Digestive System

MED 165

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Objectives

- Structure of digestive and GI organs
- Functions of the GI system
- Processes and enzymes of digestion
- Accessory organs of the GI system
- Locations of digestive processes

Functions of GI system

- Ingestion
  - Bring nutrients into the body
- Mechanical digestion
  - Break food down into smaller pieces to chemically digest
- Chemical digestion
  - Break down organic polymers into their building blocks
  - Example: Proteins are broken into amino acids
  - Example: Complex carbohydrates are broken into monosaccharides

Functions of GI system

- Absorption
  - Organic and inorganic molecules are absorbed into the blood system and carried to the appropriate location
    - Most substances are carried to the liver through the portal vein
    - Fats are carried to the subclavian vein
- Elimination
  - Not all portions of food are valuable to humans, most food results in production of waste products that are eliminated in the form of feces

Classification of Organs in GI System

- Alimentary Canal
  - Pathway that actually carries nutrients through the GI system
  - Location of mechanical and chemical digestion
  - Proceeds from the mouth (os) to the anus
- Accessory Organ
  - Assist the alimentary canal with mixing food, producing enzymes, storing nutrients
    - Tongue, salivary glands, liver, pancreas, gall bladder

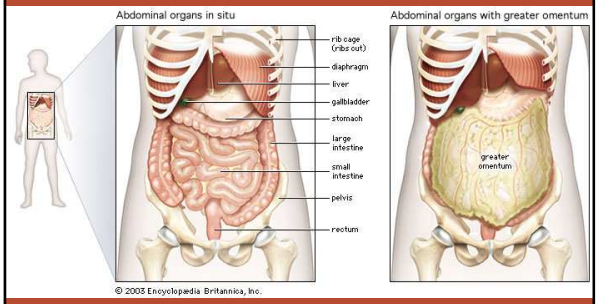
Linings of Digestive System

- Abdominal cavity is lined with a serous membrane called peritoneum
  - Visceral peritoneum lines the organs of the abdominal cavity
  - Parietal peritoneum lines the walls of the abdominal cavity

Linings of Digestive System

- Specialized peritoneal layers
  - Greater omentum
    - extends from the greater curvature of the stomach and drapes over the abdominal organs
    - Contains fat and filled with white blood cells and anti-bodies
      - Functions like protective packaging material for the abdominal organs
  - Lesser omentum
    - extends from the lesser curvature and connects to the liver
  - Mesentery
    - Specialized portion of the peritoneum that attaches the small intestines to the posterior wall of the abdominal cavity

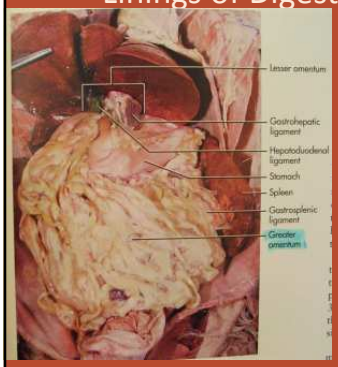
Linings of Digestive System



Linings of Digestive System

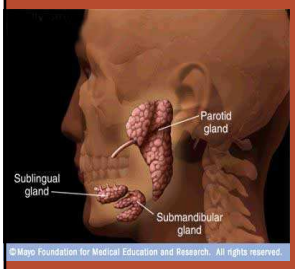
Mesentery
- Note the vascular supply of the mesentery

Linings of Digestive System



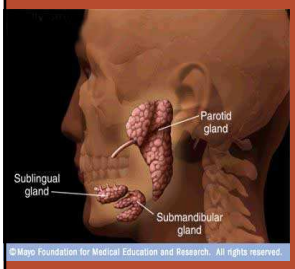
Omentum

Salivary Glands



- Produce complex mixture of mucus and digestive enzymes and secrete it into the oral cavity
  - Saliva
- Parotid
  - Largest salivary gland
  - Produces large amount of salivary amylase
  - Mumps = parotiditis

Salivary Glands



- Submandibular
  - Inferior to parotid near the angle of the lower jaw
  - Produces mucin and ptyalin
- Sublingual
  - Smallest glands, found under the tongue
  - Secrete mostly mucus

The role of saliva

- Mucin
  - Forms a protective covering of epithelial surfaces in the mouth to protect the cells from other digestive enzymes
  - Causes bacteria to aggregate and allows white blood cells to more easily capture potential infectious agents
  - Lubricates food to prevent damage to delicate epithelial linings of alimentary canal

