Digestive System

A. 2 parts

1. Gastrointestinal (GI) Tract

A) Tubular structure from mouth to anus

2. Accessory Structures

A) Teeth, tongue, salivary glands, liver, gallbladder & pancreas

B. 6 basic processes

1. Ingestion

2. Secretion

3. Propulsion

4. Digestion (catabolism)

A) Mechanical digestion

1) Chewing, mixing with tongue, churning in stomach, segmentation in small

intestine, and haustral churning in large intestine

B) Chemical digestion

1) Breakdown by enzymes

5. Absorption

6. Defecation

C. Anatomy of the Digestive System

1. Oral cavity (mouth)

A) Oral orifice – opens to outside

B) Lips & cheeks

1) Make up anterior and lateral walls of oral cavity

2) Composed of a core of skeletal muscle covered by skin

3) Lined with nonkeratinized stratified squamous

4) Aid in chewing, keeping food within oral cavity, and speech

C) Palate

1) Forms superior aspect of the oral cavity (roof of mouth)

2) 2 distinct portions

a) Hard palate – anterior portion

i) Composed of the maxilla & palatine bones

ii) Tongue forces food against it during chewing

b) Soft palate – posterior portion

i) Soft, mobile flap that raises to block the nasopharynx during swallowing

ii) Composed of a core of skeletal muscle

iii) Uvula – finger-like projection of the soft palate; function unclear

D) Tongue

1) Makes up inferior aspect of oral cavity

2) Moves food around during mastication (chewing) and swallowing

3) Essential for speech production

4) Contains taste buds – receptors for various food taste sensations

5) Lingual frenulum – connect tongue to floor of mouth

6) Papillae – small elevations on surface of tongue

a) Aid in handling of food in mouth

b) Contain taste buds & touch receptors

c) 3 types of papillae

i) Filiform – cone-shaped

(a) Most numerous

(b) Sensitive to touch

ii) Fungiform – mushroom-shaped

(a) Taste buds located on top of the papillae

iii) Circumvallate – resemble fungiform but larger with surrounding furrow

(a) Taste buds located on the sides of the papillae

2. Salivary glands – produces saliva (pH = 6.75-7.0)

A) Intrinsic salivary glands – small

1) Scattered within mucosa of tongue, palate, lips & cheeks

2) Secrete saliva to keep mouth moist

B) Extrinsic salivary glands – large

1) Lie external to oral cavity & secrete saliva into ducts leading to mouth

2) Only secrete saliva as we eat; contains digestive enzymes

3) 3 types

a) Parotid – lies slightly anterior & inferior to the ear

b) Submandibular – on medial surface of mandible, just anterior to mandibular

angle

c) Sublingual – floor of mouth just inferior to tongue

3. Teeth

A) 2 categories

1) Deciduous (baby teeth) – 20

a) Lost between ages of 6 & 12

2) Permanent – 32 (including 3rd molars – wisdom teeth)

B) 4 types

1) Incisors (8) – chisel-shaped

2) Canines (4) – cone-shaped

3) Premolars (bicuspids) (8) – broad crown (top) with two rounded cusps (bumps)

4) Molars (12) – broad crown & four rounded cusps

C) Vascular & innervated

D) Tooth structure

1) Crown

a) Portion above gum (gingiva)

b) Covered in enamel

2) Root

a) Embedded in jaw

b) Covered by cementum – calcified connective tissue

i) Attaches tooth to the periodontal ligament – connects tooth to jaw

3) Neck

a) Narrowed region between crown & root

4) Dentin

a) Bone-like substance; makes up majority of the tooth

5) Pulp cavity

a) Located within the dentin; houses blood vessels & nerves

6) Root canal

a) Extends from pulp cavity to proximal end of tooth; passageway for blood

vessels & nerves

7) Apical foramen

a) Opening at the proximal end of the tooth; allows blood vessels & nerves to

enter and leave the tooth

4. Pharynx

A) Passageway from mouth to esophagus; smooth muscles within propel food towards the esophagus

B) Oropharynx – portion connected to oral cavity

C) Laryngopharynx – portion connected to larynx & esophagus

5. Esophagus

A) Passageway for food from pharynx to stomach

B) Associated structures

1) Esophageal hiatus – passageway through the diaphragm

2) Cardiac orifice – opening between esophagus and stomach

3) Cardiac sphincter – muscle that closes off to prevent backflow from stomach into

esophagus

C) Lines with nonkeratinized stratified squamous epithelium

6. Stomach

A) Lined with simple columnar epithelium

B) Regions

1) Cardiac region – encircles the cardiac orifice at junction w/ esophagus

2) Fundus – dome-shaped, tucked under diaphragm

3) Body – large mid-portion of stomach

4) Pyloric region – terminal region of stomach

a) Pyloric sphincter – controls entry of chyme (food) into S.I.

