The American Physiological Society
Medical Curriculum Objectives Project
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Gastrointestinal

Functions and Regulation of GI Tract

GI 1. Describe the overall role of the gastrointestinal system with respect to the whole body balance of water, electrolytes, carbohydrates, fats, and proteins. Include the processes of digestion, absorption, metabolic production, metabolic consumption, secretion, and excretion. Identify appropriate metabolic waste products present in the feces.

GI 2. For carbohydrates, differentiate the processes of ingestion, digestion, absorption, secretion, and excretion, including the location in the GI tract where each process occurs. Repeat the analysis for proteins and fats.

GI 3. Identify the approximate normal volumes of fluid entering and leaving the gastrointestinal tract daily.

GI 4. Define the major characteristics and temporally relate the cephalic, gastric, and intestinal phases of GI tract regulation.

GI 5. Describe the four classes of luminal stimuli that trigger GI reflexes.

GI 6. Describe the histoanatomical characteristics of the enteric nervous system. Given either a cross section or a longitudinal section of the intestine, name and locate the myenteric and submucosal plexus.

GI 7. Contrast the sympathetic and parasympathetic modulation of the enteric nervous system and the effector organs of the GI tract.

GI 8. Classify the following enteric nervous system neurotransmitters as excitatory or inhibitatory: norepinephrine, acetylcholine, CCK, VIP, histamine, and somatostatin.

GI 9. Describe the terms “long reflex” and “short reflex” with respect to the GI tract.

GI 10. Describe the similarities and differences in regulating gastrointestinal function by nerves, hormones, and paracrine regulators. Include receptors, proximity, and local vs. global specificity.

GI 11. Identify the cell type and anatomical location of the endocrine cells secreting gastrin, secretin, and cholecystokinin (CCK), GIP, and motilin.

GI 12. Identifiy families to which gastrin, secretin, and CCK and other (non-GI) hormones

belong.

GI 13. Define the concept of "incretins," and state two gastrointestinal hormones believed to function in this manner.

GI 14. Describe function of somatostatin and histamine as paracrine regulators of acid secretion in the stomach.

Salivary Glands

GI 15. Contrast the plasma and saliva concentrations of Na^+, Cl^-, and HCO_3^- at low secretion rates and at high secretion rates and the principal cell types involved in each secretion rate.

GI 16. State the substrates and digestion products of salivary amylase (ptyalin).

GI 17. Identify the stimuli and cell types involved in GI secretion of mucous, and identify the function of salivary mucus.

GI 18. State three types of stimuli that increase salivary secretion.

GI 19. State the components of the saliva important in oral hygiene, and identify the role of salivary secretions in eliminating heavy metals.

Esophagus

GI 20. Identify the normal resting esophageal pressure and explain why this pressure varies with the respiratory cycle.

GI 21. Describe the origin and consequence of the high basal tone found in the upper esophageal sphincter (UES) and lower esophageal sphincter (LES).

GI 22. State the stimulus that initiates the swallowing sequence. Identify the point at which the swallowing sequence becomes automatic (independent of voluntary control).

GI 23. Contrast the patterns of external and internal innervations of the upper, middle, and lower esophagus.

GI 24. Describe the pressure changes that occur in the esophagus as a bolus of food moves from the pharynx to the stomach, including the pressures immediately oral and aboral to the bolus, and the pressures in the upper and lower esophageal sphincters.

GI 25. Contrast primary and secondary peristalsis based on initiating event, voluntary control, reflex propagation, and regions of the pharynx and esophagus involved.

GI 26. Contrast the lower espohageal tone, innervation, and motility defects that lead to heartburn with those leading to achalasia.

Stomach

GI 27. Describe the storage, digestion, and motility roles of the stomach.

GI 28. Contrast the Na^+, K^+, and Cl^- concentrations of gastric secretion with that of plasma at low and at high gastric secretion rates. Identify the cell types that mediate this change.

