

PART 1:OVERVIEW

- 1) Overview
 - a) Two groups of organs
 - i) Organs of the alimentary canal (GI tract or gut)
 - (1) General functions
 - (2) Organs: mouth, pharynx, esophagus, stomach, small intestine, and large intestine
 - (3) Mouth to anus (open at both ends)
 - ii) Accessory digestive organs
 - (1) General functions
 - (2) Include: teeth, tongue, gallbladder, and some glands of digestive glands (salivary glands, liver, and pancreas)
 - (3) What's considered inside and what's outside of the GIT
- 2) Digestive process is really six processes
 - a) Ingestion
 - b) Propulsion (swallowing, peristalsis)
 - c) Mechanical digestion (mouth, stomach, small intestine (segmentation))
 - d) Chemical digestion (catabolic steps occurring in the mouth and continuing through the small intestine)
 - e) Absorption
 - f) Defecation
- 3) Basic functional concepts
 - a) Digestive activity is provoked by a range of mechanical and chemical stimuli (mechanoreceptors, chemoreceptors; gland activation/inhibition, mixing/movement of lumen contents)
 - b) Controls of digestive activity are both extrinsic and intrinsic
- 4) Digestive system organs: relationships and structure
 - a) Key terms: abdominopelvic cavity, peritoneum (visceral and parietal — sound familiar?), peritoneal cavity, mesentery, retroperitoneal vs peritoneal organs
 - b) Blood supply: splanchnic = relating to viscera; splanchnic circulation: includes branches off of aorta and hepatic portal system
 - c) Four basic layers of the alimentary canal: mucosa, submucosa, muscularis externa, serosa (compare with adventicia)

PART 2: FUNCTIONAL ANATOMY OF THE DIGESTIVE SYSTEM

1) Mouth and associated organs

- a) Mouth (oral cavity): continuous with oropharynx; orbicularis oris; buccinators; palate (hard and soft); tongue (mixes food with saliva and forms bolus); salivary glands (parotid, submandibular, and sublingual); saliva (salivary amylase, lysozyme, IgA); teeth (primary vs permanent dentitions; deciduous (20) vs permanent teeth (32))
- b) Pharynx: oropharynx; laryngopharynx
- c) Esophagus: muscular tube, continuous with laryngopharynx, through mediastinum; pierces the diaphragm (esophageal hiatus); gastroesophageal (or cardiac) sphincter; GERD, hiatal hernia
- d) Digestion processes in the mouth, pharynx, and esophagus:
 - i) Mouth: ingestion; begins mechanical digestion (mastication: recall muscles of); initiates propulsion (deglutition=swallowing); begins chemical digestion (salivary amylase); essentially no absorption
 - ii) Pharynx and esophagus are only conduits so their role is only propulsion
- e) Pathology worth mentioning: GERD, hiatal hernia

2) Stomach

- a) Located in upper left quadrant (left hypochondriac, epigastric, and umbilical regions — depending on which system you're using)
- b) Food is converted to chyme
- c) Anatomical terms: regions: cardiac, fundus, body, and pyloric; gastroesophageal and pyloric sphincters; greater and lesser curvatures
- d) Greater and lesser omenta (singular=omentum) are mesenteries that are filled with fat deposits and look like an apron of fat, filled with collections of lymph nodes and serve an immunologic purpose in the peritoneal cavity and the organs within it.
- e) Four kinds of cells in gastric glands and what they produce:
 - i) Mucous neck cells: thin, acidic mucus
 - ii) Parietal cells: hydrochloric acid (HCl) and intrinsic factor; functions of acid and intrinsic factor (required for B₁₂ absorption in the small intestine; deficiency leads to pernicious anemia); HCl acid creates a very acidic environment (pH 1.5–3)
 - iii) Chief cells: pepsinogen (becomes pepsin), activated by acid environment (HCl), digests proteins

- iv) Enteroendocrine cells: produce local chemical messengers (paracrines): histamine, serotonin, somatostatin, and hormones: somatostatin and gastrin
 - f) Stomach is protected from extremely acidic, hostile environment.
 - i) Stomach is protected by a bicarbonate-rich mucosal barrier secreted by goblet cells
 - ii) Tight junctions between epithelial cells prevent leaking of the acid, preventing damage to underlying tissues
 - iii) There is rapid turnover of cells that line the surface (every 3–6 days)
 - g) Digestion in the stomach: continues mechanical digestion with churning (peristaltic waves); propels chyme into small intestine; chemical digestion through enzymes and acidic pH (protein digestion only); limited absorption (stomach does absorb alcohol and aspirin)
 - h) Emetic center in the medulla regulates/coordinates emesis: diaphragm and abdominal muscles contract, increasing intra-abdominal pressure; relaxation of cardiac sphincter; elevation of soft palate to protect nasal passages; contents are propelled through esophagus, pharynx, and exit via oral cavity
- 3) Small intestine: the major digestive organ; digestion is completed here; virtually all absorption occurs here
- a) Begins at pyloric sphincter; ends at ileocecal valve (juncture to large intestine)
 - b) Duodenum: curves around the head of the pancreas, is mostly retroperitoneal and thus relatively immobile; shortest segment of small intestine (25 cm = 10 inches long); receives bile from the gall bladder and pancreatic juice from the pancreas; produces an alkaline-rich mucus to help neutralize the acidic chyme from the stomach
 - c) Jejunum: 2.5 m (8 ft) extension from the duodenum to the ileum
 - d) Ileum: 3.6 m (12 ft) extension from the jejunum to the ileocecal valve
 - e) Surface area for absorption is vastly increased by several mechanisms including villi and microvilli
 - f) Smooth muscle contractions mix chyme with bile and intestinal juices (see below) and moves it towards the large intestine; in addition to simple peristalsis, segmentation also occurs in the small intestine (compare peristalsis vs segmentation)

