

McCance: Pathophysiology, 6th Edition

Chapter 38: Structure and Function of the Digestive System

Key Points – Print

SUMMARY REVIEW

The Gastrointestinal Tract

1. The major functions of the gastrointestinal tract are the mechanical and chemical breakdown of food and the absorption of digested nutrients.
2. The gastrointestinal tract is a hollow tube that extends from the mouth to the anus.
3. The walls of the gastrointestinal tract have several layers: mucosa, muscularis mucosae, submucosa, tunica muscularis (circular muscle and longitudinal muscle), and serosa.
4. Except for swallowing and defecation, which are controlled voluntarily, the functions of the gastrointestinal tract are controlled by extrinsic and intrinsic autonomic nerves (enteric plexus) and intestinal hormones.
5. Digestion begins in the mouth, with chewing and salivation. The digestive component of saliva is α -amylase, which initiates carbohydrate digestion.
6. The esophagus is a muscular tube that transports food from the mouth to the stomach. The tunica muscularis in the upper part of the esophagus is striated muscle, and that in the lower part is smooth muscle.
7. Swallowing is controlled by the swallowing center in the reticular formation of the brain. The two phases of swallowing are the oropharyngeal phase (voluntary swallowing) and the esophageal phase (involuntary swallowing).
8. Food is propelled through the gastrointestinal tract by peristalsis: waves of sequential relaxations and contractions of the tunica muscularis.
9. The lower esophageal sphincter opens to admit swallowed food into the stomach and then closes to prevent regurgitation of food back into the esophagus.
10. The stomach is a baglike structure that secretes digestive juices, mixes and stores food, and propels partially digested food (chyme) into the duodenum. The smooth muscles of the stomach include the outer longitudinal, middle circular, and internal oblique.
11. The vagus nerve stimulates gastric (stomach) secretion and motility.
12. The hormones gastrin and motilin stimulate gastric emptying; the hormones secretin and cholecystokinin delay gastric emptying.
13. Gastric glands in the fundus and body of the stomach secrete intrinsic factor, which is needed for vitamin B₁₂ absorption, and hydrochloric acid, which dissolves food fibers, kills microorganisms, and activates the enzyme pepsin.
14. Chief cells in the stomach secrete pepsinogen, which is converted to pepsin in the acid environment created by hydrochloric acid.

15. Acid secretion is stimulated by the vagus nerve, gastrin, and histamine and inhibited by sympathetic stimulation and cholecystokinin. Acetylcholine stimulates pepsin secretion.
16. Mucus is secreted throughout the stomach and protects the stomach wall from acid and digestive enzymes.
17. The three phases of acid secretion by the stomach are the cephalic phase (anticipation and swallowing), the gastric phase (food in the stomach), and the intestinal phase (chyme in the intestine).
18. The small intestine is 5 m long and has three segments: the duodenum, jejunum, and ileum. Digestion and absorption of all major nutrients and most ingested water occur in the small intestine.
19. The peritoneum is a double layer of membranous tissue. The visceral layer covers the abdominal organs, and the parietal layer extends along the abdominal wall.
20. Blood flow to the small intestine is primarily provided by the superior mesenteric artery.
21. The duodenum receives chyme from the stomach through the pyloric valve. The presence of chyme stimulates the liver and gallbladder to deliver bile and the pancreas to deliver digestive enzymes and alkaline secretions. Bile and enzymes flow through an opening guarded by the sphincter of Oddi.
22. Bile is produced by the liver and is necessary for fat digestion and absorption. Bile's alkalinity helps neutralize chyme, thereby creating a pH that enables the pancreatic enzymes to digest proteins, carbohydrates, and sugars.
23. Enzymes secreted by the small intestine (maltase, sucrose, lactase), pancreatic enzymes (proteases, amylase and lipase), and bile salts act in the small intestine to digest proteins, carbohydrates, and fats.
24. Digested substances are absorbed across the intestinal wall and then transported to the liver through the portal vein, where they are metabolized further.
25. The ileocecal valve connects the small and large intestines and prevents reflux into the small intestine.
26. Villi are small finger-like projections that extend from the small intestinal mucosa and increase its absorptive surface area.
27. Sugars, amino acids, and fats are absorbed primarily by the duodenum and jejunum; bile salts and vitamin B₁₂ are absorbed by the ileum. Vitamin B₁₂ absorption requires the presence of intrinsic factor.
28. Bile salts emulsify and hydrolyze fats and incorporate them into water-soluble micelles that transport them through the unstirred layer to the brush border of the intestinal mucosa. The fat content of the micelles readily diffuses through the epithelium into lacteals (lymphatic ducts) in the villi. From there fats flow into lymphatics and into the systemic circulation, which delivers them to the liver.
29. Minerals and water-soluble vitamins are absorbed by active and passive transport throughout the small intestine.

30. Peristaltic movements created by longitudinal muscles propel the chyme along the intestinal tract, whereas contractions of the circular muscles (segmentation) mix the chyme and promote digestion.
31. The ileogastric reflex inhibits gastric motility when the ileum is distended.
32. The intestinointestinal reflex inhibits intestinal motility when one intestinal segment is overdistended.
33. The gastroileal reflex increases intestinal motility when gastric motility increases.
34. The large intestine consists of the cecum, appendix, colon (ascending, transverse, descending, and sigmoid), rectum, and anal canal.
35. The teniae coli are three bands of longitudinal muscle that extend the length of the colon.
36. Haustra are pouches of colon that are formed with alternating contraction and relaxation of the circular muscles.
37. The mucosa of the large intestine contains mucus-secreting cells and mucosal folds, but no villi.
38. The large intestine massages the fecal mass and absorbs water and electrolytes.
39. Distention of the ileum with chyme causes the gastrocolic reflex, or the mass propulsion of feces to the rectum.
40. Defecation is stimulated when the rectum is distended with feces. The conically contracted internal anal sphincter relaxes and, if the voluntarily regulated external sphincter relaxes, defecation occurs.
41. The largest numbers of intestinal bacteria are in the colon. They are anaerobes consisting of *Bacteroides*, clostridia, coliforms, and lactobacilli.
42. The intestinal tract is sterile at birth and becomes totally colonized within 3 to 4 weeks.
43. Endogenous infections of the gastrointestinal tract occur by excessive proliferation of bacteria, perforation of the intestine, or contamination from neighboring structures.