The role of saliva

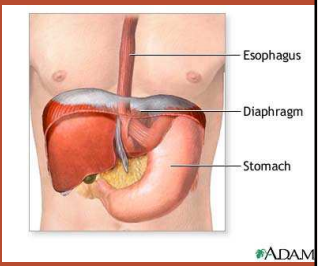
- Mucous
  - Lubrication of bolus to prevent damage to alimentary canal
- Amylase
  - Breaks down starch into glucose monomers
- Ptyalin
  - Primary type of salivary amylase

Alimentary Canal

- Mouth (Os)
  - Location of food entry
  - Contains teeth for mastication (chewing)
  - Contains tongue for mixing and tasting
- Pharynx
  - Throat
  - Moves food from the mouth into the esophagus
  - Contains specialized structures that prevent food from entering nasal cavity and airway
    - Uvula prevents food from going to nasal cavity
    - Epiglottis prevents food from entering airway

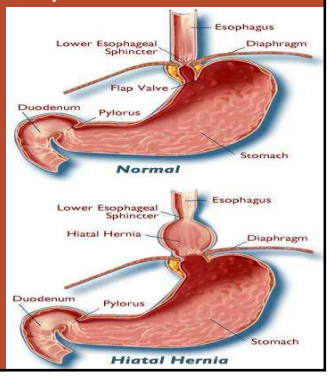
Alimentary Canal

- Esophagus
  - Muscular tube approx. 10 inches in length
  - Passes from the head into the abdominal cavity
  - Esophagus exits the thoracic cavity through a hole in the diaphragm called the hiatus



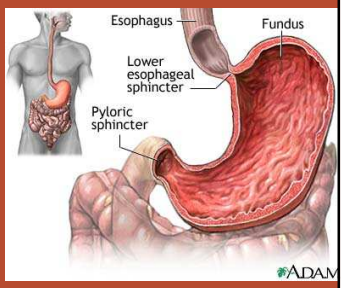
Alimentary Canal

- Hiatal hernia
  - Abnormal condition in which the fundus of the stomach protrudes into the thoracic cavity through the hiatus
  - Can become a life threatening condition in rare circumstances



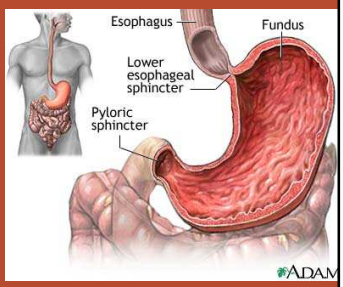
Alimentary Canal

- Stomach
  - Divided into three portions
    - Fundus
      - Upper rounded region of stomach
    - Body
      - Area between greater and lesser curvatures
    - Pylorus
      - Lower narrow region that opens into the small intestine



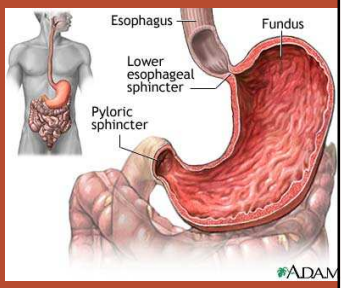
Alimentary Canal

- Stomach
  - Regulation of food in stomach is controlled by sphincters
  - Cardiac sphincter regulates food from traveling between the esophagus and stomach
  - Pyloric sphincter regulates food traveling between stomach and small intestine



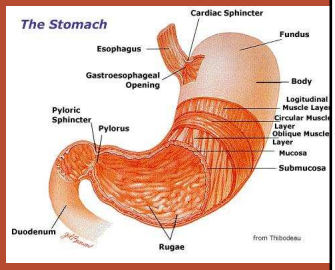
Alimentary Canal

- Pylorospasm
  - Condition common in infants in which the pyloric sphincter does not relax and causes the infant to vomit the contents of their stomach



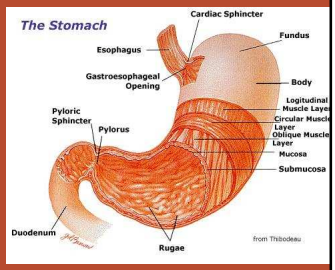
Alimentary Canal

- Layers of stomach
  - Four layers
  - Mucous = inner most layer of stomach contains gastric glands; when stomach is not full (distended) the mucousal layer folds into rugae
  - Submucosa = loose connective tissue that supports mucousal layer

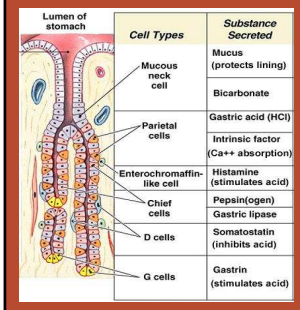


Alimentary Canal

- Layers of stomach
  - Muscular
    - Three layers of muscle that rhythmically contract mixing food with the digestive juices of the stomach
    - Create peristalsis; contractions that propel chyme (food) forward into the small intestine
  - Serosa
    - Outermost layer; tough, protective; continuous with peritoneum



