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 and 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
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 → monoglycerides + fatty acids (non-polar)
Bile salts (amphipathic) emulsify fats and help in micelle formation
Fat droplets → emulsion droplets → micelles → free monoglycerides and fatty acids → epithelial cells → chylomicrons → lacteal
4 peptide Hormones of GI tract
1. Enteroendocrine cells secrete gastrin.
2. Amino acids and peptides in stomach and parasympathetic fibers stimulate secretion of Gastrin, that in turn stimulates secretion of HCl and Pepsinogen.
3. Cholecystokinin (CCK) causes release of bile from contraction of gall bladder and enzymes from pancreas.
4. **Secretin** causes the release of bicarbonates from pancreas and potentiates the action of CCK.
5. Both CCK and Secretin inhibit secretion of HCl.
6. 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 Pepsinogen → 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.

**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 lasts about 4 hours when intestine has nutrients; followed by Post-absorptive phase when intestine is empty and body must use its own sources of energy.

During absorptive phase energy is primarily provided by Absorbed Carbohydrate and there is Uptake of glucose by liver; some glucose used to synthesize Glycogen in liver and muscles but most is used to make Fats.

During post-absorptive phase most organs use energy of Fatty Acids and ketones made from them, glucose is produced in Liver and Kidney from glycogen and gluconeogenesis but Brain continues to use glucose.

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<thead>
<tr>
<th>Absorptive phase</th>
<th>Post-absorptive phase</th>
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<tr>
<td>1. ‘Feasting’ – Lasts up to 4 hours after taking food</td>
<td>1. ‘Fasting’ – Starts after 4 hours till next meal</td>
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<td>2. Main source of energy is absorbed carbohydrates</td>
<td>2. Main source of energy is fats by lipolysis</td>
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<td>3. Net uptake of glucose by liver, promotes glycogenesis</td>
<td>3. Liver releases glucose by glycogenolysis /gluconeogenesis</td>
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<tr>
<td>4. Brain continues to use glucose</td>
<td>4. Brain uses glucose</td>
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<tr>
<td>5. Insulin present</td>
<td>5. Insulin absent</td>
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**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.