

The Digestive System

Overview

1. Food breakdown
 - CHO, Protein, Fat
2. Anatomy
3. Digestive process

➤ *Primary function:* breakdown & transport nutrients, H₂O, & electrolytes

1. **Motility** – propulsive or mixing movements
2. **Secretion** – energy requiring secretion of H₂O, electrolytes, & enzymes, bile salts, or mucus

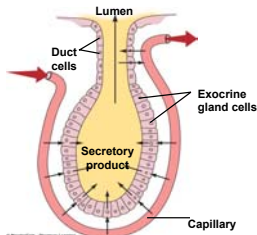
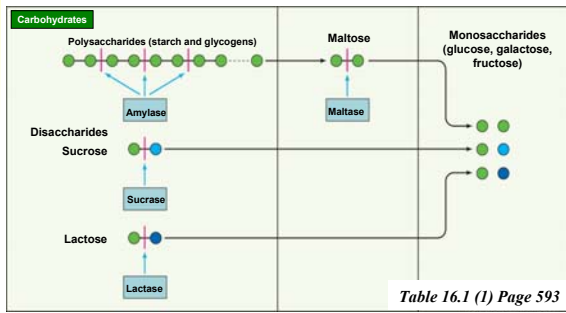


Figure 16.1
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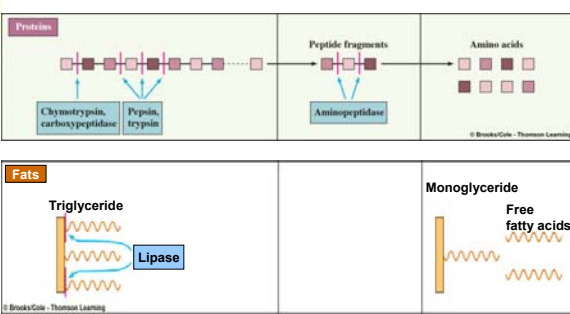
➤ *Primary function:* breakdown & transport nutrients, H₂O, & electrolytes

3. Digestion – CHO



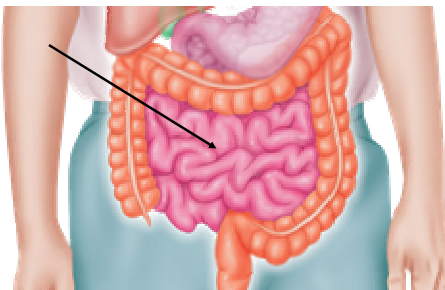
➤ *Primary function:* breakdown & transport nutrients, H₂O, & electrolytes

3. Digestion – proteins & fats



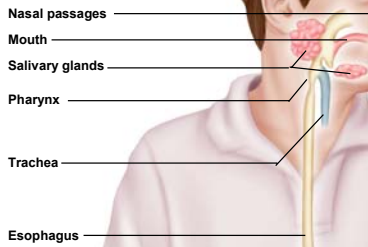
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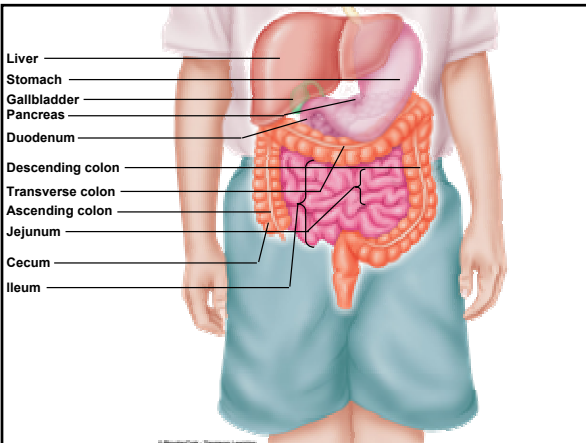
4. Absorption – primarily in small intestines



General Digestive Anatomy

1. Digestive Tract
2. Accessory Digestive Organs

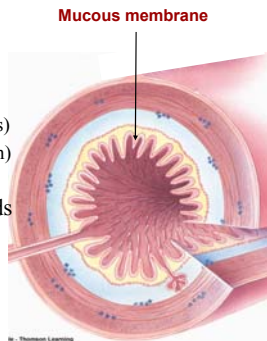




The Digestive Tract (inner layer to outer)

