

# **DIGESTIVE SYSTEM**

## **Two groupings of organs**

1. gut = alimentary canal = gastrointestinal (GI) tract
  - a. tube extending from mouth to anus
  - b. oral cavity, pharynx, esophagus, stomach
  - c. small intestine, large intestine (colon)
2. accessory organs
  - a. non-GI tract organs that contribute to digestion
  - b. tongue, teeth, liver/gallbladder, pancreas
  - c. salivary, gastric, and intestinal glands

## **Overview/functions of digestive system**

1. preparation of food for assimilation into the body
  - a. mechanical processing
    - chewing (mastication)
    - churning by the stomach
    - segmentation in the small intestine
  - b. chemical/enzymatic breakdown of sugar/lipid/protein
2. secretion of digestive acids/enzymes/buffers by
  - gastrointestinal tract
  - accessory organs, e.g., pancreas, liver
3. absorption: movement of electrolytes, vitamins, & water across epithelium into blood vessels
4. compaction, dehydration, & excretion:
  - a. dehydration/compaction of indigestible gut contents
  - b. elimination/excretion of waste from body (defecation)
  - c. waste products that are/will be defecated = feces

# Mouth - oral cavity

## 1. Teeth, tongue, hard palate

- a. mechanical breakdown of food
- b. bolus formation = swallow-able mass

## 2. Lips

- a. keep food in oral cavity during chewing
- b. lips controlled by facial musculature
- c. stabilized by labial frenulum

## 3. Cheeks

- a. aid chewing and bolus formation
- b. space between cheek and teeth = vestibule
- c. mucous membrane, stratified squamous epithelium

## 4. Gingiva (gums) *gingivitis*?

## 5. Hard palate: palatine & maxillary bones

## 6. Soft palate:

- a. muscular flap - continuation of hard palate
- b. partitions naso-/oropharynx during swallows

## 7. Tongue

- a. anchored on hyoid, stabilized by lingual frenulum
- b. intrinsic tongue muscle fibers are very complex

# Salivary glands

## 1. 3 pairs of salivary glands:

- a. Parotid - drained by parotid duct
- b. Submandibular drained by submandibular duct
- c. Sublingual drained by sublingual duct

## 2. Several functions:

- a. cleanses teeth, moistens food during bolus formation
- b. contains enzyme amylase: break down starch
- c. dissolves food/chemicals necessary for taste

# Teeth

## 1. Generic structure: crown, neck, root

## 2. Three types of material:

- a. enamel (crown)
  - hardest substance in body (calcium phosphate)
  - complicated shapes
- b. dentin (body of tooth)
  - not as hard as enamel
  - forms roots and encloses the pulp cavity
- c. cementum - holds each tooth in tooth socket

## 3. Pulp cavity:

- a. contains blood vessels and nerves
- b. root canal: narrow tunnels through roots

## 4. Four types of teeth:

- a. incisors (8): blade-shaped cusp, 1 root
- b. cuspids (4): conical pointed cusp, 1 root (fangs?)
- c. bicuspid (premolars - 8): 2 flattened cusps, 1-2 roots
- d. molars (8-12) large flattened crowns, 3-4 roots

## 5. Two generations of teeth

- a. deciduous teeth (baby teeth):
  - @ 6 months to 2 years (normal = 20 teeth)
- b. adult (non-deciduous) teeth:
  - @ 6-21 years (normal = 28-32 teeth)

## **Gut: generic X-section has 4 layers (tunics):**

### **1. Mucosa - innermost tunic**

- a. mucosal epithelium = mucous membrane
  - secretes mucous which protects the lining of the gut
  - "pleated" appearance (plicae circularis or rugae)
- b. lamina propria - loose CT
  - supports overlying mucosal epithelium

### **2. Submucosa**

- a. exocrine glands: enzyme secretion = digest food
- b. highly vascular = absorption of nutrients from food
- c. Meissner's plexus of ANS fibers
  - controls secretion of submucosal glands along GI tract

### **3. Muscularis externa (2 muscle layers)**

- a. **peristalsis** - alternating contractions of muscle (p. 666)
- b. longitudinal muscles (outer)
  - decreases length of Gut, increases diameter of lumen
- c. circular muscles (inner)
  - decreases lumen size, increases length of GI tract
- d. myenteric plexus of ANS fibers
  - controls peristalsis, segmentation of gut contents

### **4. Serosa: outermost layer (serous membrane)**

- a.k.a., visceral peritoneum!

## **Esophagus**

1. muscular, collapsible tube
2. extends from pharynx to stomach through diaphragm

## **Stomach**

1. Regions of the stomach
  - a. cardia - entrance of esophagus (cardiac “sphincter”)
  - b. fundus - domed portion
  - c. body - greater and lesser curvatures
  - d. pyloric - pyloric sphincter (valve)
2. Walls of stomach
  - a. three (not two) layers of muscles!
  - b. internal surface covered in rugae
  - c. variety of cell types:
    - "gastric juices": HCl, pepsinogen/pepsin, renin
    - mucous cells: protect walls from the gastric juices

## Small Intestine

1. Devoted to **digestion** = absorption of digested material
2. **Mucosa** is more elaborate than gastric mucosa
  - "pleated" appearance (plicae circularis) increases SA
  - plicae are 'ornamented' with villi = increase SA
  - each villus is covered in simple columnar epithelium
  - columnar epithelium (microvilli also increase SA)
3. Not particularly "small" = 15-25' long (*normally*)
4. Three segments:
  - a. **duodenum** (8-12") mixing bowl - chyme
    - submucosal glands produce mucous + buffers
    - hepatopancreatic papilla & ampulla
  - b. **jejunum** (7-9') majority of digestion & absorption
  - c. **ileum** (8-14') remaining digestion & absorption
    - GALT: Peyers patches (lymphatic tissue)
5. **Ileocecal valve**: controls flow of chyme into cecum

