Bio217: Pathophysiology Class Notes  
Professor Linda Falkow

Unit IX: Digestive System Disorders

Chapter 33: Structure and Function of the Digestive System  
Chapter 34: Alterations of Digestive Function

Gastrointestinal Tract

- **Ingestion** of food  
- **Propulsion** of food and wastes from mouth to anus (peristalsis)  
- **Secretion** of mucus, water, and enzymes  
- **Mechanical digestion** of food particles  
- **Chemical digestion** of food particles  
- **Absorption** of digested food  
- **Elimination** of waste products by defecation

Gastrointestinal Tract

- **Histology**  
  - Mucosa  
  - Submucosa  
  - Muscularis  
  - Serosa or adventitia

Stomach

Gastric Secretion

- Stomach secretes large volumes of gastric juices  
  - Mucus (protective barrier)  
  - Acid (HCl - activate enz., bactericide)  
  - Enzymes (pepsin – proteolytic)  
  - Hormones (gastrin – stim. gastric act.)  
  - Intrinsic factor (absorption of Vit. B₁₂)
Gastric Pits and Gastric Glands

Small Intestine
- 5 to 6 meters long
- Three segments
  - Duodenum
  - Jejunum
  - Ileum
    - Ileocecal valve
- Peritoneum
  - Peritoneal cavity

Small Intestine
- Muscle layers
  - Outer—longitudinal
  - Inner—circular
- Myenteric plexus
- Mucosal folds (plica)
- Villi
- Microvilli
  - = Brush border
- Lamina propria
- Lacteal

Intestinal Digestion and Absorption
- Hydrochloric acid
- Pepsin
- Pancreatic enzymes
- Intestinal enzymes
- Bile salts
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Unit IX

Large Intestine
- Cecum
- Appendix
- Colon
  - Ascending
  - Transverse
  - Descending
  - Sigmoid
- Rectum
- Anus

Ileocecal valve
O’Beirne sphincter (sigmoid into rectum)
Internal anal sphincter
External anal sphincter
Taenia coli
Haustra

Gastrointestinal Absorption

Accessory Organs of Digestion
- Liver
  - Lobes
    - Separated and attached to the anterior abdominal wall by the falciform ligament
    - Right lobe
      - Caudate and quadrate lobes
    - Left lobe
  - Glisson capsule
Vascular and Hematologic Liver Functions

- Blood storage
- Bacterial and foreign particle removal
- Synthesizes clotting factors
- Produces bile to absorb fat-soluble vitamins
- Metabolizes fats

Vascular and Hematologic Liver Functions

- Metabolizes proteins
- Metabolizes carbohydrates
- Metabolic detoxification
- Storage of minerals and vitamins

Gallbladder

- Gallbladder is a saclike organ that lies on the inferior surface of the liver
- Function of gallbladder is to store & concentrate bile between meals
- Gallbladder holds about 90 mL of bile
- Bile = emulsifies fats

Exocrine Pancreas

- Exocrine pancreas is composed of acini and networks of ducts that secrete enzymes and alkaline fluids to assist in digestion
- Pancreatic duct (Wirsung duct)
- Ampulla of Vater
Exocrine Pancreas

- Secretions
  - Potassium, sodium, bicarbonate, magnesium, calcium, and chloride
- Enzymes
  - Trypsinogen, chymotrypsinogen, and procarboxypeptidase
  - Trypsin inhibitor
  - Pancreatic alpha-amylase
  - Pancreatic lipase

Concept Check:

1. The muscularis layer of the digestive tract is:
   A. skeletal muscle throughout
   B. the layer that contains blood vessels for the wall
   C. composed of keratinized epithelium
   D. composed of circular and longitudinal fibers

2. Name the correct sequence of the GI tract layers from the lumen going out:

3. Which layer of the S.I. includes microvilli?
   A. submucosa
   B. mucosa
   C. muscularis
   D. serosa

4. What is not an example of mechanical digestion?
   A. Chewing
   B. Churning and mixing of food in stomach
   C. Peristalsis and mastication
   D. Conversion of proteins → a.a.