GI 29. Identify the protein component of chief cell secretions.

GI 30. Describe the generation of an "alkaline tide" in the hepatic portal venous system following ingestion of a meal.

GI 31. Describe the role, if any, of HCl in the gastric digestion of carbohydrates, proteins, and fats.

GI 32. Describe the pH of the stomach in the fasted state, and outline the time course and causes of the pH changes in the two hours after ingestion of a protein meal.

GI 33. State the stimuli for pepsinogen release and the mechanism for activating pepsinogen, and describe the digestion products of pepsin activity.

GI 34. Describe the role of the stomach in preventing pernicous anemia.

GI 35. Describe the regulation of H^+-K^+ ATPase, the stimuli for activation, and process of activation, including vesicular fusion with the luminal plasma membrane.

GI 36. Describe the mechanism of gastric H^+ generation and secretion, including the role of K^+, Cl-HCO_3, carbonic anhydrase, H^+-K^+ ATPase and Na^+-K^+ ATPase.

GI 37. Describe the modulation of gastric acid secretion by the enterochromafin-like cell (ECL cell) and the control of this process (including potentiation) by vagal stimulation, gastrin, histamine, and somatostatin.

GI 38. Describe the pathways, if any, for the gastric absorption of electrolytes, water, lipids, amino acids, and carbohydrates.

GI 39. State the mechanism for damage to the gastric mucosal barrier by aspirin, bile acids, and *Heliobacter pylori*.

GI 40. Identify the stimuli that a) increase gastrin release and b) inhibit gastrin release.

GI 41. State the effects of acid, fat, and solutions of high osmolarity in the duodenum on gastric secretion, and describe the mechanisms by which these effects regulate gastric secretion.

GI 42. Define receptive relaxation of the stomach and state mechanism and consequence.

GI 43. Describe origin and form of electrical activity and the progression of peristaltic waves across the body and antrum of the stomach. Include their role in mixing and propulsion of gastric contents and how the frequency is altered by the volume of gastric contents.

GI 44. Predict the effects of a) meal content (osmolarity, fat content, etc.), b) particle size, and c) volume on the rate of gastric emptying, including duodenal feedback.

GI 45. Describe the causes of peptic ulcer disease.

Pancreas

GI 46. List the major ionic and peptide/protein components secreted by the pancreas. Contrast the plasma and pancreatic concentrations of Na^+, Cl^-, and HCO_3^- at low secretion rates and at high secretion rates and the principal cell types involved in each secretion rate.

GI 47. Describe the mechanisms by which chyme from the stomach is neutralized in the duodenum.

GI 48. Describe the mechanism by which pancreatic zymogens are activated in the small intestine.

GI 49. List the stimuli that release a) secretin and b) CCK and the cellular mechanisms by which these agents control pancreatic secretion. Include any synergistic effects between CCK and secretin.

GI 50. Describes the role of CFTR in pancreatic ductular secretion, and predict the consequences of cystic fibrosis on the GI system.

GI 51. State the effects of the autonomic nerves to the pancreas and vago-vagal reflexes on pancreatic secretion.

Bile

GI 52. List the water, ionic, bile salt, and bilirubin components of bile as secreted by the liver, and explain the modification of bile as it is stored in the gall bladder. Identify the role of secretin on the hepatic production of bile.

GI 53. Describe the cellular mechanisms for the hepatic uptake, conjugation, and secretion of bile salts and bilirubin.

GI 54. Describe the role of CCK in causing release of bile from the gall bladder, including the effects on the sphincter of Oddi.

GI 55. Describe the amphipathic structure of bile acids, and predict how this property assists the digestion of fats.

GI 56. State the difference between primary and secondary bile acids.

GI 57. Contrast the physical state of an emulsion with a micellar solution, and explain the conditions for the formation of emulsifications and miceles in the duodenum.

GI 58. Define enterohepatic circulation.