## Large Intestine (colon)

1. Devoted to **dehydration**/compaction of chyme > feces
2. Not particularly "large" = 5' long (*normally*)
3. 5 main sections:
  - a. **cecum** - chyme enters cecum through ileocecal valve  
- **appendix**: blind pocket, minor lymphoid function
  - b. **ascending** (right) colon - (10-16")
  - c. **transverse** (mid) colon - (10-16")
  - d. **descending** (left) colon - (10-16")
  - e. **sigmoid** colon - (8-16")
4. 3 main "flexures":
  - a. **hepatic** (right colic) - right-side, under liver
  - b. **splenic** (left colic) - left-side, under spleen
  - c. **sigmoid** - s-shaped bend to pass down into pelvis
5. Muscular wall of colon:
  - a. **haustra** - pouches formed by colon musculature
  - b. **taenia coli** - 3 longitudinal 'ribbons' of muscle
6. Odds & Ends:
  - a. epiploic appendages: sacs of fat along length of colon
  - b. diverticula: small outpocketings of colon wall (BV's)
  - c. diverticulitis/ diverticulosis

## **Rectum & Anus**

1. Rectum (6-8"): highly muscular termination of colon
  - a. feces enter rectum - "urge to defecate"
  - b. epithelium increasingly keratinized - abrasion-resistant
2. Anus: muscular valve at terminus of rectum (verge)
  - a. internal anal sphincter (ANS)
  - b. external anal sphincter (voluntary control)

**Accessory structures:** salivary glands, liver, pancreas

## **Liver**

1. largest organ in body, large blood reservoir
2. two principal lobes
  - right & left lobes separated by falciform ligament
3. two minor lobes - quadrate & caudate

## **Blood supply**

1. hepatic artery (celiac trunk)
2. hepatic portal vein (gut wall)
3. hepatic vein (returning to IVC)

## **Histology**

1. functional units of the liver are called lobules
2. hepatic veins found at "core" of each lobule
3. each lobule encircled by numerous "triads"
  - = hepatic artery + hepatic portal vein + bile duct

## **Liver functions:**

1. metabolize carbohydrates, lipids, amino acids
2. stores vitamins & minerals (iron)
3. detoxify/remove waste products (ammonia & urea)
4. inactivate/removes various drugs & hormones
5. produce bile (emulsifies lipids)

## **Gall bladder**

1. hollow, muscular sac (cyst) for storing excess bile
2. simple structure: fundus, body, & neck

## **Bile (~ Gall)**

1. bile is produced by the liver to emulsify lipids
2. bile passes down series of ducts to duodenum
  - a. R&L Hepatic ducts > common hepatic duct
  - b. common hep. duct + cystic duct = common bile duct
  - c. common bile duct empties into duodenal papilla
3. bile released to duodenum if H-P sphincter is open
3. excess bile? or H-P sphincter closed?
  - a. bile backs-up into common bile duct > cystic duct
  - b. fills gall bladder with bile
4. bile needed in duodenum?
  - a. H-P sphincter opens
  - b. muscles in gall bladder contract
  - c. bile is injected to duodenal lumen

## **Pancreas**

1. elongate organ with lumpy, granular texture
2. located between stomach & duodenum
2. highly vascular organ - drains to HPV
3. both exocrine (99%) and endocrine (1%) functions
  - a. endocrine secretions:
    - **glucagon**, which raises glucose levels in the blood
    - **insulin**, which lowers blood glucose levels
  - b. exocrine secretions:
    - **proteinases** degrade proteins
    - **lipases** degrade fats
    - **nucleases** degrade DNA & RNA
4. pancreatic secretions (**endocrine**) leave organ:
  - through the Hepatic Portal system
5. pancreatic secretions (**exocrine**) leave organ:
  - pancreatic duct > hepatopancreatic ampulla  
> duodenal papilla > duodenal lumen

**Cholecystitis:** inflammation of gallbladder (gall stones)

**Cholelithiasis:** presence of gallstones in the gallbladder

**Cirrhosis:** destruction of hepatocytes due to:

- a. exposure to drugs (alcohol)
- b. viral infection (hepatitis C)
- c. blockage of hepatic ducts

**Ileostomy - colostomy:**

- attachment of gut to opening in body wall (stome)

## Serous membranes of the alimentary canal

1. Serous membranes line the entire peritoneal cavity:
  - a. parietal peritoneum
  - b. visceral peritoneum
2. Mesentery (generic):
  - a. double layer of serous membrane
  - b. durable, transparent sheets of tissue
  - c. suspends GI tract from posterior wall of cavity
  - d. encloses NAV's to GI tract
  - e. regional/segmental terminology
3. Development (diagram)
  - a. mesentery sheets found anterior & posterior to gut
  - b. entire gut suspended freely within cavity
  - c. organization complicated by elongation of GI tract
  - d. mesentery "disappears" in places
  - e. mesentery/organ become "fixed" to post. wall of cavity

### ***What's obvious?***

4. **Mesentery proper:** encloses the jejunum & ileum
5. **Mesocolon:** suspends transverse & sigmoid colon
6. **Lesser omentum:** connects stomach to the liver
7. **Greater omentum:**
  - a. extends from greater curvature of stomach
  - b. fat storage & localization of infection
8. **Coronary ligament:** suspends liver from diaphragm
9. **Falciform ligament:** liver to anterior abdominal wall.
10. **Round ligament:** remainder of *ductus venosus*!!!