1. Mucosa

- Mucous membrane
 - ✓ Exocrine cells (digestive juices)
 - ✓ Endocrine cells (hormones)
 - ✓ Epithelial cells (absorption)
- Degree of folding depends on location
 - ✓ Highest in small intestine



The Digestive Tract (inner layer to outer)

2. Submucosa

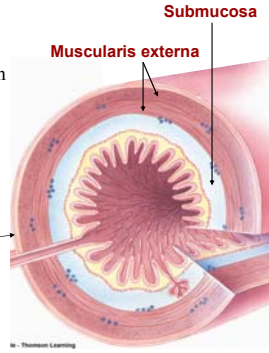
- Thick connective tissue
- ✓ Blood & nerve innervation

3. Muscularis externa

- Inner circular layer
- Outer longitudinal layer

4. Serosa

- Outer connective tissue
- ✓ Prevents friction



Digestive regulation

1. Smooth-muscle function

- Slow-wave action potentials (basal electrical rhythm)
- ✓ Interstitial cells of Cajal
- Regulate peristalsis and segmentation

2. Intrinsic nerve plexuses (**enteric nervous system**) – *digestive nervous system*

- Respond to local stimuli for secretion (digestive juices & GI hormones)
- Both excitatory & inhibitory

Digestive regulation

3. Extrinsic nerves

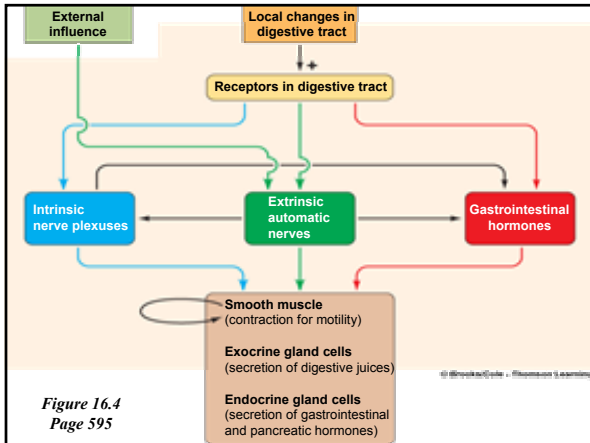
- Modify intrinsic activity and other various digestive organs (**generally sympathetic &/or parasympathetic**)

4. Gastrointestinal hormones

- Carried throughout blood influencing other areas of digestive tract

Sensory Receptors

1. Chemoreceptors
 - Sense changes in chemical components within lumen
2. Mechanoreceptors
 - Respond to stretch and tension
3. Osmoreceptors
 - Changes in osmolarity



The Digestive Process

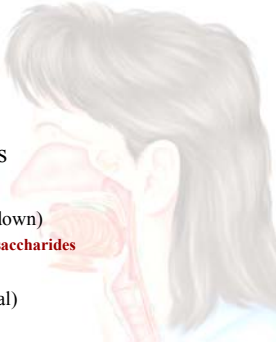
The Digestion Process

1. Mouth

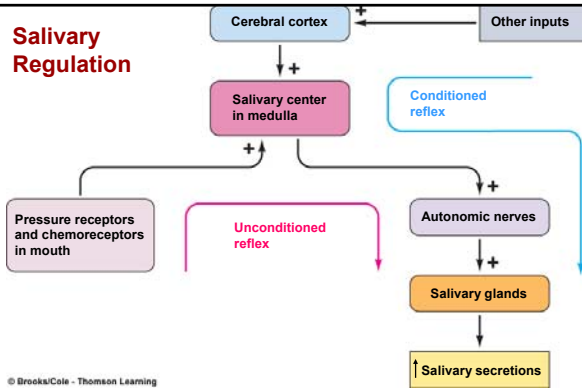
- Chewing
- Saliva secretion

➤ 3 major salivary glands

- Salivary proteins
 1. Amylase (CHO breakdown)
 - ✓ Polysaccharides to disaccharides
 2. Mucus (lubrication)
 3. Lysozyme (antibacterial)



Salivary Regulation



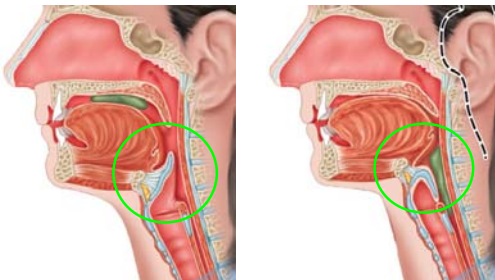
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Figure 16.5 Page 601

The Digestion Process (cont.)

