Anatomy of the Large Intestine

- The large intestine (colon) extends from the ileocecal sphincter to the anus.
- Its subdivisions include the cecum, colon, rectum, and anal canal.
- Hanging inferior to the cecum is the appendix.
- Inflammation of the appendix is called appendicitis.
- A ruptured appendix can result in gangrene or peritonitis, which can be life-threatening conditions.
• 5 feet long by 2¼ inches in diameter
• Ascending & descending colon are retroperitoneal
• Rectum = last 8 inches of GI tract anterior to the sacrum & coccyx
• Anal canal = last 1 inch of GI tract
  – internal sphincter----smooth muscle & involuntary
  – external sphincter----skeletal muscle & voluntary control
Mechanical Digestion in Large Intestine

• Mechanical movements of the large intestine include haustral churning, peristalsis, and mass peristalsis.

• Peristaltic waves (3 to 12 contractions/minute)
  – haustral churning—relaxed pouches are filled from below by muscular contractions (elevator)
  – gastroilial reflex = when stomach is full, gastrin hormone relaxes ileocecal sphincter so small intestine will empty and make room
  – gastrocolic reflex = when stomach fills, a strong peristaltic wave moves contents of transverse colon into rectum by Mass peristalsis

Chemical Digestion in Large Intestine

• No enzymes are secreted only mucous
• Bacteria ferment
  – undigested carbohydrates into carbon dioxide & methane gas
  – undigested proteins into simpler substances (indoles)----odor
  – turn bilirubin into simpler substances that produce color
• Bacteria produce vitamin K and B in colon
• Converts chyme into feces
Functions of the Large intestinal Mucosa

1. **Goblet cells**: create mucus that lubricates colon and protects mucosa.
2. **Absortive cells**: Maintains water balance, solidifies feces, absorbs vitamins and some ions

Absorption & Feces Formation in the Large Intestine

- Some electrolytes---Na+ and Cl-
- After 3 to 10 hours, 90% of H2O has been removed from chyme
- **Feces** are semisolid by time reaches transverse colon
- Feces = dead epithelial cells, undigested food such as cellulose, bacteria (live & dead)
Absorption and Feces Formation in the Large Intestine

• The large intestine absorbs water, electrolytes, and some vitamins.
• Feces consist of water, inorganic salts, sloughed-off epithelial cells, bacteria, products of bacterial decomposition, and undigested parts of food.
• Although most water absorption occurs in the small intestine, the large intestine absorbs enough to make it an important organ in maintaining the body’s water balance.

Defecation Reflex

• The elimination of feces from the rectum is called defecation.
• Defecation is a reflex action aided by voluntary contractions of the diaphragm and abdominal muscles. The external anal sphincter can be voluntarily controlled (except in infants) to allow or postpone defecation.
Defecation

- Gastrocolic reflex moves feces into rectum
- Stretch receptors signal sacral spinal cord
- Parasympathetic nerves contract muscles of rectum & relax internal anal sphincter
- External sphincter is voluntarily controlled

Defecation Problems

- **Diarrhea** = chyme passes too quickly through intestine
  - H₂O not reabsorbed
- **Constipation** = decreased intestinal motility
  - too much water is reabsorbed
  - remedy = fiber, exercise and water

Clinical Concerns

- Colonoscopy is the visual examination of the lining of the colon using an elongated, flexible, fiberoptic endoscope.
- Occult blood test is to screen for colorectal cancer.
PANCREAS

- The pancreas is divided into a head, body, and tail and is connected to the duodenum via the pancreatic duct (duct of Wirsung) and accessory duct (duct of Santorini).

- **Pancreatic islets** *(islets of Langerhans)* secrete hormones and acini secrete a mixture of fluid and digestive enzymes called pancreatic juice.

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**Accessory organs of the GI Tract**

**Pancreas:**

Produces 1.2L to 1.5L of pancreatic juices daily.

Pancreatic juice consists of a bicarbonate solution containing salts and digestive enzymes.