C) Rugae – longitudinal folds in the mucosa

D) Within the wall are a large number of gastric glands (pits)

1) Produce gastric juice (pH = 1.5-3.5)

2) Contain 4 cells types

a) Goblet cells – produce an acidic mucus unique to the stomach

b) Parietal cells – produce HCl-

c) Chief cells – produce pepsinogen (inactive form of pepsin)

d) Enteroendocrine cells – produces gastrin

i) Released when food enters the stomach

ii) Stimulates the secretion of HCl- and pepsinogen

7. Small intestine

A) Longest part of tubular gut (6-7 meters relaxed, 2-4 meters normally)

B) Possesses villi – finger-like projections of the mucosa

1) Contain capillaries and lacteals

C) Lined with simple columnar epithelium; ciliated with goblet cells

1) Possess microvilli – finger-like projection of the columnar cells

D) 3 segments

1) Duodenum (~5%)

a) Receives pancreatic enzymes via the main pancreatic duct, bile via the bile

duct, and chyme from the pyloric region of the stomach

2) Jejunum (~ 40%)

3) Ileum (~ 55%)

a) Empties into the cecum (large intestine)

8. Large intestine

A) Lined with simple columnar epithelium; ciliated with goblet cells

B) Subdivisions

1) Cecum – sac-like portion inferior to ileocecal valve

a) Ileocecal valve – located at junction of ileum and cecum; controls the

movement of chyme into L.I.

2) Colon – composed of sac-like pockets known as haustra

a) Ascending colon – moves upward along right posterior abdominal wall up to

kidney

b) Transverse colon – extends to the left across abdominal cavity

c) Descending colon – moves downward along left posterior abdominal wall

d) Sigmoid colon – S-shaped terminal end of colon

3) Rectum – passageway from sigmoid colon to anal canal (anus)

a) Anal canal (anus) – terminal portion of L.I.

i) Opens to outside of body

(a) Internal anal sphincter – smooth muscle

(b) External anal sphincter – skeletal muscle

9. Liver

A) Largest gland in the body

B) Produces bile – green, alkaline (basic) liquid stored in the gallbladder

1) Partially a digestive product & partially an excretory product

a) Bile salts – necessary for lipid digestion & absorption

b) Bilirubin – created by the breakdown of RBC

C) 2 surfaces

1) Diaphragmatic (anterior) – divided into 2 lobes by the falciform ligament

a) Right lobe

b) Left lobe

2) Visceral (posterior)

a) Caudate lobe – superior

b) Quadrate lobe – inferior

D) Hepatic artery – carries oxygenated blood from heart to liver

E) Hepatic vein – carries deoxygenated blood from liver to heart

F) Hepatic portal vein – carries blood from stomach & intestines to liver

G) Hepatic ducts – carry bile

1) Right – from right lobe

2) Left – from left lobe

3) Common hepatic – created by a merging of the right & left hepatic ducts

10. Gallbladder

A) Small (~ 4 inches) sac located on the visceral surface of the liver

B) Lined with simple columnar epithelium

C) Stores & concentrates bile

D) Cystic duct – carries bile to & from gallbladder

1) Merges with common hepatic duct to form the bile duct

2) Bile duct – carries bile to duodenum

11. Pancreas

A) Endocrine & exocrine organ

B) Tadpole-shaped

1) Consists of a head, body & tail

C) Produces pancreatic juice (pH = 8.0)

1) Contains many of the enzymes used by the S.I. for digestion

2) Produced by the aciner cells

a) Acini – clusters of aciner cells

D) Accessory pancreatic duct – lies at head on pancreas and merges with main

pancreatic duct

E) Main pancreatic duct – merges with bile duct and empties into the duodenum

1) Release of bile & pancreatic juice controlled by hepatopancreatic sphincter

D. Digestion & Absorption

1. Mouth

A) Mechanical digestion

1) Chewing and rolling of food into bolus

B) Chemical digestion

1) Salivary amylase

a) Starts breakdown of starch

2) Lingual lipase

a) Starts breakdown of dietary triglycerides

C) Normally no absorption occurs

D) Swallowing

1) 3 phases

a) Voluntary phase

b) Pharyngeal phase

c) Esophageal phase

2. Esophagus

A) Enzymes from the mouth are still working

B) Secretes no enzymes only mucus

C) No absorption

D) Peristalsis

1) Wave-like, smooth muscle contractions that move foodstuffs through the GI tract

3. Stomach

A) Mechanical digestion

1) Churning (smooth muscle contractions) mixes bolus with gastric juices yielding

chyme

B) Chemical digestion

1) HCl-

a) Inactivates salivary amylase & lingual lipase

b) Initiates protein catabolism by unfolding protein structure & activating pepsin

2) Pepsin

a) Produced when HCl- activates pepsinogen

b) Begins breakdown of peptide bonds

C) Very little absorption

1) Water, ions, aspirin, and alcohol

D) Releases chyme into S.I. in small amounts over a period of time (~4 hours)

