatin
- b 58 54. Which of the following peptides stimulates appetite?
- bombesin
  - ghrelin
  - leptin
  - cholecystokinin
- c 58 55. All of the following are involved in satiety and suppression of food intake EXCEPT \_\_\_\_.
- cholecystokinin
  - corticotropin-releasing hormone
  - neuropeptide Y
  - leptin

**Instructions:** Neural and hormonal events affect the activities of the GI tract. These can be classified as stimulatory or inhibitory. For questions 56-62, choose “a” if the action described is stimulatory and “b” if it is inhibitory.

- |   |    |  |
|---|----|--|
| b | 57 | 56. Secretin on HCl release  |
| a | 48 | 57. CCK on pancreatic zymogen release                                  |
| b | 58 | 58. Leptin secretion on desire to eat                                  |
| a | 57 | 59. CCK on the release of bile   |
| a | 57 | 60. GIP on the release of a hormone from the pancreatic $\beta$ -cells |
| b | 58 | 61. Eating a meal on ghrelin secretion                                 |
| b | 58 | 62. Ghrelin on satiety   |

## Matching

**Digestive Substances:** Match the substance important for digestion with its site of production.

<u>Key</u>	<u>Page(s)</u>	<u>Molecule</u>	<u>Site of production</u>
b	38	1. pepsinogen	a. hepatocytes
c	47, 48	2. trypsinogen	b. gastric chief cells
d	36	3. ptyalin	c. pancreatic exocrine tissue
e	44	4. digestive glycoproteins	d. salivary glands
a	49	5. cholic acid	e. small intestine

**Digestion:** From the following list shown in the box, choose the best answer and place the corresponding letter on the blank for each statement. You can only use an answer choice (letter) once — some you won't use at all.

a. amylose	g. bile	m. liver
b. saliva	h. amylase	n. gastrin
c. HCl	i. pancreas	o. stomach
d. $\alpha$ -1,4-bonds	j. lipase	p. amylopectin
e. cholecystokinin	k. trypsin	q. secretin
f. $\alpha$ -1,6-bonds	l. zymogen	r. pepsinogen

1. \_\_\_\_\_ is the regulatory peptide that is responsible for acid release from the 2. \_\_\_\_\_, whereas 3. \_\_\_\_\_ stimulates the gallbladder to release 4. \_\_\_\_\_.

A protease secreted in the stomach is 5. \_\_\_\_\_, which is released in its 6. \_\_\_\_\_ form that must be activated by the action of 7. \_\_\_\_\_.

The enzyme 8. \_\_\_\_\_ can be found in both 9. \_\_\_\_\_ (a little) and the 10. \_\_\_\_\_ (the majority), and is responsible for the digestion of triglycerides.

The enzyme 11. \_\_\_\_\_ is responsible for the digestion of polysaccharides.

**Key:** 1. n (pp. 41, 57), 2. o (p. 41, 57), 3. e (p. 48, 57), 4. g (p. 57), 5. r (p. 36, 40), 6. l (p. 35, 36), 7. c (p. 40), 8. j (p. 36, 40, 48), 9. b (p. 36), 10. i (p. 48), 11. h (p. 36)

**Enrichment<sup>1</sup>—Absorption and Transport of Nutrients:** You've just read an article about a newly discovered nutrient that is water soluble. What can you predict about how it is absorbed and transported in the body? If instead this new nutrient were lipid soluble, how would these processes be different? To answer this, match three terms with each type of nutrient solubility.

<u>Key</u>	<u>Page(s)</u>	<u>Term</u>	<u>Type of solubility</u>
b	52-53	1. passive diffusion	a. water-soluble
b	44	2. lymphatic system	b. lipid-soluble
a	44, 45	3. capillaries in villi	
b	49	4. chylomicron	
a	52-53	5. active/facilitated transport	
a	52-53	6. membrane transporter	

### Fill-in-the-Blank

#### Page(s)

- 49            1. In the hepatocyte, cholesterol is \_\_\_\_\_ into the two primary bile acids, \_\_\_\_\_ and \_\_\_\_\_ acids.  
*Key: oxidized, cholic, chenodeoxycholic*
- 49            2. Bile acids are conjugated with amino acids, \_\_\_\_\_ and \_\_\_\_\_, to make them more useful in forming micelles.  
*Key: glycine, taurine*
- 49            3. Owing to the alkaline pH of bile, the conjugated bile acids combine with \_\_\_\_\_, \_\_\_\_\_, or \_\_\_\_\_ to form bile salts.  
*Key: sodium, potassium, calcium*
- 53            4. The proximal colonic epithelial cells absorb water and the major cation \_\_\_\_\_. In contrast, potassium and the anion \_\_\_\_\_ are secreted into the lumen of the colon.  
*Key: sodium, bicarbonate*

Provide the appropriate information for four regulatory peptides in the following table. Information in each row must match.

