



Lecture 17

PHYSIOLOGY OF DIGESTION

Digestive system

The GIT or alimentary tract provides the body with a continual supply of water, electrolytes, and nutrients. This requires:

- (1) movement of food through alimentary tract;
- (2) secretion of digestive juices and digestion of food;
- (3) absorption of water, various electrolytes, and digestive products;
- (4) circulation of blood through gastrointestinal organs;
- (5) control of all these functions by local, nervous, and hormonal systems.

Each part of digestive tract is adapted to its specific functions:

- * simple passage of food, such as the esophagus;
- * temporary storage of food, such as the stomach;
- * digestion and absorption, such as the small intestine.

Digestive organs are: mouth, pharynx, esophagus, stomach, small intestine and large intestine. Accessory digestive organs are teeth, tongue and gallbladder. Accessory digestive glands are salivary glands, liver and pancreas. Sphincters divide GIT into functional segments controlled by CNS "one-way" valves (like upper esophageal, lower esophageal, pyloric, sphincter of Oddi, ileocecal, internal anal and external anal sphincters).

Digestive process involves the following essential activities:

1. Ingestion,
2. Propulsion (swallowing and peristalsis),
3. Mechanical digestion: (chewing, churning and segmentation),
4. Chemical digestion,
5. Absorption
6. Defecation

Control of gastric secretions

First: Neural control

- 1-Enteric nervous system (ENS) involves:
 - a.) Myenteric (Auerbach's) plexus, controls motor activity in gut.
 - b.) Submucosal (Meissner's) plexus, controls secretion & absorption; & regulates local blood flow.
- 2-Parasympathetic nervous system (PNS) is excitatory.
- 3-Sympathetic nervous systems (SNS) is inhibitory.
- 4-Higher brain centers.



Second: Hormonal control is summarized in the following table:

Hormone	Action
Gastrin (gastrin family)	↑ acid secretion (effects similar to CCK)
Secretin (Secretin family)	↑ bicarbonate secretion
Cholecystokinin (CCK– Gastrin family)	Contracts gall bladder ↑ enzyme secretion (similar effects to gastrin)
Motilin	↑ fasting contractions
Vasoactive intestinal peptide (VIP- Secretin family)	↑ bicarb secretion (similar to secretin)
Neurotensin & Polypeptide Y	Slow intestinal motility (ileal brake) = ↓ gastric emptying

Gastric secretion:

Parietal cells (oxyntic cells) secrete ¹HCl and ²intrinsic factor:

- 1-) **HCl acid**; The ions of **H⁺** are important in killing microbes, converting pepsinogen to pepsin, etc...
- 2-) **intrinsic factor** (important in absorption of vitamin B12)...

Peptic cells (chief cells) secrete pepsinogen.

Mucous cells secrete mucous and bicarbonate...(protects lining of stomach)

Pancreatic Secretion

Pancreatic juice is **isotonic** to plasma at all rates of secretion. It consists of:

1. **Anions** (Cl⁻ & bicarb),
2. **Cations** (K⁺ & Na⁺)
3. **proteins** (proteolytic enzymes secreted as inactive proenzymes which are activated in intestinal lumen).

Secretin and VIP hormones are released by the entry of acid into the duodenum & stimulate bicarbonates & water secretion from the duct cells.

CCK and gastrin hormones are released by the presence of amino acids & fats in the duodenum & stimulate enzyme secretion from acinar cells.



Hepatobiliary Secretion:

Bile is required for digestion & absorption of fats. Composition of bile:

1. Inorganic & organic substances,
2. Bile acids & salts,
3. Major bile pigments are bilirubin & biliverdin (metabolites of hemoglobin),
4. Proportion of phospholipids & cholesterol.

Types of GI contractions

1. Tonic contractions: in the fundus of stomach, gallbladder, & sphincters.
2. Segmental contractions: circular smooth muscle.
3. Peristaltic contractions: longitudinal & circular smooth muscle.
4. Inhibited or absent: periods of quiescence.

Peristalsis is a reflex initiated by gut wall stretch in all parts of the gastrointestinal tract.

Secretion in the gastrointestinal tract

First: Carbohydrates digestion:

- 1) In the mouth; **salivary α -amylase** digests starch.
- 2) In the small intestine there are;
 - a.) **salivary and pancreatic α -amylases** act on polysaccharides.
 - b.) **oligosaccharidases** which are: * **α -dextrinase** (also called **isomaltase**), * **maltase**, * **sucrase**, * **lactase**, * **trehalase**.

Second: Protein digestion:

- 1-) in the stomach; **pepsin** and **gelatinase**
- 2-) In the small intestine; **pancreatic trypsin, chymotrypsins, and elastase** are called **endopeptidases**.

Third: Lipid digestion

- 1-) in the mouth; **lingual lipase** which is secreted by Ebner's glands on the dorsal surface of the tongue and becomes active in the stomach and can digest as much as 30% of dietary triglyceride.
- 2-) in the stomach; **gastric lipase** is less important.
- 3-) in the duodenum; **pancreatic lipase** is one of the most important.
- 4-) in the intestinal lumen; **colipase** is secreted in pancreatic juice and is activated by trypsin.

Absorption:

- 1-) **Glucose and galactose** absorbed by secondary active transport with Na^+
- 2-) **Fructose** is absorbed by facilitated diffusion.
- 3-) **Pentoses** are absorbed by simple diffusion.
- 4-) Several transport systems for **amino acids** absorption into enterocytes.
- 5-) Water and electrolytes absorption occurs mainly in small and large intestinal mucosa.