

Topic 34: DIGESTION I

I Overview

- A Purpose: to transfer nutrients, water, and electrolytes from the food we eat into the body's internal environment
- B Four basic digestive processes
 - 1 **motility**
 - 2 **secretion**
 - 3 **digestion**
 - 4 **absorption**
- C Digestive system
 - 1 consists of digestive tract (esophagus, stomach, intestines) and accessory digestive organs (salivary glands, exocrine pancreas, biliary system)
 - 2 digestive tract is continuous from mouth to anus so the lumen is continuous with the external environment
- D Regulation of digestive function
 - 1 receptor activation: the wall of the digestive tract contains three different types of sensory receptors that respond to local chemical or mechanical changes
 - a **chemoreceptors** sensitive to chemical components within the lumen
 - b **mechanoreceptors** sensitive to stretch or tension within the wall
 - c **osmoreceptors** sensitive to the osmolarity of the luminal contents
 - 2 messages are sent by three mechanisms
 - a intrinsic nerves (local nerve reflexes -- enteric nervous system)
 - b extrinsic nerves (parasympathetic and sympathetic)
 - c gastrointestinal hormones
 - 3 responses are mediated by
 - a smooth muscle (is rhythmically active, but rate of activity can be changed)
 - b exocrine glands (release substances into the gut lumen)

- II Mouth (motility, secretion, some digestion)
 - A Motility = mastication: teeth are responsible for the first step of the digestive process, chewing, which breaks up food, mixes it with saliva, and stimulates digestive secretions
 - B Secretion = saliva
 - 1 permits taste buds to work
 - 2 facilitates chewing and swallowing
 - 3 contains salivary amylase (starch → maltose)
 - 4 contains lysozyme (kills bacteria)
 - C Digestion = some digestion of starch to maltose

- III Pharynx and Esophagus (motility only: swallowing)
 - A bolus, or ball of food, voluntarily pushed to the pharynx at the rear of the mouth
 - B pressure of bolus on pharyngeal pressure receptors sends afferent impulses to the swallowing center in the medulla
 - C all-or-none reflex activates muscles for swallowing

- IV Stomach (motility, secretion, digestion, and just a bit of absorption)
 - A Stomach motility
 - 1 four aspects of gastric motility
 - a gastric filling (stomach can expand from 50 ml to 1L!)
 - b gastric storage
 - i food from esophagus is stored in the “top” of the stomach without being mixed
 - c gastric mixing
 - i waves of contractions propels chyme toward the pyloric sphincter but only a few ml pass through at any one time
 - ii contractions close the sphincter blocking further passage of chyme so chyme is tossed back
 - iii retropulsion, tossing back and forth, causes thorough

- C Control of gastric secretion: three phases
 - 1 cephalic phase: increased secretion of HCl and pepsinogen in response to stimuli acting in the head even before food reaches the stomach (mediated by CNS)
 - 2 gastric phase: when food reaches the stomach, stimuli within the stomach increases gastric secretion (mediated by gastrin)
 - 3 intestinal phase: helps to shut off flow of gastric juices as chyme begins to be emptied into the duodenum (mediated by secretin, CCK, GIP, and local nervous control)
- D Digestion
 - 1 carbohydrate digestion continues in the stomach (from salivary enzymes) and protein digestion begins
- E Absorption
 - 1 stomach absorbs alcohol and aspirin but no food, and no H₂O (but water empties rapidly into sm. intestine where it is absorbed)

V Small Intestine (motility, digestion, and absorption; secretions come from pancreas and liver)

- A Motility
 - 1 Segmentation
 - a contractile rings form every few cm; relaxed area between contractions hold bolus of chyme
 - b after a brief period, rings relax, and new contractile rings form in previously relaxed areas
 - c new contraction forces chyme both backwards and forwards into new relaxed areas.
 - d in this way, chyme is mixed, chopped, and propelled
 - 2 Control of segmentation
 - a self-induced electrical activity
 - b slow-wave potentials: rhythmic, wavelike fluctuations in membrane potential in pacesetter cells
 - c rate of rhythmic, digestive contractile activities depends on the inherent rate established by the involved pacesetter cells
 - d level of contractility varies with cytosolic Ca²⁺
 - e influenced by
 - i distention of intestine enhances (after you eat)
 - ii extrinsic nerve activity
 - *parasympathetic enhances
 - *sympathetic inhibits

- 3 Migrating motility complex
 - a cleans SI by “sweeping it clean” between meals
 - b peristaltic waves that move down SI & push any remaining contents toward the Large Intestine