2. Pharynx & Esophagus

- Swallowing reflex



The Digestion Process (cont.)

2. Pharynx & Esophagus

- Peristalsis

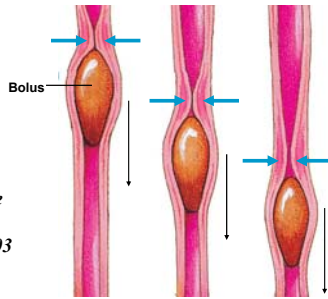


Figure
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The Digestion Process (cont.)

Stomach

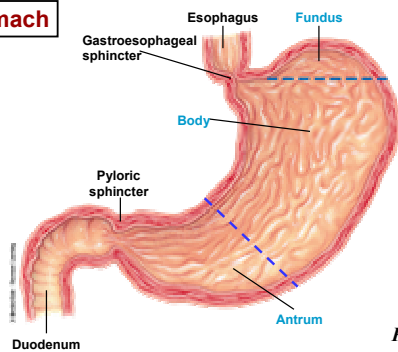


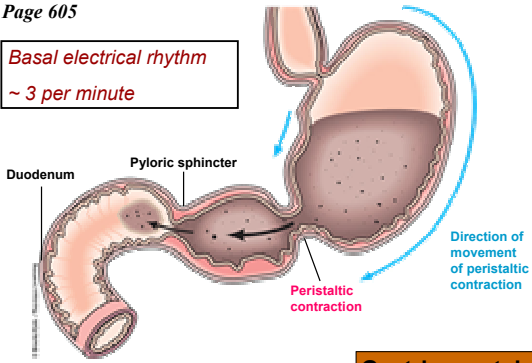
Figure
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Stomach Functions

1. Storage
2. Gastric mixing & mucous secretion
3. Production of chyme
4. Secretes hydrochloric acid (HCl)
 - Reduces large food particles
 - Kills microorganisms ingested in food
5. Initial stages of protein breakdown
 - **Pepsinogen forming pepsin**

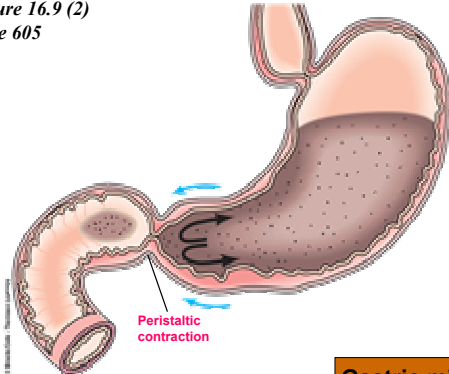
Figure 16.9 (1)
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Basal electrical rhythm
~ 3 per minute



Gastric emptying

Figure 16.9 (2)
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Gastric mixing

Regulation of Gastric Emptying

- Amount of chyme
- Neural response
 - Intrinsic nerve plexus (short reflex)
 - Autonomic nerves (long reflex)
- Hormonal
 - Enterogastrones (secretin & cholecystinin – CCK) released from duodenal mucosa
 - ✓ Inhibit antral contractions

} **Enterogastric Reflex**

Regulation of Gastric Emptying

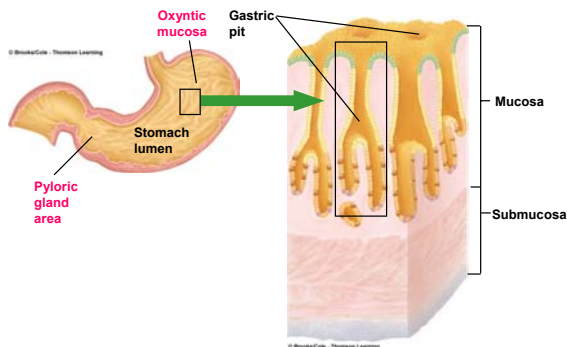
- Duodenum
 1. Fat ~ can only be processed in small intestine
 2. Acid (unneutralized)
 - ✓ Excess HCl not buffered by sodium bicarbonate
 3. Hypertonicity ~ increased osmolarity due to abundance of amino acids and glucose
 4. Distension
- Emotions

