

CHAPTER 24 DIGESTIVE SYSTEM

CHAPTER OVERVIEW: This chapter describes the location, structure and functions of the organs of the digestive system. The neuronal, hormonal and local controls of smooth muscle motility and digestive gland secretion are described and explained for each major region of the digestive tract. The functions of the digestive secretions from each organ are considered in detail. The roles of the digestive system in the maintenance of homeostasis are reviewed. How the major nutrients are digested, absorbed, and transported, is reviewed.

OUTLINE (two to four fifty-minute lectures):
Seeley, A&P, 5/e

apt. ject.	Topic Outline, Chapter 24	Figures & Tables	Transparen Acetates
	I. General Overview, p. 782 A. Digestive Tract; Alimentary Tract; Alimentary Canal = Mouth to Anus (G.I. Tract = Stomach & Intestines only) B. Accessory Organs	Fig. 24.1, p.782	TA-492
1	II. Anatomy Overview, p. 782	Fig. 24.1, p.782	TA-492
2	III. Histology Overview, p. 782 1. Types of Glands a. Unicellular b. Multicellular Glands within Tract Wall c. Multicellular Glands outside of Tract (Accessory Glands) A. Mucosa Mucous Epithelium, Lamina Propria, Muscularis Mucosae B. Submucosa - Connective Tissue, Nerves, Blood Vessels, Glands C. Muscularis - Longitudinal and circular Smooth Muscle, Myenteric Plexus D. Serosa or Adventitia - Connective Tissue	Fig. 24.2, p.783	TA-493
3	IV. Physiology Overview, p. 784 A. Ingestion - Taking in Food B. Mastication - Chewing, Mechanical Digestion C. Propulsion - Movement Through Tract; Peristalsis D. Mixing - Mechanical digestion, Aids Chemical Digestion E. Secretion - Lubricate, Liquify and Chemically digest F. Digestion - Breakdown into Components by Mechanical and Chemical Means G. Absorption - Transport (From Tract to Blood, Lymph) by simple Diffusion, Facilitated Diffusion, Active Transport, and Cotransport H. Transportation - Distribution Throughout Body I. Elimination - Removal of Waste Products of Digestion,	Table 24.1, p.785 Table 24.2, p.786 Fig. 24.3a, p.786 Fig. 24.3b, p.786	

Defecation

J. Regulation - Coordination of Activities by Nerves (Vagus Nerve) and Hormones

V. Anatomy and Histology of the Digestive Tract, p. 786

4	A. Oral Cavity		
	1. Boundaries		
	a. Anterior – Lips		
	b. Posterior – Fauces		
	c. Lateral – Cheeks		
	d. Superior – Palate (Hard & Soft)		
	e. Inferior – Tongue and Muscular Floor		
	f. Regions		
	1). Vestibule = Between Lips/Cheeks and Alveolar Processes		
	2). Oral Cavity Proper = Medial to Alveolar Processes		
	2. Lips and Cheeks	Fig. 24.4, p.787	
	a. Buccinator Muscle and Buccal Fat Pad		
	b. Important in Mastication and Speech		
	3. Tongue	Fig. 24.4, p.787	
	a. Frenulum	Clinical Notes 1-3, pp.787-788	
	b. Intrinsic and Extrinsic Muscles		
	c. Papillae		
	d. Functions in Speech, Taste, Mastication, Swallowing		
5	4. Teeth		
	a. Deciduous and Permanent	Fig. 24.5, p.788	
	b. Tooth Structure	Clinical Note, p.788	
	1). Root, Neck, Crown	Fig. 24.6, p.789	TA-494
	2). Pulp with Vessels and Nerves	Clinical Note, p.789	
	3). Dentin, Enamel, Periodontal Ligaments		
	5. Muscles of Mastication	Fig. 11.8, p.321	TA-200
	a. Mandible to Skull - Masseter, Temporal		
	b. Floor to Roof of Mouth - Medial and Lateral Pterygoids		
	6. Palate and Palatine Tonsils	Fig. 24.4a, p.787	
6	7. Salivary Glands	Fig. 24.7, p.790	TA-495
	a. Parotid Glands	Clinical Notes 1 & 2, p.790	
	b. Submandibular Glands		
	c. Sublingual Glands		
	B. Pharynx Nasopharynx, Oropharynx, and Laryngopharynx	Predict Quest. 1	
7	C. Esophagus		
	1. Length - 25 cm		