<b>Name of the peptide</b>	<b>Production site(s)</b>	<b>Major action(s)</b>
5. somatostatin		
6. cholecystokinin		
7. secretin		
8. gastrin		

*Key: See Table 2.2 (p. 57)*

5. *Production site(s): pancreas and small intestine. Major action(s): inhibits gastric secretions and motility and secretions of the pancreas and gall bladder.*

<sup>1</sup> These matching items are related but go beyond the text chapter.

6. *Production site(s): small intestine. Major action(s): stimulates gall bladder contraction and pancreatic secretions.*
7. *Production site(s): small intestine. Major action(s): stimulates pancreatic juice and enzyme secretion and inhibits gastrointestinal motility.*
8. *Production site(s): stomach and small intestine. Major action(s): stimulates motility and gastric acid secretion.*

## **Short Answer** (with suggested answer key)

### **Page(s)**

- 42
1. Discuss the role of drug therapies such as Tagamet, Zantac, and Pepcid in the treatment of peptic ulcers.
 

*Key: Grading rubric – answer should include the following items:*

    - *These drugs are H<sub>2</sub> receptor blockers.*
    - *They block the ability of histamine to bind to its H<sub>2</sub> receptor.*
    - *Therefore, acid release from the parietal cell is decreased.*
    - *Less acid reduces irritation at the site of the peptic ulcer.*
- 46-47
2. Describe the effect of starvation on immunological defense/barriers in the gastrointestinal tract and the possible consequences.
 

*Key: Grading rubric – answer should include the following items*

    - *Starvation (or insufficient nutrition) can cause atrophy of the GI tract.*
    - *Atrophy of gut cells permits bacteria from the gut to enter the blood.*
    - *Gut bacteria in the blood can proliferate into overwhelming infection (sepsis).*
    - *Multiple organs can fail if sepsis is not stopped, resulting in death.*
- 49-51
3. What happens to reabsorbed bile acids after transport back to the liver?
 

*Key: Grading rubric – answer should include the following items:*

*Reabsorbed bile acids are reconstituted to amino acids and secreted into bile along with the newly synthesized bile acids.*
- 51
4. Describe the mechanisms by which resin-type drugs and functional foods containing phytosterols lower high blood cholesterol levels.
 

*Key: Grading rubric – answer should include the following items:*

    - *Resins bind bile acids in the intestinal tract and interfere with recirculation of bile.*
    - *Phytosterols and -stanols bind both bile acids and cholesterol and enhance fecal excretion, limiting recirculation to the liver.*
    - *As fewer recirculated bile acids return to the liver, hepatocytes must synthesize more new bile acids, using cholesterol to do so.*
    - *This increased use of cholesterol decreases blood cholesterol.*

*BONUS or for use on a final exam. Soluble fibers such as pectin and beta-glucans in natural foods do the same thing. (See page 120 in Chapter 4.)*

- 54-55            5. Develop a hypothesis regarding the effects of a wide-spectrum antibiotic on the beneficial effects of gut flora.

**Key:** Grading rubric – answer should include the following items:

- Broad-spectrum antibiotics kill most “friendly” gut bacteria along with the pathogenic bacteria they are taken to kill.
- Therefore, the logical hypothesis is that many of the beneficial effects of gut flora are abrogated by antibiotics.
- Some of these effects that might be diminished are vitamin K and biotin production, and generation of beneficial short-chain fatty acids for use by colon cells and absorption into the body.

- 55                6. What are probiotics and prebiotics? Give examples of each.

**Key:** Grading rubric – answer should include the following items:

- Probiotics are beneficial gut bacteria supplied by foods, usually lactobacilli and bifidobacteria from fermented milk products (yogurt, kefir) or fermented teas (kombucha) or vegetables (sauerkraut, kimchee), and fermented soy (miso, tempeh). Also, probiotics are now available as dietary supplements.
- Prebiotics are components of foods not digested by human enzymes (fibers such as fructooligosaccharides) that are preferred by lactobacilli and bifidobacteria, causing their preferential growth.

