Physiology of Digestive System

Chapter Outline

- Gastro-Intestinal Tract
- External glands – Salivary, liver and Pancreas
- 4 major processes of Physiology of Digestive system
  - Digestion
  - Secretion
  - Absorption
  - Motility
- Disorders

Liver Functions

- Exocrine – Digestive Functions
  - Synthesizes and secretes bile salts
  - Secretes bicarbonate rich solution to neutralize acidity
- Other Important functions include
  - Secretion and degradation of hormones
  - Release of Blood clotting factors
  - Release of plasma proteins like albumin
  - Synthesis of glycogen from glucose
  - Oxidative Deamination of amino acids to form keto-acids
  - Synthesis of triglycerides – released as lipoproteins
  - Glycogenolysis and Gluconeogenesis

Water Volumes in GI tract

- Salivary secretion – 1500ml
- Pancreatic secretion – 1500ml
- Intestinal secretion – 1500ml
- Gastric secretion – 2000ml
- Bile secretion – 500ml
- Intake of water in food – 1200ml
- Total = 6800ml
- Total Absorption = 6700ml
- Passed in feces = 100ml

Histology of Gastrointestinal tract

GI Tract is formed of 4 layers; starting from outer side

- **Serosa**: or serous membrane is formed of Squamous epithelium and a small amount of connective tissue.
- **Muscularis Externa**: is formed of external longitudinal and inner circular smooth muscles.
- **Submucosa**: is areolar connective tissue having blood and lymphatic vessels in it.
- **Mucosa**: or mucous membrane is formed of 3 parts. A) muscularis is a thin layer of smooth muscles. B) Lamina propria is a small amount of areolar connective tissue. C) Epithelium is mostly simple columnar. It helps in secretion and absorption.
- **Alimentary Canal**: is a long coiled tube starting with mouth and ending at anus.

Bile Salts Digestion and Absorption of Fats

- Fats $\rightarrow$ monoglycerides + fatty acids (non-polar)
- Bile salts (amphipathic) emulsify fats and help in micelle formation
- Fat droplets $\rightarrow$ emulsion droplets $\rightarrow$ micelles $\rightarrow$ free monoglycerides and fatty acids $\rightarrow$ epithelial cells $\rightarrow$ chylomicrons $\rightarrow$ lacteal

4 peptide Hormones of GI tract

- Enteroendocrine cells secrete gastrin.
- Amino acids and peptides in stomach and parasympathetic fibers stimulate secretion of Gastrin, that in turn
stimulates secretion of HCl and Pepsinogen.

- Cholecystokinin (CCK) causes release of bile from contraction of gall bladder and enzymes from pancreas.
- Secretin causes the release of bicarbonates from pancreas and potentiates the action of CCK.
- Both CCK and Secretin inhibit secretion of HCl.
- GI peptide promotes insulin secretion by pancreas.

Gastric Secretion

- Gastric glands lie at the base of gastric pits in the stomach mucosa. Chief cells are most common and secrete protein digesting enzymes Pepsinogen. Single large cells – Parietal Cells open into gastric glands and secrete concentrated HCl acid. HCl acid change inactive protein digesting enzyme Pepsingogen → Pepsin.
- HCl acid also helps to dissolve food, and kills microbes.
- Mucous covers the luminal side of GI epithelium and protect it against the action of HCl / enzymes.
- Zymogens are inactive protein digesting enzymes; examples include pepsinogen in gastric and trypsinogen in pancreatic juices.
- Fat soluble substances like Alcohol and Aspirin easily pass into blood in stomach and can easily cause gastric irritation.
- Digestion is chemical and physical breakdown of molecules of food to make them absorbable across intestinal epithelium.

Motility

- Segmentation movements are most common and help to mix and churn food to facilitate better digestion
- Peristalsis is occasional downstream movement to push food forward toward anus.
- Negative Peristalsis is used in vomiting reflex. It is upstream movement from small intestine to mouth through stomach and esophagus.

Colon

- Some absorption in colon: colon reabsorbs vitamins K, Biotin, and B5 = pantothenic acid released by bacteria, Na⁺ and K⁺ ions, and most of water. Undigested food remains in colon for 10-12 hours and changes into feces.
- Bacteria living in colon can digest fibers and are helpful in: a) disposal of toxic by-products of digestion b) secrete vitamins like K and some B-complex vitamins c) increase bulk of feces – about 50%.

Absorptive and Postabsorptive phases

Absorptive phase
- ‘Feasting’ – Lasts up to 4 hours after taking food
- Main source of energy is absorbed carbohydrates
- Net uptake of glucose by liver
- Brain continues to use glucose
- Insulin present

Post-absorptive phase
- ‘Fasting’ – Starts after 4 hours till next meal
- Main source of energy is fats by lipolysis
- Liver releases glucose from glycogenolysis/gluconeogenesis
- Brain uses glucose

5. Insulin absent

Diabetes Mellitus

- Type 1 Diabetes Mellitus is caused due to lack or almost lack of insulin and Type 2 Diabetes Mellitus is caused due to Resistance to insulin though insulin is almost normal or even above normal levels.
- Thyroid Hormones are the single dominant factor for increasing BMR in body except Brain, this ability to increase BMR is called Calorigenic Effect.