	2. Muscle Layers = Skeletal Muscle in Superior Portion, Smooth Muscle in Inferior Portion		
	3. Upper and Lower Esophageal Sphincters	Clinical Note, p.791	
	4. Mucosal Lining = Moist Stratified Squamous Epithelium with Mucous Glands in Submucosa		
8	D. Stomach	Fig. 24.8, p.792	TA-496
	1. Stomach Anatomy		
	a. Gastropharyngeal Opening and Cardiac Sphincter		
	b. Greater and Lesser Curvatures		
	c. Pyloric Region, Opening and Sphincter	Clinical Note, p.791	
	2. Stomach Histology		
	a. Serosa = Visceral Peritoneum		
	b. Muscularis has Three Layers	Fig. 24.8a, p.792	TA-496
	c. Rugae		
	d. Gastric Pits and Glands	Fig. 24.8b,c, p.792	TA-496
	1). Surface Mucous Cells		
	2). Mucous Neck Cells		
	3). Parietal Cells, Produce Hydrochloric Acid and Intrinsic Factor		
	4). Chief Cells, Produce Pepsinogen		
	5). Endocrine Cells, Produce Regulatory Hormones		
	e. Simple Columnar Epithelium		
9	E. Small Intestine	Fig. 24.9, p.793	
	1. Length = 4.6 to 9 m		
	2. Duodenum	Fig. 24.10, p.794	TA-497
	a. 180° Arc		
	b. Papillae		
	1). Greater Duodenal Papilla and Hepatopancreatic Ampulla		
	2). Lesser Duodenal Pa-pilla and Accessory Pan-creatic Duct		
	c. Modifications that Increase Surface Area	Fig. 24.11, p.795	TA-498
	1). Plica Circularis		
	2). Villi		
	3). Brush Borders and Microvilli		
	d. Mucosa = Simple Columnar Epithelium		
	1). Absorptive Cells		
	2). Goblet Cells		
	3). Granular Cells		
	4). Endocrine Cells		
	e. Intestinal Glands		
	3. Jejunum and Ileum	Fig. 24.9, p.793	
10	F. Liver		
	1. Liver Anatomy	Fig. 24.12, p.796	TA-499
	a. Largest Internal Organ - 1.36 Kg		
	b. Four Lobes - Right, Left, Caudate and Quadrata		
	c. Porta - Inferior Surface		