4. Small Intestine

A) Digestion

1) Mechanical digestion

a) Peristalsis

b) Segmentation

i) Oscillating, ring-like, smooth muscle contractions

(a) Mixes chyme with digestive juices

(b) Brings digestive products into contact with mucosa helping absorption

2) Chemical digestion

a) CHO catabolism – desirable end product is glucose in all cases (however,

sometimes the end product is fructose or galactose)

i) Brush border enzymes (released from the small intestine itself)

(a) Glucoamylase

(b) Dextrinase

(c) Maltase

(d) Sucrase

(e) Lactase

ii) Pancreatic enzymes

(a) Pancreatic amylase

b) Protein catabolism – desirable end product is a single amino acid

i) Brush border enzymes

(a) Carboxypeptidase

(b) Aminopeptidase

(c) Dipeptidase

ii) Pancreatic enzymes

(a) Trypsin & chymotrypsin

(b) Carboxypeptidase

c) Lipid catabolism – desirable end products are 2 fatty acids & 1

monoglyceride or 3 fatty acids and 1 glycerol

i) Bile salts

(a) Emulsification

ii) Pancreatic lipase

B) Absorption – about 90% of all absorption occurs here

1) CHO absorption (monosaccharides; glucose, fructose, galactose)

a) Fructose

i) Facilitated diffusion

b) Glucose & galactose

i) Secondary active transport with Na+ (cotransport)

2) Protein absorption (individual amino acids)

a) Secondary active transport with Na+  (cotransport)

3) Lipid absorption (monoglycerides & fatty acids)

a) Aided by the actions of bile

i) Bile salts & lecithin bind with fatty acids & monoglycerides forming small

clusters known as micelles

(a) Micelles are absorbed into the columnar cells where triglycerides

reform

ii) Triglycerides are coated with phospholipids & cholesterol resulting in

chylomicrons

iii) Chylomicrons are then absorbed into the lacteals by simple diffusion

C) Chyme may spend up to 4 hours in the small intestine

5. Pancreas

A) Accessory to the S.I.

B) Produces:

1) Pancreatic juice

a) Buffers the acidic chyme coming from the stomach

i) Stops the action of pepsin

2) Pancreatic enzymes

a) Work in small intestine

6. Liver

A) Accessory to the S.I.

B) Many functions

1) Plasma protein production

2) Removal of drugs & hormones

3) Fat-soluble vitamin storage

4) Produces & stores glycogen

5) Phagocytosis of worn/old RBC

a) Results in the production of bilirubin

6) Synthesis of bile salts

7) Produces bile

a) Yellow-green, alkaline solution containing bile salts, bilirubin, cholesterol,

lecithin & and a number of electrolytes

b) Involved with lipid catabolism & absorption

7. Gallbladder

A) Stores & concentrates bile by absorbing water & ions

B) Releases bile into S.I. in response to the release of cholecystokinin (CCK)

1) Released from intestinal lining in response to fatty chyme entering the duodenum

8. Large Intestine

A) Digestion

1) Mechanical digestion

a) Peristalsis at a slow rate

b) Haustral churning

i) Contraction of an individual haustrum

c) Mass peristalsis

i) Strong wave beginning in transverse colon and pushing contents into

rectum

2) Chemical digestion

a) No enzymes secreted, just mucus

b) Bacteria living in L.I. finish digestion

i) Ferment CHO – provide themselves with energy

ii) Some B vitamins & vitamin K are end products of bacterial action

B) Absorption

1) Water

2) Electrolytes (Na+ & Cl-)

3) Vitamins

C) Chyme may remain in the large intestine for 3-10 hours

D) Defecation

1) Lumbar reflex initiated when feces enters the rectum

2) Impulses travel back to internal anal sphincter as well as to the cerebral cortex

a) Internal anal sphincter relaxes allowing feces into the anus

3) Cerebral cortex fires causing external anal sphincter to relax and the rectal

muscles to contract

E. Disorders of the Digestive System

1. Peritonitis – inflammation of the peritoneum

2. Mumps – swollen parotid glands as a result of a virus (Myxovirus)

3. Heartburn – failure of the cardiac sphincter to remain closed

4. Hiatal hernia – upper portion of the stomach protrudes above the diaphragm

5. Gastric (or Peptic) ulcers – erosion of the stomach (or small intestine) wall associated

with the *Helicobacter* bacteria

6. Enteritis – inflammation of either intestine; however usually the small intestine

7. Hepatitis – inflammation of the liver as a result of a viral infection (A-E, G)

8. Cirrhosis – chronic inflammation of the liver due to alcoholism or hepatitis

9. Gallstones – highly concentrated cholesterol derivatives in bile

10. Jaundice – accumulation of bilirubin in the skin as a result of a blockage or liver

disease resulting in a yellow skin color