

CHAPTER 21 READING QUESTIONS

These reading questions are designed to help you focus your reading on the most important points in the chapter. They are arranged using chapter section headers so that the file can be easily edited to reflect the material covered in class.

21.1 ANATOMY OF THE DIGESTIVE SYSTEM

1. List the glands and secretions involved in chemical digestion in the GI tract. (Fig. 21.1a, b)
2. What is chyme?
3. The GI tract is a long tube separated into segments by _____.
4. Digestion takes place mainly in the _____ of the GI tract. Digestive products absorbed across the epithelium pass into the _____ compartment.

The Digestive System Is a Tube

5. Trace a piece of food that enters the digestive system through the mouth, and follow its undigested portion until it is excreted. Include the sphincters the food passes. (Fig. 21.1)
6. List the three sections of the stomach.
7. List the three sections of the small intestine.
8. The digestive waste that leaves the body is called _____.

The GI Tract Wall Has Four Layers

9. List and briefly describe the four layers of the GI wall in the stomach and intestines, from inner to outer layers. (Fig. 21.1d–f)

Mucosa

10. List and summarize the three layers of the mucosa.
11. What anatomical modifications increase the surface area facing the lumen of the stomach and intestine? (Fig. 21.1d)

12. The tubular invaginations of the lumen that extend into supporting connective tissue are called _____ in the stomach and _____ in the small intestine.
13. List the types of epithelial cells found in the lumen of the GI tract. What is the function of each?
14. Compare cell-to-cell junctions of the stomach with those in the intestines.
15. Why are GI stem cells constantly replacing epithelial cells in the crypts and gastric glands?
16. Describe the components and functions of the lamina propria. (Fig. 21.1e)
17. What are Peyer's patches? (Fig. 21.1f)
18. Describe the muscularis mucosae.

Submucosa

19. What structures are found in the submucosa? (Fig. 21.1e, f)

Muscularis Externa

20. The outer intestinal wall consists of two smooth muscle layers. (Fig. 21.1d–f) Contraction of the _____ layer decreases lumen diameter, and contraction of the _____ layer shortens the length of the tube. The stomach has an incomplete third muscle layer, arranged _____.
21. What is the myenteric plexus and where is it found?

Serosa

22. Describe the serosa.
23. What are the peritoneum (peritoneal membrane) and mesentery?

21.2 DIGESTIVE FUNCTION AND PROCESSES

24. What is the primary function of the GI tract?

25. List and define the four basic processes of the digestive system. (Fig. 21.2)
26. List challenges the GI tract must overcome to carry out its functions. (Fig. 21.3)
27. What is the name given to the GI system's immune tissue? Why does the GI tract have the largest collection of lymphoid tissue of any organ?

We Secrete More Fluid than We Ingest

28. List the sources and volumes of fluid input into the GI tract. (Fig. 21.3)
29. How are gastrointestinal epithelial cells similar to renal tubule epithelial cells?

Digestive Enzymes

30. List the structures that secrete digestive enzymes.
31. Describe the synthesis, storage, and release of digestive enzymes.
32. Enzymes secreted in inactive form are known collectively as _____.
33. What types of pathways control enzyme release?

Mucus

34. Mucus is composed of glycoproteins called _____.
35. Name two functions of mucus.
36. Mucus is made by specialized cells: _____ cells in the salivary glands and stomach, and _____ cells in the intestine.
37. List signals for mucus release.

Digestion and Absorption Make Food Usable

38. The GI system digests macromolecules into absorbable units using a combination of _____ and _____ breakdown.
39. The optimal pH for a particular digestive enzyme function reflects _____.
40. Where does most nutrient absorption take place?

Motility: GI Smooth Muscle Contracts Spontaneously

41. What are the two purposes of GI motility?
42. What determines gastrointestinal motility?
43. Most of the intestinal tract is composed of _____-unit smooth muscle whose cells are electrically connected by _____ junctions.
44. Distinguish between tonic and phasic contractions and tell where in the GI tract each contraction type can be found.
45. Describe how a slow-wave potential generates smooth muscle contraction in the GI tract. What roles do interstitial cells of Cajal (ICCs) and gap junctions play in this process? (Fig. 21.4a)

GI Smooth Muscle Exhibits Different Patterns of Contraction

46. Describe the three general patterns of muscle contraction in the gut. What does each one accomplish? (Fig. 21.4)
47. What is a bolus?

21.3 REGULATION OF GI FUNCTION

48. Of the four GI processes, _____ and _____ are the primary regulated functions.

The Enteric Nervous System Can Act Independently

49. Briefly describe the similarities between the ENS and the CNS.
50. Contrast short reflexes with long reflexes. (Fig. 21.5)
51. Describe the roles of the following structures in short reflexes:
 - a. submucosal plexus
 - b. myenteric plexus

- 52. Define and distinguish between the terms long reflex and cephalic reflex. (Fig. 21.5)
- 53. Briefly describe how the GI tract can be influenced by feedforward reflexes and emotions.
- 54. Briefly describe how the autonomic nervous system influences long reflexes.

