Anatomy of the Digestive Tract

• The digestive system (Figure 2-1)
  – Digestion: begins in the mouth
  – Mouth to the esophagus
  – Esophagus to the stomach
  – The small intestine
  – The large intestine (colon)
  – The sphincters (4)
Figure 2-1 p39

- **Pharynx**: directs food from mouth to esophagus.
- **Epiglottis**: protects airways during swallowing.
- **Upper esophageal sphincter**: allows passage from mouth to esophagus.
- **Esophagus**: passes food from the mouth to the stomach.
- **Lower esophageal sphincter**: allows passage from esophagus to stomach.
- **Liver**: manufactures bile salts, detergent-like substances, to help digest fats.
- **Gallbladder stores bile until needed.**
- **Pyloric sphincter**: allows passage from stomach to small intestine; prevents backflow from small intestine.
- **Bile duct**: conducts bile from the gallbladder to the small intestine.
- **Ileocecal valve**: allows passage from small intestine to the large intestine; prevents backflow from large intestine.
- **Appendix**: houses bacteria and lymph cells.
- **Mouth**: chews and mixes food with saliva.
- **Salivary glands**: secrete saliva.
- **Stomach**: churns, mixes, and grinds food to a liquid mass; adds acid, enzymes, and fluid.
- **Pancreas**: manufactures enzymes to digest all energy-yielding nutrients and releases bicarbonate to neutralize acidic chyme that enters the small intestine.
- **Pancreatic duct**: conducts pancreatic juice from the pancreas to the small intestine.
- **Small intestine (duodenum, jejunum, ileum)**: secretes enzymes that digest all energy-yielding nutrients to smaller nutrient particles; cells of wall absorb nutrients into blood and lymph.
- **Large intestine (colon)**: absorbs water and minerals; passes waste (fiber, bacteria, and unabsorbed nutrients) along with water to the rectum.
- **Rectum**: stores waste prior to elimination.
- **Anus**: holds rectum closed; opens to allow elimination.
Anatomy of the Digestive Tract (cont’d.)

• The involuntary muscles and the glands
  – Gastrointestinal motility
  – Peristalsis and segmentation (Figure 2-2)
    • Peristalsis: pushes contents along
    • Segmentation: periodic squeezing or partitioning
  – Liquefying process: occurs in the mouth and stomach
  – Stomach action: three layers of muscle
The Process of Digestion

• Digestion in the mouth
  – Salivary glands secrete saliva: salivary amylase breaks down starch

• Digestion in the stomach
  – Gastric glands secrete gastric juice
  – Initial breakdown of proteins takes place
The Process of Digestion (cont’d.)

- Digestion in the small and large intestines
  - Digestive enzymes: provided by pancreas and glands in the intestinal wall
  - Bicarbonate: neutralizes the acidic chyme
  - Bile: secreted by liver and stored in the gallbladder; emulsifies fats
The Process of Digestion (cont’d.)

- Digestion in the small and large intestines
  - The rate of digestion: depends on content of the meal
  - Protective factors: intestinal flora
  - The final stage
  - Carbohydrate, fat, and protein: disassembled to basic building blocks before they are absorbed
In the stomach, the fat and watery GI juices tend to separate. The enzymes are in the water and can’t get at the fat.

When fat enters the small intestine, the gallbladder secretes bile. Bile has an affinity for both fat and water, so it can bring the fat into the water.
Bile’s emulsifying action converts large fat globules into small droplets that repel each other. After emulsification, the enzymes have easy access to the fat droplets.
The Absorptive System

• The small intestine
  – The small intestinal villi (Figure 2-5)
  – Microvilli: trap nutrient particles and transport them into the cells
  – Specialization in the intestinal tract
    • Successive portions of the tract are specialized to absorb different nutrients
  – The myth of “food combining”: gross underestimation of the body’s capabilities
Figure 2-5 p46

The wall of the small intestine is wrinkled into thousands of folds and is carpeted with villi.

Between the villi are tubular glands that secrete enzyme-containing intestinal juice.

Three cells of a villus. Each cell is covered with microvilli.
The Absorptive System (cont’d.)

• Absorption of nutrients
  – Transport systems
    • Blood stream: water-soluble nutrients released directly into blood stream
    • Lymphatic system: carries chylomicrons to point of entry into the blood stream near the heart
Transport of Nutrients

• Circulatory system: delivers nutrients wherever they are needed
• The vascular (blood circulatory) system
  – Closed system
  – Route: heart → arteries → capillaries (in intestines) → hepatic portal vein → sinusoids (in liver) → hepatic vein → heart
• The lymphatic system: one-way route
Transport of Nutrients (cont’d.)

• Transport of lipids: lipoproteins
  – Types of lipoproteins
    • Very-low-density lipoproteins (VLDL)
    • Very-low-density lipoproteins (VLDL)
    • High-density lipoproteins (HDL)
  – Health implications of LDL and HDL
    • Factors that improve LDL-to-HDL ratio: weight management; polyunsaturated or monounsaturated fatty acids in the diet; soluble fibers and physical activity
A typical lipoprotein contains an interior of triglycerides and cholesterol surrounded by phospholipids. The phospholipids' fatty acid “tails” point toward the interior, where the lipids are. Proteins near the outer ends of the phospholipids cover the structure. This arrangement of hydrophobic molecules on the inside and hydrophilic molecules on the outside allows lipids to travel through the watery fluids of the blood.
When Digestion Becomes Embarrassing - Gas

**Stomach** – Air
Carbonated beverages
Swallowing Air – Straws, Gulping, Mouth Open
Chewing Gum
Cure: Burp, Simethicone, Charcoal

**Intestine** – $\text{H}_2$, $\text{CO}_2$, $\text{CH}_4$, $\text{H}_2\text{S}$
Bacteria + Non-Digested Food
Sugar, Fiber, Milk (Lactose)
Bad Foods – Beans, Onions, Cabbages, High Fiber Foods
Cure – Flatulence! (borborygmus)

200 600ml/day 2000

Normal
The System at Its Best

- Lifestyle factors impacting GI tract health
  - Sleep
  - Physical activity
  - State of mind
  - Nutrition