Accessory Organs of Digestion

1. The liver is the largest organ in the body. It has digestive, metabolic, hematologic, vascular, and immunologic functions.
2. The liver is divided into the right and left lobes and is supported by the falciform, round, and coronary ligaments.
3. Liver lobules consist of plates of hepatocytes, which are the functional cells of the liver.
4. The hepatic artery supplies blood to the liver. The portal vein receives blood from the inferior and superior mesenteric veins.
4. Hepatocytes synthesize 700 to 1200 ml of bile per day and secrete it into the bile canaliculi, which are small channels between the hepatocytes. The bile canaliculi drain bile into the common bile duct and then into the duodenum through an opening called the *major duodenal papilla (sphincter of Oddi)*.

5. Sinusoids are capillaries located between the plates of hepatocytes. Blood from the portal vein and hepatic artery flows through the sinusoids to a central vein in each lobule and then into the hepatic vein and inferior vena cava.
6. Kupffer cells, which are part of the mononuclear phagocyte system, line the sinusoids and destroy microorganisms in sinusoidal blood.
7. The primary bile acids are synthesized from cholesterol by the hepatocytes. The primary acids are then conjugated to form bile salts. The secondary bile acids are the product of bile salt deconjugation by bacteria in the intestinal lumen.
8. Most bile salts and acids are recycled. The absorption of bile salts and acids from the terminal ileum and their return to the liver are known as the enterohepatic circulation of bile.
9. Bilirubin is a pigment liberated by the lysis of aged red blood cells in the liver and spleen. Unconjugated bilirubin is fat soluble and can cross cell membranes. Unconjugated bilirubin is converted to water-soluble, conjugated bilirubin by hepatocytes and is secreted with bile.
10. Fats are synthesized by the liver from protein and carbohydrates and include glycerol, free fatty acids, phospholipids, and cholesterol. Fat absorbed by intestinal lacteals is primarily triglyceride, which is hydrolyzed to glycerol and free fatty acid.
11. Proteins synthesis by the liver requires all essential amino acids. The liver synthesizes albumin, globulin, and several serum enzymes and can convert amino acids to carbohydrates by removal of ammonia.
12. Carbohydrates can be released as glucose, stored as glycogen, or converted to fat.
13. The liver performs many metabolic functions including detoxification of exogenous and endogenous chemicals and hormones.
14. The gallbladder is a saclike organ located in the inferior surface of the liver. The gallbladder stores bile between meals and ejects it when chyme enters the duodenum.
15. Stimulated by cholecystokinin, the gallbladder contracts and forces bile through the cystic duct and into the common bile duct. The sphincter of Oddi relaxes, enabling bile to flow through the major duodenal papilla into the duodenum.
16. The pancreas is a gland located behind the stomach. The endocrine pancreas produces hormones (glucagon and insulin) that facilitate the formation and cellular uptake of glucose. The exocrine pancreas secretes an alkaline solution and the enzymes (trypsin, chymotrypsin, carboxypeptidase, α -amylase, lipase) that digest proteins, carbohydrates, and fats.
17. Secretin stimulates pancreatic secretion of alkaline fluid, and cholecystokinin and acetylcholine stimulate secretion of enzymes. Pancreatic secretions originate in acini and ducts of the pancreas and empty into the duodenum through the common bile duct or an accessory duct that opens directly into the duodenum.

Tests of Digestive Function

1. Numerous diagnostic tests can evaluate structure and function (digestion, secretion, absorption) of the gastrointestinal tract. Roentgenograms and scans are most commonly used

to evaluate structure, in addition to direct observation by endoscopy. Gastric and stool analysis and blood studies provide important information about digestion, absorption, and secretion.

2. Plasma chemistry levels and imaging procedures are commonly used to diagnose alterations in liver function. Of particular importance are the enzymes LDH, AST, and ALT. Plasma bilirubin levels reflect alterations in bilirubin and bile metabolism, and prothrombin times are prolonged in hepatitis and chronic liver disease.
3. Obstructive diseases of the gallbladder are evident by elevated serum bilirubin, elevated urine urobilinogen, and increased stool fat. The serum leukocytes become elevated with inflammation of the gallbladder.
4. The most significant indicators of pancreatic dysfunction are serum amylase and stool fat. Both values are increased with diseases of the pancreas.

Aging and the Gastrointestinal System

1. Advancing age is often associated with the loss or wearing down of teeth, diminished senses of taste and smell, and diminished salivary secretions, all of which may make eating difficult and reduce appetite.
2. Aging reduces gastric motility and secretions, particularly of hydrochloric acid. These changes slow gastric digestion and emptying.
3. Intestinal motility and absorption of carbohydrates, proteins, fats, and minerals decrease with age.
4. Efficiency of drug and alcohol metabolism decreases with age and can be related to decreased liver perfusion and decreased liver enzymes.