GI Peptides Include Hormones, Neuropeptides, and Cytokines

- 55. Which GI functions are under GI peptide control? (Tbl. 21.1)

GI Hormones

- 56. For a chemical secreted by cells in the gut to be called a hormone, it must be secreted into what compartment?

GI Hormone Families

- 57. Name the three families of GI peptides and give examples of each.
- 58. What do the following abbreviations stand for? (Tbl. 21.1)

CCK

GIP

GLP-1

21.4 INTEGRATED FUNCTION: THE CEPHALIC PHASE

- 59. Describe the cephalic phase of digestion. (Fig. 21.8)

Chemical and Mechanical Digestion Begins in the Mouth

- 60. List the functions of saliva. Identify specific enzymes involved with these functions.
- 61. What is the result of food processing (chemical and mechanical) in the oral cavity?

Saliva Is an Exocrine Secretion

- 62. Describe the composition of saliva.

63. Which division of the nervous system controls saliva secretion? What stimuli can trigger saliva secretion?
64. Diagram the mechanism for saliva production.
65. Describe the regulatory control of salivation.

Swallowing Moves Food from Mouth to Stomach

66. Diagram the deglutition reflex. (Fig. 21.7)
67. Describe the structure and function of the lower esophageal sphincter.

21.5 INTEGRATED FUNCTION: THE GASTRIC PHASE

68. How many liters of food, drink, and saliva enter the fundus of the stomach each day?
69. Name and briefly describe the three general functions of the stomach.
70. When does the gastric phase of digestion begin?
71. What is the purpose of the vagal reflex? To which phase does this reflex belong?

The Stomach Stores Food

72. Compare upper stomach action to lower stomach action upon the arrival of food.
73. What is the importance of food storage in the stomach?
74. Enhanced gastric motility during a meal is primarily under _____ control and is stimulated by _____ of the stomach.

Gastric Secretions Protect and Digest

75. Describe gastric glands. (Fig. 21.1e)

Gastrin Secretion

76. Diagram the mechanism(s) involved in gastrin secretion.
77. What is gastrin's primary action?

Acid Secretion

- 78. Diagram the mechanism(s) involved in the secretion of gastric acid. (Fig. 21.9c)
- 79. List the functions of gastric acid.

Enzyme Secretion

- 80. List and indicate the primary functions of the enzymes secreted by the stomach.
- 81. Diagram the mechanism(s) involved in the secretion of pepsin. (Fig. 21.10)

Paracrine Secretions

- 82. Describe the secretion and primary function of the following paracrines secreted by the stomach:

Histamine

Intrinsic factor

Somatostatin (SS)

The Stomach Balances Digestion and Defense

- 83. What normally protects the gastric mucosa from enzymes and acid? (Fig. 21.9b) How is this protection compromised in Zollinger-Ellison syndrome?
- 84. The most common causes of peptic ulcers are _____ and _____, not excess acid secretion.

21.6 INTEGRATED FUNCTION: THE INTESTINAL PHASE

- 85. When does the intestinal phase begin?
- 86. Describe the brush border surface of intestinal epithelial cells. What is its purpose? (Fig. 21.11, 21.1f)

87. What is the significance of the hepatic portal system in intestinal absorption? Describe its anatomy and physiology. (Fig. 21.12)

Intestinal Secretions Promote Digestion

88. In addition to digestive enzymes, list and briefly describe the role of four other intestinal secretions.

Isotonic NaCl Secretion

89. Diagram the production of the isotonic NaCl solution secreted by crypt cells in the small intestine and the colon. (Fig. 21.13)

The Pancreas Secretes Enzymes and Bicarbonate

90. The pancreas is an organ that contains both types of secretory epithelium: _____ and _____.
91. Compare and contrast the anatomy and physiology of the endocrine pancreas and the exocrine pancreas.

Enzyme Secretion

92. Where is enteropeptidase found? Describe its action. (Fig. 21.14)
93. What are the signals for enzyme release?

Bicarbonate Secretion

94. Diagram the process of pancreatic bicarbonate production that results in the secretion of a watery sodium bicarbonate solution. (Fig. 21.14)
95. What is cystic fibrosis? What are the pathological aspects of the condition?

The Liver Secretes Bile

96. What is bile? Which cells secrete it?
97. List and describe the key components of bile.

98. Describe the role(s) of the gallbladder.

Most Digestion Occurs in the Small Intestine

99. Describe protein digestion in the small intestine. What digestion has already happened before arrival in the small intestine? What digestion takes place in the small intestine?

100. Describe carbohydrate digestion in the small intestine. What digestion has already happened before arrival in the small intestine? What digestion takes place in the small intestine?

101. Describe fat digestion in the small intestine. What digestion has already happened before arrival in the small intestine? What digestion takes place in the small intestine?

