Digestive system

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Components

- Oral cavity
- Alimentary Canal
- Accessory organs
  - teeth
  - salivary glands
  - liver
  - gall bladder
  - pancreas
  - appendix
Functions

- Motility
- Secretion
- Digestion
- Absorption
Terminology

- **Ingestion**
  - to take in food
- **Mastication**
  - chewing (mechanical breakdown of food)
- **Deglution**
  - swallowing
- **Digestion**
  - chemical breakdown of food
- **Absorption**
  - passage of nutrients from the gi tract lumen to the blood
- **Peristalsis**
  - Waves of smooth muscle contraction to propel food
- **Defecation**
  - formation and excretion of solid waste
Digestive tract tunics

Slide 49 Esophagus

- Mucosa
- Submucosa
- Muscularis externa
- Adventitia
Digestive tract tunics
Mucosa

- Absorptive layer, large surface area
- 3 major components
  - mucosal epithelium
    - columnar epithelium (stomach, intestines) or stratified squamous
    - Crypts of Leiberkuhn
      - folds in the mucosa, source of new epithelial cells
  - lamina propria
    - loose CT of the mucosa, with capillaries that receive absorbed nutrients
    - lymphatic tissue: capillaries and lymphatic nodules involved in absorption of fat
    - Peyer’s Patches: aggregates of lymph nodes, significant protection against intestinal infections
  - muscularis mucosae
    - a thin layer of smooth muscle that keeps the folds of the mucosa folded
Submucosa, Muscularis Externa, Serosa

• **submucosa**
  - tissue: dense irregular CT
  - Meissner’s plexus
    • nerve supply to the muscularis mucosae

• **muscularis externa**
  - mainly a double layer of smooth muscle, propels and mixes digestive contents
    • circular layer: thick inner layer, muscle fibers describe a circle
    • longitudinal layer: thin outer layer, muscle fibers run along the length of the GI tract
  - Auerbach’s plexus: nerve supply to the muscularis externa

• **Serosa**
  - loose CT + simple squamous epithelium
  - outer wall of the GI tract, visceral peritoneum,
Mouth and Pharynx

• Tongue
  - a muscular soft organ, involved in moistening/mixing food, taste, speech

• lingual tonsils
  - aggregates of lymph nodes located on the posterior/superior aspect

• frenulum linguæ
  - an inferior attachment of the tongue to the lower jaw

• Papillae
  - microscopic folds in the tongue containing taste buds
teeth

Enamel
Dentin
Pulp in pulp cavity
Gingival sulcus
Gingiva

Crown
Neck
Root

Alveolar bone
Periodontal ligament
Root canal
Cementum
Apical foramen
Artery, nerve, vein
Characteristics of human teeth

• Heterodont dentition
• Diphyodont
  – 2 sets of teeth within 1 life time
• dental formulas
  – (I – C – P – M in each quadrant):
Deciduous teeth

Names of teeth

- Central incisor (7-9 months)
- Lateral incisor (9-11 months)
- Canine (18-20 months)
- 1st molar (14-16 months)
- 2nd molar (24-26 months)

Age at eruption

Upper teeth

- 2nd molar: 24-26
- 1st molar: 14-16
- Canine: 18-20
- Lateral incisor: 9-11
- Central incisor: 7-9

Lower teeth

- 6-8 (6-12)
- 12-14 (12-18)
- 16-18
- 20-22

I - C - P - M
2 - 1 - 0 - 2
2 - 1 - 0 - 2
Permanent Teeth

Names of teeth
- Central incisor
- Lateral incisor
- Canine
- 1st premolar
- 2nd premolar
- 1st molar
- 2nd molar
- 3rd molar (wisdom tooth)

Age at eruption (years)
- 7-8
- 8-9
- 11-12
- 10-11
- 10-12
- 6-7
- 12-13
- 17-25
- 17-25
- 11-13
- 6-7
- 11-12
- 10-12
- 9-10
- 7-8
- 6-7

I - C - P - M
2 - 1 - 2 - 3
2 - 1 - 2 - 3
salivary glands

• release water, lysozyme, digestive enzymes, mucus
• Locations
  - buccal: in cheeks
  - parotid: largest, anterior to the ear (pure serous)
  - submandibular (submaxillary): medial to mandible (contain serous/mucus cells)
  - sublingual: inferior aspect of the tongue
Serous and mucous cells
Esophagus

- **function**
  - move food to the stomach
- **lining epithelium**
  - stratified squamous
- **muscle layer**
  - 1st third
    - skeletal muscle
  - 2nd third
    - a mixture of skeletal and smooth muscle
  - 3rd third
    - smooth muscle
Stomach

- a large, muscular distensible portion of the GI tract

Functions
- food storage
- initiates protein digestion
- kills bacteria
- moves food to SI
- intrinsic factor
Anatomical structure of stomach

