

Nutrition Physiology-1

Digestion and Absorption of Food

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Digestive System

- Gastrointestinal (GI) tract (alimentary canal)
 - Mouth
 - Pharynx
 - Esophagus
 - Stomach
 - Small intestine
 - Large intestine
- Accessory organs
 - Salivary glands
 - Liver
 - Gallbladder
 - Exocrine pancreas

Digestive System

- Primary Function
 - Movement of nutrient molecules from the external environment to the internal environment

Digestive System

- Secondary Functions
 - Protection
 - GI tract provides a huge external surface for pathogens to gain entrance into the internal environment
 - Mass balance
 - Ensuring daily fluid input and output are equal

Digestive System

- 500-800g food/day
- 1200 mL water/day
- 7000 mL secreted fluid/day
- 99% absorption
- Liquid in feces = loss of water (4% of total loss from body)

Digestive System

- **Digestion:** dissolving and breaking down of macromolecules
 - **Secretion** of enzymes and chemicals into GI tract

Digestive System

- **Absorption:** movement of small molecules and water from the lumen across epithelial cells to the interstitial fluid
 - Fat soluble nutrients → lymphatic vessels
 - Other than fats → Capillaries
→ hepatic portal vein

Digestive System

- **Motility:** contractions of smooth muscles in the GI tract wall
 - Mixing luminal content with secretions
 - Movement of content from mouth to anus

Mouth

- Chopping and mixing of food with salivary secretions
 - **Bolus**: chewed food mixed with saliva
- Little digestion or absorption
- Stimulation of sensory and mechanoreceptors triggers cephalic phase

Mouth

- Salivary glands
 - Parotid
 - Sublingual
 - Submandibular
- Saliva
 - Mucus, water, HCO_3^- , several enzymes
 - Moistens and lubricates food particles for swallowing
 - Buffers the acidity of ingested food
 - Removes the metabolites from bacteria living around the teeth
 - Lysozyme antibacterial enzyme

Mouth

- Saliva
 - Amylase → polysaccharides
 - Lipase → triglycerides

 - Minor role in digestion (limited time before they are inactivated in acidic pH of the stomach)

 - Both sympathetic and parasympathetic (greater) system activates secretion

Pharynx and Esophagus

- Pharynx and esophagus
 - Swallowing reflex
 - Peristalsis

GI Tract Wall

- Highly convoluted apical surface
 - Increases surface area for absorption
- Single layer of epithelial cells
 - Tight junctions
 - Continuously replaced
- Invaginations of the epithelium form exocrine glands
 - Acid, HCO₃ enzymes, water, ions, mucus
- Enteroendocrine cells
 - At the base of villi
 - Secrete hormones to control GI functions

GI Tract Wall

- Lamina propria: Loose connective tissue
 - Small blood vessels, neurons, lymphatic vessels
- Muscularis mucosa: layer of smooth muscle

GI Tract Wall

- Submucosa
 - Connective-tissue layer
 - Blood and lymphatic vessels
 - Submucosal plexus: network of neurons
 - Project to epithelial cells of apical surface

GI Tract Wall

- Muscularis externa:
smooth muscle
 - Circular muscles : narrows the lumen
 - Longitudinal muscles: shortens the tube
- Myenteric plexus
 - Connects with submucosal plexus
 - Innervated by sympathetic and parasympathetic neurons

GI Tract Wall

- Serosa
 - Thin layer of connective tissue
 - Outer surface of the tube
 - Connects to the abdominal wall

Stomach

- **Chyme:** mixture of ingested food and gastric secretions
 - Proteins, polysaccharides, droplets of fat, ions, water...
- Dissolve, partially digest the macromolecules
- Regulates emptying rate
- Highly acidic environment

Stomach

- Fundus
- Body
- Antrum
- Pyloric sphincter

Stomach

- Mucous cells
 - Secrete mucus
- Chief cells
 - Secrete pepsinogen
- Parietal cells
 - Secrete acid and intrinsic factor
 - Intrinsic factor: protein that binds and allows absorption of vitamin B12

Stomach

- Canaliculi: Invaginations of the apical membrane of parietal cells
 - Increase the surface and maximize secretion
- G cells
 - In the antrum
 - Enteroendocrine cells
 - Secrete gastrin
- ECL cells
 - Enterochromaffin-like cells
 - Secrete histamine
- D cells
 - Secrete somatostatin

Stomach

- Acidic environment
 - Denaturates proteins
 - More sites for digestive enzymes
 - Kills most of the bacteria
- 2 L/day HCl secretion
- Gastrin, acetylcholine and histamine increase acid secretion
- Somatostatin decrease acid secretion
- Increase in Parasympathetic activity; increase in release of acetylcholine, gastrin and histamine
- Stimuli in the early portion of duodenum decrease acid secretion (acid inhibits digestive activity in small intestine)

Stomach

Food reach the stomach

1. Gastric phase stimuli
 - Distension from the volume of the ingested material
 - Presence of peptides and amino acids
2. Enteric nervous system activation
3. Release of gastrin, histamine, acid

Stomach

Control of acid concentration

- Increase in H^+ ;
 - Inhibition of gastrin secretion
 - Release of somatostatin
 - Inhibits acid secretion

Stomach

- Pepsinogen released from chief cells, in acidic environment, pepsin formation
- Pepsinogen secretion parallels acid secretion
- Zymogens: inactive enzymes ?
 - Protects the cell from proteolytic damage

Stomach

- Pepsinogen released from chief cells,
 - +HCl → pepsin
- Pepsin accelerates protein digestion
- Digestion of collagen
 - Greater surface area for digestion of meat