- 1). Blood Vessels
 - a). Hepatic Portal Vein
 - b). Hepatic Artery
 - 2). Lymphatic Vessels
 - 3). Nerves
 - 4). Ducts
 - a). Two Hepatic Ducts Combine to Form Common Hepatic Duct
 - b). Join with Cystic Duct to Form Common Bile Duct
- Fig. 24.13, p.797 TA-500
- 2. Liver Histology
 - a. Connective Tissue Capsule and Bare Area
 - b. Lobule Structure - Hexagonal
 - 1). Central Veins - Blood Leaving Liver
 - 2). Portal Triads at Corners
 - a). Hepatic Duct - Bile Leaving Liver
 - b). Hepatic Portal Vein - Blood Entering Liver
 - c). Hepatic Artery - Blood Entering Liver
 - 3). Hepatic Cords of Hepatocytes Between
 - 4). Hepatic Sinusoids - Mixing of Venous and Arterial Blood
 - a). Endothelial Cells
 - b). Hepatic Phagocytic Cells (Kupffer Cells)
- Clinical Note, p.798
Fig. 24.12c, p.796 TA-499
Fig. 24.12d, p.796 TA-499
- G. Gallbladder
 - 1. Size - 8 cm. X 4 cm.
 - 2. Wall Structure
 - a. Mucosa with Rugae
 - b. Muscularis of Smooth Muscle
 - c. Outer Serosa
- Fig. 24.13, p.797 TA-500
- H. Pancreas
 - 1. Structure - Head, Body, Tail
 - 2. Endocrine Portion - Pancreatic Islets
 - 3. Exocrine Portion - Acini
 - a. Interlobular Ducts
 - b. Pancreatic Duct to Hepatopancreatic Ampulla
- Fig. 24.10, p.794 TA-497
Fig. 24.13, p.797 TA-500
- I. Large Intestine
 - 1. Cecum and Vermiform Appendix
 - 2. Colon
 - a. Size = 1.5 - 1.8 m.
 - b. Parts
 - 1). Ascending Colon
 - 2). Descending Colon
 - 3). Transverse Colon
 - 4). Sigmoid Colon
 - c. Incomplete Longitudinal Muscle Layer
 - 1). Teniae Coli
 - 2). Haustra
 - d. Epiploic Appendages
- Fig. 24.14, p.799 TA-501
Fig. 24.15, p.800 TA-502
Clinical Note, p.798

	e. Crypts = Tubular Glands		
	3. Rectum		
	4. Anal Canal with Internal and External Anal Sphincters	Clinical Note, p.799	
12	J. Peritoneum		
	1. Serous Membranes	Clinical Note, p.800	
	2. Visceral Peritoneum and Parietal Peritoneum		
	3. Mesenteries	Fig. 24.16, p.801	TA-503
	a. Retroperitoneal Organs		
	b. Greater Omentum	Predict Quest. 2	
	c. Lesser Omentum		
	d. Omental Bursa		
	e. Coronary and Falciform Ligaments		
	f. Mesentery Proper		
	1). Transverse Mesocolon		
	2). Sigmoid Mesocolon		
	3). Mesoappendix		
	VI. Functions of the Digestive System, p. 801	Table 24.3, p.802	
	1. Movement, Secretion, and Absorption	Systemic Inter-	
	2. Regulation is Neural and Hormonal	actions, p.826	
13	A. Functions of the Oral Cavity		
	1. Secretions of the Oral Cavity, 1-1.5 L / Day		
	a. Serous Saliva		
	b. Salivary Amylase		
	c. Lysozyme		
	d. Mucin		
	e. Primarily Parasympathetic Control		
14	2. Mastication		
	a. Chewing = Mastication		
	b. Mastication Reflex Integrated in Medulla Oblongata		
14	B. Deglutition	Fig. 24.17, p.804	TA-504
	a. Swallowing = Deglutition		
	b. Voluntary Phase		
	c. Pharyngeal Phase (1-2 sec.)		
	1). Reflex Stimulus = Tactile Receptors in Oropharynx		
	2). Afferent – Cranial Nerves V, IX		
	3). Swallowing Center in Medulla Oblongata		
	4). Efferent – Cranial Nerves V, IX, X, XI		
	5). Effectors are Pharyngeal Constrictor Muscles	Predict Quest. 3; Predict Quest. 4	
	d. Esophageal Phase (5-8 sec.)	Fig. 24.17e, p.804	TA-504
	1). Peristaltic Waves	Clinical Note, p.805	
	2). Stimulus = Bolus in Upper Esophagus		
	3). Intramural Nerve Plexus		
15	C. Stomach Functions		
	1. Secretions of the Stomach (2 -3 L/ Day)	Clinical Note, p.805 Table 24.3, p.802 Table 24.4, p.807	