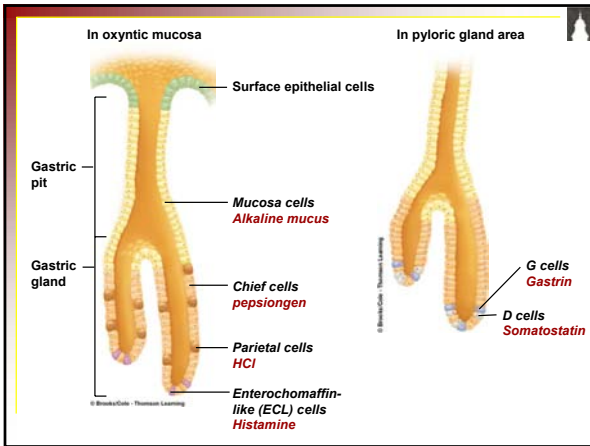
Gastric Digestive Juices

~ 2 liters/day

- Responsibility of cells lining gastric mucosa
 1. Oxyntic mucosa
 - Body
 - Fundus
 2. Pyloric gland area (PGA)
 - Antrum

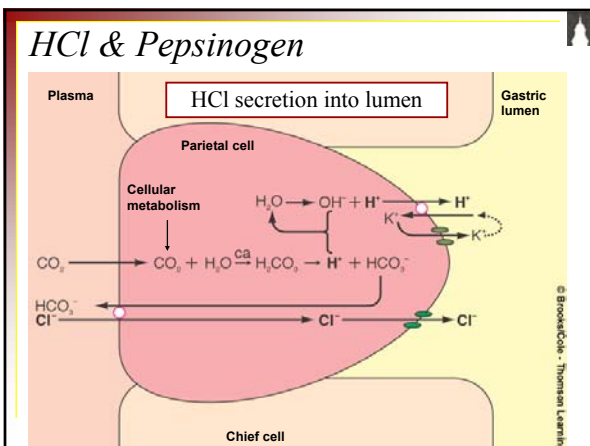
Table 16.4
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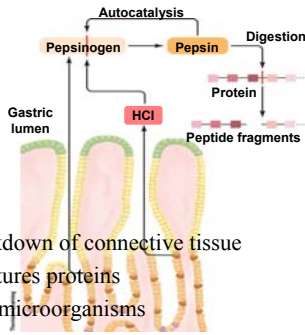
Chief & Parietal Cell Regulation

- Acetylcholine (Ach)
 - Stimulates both
 - Also stimulates G and ECL cells
- Histamine (*paracrine*)
 - Released from ECL cells & increases HCl secretion
- Somatostatin
 - Released from D cells
 - Provides negative feedback



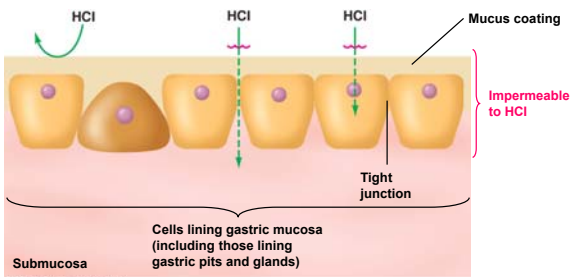
➤ *HCl* functions to:

- Activate pepsinogen to form pepsin



- Breakdown of connective tissue
- Denatures proteins
- Kills microorganisms

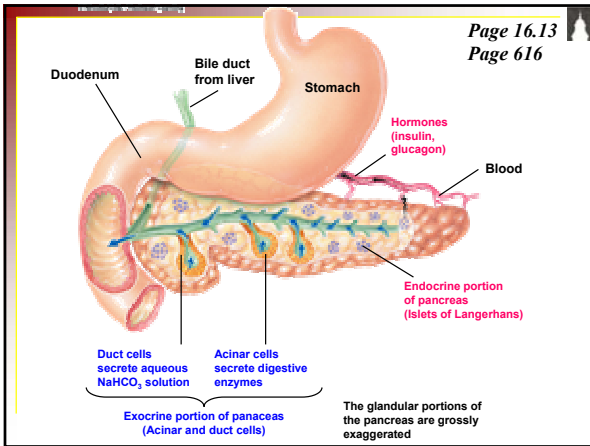
Gastric Mucosal Barrier



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Food leaving the Stomach...