GI 59. Describe the mechanism of reabsorption of bile acids in the early portion of the small intestine with the mechanism found in the later part of the small intestine.

GI 60. Predict the effects of an increase in hepatic portal vein bile acid concentration on the rate of bile secretion, bile acid synthesis, and diseases of the gallbladder.

Small Intestine

GI 61. Describe the role of the microvilli, the unstirred layer, and tight junctions in determining the rate at which glucose, amino acids, water, lipids, and electrolytes are absorbed.

GI 62. List the chemical classes of the carbohydrates entering the duodenum from the stomach, and identify mechanisms mediating further digestion and absorption across the apical and basolateral membranes of the intestinal epithelia. Include pancreatic secretions and brush-border enzymes.

GI 63. Predict the small intestine and colonic consequence of a deficiency in the enzyme lactase, and identify ethnic groups who commonly exhibit this deficiency.

GI 64. List the chemical classes of the proteins entering the duodenum from the stomach, and identify mechanisms mediating further digestion and absorption across the apical and basolateral membranes of the intestinal epithelia. Include pancreatic secretions and brush-border enzymes.

GI 65. Contrast the secondary active transport of amino acids with that of di- and tri-peptides, including the ion used as the energy source.

GI 66. List the chemical classes of the lipids entering the duodenum from the stomach, and identify mechanisms mediating further digestion and absorption across the apical and basolateral membranes of the intestinal epithelia. Include the roles of pancreatic lipase, colipase, and micelles.

GI 67. Describe the role of the endoplasmic reticulum in processing lipids absorbed across the apical membrane of enterocytes.

GI 68. Describe the composition and formation of chylomicrons, their movement across the enterocyte basolateral membrane, and the route of entry into the cardiovascular system.

GI 69. Define steatorrhea, and predict the effects of steatorrhea on the absorption of fat-soluble vitamins.

GI 70. Describe the absorption of water-soluble vitamins, including the role of intrinsic factor in the absorption of vitamin B_{12}.

GI 71. Describe the changes in osmolarity that occur in chyme as it passes from the stomach through the duodenum and colon, and identify the cause of this change.

GI 72. Describe the pathways, if any, by which sodium ions, water, iron, and calcium are absorbed in the small intestine and colon.

Large Intestine

GI 73. Diagram the cellular mechanisms of colonic sodium, potassium, and bicarbonate secretion and the regulation of this process by aldosterone.

GI 74. Define "dietary fiber" and list sources commonly found in the US diet.

GI 75. Identify substrates and products of colonic bacterial metabolism, and predict the impact of metabolites on the rate and composition of intestinal gas formation (flatus).

GI 76. Describe the production and absorption of short chain fatty acids in the colon.

Intestinal Motility

GI 77. Describe the characteristics of the basic electrical rhythm (BER) of the small intestine and its relation to smooth muscle contractile activity.

GI 78. Describe the role of "interstitial cells of Cajal" in generation of electrical slow waves, and predict the consequence of the frequency gradients of electrical slow waves occurring within the intestinal tract.

GI 79. Explain the functional significance of ongoing activity of enteric inhibitory motor neurons to intestinal circular muscle.

GI 80. Contrast the patterns of intestinal motility seen during the absorptive phase (segmentation) with that of the post-absorptive phase between meals [the migrating motility complex (MMC)].

GI 81. Contrast the effects of parasympathetic and sympathetic nervous activity in modulating small intestinal motility.

GI 82. Describe the effects of distension on small intestinal motility.

GI 83. State effects of increased pressure in the ileum and cecum on the ileocecal sphincter, including defining the term “gastroileal reflex.”

GI 84. Compare colonic motor activity with the motor activity in the small intestine.

GI 85. Contrast the colonic motor activity during a “mass movement” with that during haustral shuttling and the consequence of each type of colonic motility.

GI 86. Describe the sequence of events occurring during reflexive defecation, differentiating those movements under voluntary control and those under intrinsic control.