	a. Mucus - Surface Mucous Cells and Mucous Neck Cells		
	b. Hydrochloric Acid – Parietal Cells	Fig. 24.18, p.806	
	c. Gastrin - Endocrine Cells	Predict Quest. 5	
	d. Intrinsic Factor - Parietal Cells		
	e. Pepsinogen - Chief Cells		
	2. Regulation of Stomach Secretion	Clinical Focus, p.809	
	a. Neural Mechanisms		
	b. Hormonal Influences	Table 24.4, p.807	
		Clinical Note, p.806	
16	c. Phases		
	1). Cephalic Phase	Fig. 24.19a, p.808	TA-506
	2). Gastric Phase	Fig. 24.19b, p.808	TA-507
	3). Intestinal Phase	Fig. 24.19c, p.808	TA-508
	3. Stomach Filling		
	4. Mixing of Stomach Contents - Formation of Chyme	Fig. 24.20, p.810	
	a. Mixing Waves (80%)		
	b. Peristaltic Waves (20%)		
	5. Stomach Emptying	Clinical Note, p.810	
	a. Time		
	1). Liquids = 1.5-2.5 hrs.		
	2). Meal = 3-4 hrs.		
	b. Pyloric Pump		
17	6. Regulation of Stomach Movements	Clinical Note, p.810	
	a. Coordinated with Control of Secretion		
	b. Too Fast or Slow Impairs Normal Absorption		
18	D. Functions of the Small Intestine		
	1. Secretions of the Small Intestine	Table 24.3, p.802	
		Table 24.4, p.807	
	a. Primarily Mucus, Electrolytes, and Water from Intestinal Mucosa	Clinical Note, p.812	
	b. Hormones - Secretin and Cholecystokinin		
	c. Digestive Enzymes Bound to Microvilli – Disaccharidases, Peptidases and Nucleases		
	2. Movement in the Small Intestine - 3-5 hr. from Pylorus to Ileocecal Valve		
	a. Segmental Mixing Contractions	Fig. 24.3b, p.786	
	b. Peristaltic Propulsive Contractions	Fig. 24.3a, p.786	
	c. Local Neural and Chemical Signals		
	3. Absorption from the Small Intestine		
	a. Nutrients		
	b. Water from Food and from Digestive Secretions		
19	E. Liver Functions - Most by Hepatocytes	Clinical Note, p.813	
	1. Bile Production		
	a. 600-1000 ml / Day		
	b. Functions		
	1). Bile Salts - Emulsify Fats		
	2). Contains Bilirubin and Other Excretory Products		
	c. Control	Fig. 24.21, p.811	TA-509
	2. Nutrient Storage - Glycogen, Fat Soluble Vit., Fat,		

	Iron, and Copper		
	3. Nutrient Interconversion - Hepatocytes		
	4. Detoxification - Hepatocytes		
	5. Phagocytosis – Kupffer Cells		
	6. Synthesis – Especially Plasma Proteins		
19	F. Functions of the Gallbladder		
	1. Temporary Bile Storage (40 -70 ml.)		
	2. Control	Fig. 24.21, p.811	TA-509
	3. Gallstones	Clinical Note, p.809	
19	G. Functions of the Pancreas	Clinical Note, p.810	
	1. Formation of Pancreatic Juice		
	a. Aqueous Component with High Bicarbonate Ion Concentration	Fig. 24.22, p.814	TA-510
	b. Pancreatic Enzymes	Table 24.3, p.815 Table 24.4, p.807	
	1). Proteolytic Enzymes		
	2). Pancreatic Amylase		
	3). Lipases		
	4). Deoxyribonucleases and Ribonucleases		
	2. Control of Pancreatic Secretion	Fig. 24.23, p.815	TA-511
	a. Neural Controls – Parasympathetic and Sympathetic		
	b. Secretin and Cholecystokinin	Predict Quest. 6	
20	H. Functions of the Large Intestine		
	1. Transit Time = 18 -24 hr.	Clinical Note, p.816	
	2. Secretions of the Large Intestine	Table 24.3, p.802	
	a. Primarily Mucus	Clinical Note, p. 816	
	b. Bicarbonate/Chloride Exchange		
	3. Water Reabsorption with Na ⁺ /Cl ⁻ Gradient		
	4. Symbiotic Bacteria		
	a. 30% of Dry Weight Feces		
	b. Vit. K Production		
	c. Flatus		
	5. Movement in the Large Intestine	Fig. 24.24, p.817	TA-512
	a. Mass Movements		
	b. Gastrocolic Reflexes		
	c. Duodenal Reflexes		
	d. Defecation Reflex Aided by Voluntary Movements	Clinical Note, p.817	
21	VII. Digestion, Absorption, and Transport, p. 817	Table 24.5, p.818 Clinical Focus, p.824	
	A. Carbohydrates		
	1. Digestion	Clinical Note 1, p.818	
	a. Amylases		
	b. Disaccharidases in Intestinal Epithelium		
	2. Absorption and Transport	Fig. 24.25, p.819 Clinical Note 2, p.818	TA-513
	a. Sodium Cotransport Mechanism		
	b. Role of Insulin		

