Overview of the Digestive System

- Organs are divided into two groups
  - **The alimentary canal**
    - Mouth, pharynx, and esophagus
    - Stomach, small intestine, and large intestine (colon)
  - **Accessory digestive organs**
    - Teeth and tongue
    - Gallbladder, salivary glands, liver, and pancreas

The Alimentary Canal and Accessory Digestive Organs

![Diagram of the alimentary canal and accessory digestive organs](image)
Digestive Processes

- Ingestion
- Propulsion
- Mechanical digestion
- Chemical digestion
- Absorption
- Defecation

Peristalsis

- Major means of propulsion
- Adjacent segments of the alimentary canal relax and contract

Segmentation

- Rhythmic local contractions of the intestine
- Mixes food with digestive juices
The Peritoneal Cavity and Peritoneum

- **Peritoneum** – a serous membrane
  - Visceral peritoneum – surrounds digestive organs
  - Parietal peritoneum – lines the body wall
- **Peritoneal cavity** – a slit-like potential space

![Figure 23.5: Parietal peritoneum](image)

Mesenteries

- **Lesser omentum** attaches to lesser curvature of stomach

![Figure 23.6a: Lesser omentum](image)

Mesenteries

- **Greater omentum** – a “fatty apron” of peritoneum
- **Greater omentum and transverse colon reflected**

![Figure 23.6c: Greater omentum](image)
Mesenteries

- Sagittal section through the abdominopelvic cavity
- Mesenteries attach to posterior abdominal wall

Histology of the Alimentary Canal Wall

- Same four layers from esophagus to anus
  - The mucosa – innermost layer
    - Consists of:
      - Epithelium
      - Lamina propria
      - Muscularis mucosae
  - The submucosa – external to the mucosa
    - Contains blood and lymphatic vessels, nerve fibers
  - The muscularis externa – external to the submucosa
    - Two layers
      - Circular muscularis
      - Longitudinal muscularis
  - The serosa – the outermost layer
    - The visceral peritoneum
  - Nerve plexuses
    - Myenteric nerve plexus
    - Submucosal nerve plexus

Histology of the Alimentary Canal
Histology of the Alimentary Canal

Figure 23.7b

(b) Light micrograph cross section through the small intestine (30×)

Submucosa
Muscularis externa
Serosa

Smooth Muscle

Figure 23.8a, b

Small intestine
Mucosa

(a) Location and plane of section shown in (b)
(b) Cross section of the intestine showing the smooth muscle layers (one circular and the other longitudinal) running at right angles to each other

Longitudinal layer of smooth muscle in cross section
Circular layer of smooth muscle in cross section

The Mouth and Associated Organs

• The mouth – oral cavity
  • Mucosal layer
    • Stratified squamous epithelium
    • Lamina propria
  
• The lips and cheeks
  • Formed from orbicularis oris and buccinator muscles, respectively
Anatomy of the Mouth

- The labial frenulum
  • Connects lips to gum

- The palate
  • Forms the roof of the mouth

The Tongue

- Interlacing fascicles of skeletal muscle
- Grips food and repositions it
- Helps form some consonants
- Intrinsic muscles – within the tongue
- Extrinsic muscles – external to the tongue
The Superior Surface of the Tongue

- Tongue papillae
  - Filiform papillae
  - Fungiform papillae
  - Vallate papillae

Figure 23.12

The Teeth

- Dentition and dental formula
- Deciduous teeth – 20 teeth
  - First appear at 6 months of age
- Permanent teeth – 32 teeth
  - Most erupt by the end of adolescence
- Dental formula – shorthand
  - Way to indicate number and position of teeth

Figure 23.13a

Incisors
- Central (6–8 mo)
- Incisors (central (7 yr)
- Canine (eyetooth)
  - (16–20 mo)
  - (11 yr)
- Premolars (bicuspids)
  - First premolar
  - (11 yr)
  - Second premolar
  - (12 yr)
- Molars
  - First molar
  - (6–7 yr)
  - Second molar
  - (12–13 yr)
  - Third molar — (wisdom tooth)
  - (17–25 yr)

Permanent teeth
### The Teeth

- **Deciduous teeth**
- **Permanent teeth**

![Figure 23.13b](image)

### Tooth Structure

- **Longitudinal section of tooth in alveolus**

![Figure 23.14](image)

### The Salivary Glands

- **Ducts of sublingual gland**
- **Sublingual gland**
- **Submandibular duct**
- **Posterior belly of digastric muscle**
- **Parotid duct**
- **Masseter muscle**
- **Body of mandible**
- **Submandibular gland**

![Figure 23.15](image)
The Pharynx

- **Oropharynx and laryngopharynx** – passages for air and food
- Lined with stratified squamous epithelium
- External muscle layer
  - Consists of superior, middle, and inferior pharyngeal constrictors

The Esophagus

- **Gross anatomy** – muscular tube
  - Begins as a continuation of the pharynx
  - Joins the stomach inferior to the diaphragm
- **Microscopic anatomy**
  - Epithelium is stratified squamous epithelium
  - When empty – mucosa and submucosa in longitudinal folds
  - Mucous glands – primarily compound tubuloalveolar glands
  - Muscularis externa – skeletal muscle first third of length
  - Most external layer – adventitia