Mixed with secretions from **pancreas** and **liver**



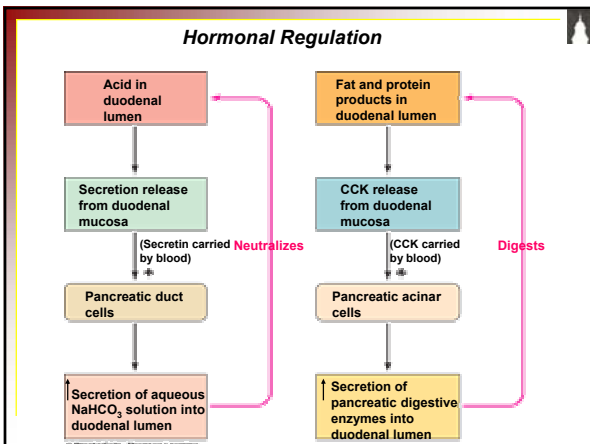
Pancreas

➤ Exocrine & endocrine tissue

1. Exocrine: secretes enzymes capable of breaking down CHO, fat, & protein
 - ✓ Proteolytic enzymes: protein
 - ✓ Pancreatic amylase: CHO
 - ✓ Pancreatic lipase: fat

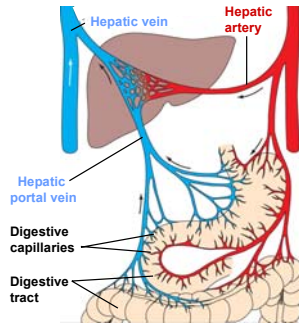
} Regulated by secretin & cholecystokinin (CCK)

2. Endocrine (hormones): Insulin & glucagon



Liver

- Digestive role: secretion of bile salts
 - Aid fat digestion & absorption

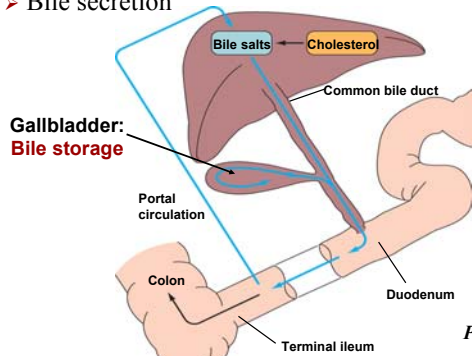


**Blood flow –
Hepatic Portal
System**

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Liver

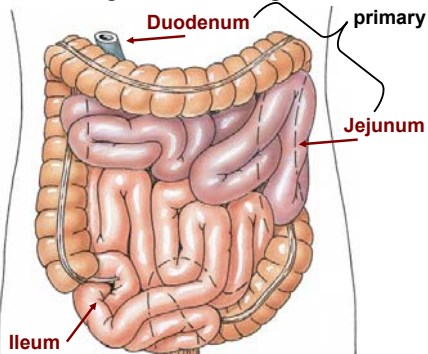
- Bile secretion



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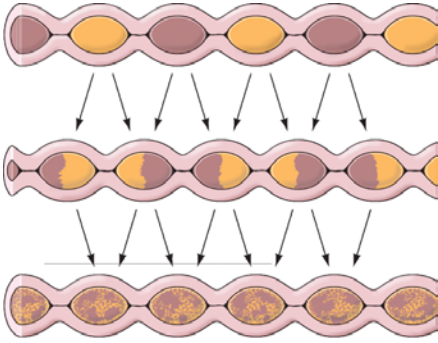
Small Intestine

