The Digestive System and Nutrition

BIO 105
Chapter 15

Functions of the Digestive System
1. Digestion (mechanical & chemical)
2. Secretion
3. Absorption
4. Motility
5. Excretion

The Gastrointestinal Tract
(~20 ft tube)

The Gastrointestinal Tract
+ Accessory structures
Structure of the Gastrointestinal (GI) Tract

Mouth

ACCESSORY STRUCTURES

Glands

Upper jaw

Lower jaw

Enamel

Dentine

Pulp cavity

Gum crests

Mandible

Tongue

Maxillary sinuses

Paranasal sinuses

Eustachian tubes

2

Lacrimal apparatus

Teeth

Anatomy

Organs

Blood vessels

Lymphatic vessels

Nerve

The mucosa is a thin layer of tissue that lines the digestive tract.

The submucosa is a layer of connective tissue that contains blood vessels and nerves.

The muscularis is made up of layers of smooth muscle that contract to move food through the tract.

The serosa is a thin layer of connective tissue that lines the outside of the GI tract.

Mouth

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Mouth

- Mechanical & chemical digestion occur here

Esophagus - Peristalsis

(a) Voluntary phase

(b) Involuntary phase

- Reflex movement of the soft palate prevents food entering the nasal cavity.
- Muscles contract, forcing the bolus into the esophagus.
- The epiglottis closes the opening to the respiratory system, preventing food from entering.
- A muscle ring at the top of the esophagus relaxes, opening the esophagus. Food is pushed into esophagus.

Esophagus, Waves of contraction, Bolus, Stomach
Stomach

- J-shaped organ
- Storage
- Digestion
- Production of chyme

Gastric Glands

In addition to regulation of blood glucose, the pancreas also has a role in digestion through the secretion of 4 classes of digestive enzymes:

1. amylase
2. proteolytic
3. lipase
4. nucleases

Accessory Structures

Pancreas

Surface epithelium
- Gastric pit
- Mucus-secreting cell
- Pepsinogen-secreting cell
- HCl-secreting cell
- Blood vessels

Mucosa
- Submucosa
- Muscularia
- Serosa

The liver produces bile, which empties into the common bile duct, being released into the small intestine.
Liver & Gall bladder

Liver produces bile

Gall bladder stores bile

Bile – mixture of ions, cholesterol, bile pigments, bile salts, and water

Fat emulsification

• Bile salts become incorporated into fat droplets, and in combination with intestinal motility break down the fat droplet into smaller droplets.

Gall Stones

<table>
<thead>
<tr>
<th>Structure</th>
<th>Secretions/Functions</th>
<th>Site of Action of Chemical Secretions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salivary glands (sublingual, submandibular, parotid)</td>
<td>Secrete saliva, a liquid that moistens food and contains salivary amylase for digesting carbohydrates</td>
<td>Mouth</td>
</tr>
<tr>
<td>Pancreas</td>
<td>Digestive secretions include bicarbonate ions that neutralize acidity, enzymes that digest carbohydrates, proteins, fats, and nucleic acids</td>
<td>Small intestine</td>
</tr>
<tr>
<td>Liver</td>
<td>Digestive function is to produce bile, a liquid that emulsifies fats, making chemical digestion easier and facilitating absorption</td>
<td>Small intestine</td>
</tr>
<tr>
<td>Gallbladder</td>
<td>Stores bile and releases it into small intestine</td>
<td>Small intestine</td>
</tr>
</tbody>
</table>
Small Intestine

Carbohydrate digestion & absorption

(a) Carbohydrate digestion

Capillary

To liver

Polysaccharide
Disaccharide
Monosaccharide
Glucose
Fructose
### Table 1.1: Table of Functions of the Digestive System

<table>
<thead>
<tr>
<th>Section</th>
<th>Function/Part</th>
<th>Mechanical Action</th>
<th>Physiological Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouth</td>
<td>Broken food moves back and forward</td>
<td>Teeth break food into smaller pieces</td>
<td>Salivation begins to produce saliva</td>
</tr>
<tr>
<td>Pharynx</td>
<td>Food then moves into pharynx</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Oesophagus</td>
<td>Food enters through a muscular sphincter</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Stomach</td>
<td>Food is stored, mixed, and ground</td>
<td>Churning of stomach mixes food with gastric juice, creating a bolus</td>
<td>Liquid digestion begins</td>
</tr>
<tr>
<td>Small Intestine</td>
<td>Food is further digested and absorption occurs</td>
<td>Segmental contractions mix food with intestinal juices, producing chyme, and fats</td>
<td>Nutrient absorption is completed in the jejunum</td>
</tr>
<tr>
<td>Large Intestine</td>
<td>Main functions are: water absorption, electrolyte absorption, and formation of stool</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Rectum</td>
<td>Final storage and preparation of stool for excretion</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

### Table 2.1: Major Digestive Enzymes

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Site of Production</th>
<th>Site of Action</th>
<th>Substrate and Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates dipeptidases</td>
<td>Mouth, salivary glands</td>
<td>Mouth</td>
<td>Polysaccharides into shorter monosaccharides</td>
</tr>
<tr>
<td>Amylase</td>
<td>Pancreas, small intestine</td>
<td>Small intestine</td>
<td>Polysaccharides into disaccharides</td>
</tr>
<tr>
<td>Maltase</td>
<td>Small intestine</td>
<td>Small intestine</td>
<td>Disaccharides into monosaccharides</td>
</tr>
<tr>
<td>Sucrase</td>
<td>Small intestine</td>
<td>Small intestine</td>
<td>Disaccharides into glucose and fructose</td>
</tr>
<tr>
<td>Lactase</td>
<td>Small intestine</td>
<td>Small intestine</td>
<td>Disaccharides into glucose and galactose</td>
</tr>
</tbody>
</table>

### Table 3.1: Fat-Soluble Vitamins

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Site of Absorption</th>
<th>Site of Action</th>
<th>Substrate and Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>Small intestine</td>
<td>Small intestine</td>
<td>Carotenoids into vitamin A</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Intestine</td>
<td>Intestine</td>
<td>Cholecalciferol into vitamin D</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>Intestine</td>
<td>Intestine</td>
<td>Tocopherols into tocopherols</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>Intestine</td>
<td>Intestine</td>
<td>Phylloquinone into phylloquinone</td>
</tr>
</tbody>
</table>