5. Which part of the S.I. is most distal from pylorus?
   A. Jejunum
   B. pyloric sphincter
   C. Duodenum
   D. Cardiac sphincter

Alterations of Digestive Function

Chapter 34

Clinical Manifestations of Gastrointestinal Dysfunction

- Anorexia
  - Lack of a desire to eat despite physiologic stimuli that would normally produce hunger
- Vomiting (emesis)
  - Forceful emptying of the stomach and intestinal contents through the mouth
- Nausea
  - Subjective experience associated with a number of conditions
  - Common symptoms of vomiting are hypersalivation and tachycardia
Clinical Manifestations of Gastrointestinal Dysfunction

- Constipation
  - Constipation is defined as infrequent or difficult defecation
  - Pathophysiology
    • Neurogenic disorders, low-residue diet, sedentary lifestyle, excessive use of antacids (Ca carbonate), use of opiates (codeine)

Clinical Manifestations of Gastrointestinal Dysfunction

- Diarrhea
  - Increased frequency of bowel movements
  - Increased volume, fluidity, weight of the feces
  - Major mechanisms of diarrhea
    • Osmotic diarrhea (lactase deficiency)
    • Secretory diarrhea (excess mucosal secretions due to bacteria)
      - Following antibiotic therapy
    • Motility diarrhea (increased motility due to intestinal surgery)

Disorders of Motility

- Dysphagia
  - Dysphagia is difficulty swallowing
  - Types
    • Mechanical obstructions (tumors, diverticular herniations)
    • Functional obstructions (neural or muscular)
  - Achalasia
    • Denervation of smooth muscle in the esophagus and lower esophageal sphincter relaxation

Achalasia

Increase in LES muscle tone; loss of peristalsis in esophagus

Disorders of Motility

- Gastroesophageal reflux disease (GERD)
  - Heartburn
  - Reflux of chyme (high acid) from stomach to esophagus
  - If inflammation of esophagus → esophagitis
  - Less LES pressure means more reflux

Disorders of Motility

- Hiatal hernia
  - Defect in esophageal hiatus permits part of stomach to enter thoracic cavity
  - Caused by:
    • Ascites
    • Pregnancy
    • Obesity
    • Constrictive clothes
    • Bending, straining, coughing
  - Occurs with:
    • Reflux, peptic ulcer, g.b. disorders (inflammation & stones), pancreatitis, diverticulosis
Hiatal Hernia

A. **Sliding hiatal hernia** – Stomach moves into thoracic cavity

B. **Paraesophageal hiatal hernia** – Greater curvature herniates through 2nd opening

Gastritis

- inflammatory disorder of the gastric mucosa

- Acute gastritis – erosion of superficial epithelium (due to drugs or chemicals)

- Chronic gastritis – thinning degeneration of stomach wall (elderly)

Peptic Ulcer Disease

- A break or ulceration in the protective mucosal lining of lower esophagus, stomach, or duodenum

- Acute and chronic ulcers

- Superficial
  - Erosions

- Deep
  - True ulcer

Peptic Ulcer Disease

- Duodenal ulcers
  - Most common of the peptic ulcers
  - Developmental factors
    - *Helicobacter pylori* infection
      - Toxins and enzymes that promote inflammation and ulceration
    - Hypersecretion of stomach acid and pepsin
    - *Use of NSAIDs* (aspirin, ibuprofen, naproxen)
    - High gastrin levels
    - Acid production by cigarette smoking
    - Stress and ulcer disease – inconclusive major causes of duodenal ulcers

Duodenal Ulcer

A. Deep ulcer – into muscle layer

B. Sequence of ulcer formation (normal mucosa → duodenal ulcer)

C. Bilateral (kissing) ulcers due to NSAIDs

Gastric Ulcer

- Gastric ulcers tend to develop in antral region of stomach, adjacent to acid-secreting mucosa of body