• 3 layers of smooth muscle
  – longitudinal, circular and oblique
• Rugae
  – macroscopic folds in the stomach, luminal lining
  – flatten when the stomach is full
  – Also in gall bladder and urinary bladder
Histology of stomach

- lining epithelium
  - simple columnar epithelium
  - Microvilli increase surface area
- gastric glands
  - microscopic folds, secrete gastric juice.
- gastric pits
  - openings from gastric glands to gastric lumen
Five types of cells

- 1) chief (zymogenic) cells
  - secrete pepsinogen
- 2) parietal cells
  - secrete HCl
- 3) goblet cells
  - secrete mucus
- 4) G-cells
  - secrete hormones to support stomach activity
- 5) argentaffin cells
  - secrete histamine and serotonin to support stomach activity
Small intestine

• ~ 3 meters long
• Function
  - Digestion and absorption
• 3 histologically different regions
  - Duodenum
  - Jejunum
  - Ileum
Stomach
Duodenum
Duodenojejunal flexure
Jejunum
Ascending colon
Mesentery
Ileocecal junction
Cecum
Appendix
Ileum
Duodenum

- **Length**
  - Approx 25 cm

- **Function**
  - 95% of digestion and absorption

- **Surface area**
  - 600x’s its length = 15000 cm, 150 m or approx 138 yards!

Note the Brunner’s glands in the submucosa
Surface area

• **Plicae circularis**
  - macroscopic permanent folds (permanent until death)
  - Circular pleats like conduit

• **Villi**
  - fingerlike projections

• **Microvilli**
  - submicroscopic folds on apical surface of columnar cells
  - “brush border”
Villi and microvilli
Ampullae

- enlargements allowing for openings from pancreatic and bile ducts
- Hepatopancreatic duct
  - Ampulla of Vater
  - Sphincter of Oddi
- Accessory duct
  - Duct of Santorini
Jejunum

- 1 m long
- histologically similar to duodenum, but lacking Brunner’s glands
- completes digestion and absorption started in the duodenum
Ileum

- 2m long
- mainly water, mineral, vitamin absorption
Large intestine

- regions (7)
  - Cecum
  - Ascending
  - Transverse
  - Descending
  - Sigmoid
  - Rectum
  - Anus
Large intestines

- Approx 1.5 m long
- Lining epithelium
  - Predominately simple columnar
  - Stratified squamous in the anal canal
- Haustra
  - Sacs or pouches seen along the length of the large intestine
  - Haustral churning
    - Contraction of the haustra
    - Mixes feces, max absorption of water
- Taenia coli
  - 3 distinct bands of smooth muscle (longitudinal) running the length of the large intestine
Epiploic appendages

- Small fat-filled pouches of unknown function
- Primarily attached to transverse and sigmoid colon
- Inflammation is called epiploic appendagitis and is sometimes mistaken for acute appendicitis
Histology of large intestines

• Many Crypts of Lieberkuhn without Paneth cells
• Increasing number of goblet cells as move from cecum to rectum
Histological comparison between small and large intestines
Rectum and anus

- **Rectum**
  - stores feces until defecation
  - Characterized by deep crypts of Lieberkühn

- **Anus**
  - contains 2 sphincter muscles controlling passage of feces to the exterior.
  - Mucosa transitions from simple cuboidal to stratified squamous nonkeratinized to stratified squamous keratinized at anus
Appendix

• 5-6 cm long
• an extension of lymphatic tissue near the ileocecal junction
Functions of Liver

• Bile production and secretion
• Detoxication of blood
• Secretion of glucose, triglycerides, ketone bodies
• Plasma protein production
Gross Anatomy of Liver

Lobes: Left, Right, Caudate, Quadrate

Posterior aspect
Gross anatomy of the liver, anterior aspect
Ligaments

- falciform ligament
  - suspends liver from diaphragm

- ligamentum teres hepatis
  - extends from falciform ligament to umbilicus (remnant of umbilical vein)
Liver Lobules

- hepatic plates
  - arrangement of hepatocytes around the central vein
- hepatocytes
- central veins
  - from the hepatic portal vein to hepatic veins
- bile canaliculi
  - from hepatocytes to duodenum
Interlobular septum
Central vein
Hepatic lobule
Hepatic triad
Hepatic portal vein
Hepatic artery
Bile ductule
Hepatocytes
Bile canaliculus
Sinusoid
Interlobular septum
Histology of the liver
Movement of blood and bile through the liver
gall bladder

- small distensible organ
- stores bile
- bile ducts
  - hepatic
  - cystic
  - common bile
Pancreas
pancreas

- **acinar cells**
  - exocrine
  - secrete most digestive enzymes and bicarbonate
- **pancreatic islets**
  - Islets of Langerhans
  - endocrine
  - secrete hormones (insulin and glucagon)
- **pancreatic ducts**
  - collect enzymes, bicarb, pass them onto the duodenum
Gastric bypass surgery
Gastric bypass surgery

Lap band procedure