Bicarbonate helps buffer acidic chyme from the stomach.
Histology of the Pancreas

• **Acinar cells:** Secrete pancreatic juice, a mixture of bicarbonate fluid and digestive enzymes.
• **Islet of Langerhans:**
  Alpha cells - glucagon
  Beta cells - insulin
  Delta cells - somatostatin
  F-cells - pancreatic polypeptide

Neural and Hormonal Control of the Pancreas

- **Secretin:**
  acidity in intestine causes increased sodium bicarbonate release

- **GIP:**
  fatty acids & sugar causes increased insulin release

- **CCK:**
  fats and proteins cause increased digestive enzyme release
LIVER AND GALLBLADDER

- The liver is the heaviest gland in the body and the second largest organ in the body after the skin.
- Anatomy of the Liver and Gallbladder
  - The liver is divisible into left and right lobes, separated by the falciform ligament. Associated with the right lobe are the caudate and quadrate lobes.
  - The gallbladder is a sac located in a depression on the posterior surface of the liver.

Histology of the Liver

- The lobes of the liver are made up of lobules that contain hepatic cells (liver cells or hepatocytes), sinusoids, stellate reticuloendothelial (Kupffer’s) cells, and a central vein.
- Bile is secreted by hepatocytes.
- Bile passes into bile canaliculi to bile ducts to the right and left hepatic ducts which unite to form the common hepatic duct.
- Common hepatic duct joins the cystic duct to form the common bile duct which enters the hepatopancreatic ampulla.
Pathway of Bile Secretion

- Bile capillaries
- Hepatic ducts connect to form common hepatic duct
- Cystic duct from gallbladder & common hepatic duct join to form common bile duct
- Common bile duct & pancreatic duct empty into duodenum

Accessory organs of the GI Tract

Liver:
- Produces .8L to 1.0L of bile per day
  - yellow-green in color & pH 7.6 to 8.6
- Components
  - water & cholesterol
  - bile salts = Na & K salts of bile acids
  - bile pigments (bilirubin) from hemoglobin molecule
    - globin = a reusable protein
    - heme = broken down into iron and bilirubin
Bile - Overview

• Hepatic cells (hepatocytes) produce *bile* that is transported by a duct system to the gallbladder for concentration and temporary storage.
• Bile is partially an excretory product (containing components of worn-out red blood cells) and partially a digestive secretion.
• Bile’s contribution to digestion is the emulsification of triglycerides.
• The fusion of individual crystals of cholesterol is the beginning of 95% of all *gallstones*. Gallstones can cause obstruction to the outflow of bile in any portion of the duct system. Treatment of gallstones consists of using gallstone-dissolving drugs, lithotripsy, or surgery.

Bile - Overview

• The liver also functions in carbohydrate, lipid, and protein metabolism; removal of drugs and hormones from the blood; excretion of bilirubin; synthesis of bile salts; storage of vitamins and minerals; phagocytosis; and activation of vitamin D.
• In a liver biopsy a sample of living liver tissue is removed to diagnose a number of disorders.
Major Functions of the liver

1. **Carbohydrate metabolism**: maintains blood sugar levels.
   a. Low sugars levels: (control- glucagon)
      *glycogenolysis* glycogen $>$ glucose
   b. High sugars levels: (control- insulin)
      *glycogenesis* glucose $>$ glycogen

2. **Lipid metabolism**
   a. Produce fats: *lipogenesis*
   b. Break down fats: *lipolysis, beta oxidation*
   c. Synthesize cholesterol
   d. Stores triglycerides

3. **Protein metabolism**:
   a. Synthesize most plasma proteins such as clotting proteins
   b. *Deaminate* amino acid: remove NH$_2$

4. Processes drugs, hormones, and alcohol

5. Excretes *bilirubin* (derived from the heme unit of recycled red blood cells)

6. **Storage of Vitamins** (A, B12, D, E, and K) and iron

7. **Phagocytosis** of aged red and white blood cells and some bacteria by Kupffer’s (reticuloendothelial) cells

8. **Activation** of Vitamin D

9. **Stores** iron and copper
Lobule: The Functional Unit of the Liver

Hepatic Blood and Lobular Structure
Histology of a lobule demonstrating the central vein

Histology of a lobule demonstrating the hepatic triad