B. Lipids			
1. Emulsification by Bile Salts		Clinical Note, p.819	
2. Digestion by Pancreatic Lipases			
3. Absorption			
a. Micelle Formation			
b. Simple Diffusion Across Intestinal Epithelium	Fig. 24.26, p.820		TA-514
c. Formation of Chylomicrons = 85% Triacylglycerol, 7% Cholesterol, 7% Phospholipid, and 1% Protein			
4. Lipid Transport - in Lacteals	Fig. 24.27, p.821		TA-515
a. Lipoproteins	Fig. 24.28, p.822		
1). Very Low Density Lipoproteins (VLDL)	Fig. 24.29, p.822		
2). Low-Density Lipoprotein (LDL) to Cells Receptor-Mediated Endocytosis	Fig. 24.28, p.822		
3). High-Density Lipoproteins (HDL) Back to Liver for Recycling or Disposal	Clinical Note, p.820		
C. Proteins		Table 24.5, p.818	
1. Digestion			
a. Pepsin			
b. Pancreatic Peptidases to Small Peptides			
c. Tripeptides, Dipeptides and Amino Acids by Peptidases on Intestinal Epithelium			
2. Absorption			
a. Separate Sodium Cotransport Mechanisms for Acidic, Basic and Neutral Amino Acids			
b. Most Enter as Di- and Tri-peptides			
c. Final Digestion to Single Amino Acids is Intracellular to Hepatic Portal System	Fig. 24.30, p.823		TA-516
3. Uptake by Other Cells = Active Transport under Hormonal Control			
D. Water			
1. 92% Absorbed in Small Intestine, 6-7% Absorbed in Large Intestine	Fig. 24.31, p.823		TA-517
2. Direction of Diffusion Determined by Osmotic Gradients			
E. Ions			
1. Active Transport of Sodium, Potassium, Magnesium, and Phosphate			
2. Passive Diffusion of Chloride Following Sodium; Active Transport of Chloride in Ileum			
3. Active Transport of Calcium Requires Vit. D and is Under Hormonal control			

VIII. Systems Pathology: Diarrhea, p. 825

Predict Quest. 7

IMPORTANT CONSIDERATIONS: If there are only two lectures available for the discussion of the digestive tract, the details of the anatomy should be left for the laboratory and the lectures should concentrate on the functions and controls of the parts of the tract, followed by discussion of the specific digestion and absorption of the major nutrients. If there are four lecture sessions available, then more discussion of the overall structure and function of the digestive system is possible as well as more in-depth coverage of the regulatory mechanisms.

SEE INSTRUCTOR'S MANUAL AND COURSE SOLUTIONS MANUAL FOR ADDITIONAL RESOURCES.