- Pathophysiology
  - Primary defect is an increased mucosal permeability to hydrogen ions
  - Gastric secretions normal or less than normal
Inflammatory Bowel Diseases (IBD)

- Chronic, relapsing inflammatory bowel disorders of unknown origin
due to genetics, immune system dysfunction, microbes
- Ulcerative colitis
  - Affects sigmoid colon and rectum (most often)
- Crohn disease
  - Affects small bowel – regional enteritis
  - Affects colon – Crohn’s disease of colon (or granulomatous colitis)

Ulcerative Colitis

- Chronic inflammatory disease that causes ulceration of the colonic mucosa
  - Sigmoid colon and rectum
- Suggested causes
  - Infectious, immunologic (anticolon antibodies), dietary, genetic (supported by family studies and identical twin studies)

Ulcerative Colitis

- Symptoms
  - Diarrhea (10 to 20/day), bloody stools, cramping
- Treatment
  - Broad-spectrum antibiotics and steroids
  - Immunosuppressive agents
  - Surgery
- An increased colon cancer risk demonstrated

Crohn Disease

- Granulomatous colitis, ileocolitis, or regional enteritis
- Idiopathic inflammatory disorder; affects any part of digestive tract, from mouth to anus
- Difficult to differentiate from ulcerative colitis
  - Similar risk factors and theories of causation as ulcerative colitis

Diverticular Disease of the Colon

- Diverticula
  - Herniations of mucosa through muscle layers of colon wall, especially sigmoid colon
- Diverticulosis
  - Asymptomatic diverticular disease
- Diverticulitis
  - Inflammatory stage of diverticulosis

Appendicitis

- Inflammation of the vermiform appendix
  - (affects 7-12% of pop.)
- Possible causes
  - Obstruction, ischemia, increased intraluminal pressure → decr. blood flow → hypoxia, infection, ulceration, etc.
- Epigastric and RLQ pain
- Most serious complication is peritonitis
Liver Disorders

- **Jaundice (icterus)**
  - Greenish, yellow pigmentation of skin due to increased plasma bilirubin levels (hyperbilirubinemia)
  - **Extrahepatic Obstructive jaundice**
    - Due to gallstone or tumor blockage of common bile duct
    - Bilirubin conjugated by hepatocytes (liver) cannot enter duodenum → appears in urine (water soluble)
  - **Intrahepatic**
    - Hepatocyte dysfunction
    → unconjugated bilirubin (fat soluble)

- **Hemolytic jaundice**
  - Excessive hemolysis of red blood cells or absorption of a hematoma
  - Increased amount of unconjugated bilirubin (not water soluble)

Cirrhosis

- Irreversible inflammatory chronic disease that disrupts liver function and structure
- Decreased hepatic function caused by nodular and fibrotic tissue synthesis (fibrosis)
- Disorganized hepatic tissue
  → cobbled appearance
  → impeded blood flow → portal HT
  → increased pressure → esophageal varicies → GI bleeds
Cirrhosis

- Alcoholic (aka portal or nutritional) cirrhosis
  - Malnutrition and oxidation of alcohol damages hepatocytes
- Biliary (bile canaliculi)
  - Cirrhosis begins in the bile canaliculi and ducts
  - Autoimmune or obstructive

Disorders of the Gallbladder

- Obstruction or inflammation (cholecystitis) is most common cause of gallbladder problems
- Cholelithiasis—gallstone formation
  - Types
    - Cholesterol (most common) and pigmented (cirrhosis)
  - Risks
    - Obesity, middle age, female, Native American ancestry, and gallbladder, pancreas, or ileal disease

Gallstones

Disorders of the Pancreas

- Pancreatitis
  - Inflammation of the pancreas
  - Associated with several other clinical disorders
    - Caused by an injury or damage to pancreatic cells and ducts, causing a leakage of pancreatic enzymes into pancreatic tissue