Microscopic Structure of the Esophagus

- Mucosa
  - Contains stratified squamous epithelium
  - Submucosa (skeletal connective tissue)
- Muscularis externa
  - Circular layer
  - Longitudinal layer
- Adventitia (fibrous connective tissue)

(a) Cross section through esophagus (5x)
(b) Gastroesophageal junction, longitudinal section (85x)
The Stomach

- Site where food is churned into chyme
- Protein digestion begins
- Secretes pepsin
  - Functions under acidic conditions

The Stomach

The Stomach—Microscopic Anatomy

Figure 23.17a

Figure 23.17b

Figure 23.17c

Figure 23.17d
The Small Intestine – Gross Anatomy

- Longest portion of the alimentary canal
- Site of most enzymatic digestion and absorption
- Three subdivisions
  - Duodenum
    - Brunner’s glands
  - Jejunum
  - Ileum
    - Peyer’s patches

The Small Intestine—Structural Features

- Vein carrying blood to hepatic portal vessel
- Muscle layers
- Circular folds
- Villi
- Lumen
- Absorptive cells
- Lacteal
- Intestinal crypt
- Mucosa associated lymphoid tissue
- Muscularis mucosae
- Duodenal gland
- Submucosa
- Enteroendocrine cells
- Venule
- Lymphatic vessel
- Microvilli (brush border)
- Goblet cell
- Blood capillaries
- Vilus
- Intestinal crypt
- Absorptive cells
- Goblet cells

The Duodenum

- Receives digestive enzymes and bile
- Main pancreatic duct and common bile duct enter duodenum
  - Sphincters control entry of bile and pancreatic juices
The Duodenum and Related Organs

The Large Intestine
- Digested residue contains few nutrients
- Small amount of digestion by bacteria
- Main functions – absorb water and electrolytes
- Mass peristaltic movements force feces toward the rectum

Gross Anatomy of Large Intestine
- Subdivided into:
  - Cecum, vermiform appendix, colon, rectum, anal canal
- Special features of large intestine
  - Teniae coli, haustra, and epiploic appendages
- Cecum – a blind pouch
- Vermiform appendix – contains lymphoid tissue
  - Neutralizes pathogens
- Colon – divided into distinct segments
  - Ascending, transverse, descending, and sigmoid colon
- Rectum – descends along the inferior half of the sacrum
- Anal Canal – the last subdivision of the large intestine
**Gross Anatomy of Large Intestine**

- Right colic (hepatic) flexure
- Transverse colon
- Superior mesenteric artery
- Haustrum
- Descending colon
- Ileocecal valve
- Cecum
- vermiform appendix
- Convergent edge of mesentery
- Sigmoid colon
- External anal sphincter
- Anal canal
- External anal sphincter
- Levator ani muscle
- Hemorrhoidal veins
- Internal anal sphincter
- Anal columns
- Anal valves
- Pectinate line
- Anal sinuses
- Anus

**Microscopic Anatomy of Large Intestine**

- Villi are absent
- Contains numerous goblet cells
- Intestinal crypts – simple tubular glands
- Lined with simple columnar epithelial tissue
- Epithelium changes at anal canal
  - Becomes stratified squamous epithelium
The Liver

- Largest gland in the body
- Performs over 500 functions
- Digestive function – bile production
- Performs many metabolic functions

Visceral Surface of the Liver

Microscopic Anatomy of Liver
The Gallbladder

- Stores and concentrates bile
- Expels bile into duodenum
  - Bile emulsifies fats
- Cholecystokinin—released from enteroendocrine cells in response to fatty chyme

The Pancreas

- Pancreatic duct penetrates duodenal wall
- Endocrine functions
  - Insulin (beta cells) and glucagons (alpha cells)
- Exocrine functions—Acinar cells make, store, and secrete pancreatic enzymes
  - Majority of pancreatic secretions
  - Pancreatic juice secreted into small intestine
    - Carbohydrases
    - Lipases
    - Nucleases
    - Proteolytic enzymes
Disorders of the Digestive System

- Intestinal obstruction
  - Mechanical obstructions
    - Adhesions, tumors, or foreign objects
  - Nonmechanical obstruction
    - Halt in peristalsis
      - Trauma
    - Intestines touched during surgery

Disorders of the Digestive System

- Inflammatory bowel disease
  - Inflammation of intestinal wall
    - Crohn’s disease
    - Ulcerative colitis
  - Viral hepatitis – jaundice and flu-like symptoms
    - Major types – A, B, C, and G
  - Cystic Fibrosis and the Pancreas
The Digestive System in Later Life

- Middle age – gallstones and ulcers
- Old age – activity of digestive organs decline
  - Fewer digestive juices and enzymes produced
  - Absorption is less efficient
  - Dehydration of fecal mass leads to constipation
  - Diverticulosis and cancer of digestive organs