Bile Salts Facilitate Fat Digestion

102. Name five common forms of fat or fat-related molecules in the Western diet.

103. Why is it necessary to emulsify fats? How is this emulsification achieved and what substances are involved? (Fig. 21.16a)

104. Describe the generalized enzymatic reaction carried out by lipases in fat digestion. Why is colipase necessary? (Fig. 21.16c)

Fat Absorption

105. Why are fats absorbed primarily by simple diffusion?

106. How is cholesterol absorbed?

107. Diagram the process of fat digestion and absorption, beginning at the small intestine and ending at the heart. (Fig. 21.16d)

Carbohydrates Are Absorbed as Monosaccharides

108. Name the enzyme involved in each of the following reactions. (Fig. 21.17)

maltose → monosaccharides

starch → maltose

sucrose → monosaccharides

lactose → monosaccharides

109. Into which monosaccharides are the following disaccharides digested? (Fig. 21.17)

maltose →

sucrose →

lactose →

Carbohydrate Absorption

110. Diagram the processes for intestinal absorption of glucose, galactose, and fructose. (Fig. 21.17b)

111. Why don't enterocytes consume the glucose they absorb?

Proteins Are Digested into Small Peptides and Amino Acids

112. Name the type of enzyme responsible for each of the following reactions, and give some examples of each. (Fig. 21.18b)

a. breaks interior peptide bonds to make smaller peptides.

Examples:

b. breaks exterior peptide bonds to make single amino acids.

Examples:

Protein Absorption

113. What are the primary products of protein digestion? How is each product absorbed? (Fig. 21.18c)

114. Between 30% and 60% of the protein found in the intestinal lumen comes from what source?

Some Larger Peptides Can Be Absorbed Intact

115. Describe the way in which some larger peptides are absorbed intact.
116. Proteins absorbed as small peptides may act as _____, which stimulate antibody formation and can result in allergic reactions.

Nucleic Acids Are Digested into Bases and Monosaccharides

117. How are nucleic acids digested and absorbed?

The Intestine Absorbs Vitamins and Minerals

118. How are fat-soluble vitamins absorbed?
119. How are water-soluble vitamins absorbed? What's the major exception?

Iron and Calcium

120. How are minerals typically absorbed?
121. Compared to other minerals, what is significant about the process by which iron and calcium are absorbed?
122. Describe iron absorption. (Fig. 21.19a) How is it regulated?
123. Describe calcium absorption. (Fig. 21.19b)

The Intestine Absorbs Ions and Water

124. Where does most water absorption take place? Where else is water absorbed?
125. Now describe how water is absorbed and how its absorption is related to specific ion transport processes. (Fig. 21.19c)

Regulation of the Intestinal Phase

126. Identify the feedback and feedforward goals of the intestinal phase reflexes.

127. Take the following stimuli and describe the reflex initiated (Fig. 21.20):

- a. presence of acidic chyme in the duodenum
- b. meal containing fats
- c. meal containing carbohydrates
- d. hyperosmotic solution in the intestine

128. How is food propelled through the small intestine? How is this process regulated?

The Large Intestine Concentrates Waste

129. List the seven regions of the large intestine as they would be encountered by chyme entering from the small intestine. Include any valves that might be encountered. (Fig. 21.21)

130. How does the wall of the large intestine differ from the wall of the small intestine? Describe the muscularis, the mucosa, and the luminal surface.

Motility in the Large Intestine

131. Chyme that enters the colon continues to be mixed by _____.

132. Describe mass movement, the unique colonic contraction. What reflex is associated with this type of contraction?

133. The anus is closed by two sphincters. Describe those sphincters.

134. Describe the defecation reflex, beginning with the stimulus for defecation.

135. Describe some of the results that emotional influences can have on defecation.

Digestion and Absorption in the Large Intestine

136. How do bacteria in the large intestine participate in digestion?

137. What is flatus?

Diarrhea Can Cause Dehydration

138. What is diarrhea?

139. What is osmotic diarrhea? How does it occur?
140. What is secretory diarrhea? How does it occur? (Fig. 21.13)
141. How can diarrhea cause dehydration? What are the appropriate therapies?

21.7 IMMUNE FUNCTIONS OF THE GI TRACT

142. What are the GI tract's first lines of defense in fighting off pathogens?
143. Pathogens or toxic materials in the small intestine trigger sensory receptors and responses from the immune cells of the _____. What are two common responses?

M Cells Sample Gut Contents

144. Describe the components of the immune system of the intestinal mucosa. (Fig. 21.1f)
145. How are antigens brought into the M cells? What do M cells do with the antigens they've ingested?
146. If the antigen is threatening, what responses does the immune system initiate?
147. What are inflammatory bowel diseases?
148. Through what mechanism have some pathogenic bacteria learned to cross the barrier created by the intestinal epithelium?

Vomiting Is a Protective Reflex

149. What is emesis? What does it accomplish?
150. What condition can be caused by excessive vomiting?
151. Describe the mechanism of the vomiting reflex.