Disorders of the Gallbladder

- Gallstones
  - Cholesterol stones form in bile that is supersaturated with cholesterol
- Gallstones
  - Theories
    - Enzyme defect increases cholesterol synthesis
    - Decreased secretion of bile acids to emulsify fats
    - Decreased resorption of bile acids from ileum
    - Gallbladder smooth muscle hypomotility and stasis
    - Genetic predisposition
    - Combination of any or all of the above
Disorders of the Pancreas

- **Pancreatitis**
  - These enzymes cause autodigestion of pancreatic tissue and leak into bloodstream to cause injury to blood vessels and other organs
  - Chronic pancreatitis
    - Related to chronic alcohol abuse and biliary tract obstruction (gallstones)

Digestive System Cancers

- **Esophagus** — relatively rare (increased in white males)
  - Ulcerations due to reflux
  - Chronic exposure to irritants (alcohol and tobacco)
  - Inadequate nutrition

- **Stomach** — declining incidence in US (1-2% of new cancers)
  - H. pylori
  - Heavy use of salt & nitrates
  - Low intake fruits and veg.
  - Alcohol & tobacco use

Stomach Cancer

- Colon and rectum — 3rd most common cause of cancer and cancer death in US
  - Age
  - High fat, low fiber diet
  - Alcohol & tobacco use
  - Obesity
  - Family history
  - Cough potato

Colon Cancer

**Development of Colon Cancer from Adenomatous Polyps**

- Ascending colon (25%)
  - Pain, mass, change in bowel habits, anemia

- Transverse colon (15%)
  - Pain, obstruction, change in bowel habits, anemia

- Descending colon (15%)
  - Pain, change in bowel habits, bright red blood in stool, obstruction

- Rectum (45%)
  - Blood in stool, change in bowel habits, rectal discomfort

**Signs and Symptoms by Location**

- Ascending colon (25%)
  - Pain, mass, change in bowel habits, anemia

- Transverse colon (15%)
  - Pain, obstruction, change in bowel habits, anemia

- Descending colon (15%)
  - Pain, change in bowel habits, bright red blood in stool, obstruction

- Rectum (45%)
  - Blood in stool, change in bowel habits, rectal discomfort
<table>
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| 1. Which of the following does not cause constipation?  
|   - A. Opiates  
|   - B. Sedentary lifestyle  
|   - C. hyperthyroidism  
|   - D. Depression  |

|   2. Osmotic diarrhea is caused by:  
|   - A. Lactase deficiency  
|   - B. Bacterial endotoxins  
|   - C. Ulcerative colitis  
|   - D. All of the above  |

| 3. A common manifestation of hiatal hernia:  
|   - A. Gastroesophageal reflux  
|   - B. Diarrhea  
|   - C. Postprandial substernal pain  
|   - D. A and C are correct  |

| 4. Peptic ulcers may be located in the:  
|   - A. Stomach  
|   - B. Esophagus  
|   - C. Duodenum  
|   - D. Colon  
|   - E. A, B, C are correct  |

| 5. Gastric ulcers:  
|   - A. May lead to malignancy  
|   - B. Occur at a younger age than duodenal ulcers  
|   - C. Always have incr. acid production  
|   - D. Exhibit nocturnal patterns  |

| 6. In pancreatitis:  
|   - A. Tissue damage likely results from rel. of pan. Enz.  
|   - B. High cholesterol is the cause  
|   - C. Diabetes is uncommon in chronic pancreatitis  
|   - D. Bacterial infection is the cause  |

| 7. The characteristic lesion of Crohn disease is:  
|   - A. Found in the ileum  
|   - B. Precancerous  
|   - C. Granulomatous  
|   - D. Both A and C are correct  |

| 8. Gastroesophageal reflux is:  
|   - A. Caused by rapid gastric emptying  
|   - B. Excessive LES functioning  
|   - C. Associated with abdominal surgery  
|   - D. Caused by relaxation of LES  |