Topic 35: DIGESTION II

I Small Intestine, continued

B Secretions: NONE of significance from the small intestine itself, but LOTS from pancreas and liver/gall bladder

C Pancreatic secretions

- 1 elongated gland that contains both exocrine and endocrine tissue
 - a exocrine: clusters of secretory cells that form sacs known as acini
 - b endocrine: isolated islands dispersed in pancreas that make insulin and glucagon

- 2 exocrine pancreas secretes digestive enzymes and an aqueous alkaline fluid
 - a pancreatic proteolytic enzymes
 - i trypsinogen, chymotrypsinogen, and procarboxypeptidase
 - ii secreted in inactive form; trypsinogen is converted to active form, trypsin, by an enzyme in the small intestine, enterokinase
 - iii trypsin can activate more trypsinogen and the other two
 - iv all of these digest protein to amino acids and small peptide chains
 - b pancreatic amylase
 - i polysaccharides (glycogen and starch) to disaccharides (maltose)
 - c pancreatic lipase
 - i important for digestion of fat to absorbable units, from triglycerides to monoglycerides and free fatty acids
 - d pancreatic aqueous alkaline secretion
 - i important to neutralize the acidic chyme as it is emptied from the stomach into the duodenum (rich in Na_2CO_3)

- 3 exocrine secretion is hormonally regulated
 - a acid in the duodenum causes release of secretin which stimulates secretion of alkaline fluid
 - b fat causes CCK release which stimulates release of digestive enzymes

C Liver: miscellaneous and secretory contributions to small intestine

- 1 many important functions
 - a metabolic processing of nutrients from digestive system
 - b storage of glycogen, fats, iron
 - c synthesis of plasma proteins
 - d detoxification
 - e excretion of cholesterol and bile pigments (bilirubin and biliverdin, from breakdown of hemoglobin)
 - f secretion of bile salts
- 2 anatomy
 - a each hepatocyte (liver cell) performs all of the above functions
 - b hepatic portal system: veins from stomach and intestine enter hepatic portal vein, which carries absorbed products.
- 3 bile
 - a stored in gallbladder
 - b bile salts aid fat digestion and absorption
 - i detergent action of bile salts: convert large fat globules into a lipid emulsion of many small fat droplets to increase surface area for digestion

D Digestion in SI lumen

- 1 Accomplished by pancreatic enzymes.
 - a fats broken into monoglycerides and free fatty acids and is completed
 - b proteins broken into small peptides and amino acids
 - c carbohydrates broken into disaccharides
- 2 Brush-border enzymes finish the job
 - a these are enzymes found on the surface of cells of the small intestine (enterokinase was also a brush-border enzyme)
 - b aminopeptidase – final digestion of small peptides into amino acids
 - c maltase – final digestion of maltose into 2 glucoses
 - d sucrase - digestion of sucrose (cane sugar) into fructose and glucose
 - e lactase - digestion of lactose (milk sugar) into glucose and galactose

- E Absorption
 - 1 Major function of SI is absorption of contents from lumen into SI cells.
 - 2 Absorption facilitated by
 - a large surface area of SI
 - i folds and projections called villi and microvilli increase surface area
 - b special transport mechanisms
 - i Na^+ is actively transported
 - ii many other substances (amino acids, glucose, etc.) are co-transported with the Na^+ using secondary active transport
 - c Fat absorption is different
 - a bile salts and digested fat (monoglycerides, free fatty acids) form micelles
 - b when micelles reach epithelial cell, the fat part of the micelle diffuses through membranes

II Large Intestine (motility and absorption only)

- A Motility
 - 1 Movements of LI are slow and non-propulsive
 - 2 Primary method of motility is called haustral contractions
- B Absorption
 - 1 Primarily a drying and storage organ
 - 2 Water and salt extracted from contents
 - 3 Intestinal flora synthesize Vitamin K (of use in blood clotting)
 - 4 Remainder (feces) eliminated by defecation
 - 5 Feces consist of undigested (by the rest of the gut) material,
- C Gas
 - 1 Some materials are poorly digested by remainder of digestive tract
 - a lactose (see above)
 - b some complex carbohydrates and other things

2 Gut bacteria gobble them up and make gases as byproducts

3 But why does it smell?

D Defecation Reflex

1 distention of rectum by fecal material causes internal anal sphincter to relax, which causes increased rectal contractions

2 if external sphincter (which is skeletal muscle and so under voluntary control) is relaxed, defecation occurs

3 if external sphincter is not relaxed, defecation is delayed