- Primary site of digestion & absorption



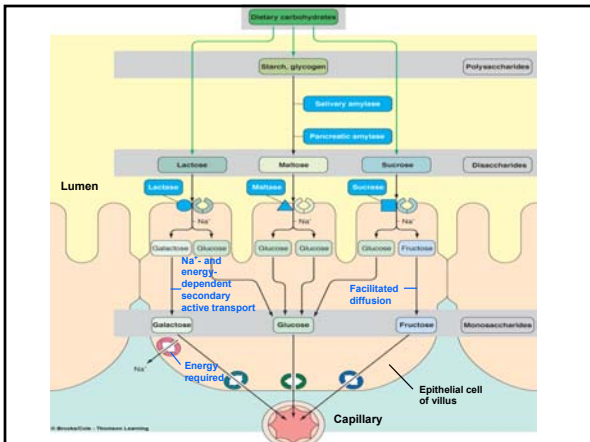
Segmentation of chyme

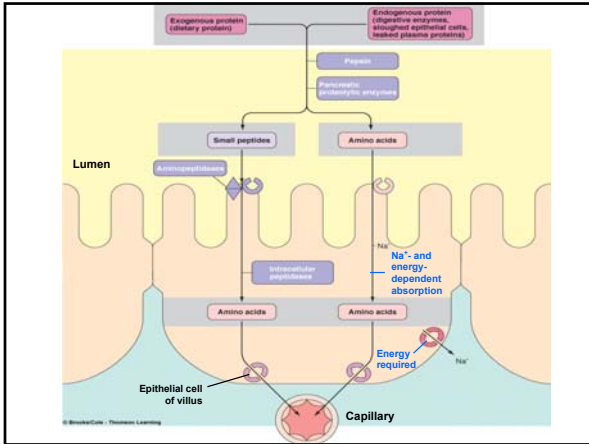
- Initiated by pacesetter cells

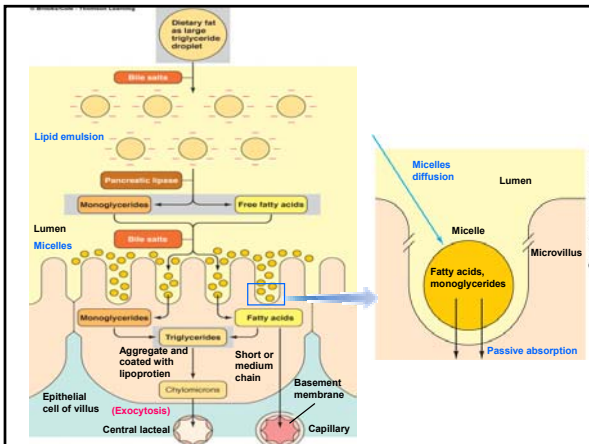


Small intestine – digestion & absorption

- Potential for increased surface area
 1. Extensive folding
 2. Villi & microvilli
 - ✓ Increased digestive enzyme release
- Pancreatic enzymes
 - Fat reduced to FFA (with help of bile salts)
 - ✓ Lipase
 - Proteins to AA
 - ✓ Aminopeptidases
 - CHO to di- and monosaccharides
 - ✓ Maltase, sucrase, lactase







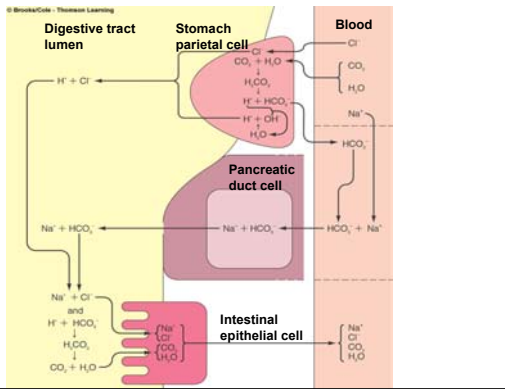
Small intestine – digestion & absorption

1. Vitamin absorption (passive)
 - Water-soluble
 - Fat-soluble

2. Iron absorption – *regulated*
 - Absorbed into epithelial cells
 - ✓ Either used immediately for production of RBC or
 - ✓ Stored as **ferritin**

3. Calcium absorption – *regulated*
 - Active transport stimulated by Vitamin D

Biochemical Balance



Large Intestine

