Digestive System
Chapter 18

Function
• Obtain resources from the external environment
  – Water
  – Minerals
  – Nutrients (Lipids, Carbohydrates, Proteins)
  – Vitamins
• Break down large particles into smaller ones
• Transfer materials from external environment → blood → cells

Anatomy
Digestive tract
• oral cavity
• pharynx
• esophagus
• stomach
• small intestine
• large intestine
• anus

Accessory organs
• salivary glands
• pancreas
• liver
• gall bladder

Digestive Processes
• Motility
  – movement of food through the digestive system
• Secretion
  – release of substances to enhance breakdown of food
• Digestion
  – physical and chemical breakdown of food
• Absorption
  – transfer of materials to internal environment

Motility
• Muscle contractions of digestive tract
  1. propulsion of food through GI tract
  2. mixing of food with digestive juices (facilitates digestion and absorption)
• Processes:
  – ingestion (taking food into mouth)
  – mastication (chewing)
  – deglutition (swallowing)
  – peristalsis (rhythmic movement of GI tract)
  – segmentation (mixing in intestine)
Secretion

- Digestive juices
  - enzymes, bile salts, mucus, etc. released by exocrine glands into GI tract
- Most food molecules too large to absorb
- Must break bonds with enzymes (various organs)
- Enzyme function aided by...
  - HCl (stomach)
  - Bile (liver)
  - NaHCO₃ (pancreas)

Digestion

- Physical and chemical break down nutrients into absorbable unit
  1. Physical digestion (chewing, mixing)
  2. Chemical digestion (enzyme catalyzed)
     - polysaccharides → monosaccharides
     - proteins → amino acids
     - fats → glycerol + fatty acids

Absorption

- Transfer of digested materials across the digestive epithelium
  - intestinal lumen → blood or lymph

Gastrointestinal Tract Structure

- Mucosa (lumen side)
  - Epithelial tissue
- Submucosa
  - elastic connective tissue
  - contains lymph and blood vessels
- Muscularis
  - smooth muscle
- Serosa
  - outer layer of connective tissue
  - secretes serous fluid

Mouth

- Ingestion - bringing food into the body
  - tongue - taste buds detect chemical composition of food
- Mastication - chewing (physical digestion)
  - teeth and tongue
- Chemical digestion - saliva
  - moistens food
  - amylase - breaks down starch into maltose
  - lysozyme - antibacterial agent

Pharynx and Esophagus

- Transport food and water to stomach, secretes mucus
  - deglutition (swallowing) reflex moves food to stomach
- Movement of food bolus in esophagus (and rest of GI tract) via peristalsis
Stomach

- Muscular sac-like organ
- Chemical and physical digestion
  - forms chyme
- Stores food, releases small amts. to small intestine
  - takes 2-6 hours for stomach to empty
- Inner surface lined w/ rugae

Stomach Mucosal Cells

- goblet cells – mucus
  - Gastric Mucosal Barrier = mucus and layer of HCO3 that protects stomach epithelium
- parietal cells – HCl
  - kills bacteria, denatures proteins
- chief cells - pepsinogen
  - pepsinogen activated by HCl
  - pepsin breaks down proteins

Small Intestine

- 12’ long tube (20’ in cadavers)
- Duodenum (1”) → Jejunum (4”)
  → Ileum (7”)
- Most chemical digestion occurs here
- Most absorption occurs here
- Large surface area
  - Plicae – folds in mucosa
  - Villi – finger-like projections
    - Capillaries, central lacteal (absorption)
    - Microvilli (“brush border”) on epithelium

Chemical Digestion: Small Intestine

- brush-border enzymes
  - bound to epithelial cell membranes
  - hydrolyze disaccharides, polypeptides, etc.
  - e.g. enterokinase - activates trypsin (pancreatic enz.)

Chemical Digestion: Pancreas

- Exocrine cells secrete pancreatic juice into duodenum
  - amylase - breaks down starch
  - trypsinogen
    - converted to trypsin by enterokinase
    - breaks down polypeptides
  - lipase - digests triglycerides
  - many others (proteases, nuclease, etc.)
  - NaHCO3 (alkaline) - neutralizes stomach acidity

Chemical Digestion: Liver

1. secretes bile
   - stored in gall bladder, secreted into duodenum
   - bile salts used for lipid absorption
   - bilirubin secretion
2. metabolic processing of absorbed materials
   - Nutrient-rich blood from villi
     - flows into hepatic portal system
     - processed by liver prior to general circulation
Chemical Digestion

3. degradation of waste, hormones, drugs, etc.
4. synthesizes plasma proteins
5. stores glycogen, fats, minerals and vitamins

Absorption: Carbohydrates and Proteins

- digested into monosaccharides and amino acids / small peptides
- transported into the epithelium by cotransport
  - coupled to flow of Na⁺ or H⁺ into epithelial cells
- transported into blood entering hepatic portal system

Absorption: Lipids

- emulsification
  - lipids interact w/ bile salts
  - form emulsification droplets
- pancreatic lipases break emulsified fat into free fatty acids and monoglycerides
- absorbed by epithelium

Absorption: Lipids

- reform triglycerides in epithelial cells
- combined w/ protein to form chylomicrons
- chylomicrons released via exocytosis into submucosa
- enter central lacteal → lymphatic system
- transported to blood

Large Intestine

- colon, cecum, appendix, rectum (5 ft long)
- small amount of salt and water absorbed here
- main function is to store undigested material (feces)
- 30% dry weight of feces = bacteria (E. coli)
  - live in large intestine (produce vitamin K)