

# Nutrition Physiology-3

## Digestion and Absorption of Food

Simge Aykan, PhD

Department of Physiology

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# Absorption Pathways

- Fats and fat soluble nutrients first enter the lymphatic system
- Venous drainage passes first, via the hepatic portal vein, to the liver
- In the liver, blood flows through a second capillary network (portal circulation), and processed before entering the general circulation
- Water soluble nutrients move directly from the interstitial fluid compartment into intestinal capillaries

# Large Intestine

- Concentration
- Absorbtion (ions, water)
- Temporary storage
- Bacteria
  
- Feces: undigested material that is expelled from the body

# Large Intestine

- 1500 ml chyme/day
- Active transport of  $\text{Na}^+$  from lumen to extracellular fluid, accompanying osmotic absorption of water
- Net movement of  $\text{K}^+$  from blood into the large intestine lumen

# Regulation of GI Processes

- Gastrointestinal reflexes are initiated by:
  - Distention of the wall by the volume of the luminal content
  - Chyme osmolarity (total solute concentration)
  - Chyme acidity
  - Chyme concentrations of specific digestion products like monosaccharides, fatty acids, peptides and amino acids

# Regulation of GI Processes

- **Enteric Nervous System**

- Local neural network
- Submucosal + myenteric plexus
- Synapse with;
  - Other neurons
  - Smooth muscles
  - Glands
  - Epithelial cells
  
- Myenteric plexus → smooth muscle activity, motility
- Submucosal plexus → gland function and secretory activity

# Regulation of GI Processes

- Neural reflexes can occur entirely within the tract independent of Central Nervous System (CNS) – *short reflexes*
- CNS effect by autonomic nervous system
  - Sympathetic and parasympathetic branches enter the intestinal tract and synapse with neurons in both plexuses – *long reflexes*

# Regulation of GI Processes

- Enteroendocrine cells
  - Release hormones
  - Stomach and small intestine
  - One surface is exposed to the lumen (stimulation side)
  - Opposite side secrete hormones to the blood



# Regulation of GI Processes

- GI Hormones
  - Feedback control system that regulates GI luminal environment
  - Affect more than one type of target cell

# Regulation of GI Processes

- Cholecystikinin (CCK)
  - Fatty acids in the small intestine
  - CCK secretion from small intestine
  - CCK stimulates pancreas
  - Increase the secretion of digestive enzymes
  - Gallbladder contraction
  - Relaxation of sphincter
  - Secretion flow into small intestine

# Phases of GI control

- Cephalic, gastric, intestinal
- Cephalic:
  - “Head”
  - Sensory receptors in the head are stimulated by sight, smell, taste and chewing (also various emotional states)
  - Efferent pathways mediated by parasympathetic neurons in vagus nerve
  - Vagus → GI nerve plexus → secretory and contractile activity

# Phases of GI control

- Gastric
  - Stimuli in stomach
    - Distention, acidity, amino acids and peptides
  - Both short and long neural reflexes
  - Release of gastrin

# Phases of GI control

- Intestinal
- Stimuli in small intestine
  - Distension, acidity, osmolarity, various digestive products
  - Both short and long neural reflexes
  - Release of secretin, CCK, GIP

# Regulation of Absorptive and Postabsorptive States

- Absorptive state: ingested nutrients enter the blood from the gastrointestinal tract
- Postabsorptive state: the gastrointestinal tract is empty of nutrients and the body's own stores must supply energy
- Fasting: 24 hour without eating

# Regulation of Absorptive and Postabsorptive States

- Insulin → Beta cells
  - Increased during absorptive state
  - Decreased during postabsorptive state
  - Insertion of GLUT-4
  - High glucose transport into the cells
- Glucagon → Alpha cells
  - Increased if circulating concentration of glucose decrease
  - Increase the plasma concentration of glucose and ketones to prevent hypoglycemia

# Regulation of Appetite

- Digestion is controlled by the nervous system and hormones
  - Food triggers nervous system responses
    - The thought of food stimulates the hypothalamus, which controls many involuntary responses of the nervous system
    - The hypothalamus stimulates the nervous pathways that prepare the digestive system to process food
      - Salivation, for example, increases and the stomach produces more acid and protective mucus



# Regulation of Appetite

- Hormones regulate hunger
  - Two appetite-regulating hormones discovered in the 1990s are leptin and ghrelin
    - **Leptin** is a peptide secreted by fat cells
      - When calorie intake is restricted, leptin in the bloodstream is reduced, stimulating the hypothalamus to trigger hunger
    - **Ghrelin** is a peptide secreted by gastric gland cells in the stomach lining
      - An increase in circulating ghrelin occurs prior to mealtime, stimulating hunger via the hypothalamus

# Regulation of Appetite

- Ghrelin → hunger
- Insulin → suppression of appetite
- Leptin → suppresses appetite
- Peptide YY → suppresses the appetite