- 55-56            7. Discuss three of the five mechanisms by which probiotics may be helpful in diarrheal illnesses.

**Key:** Grading rubric – answer should include 3 of the following items:

- Enhance immune defense system by increasing IgA production, tightening the mucosal barrier, and enhancing cytokine release and phagocytic activity
- Displace or antagonize pathogenic bacteria from colonizing
- Acidify colonic pH by fermentation
- Promote excretion of toxic substances such as nitrosamines, bile acids
- Enhance fecal bulk to speed up transit time and lower colon exposure to toxins

- 56                8. If psychological stress increases the output of norepinephrine from the sympathetic nervous system and epinephrine from the adrenal gland, predict the ways in which digestion may be affected.

**Key:** Grading rubric – answer should include the following items:

*Because norepinephrine and epinephrine decrease muscle contractions of the gut, constrict sphincters, and thus decrease gastrointestinal motility, stress would inhibit peristalsis and slow digestion.*

- 58                9. Bariatric surgery involves removal or bypass of a large portion of the stomach. Speculate on how the production of ghrelin following bariatric surgery might affect appetite and explain your reasoning.

**Key:** Grading rubric – answer should include the following items:

- Ghrelin is secreted primarily from endocrine cells of the stomach and acts in the brain to stimulate appetite.
- If fewer cells are present or active after removal or bypass of the stomach, less ghrelin is likely to be produced to stimulate appetite and food intake should fall.

43-45, 59

10. Discuss the functions and significance of the folds of Kerckring, the villi, and the microvilli.

**Key:** Grading rubric – answer should include the following items:

- The folds of Kerckring, villi, and microvilli dramatically increase the surface area of the intestinal lumen exposed to products of digestion.
- Cells lining the villi also produce digestive enzymes and regulatory peptides.
- This is important because the large surface area maximizes absorption of nutrients and release of regulatory peptides produced in the gut.

## Perspective – An Overview of Selected Digestive System Disorders with Implications for Nourishing the Body

### Short Answer (with suggested answer key)

#### Page(s)

60-61

1. Discuss the role of high-fat foods, chocolates, peppermint, and smoking in gastroesophageal reflux disease.

**Key:** Grading rubric – answer should include the following items:

- GERD is marked by backward flow of acidic chime from the stomach into the esophagus.
- This causes pain and inflammation of the lower esophagus (a common term for the pain is “heartburn”).
- The primary cause of GERD is thought to be the incompetence of the lower esophageal sphincter – i.e., its failure to properly contract.
- Overeating, lifting, or lying down after eating can exacerbate GERD.
- High-fat foods, chocolates, peppermint, and smoking all decrease gastroesophageal sphincter pressure and sometimes avoiding these foods helps lessen episodes of GERD.
- Other food components such as caffeine and alcohol can stimulate acid secretions and so avoiding them can sometimes help lessen GERD. Spices and citrus foods can irritate the inflamed esophagus and also should be avoided.
- Protein can help the sphincter contract and may lessen GERD. But protein from dairy products may not be helpful because of the high calcium content, which stimulates gastrin and hydrochloric acid. Eggs, meat, or legumes are better protein choices.

- 61                    2. Why are water-miscible fat-soluble vitamins recommended for individuals with Crohn's disease?

*Key: Grading rubric – answer should include the following items:*

- *Crohn's is associated with diarrhea and fat malabsorption.*
- *Therefore, fat-soluble vitamins are also not very well absorbed.*
- *Water-miscible fat-soluble vitamins may be better absorbed.*

- 61                    3. Name 4 grains that can cause severe discomfort in people with celiac disease. What are the proteins that are problematic in each grain?

*Key: Grading rubric – answer should include the following items:*

- *Rye because of the secalin storage protein*
- *Barley, containing hordein protein*
- *Wheat, containing gliadin protein*
- *Triticale, which is a hybrid grain from wheat and rye that contains gluten-type storage proteins*

- 61                    4. What causes the diarrhea associated with pancreatitis?

*Key: Grading rubric – answer should include the following items:*

- *Diarrhea comes from poor digestion due to lack of digestive enzymes from the pancreas and malabsorption.*
- *This irritates the gut lining and results in diarrhea.*