4) Liver and gallbladder

- a) Liver produces bile, a fat emulsifier; and the gallbladder stores (and concentrates) it; gallbladder has a muscular wall that facilitates excretion of bile into the duodenum (where it is mixed with pancreatic juice)
- b) Located under the diaphragm and within the ribcage in the right upper quadrant (right hypochondriac + epigastric regions)
- c) Consists of 4 lobes
- d) Main function is to filter and process the nutrient-rich blood from the intestines (review the hepatic portal system from CV chapter, p.764)
 - i) Processes bloodborne nutrients (eg, store glucose as glycogen, use amino acids to assemble proteins)
 - ii) Stores fat-soluble vitamins
 - iii) Plays an important role in detoxification
- e) Bile: alkaline solution containing bile salts to emulsify fats (bile salts are recycled); chief bile pigment is bilirubin (waste product of heme group from Hb as RBCs are broken down)
- f) Pathology worth mentioning: hepatitis (HVA-F), cirrhosis, portal hypertension, gallstones, and jaundice

5) Pancreas

- a) Mostly retroperitoneal, deep to the stomach; has two regions: head and tail
- b) Exocrine (vs. endocrine) function: produces digestive enzymes and secretes them in a pancreatic juice into the duodenum (mixes with bile from the gall bladder)
- c) Pancreatic juice is alkaline (pH about 8) and consists of: water, enzymes, electrolytes (mostly bicarbonate); it's mainly the pancreatic juice that neutralizes the acid from stomach

6) Large intestine: from ileocecal valve to anus (1.5 m) with the major function of absorbing the remaining water from indigestible food and store the residue until it is eliminated as feces

- a) Anatomical terms: abdominal cavity: ileocecal valve, vermiform appendix, cecum, ascending colon, right colic (hepatic) flexure, transverse colon, left colic (splenic) flexure, descending colon, sigmoid colon; pelvic cavity: rectum; external to abdominopelvic cavity: anal canal (last segment of the large intestine) and the anus (internal anal sphincter and external anal sphincter); internal anal sphincter is composed of smooth muscle (involuntary control); external anal sphincter is composed of skeletal muscle (voluntary control)

- b) Bacterial flora: metabolize proteins and ferment some of the indigestible carbohydrates, producing the gases released as flatus; also synthesize B complex vitamins and most of the vitamin K the liver requires to synthesize some of the blood clotting proteins; viruses and protozoans are also present
 - c) Digestion: aside from the minor breakdown completed by the bacterial flora, no further food breakdown occurs in the large intestine; aside from water absorption and collecting vitamins from the bacterial flora, very little absorption occurs here; emphasis on the propulsive movements that move the feces towards the anus, storage, and finally defecation
 - d) Pathology worth mentioning: diverticulosis vs diverticulitis, diarrhea, constipation (massage application)
- 7) Defecation reflex: parasympathetic reflex (triggers and reflex loop), internal and external anal sphincters, aiding the process with Valsalva's maneuver.

PART 3: PHYSIOLOGY OF CHEMICAL DIGESTION

- 1) Overview
 - a) Chemical digestion is catabolic (review what that means)
 - b) Terms to review: monomer, enzyme, hydrolysis
- 2) Carbohydrates
 - a) Review: monosaccharide (glucose, fructose, and galactose), disaccharides (sucrose, lactose, and maltose), polysaccharides (glycogen, starch), cellulose
 - b) Review: salivary amylase, pancreatic amylase, maltase, sucrase, and lactase
 - c) Digestion begins in the mouth and continues through small intestine
 - d) Pathology worth mentioning: "lactose intolerance"
- 3) Proteins
 - a) Come from diet, but also from enzymes that we produce and from shed mucosal cells
 - b) Review: protein, polypeptide, peptide, amino acid
 - c) Begins in the stomach (by pepsin); role of acidic pH; trypsin from the pancreas

4) Lipids

- a) Small intestine is the sole site of digestion bc/ lipase is released by the pancreas (review lipase)
- b) Emulsification by bile salts; how is this different from digestion?
- c) Review: triglycerides, fatty acids, glycerol

5) Nucleic acids

- a) Are present in the nuclei of the cells that makeup ingested food and are digested by nucleases in the pancreatic juice

6) Absorption

- a) Most absorption is via the small intestine and completed by the time chyme reaches the ileum.
- b) Most nutrients are absorbed via active transport mechanisms that require ATP; they then enter the vilus and are carried to the liver via the hepatic portal system