Alimentary Canal



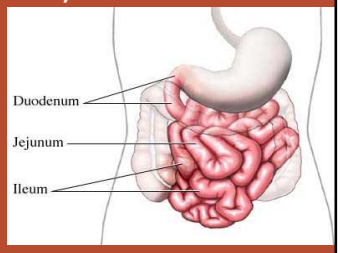
- Gastric Glands
  - Found in mucousal layer of stomach; Contain cells that create gastric juices

Alimentary Canal

- Enteroendocrine Glands
  - Secrete gastrin; substance that stimulates parietal cells to secrete hydrochloric acid anc chief cells to secrete pepsinogen
- Parietal Cells
  - Produce hydrochloric acid (HCl)
  - HCl activates pepsinogen into pepsin and destroys bacteria in the stomach
  - Keep the Ph of stomach near 1-2
- Chief Cells
  - Produce pepsinogen; precursor of pepsin which is a protease
- Goblet Cells
  - Produce an alkaline mucous that lubricates and protects lining of the stomach

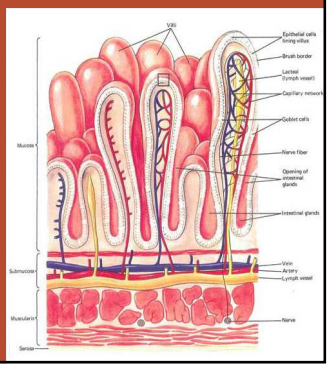
Alimentary Canal

- Small Intestine
  - Responsible for the majority of the chemical absorption in the digestive system
  - Approx. 20 feet in length
  - Made of three regions
    - Duodenum
      - 12 inch proximal region
    - Jejumum
      - 8 feet middle region
    - Ileum
      - 10- 12 feet distal small intestine



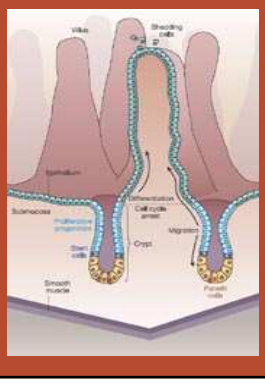
Alimentary Canal

- Small Intestine
  - Mucosa of small intestine is arranged in thousands of villi
  - Villi increase surface area of small intestine and increase absorptive potential of organ
  - In between villi, you have intestinal crypts/ glands



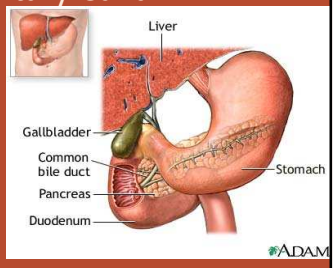
Alimentary Canal

- Small Intestine
  - Intestinal crypts contain enteroendocrine cells that produce 2 hormones
  - Secretin
    - Released in response to a lowering pH of intestines because acid covered chyme enters duodenum
    - Causes pancreas to release digestive enzymes including a highly basic susbtance
  - Cholecystokinin
    - Stimulates gall bladder to squirt bile into duodenum



Alimentary Canal

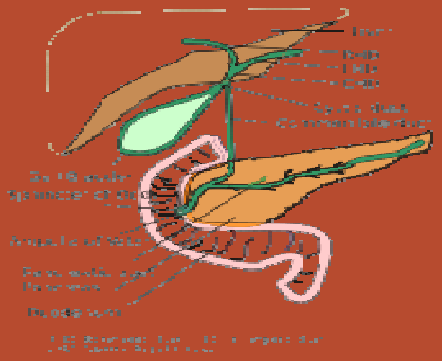
- Duodenum
  - Majority of absorption occurs in duodenum
  - Hepatopancreatic ampulla (HPA) is the opening of the common bile duct into the duodenum
  - HPA is regulated by the sphincter of Odi



Digestive Enzymes of the Small Intestine

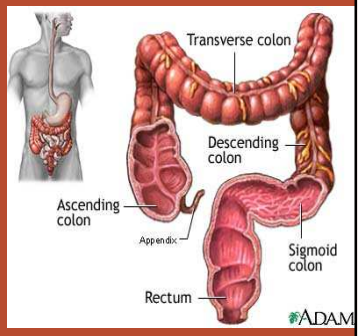
Intestinal Enzyme	Polymer	Monomer
Intestinal lipase	Fat/ Triglyeride	Glycerol + Fatty acids
Maltase	Maltose	2 molecules of glucose
Sucrase	Sucrose	Glucose + fructose
Lactase	Lactose	Galactose + glucose

Hepatopancreatic Ampulla



Alimentary Canal

- Large Intestine
  - Responsible for absorption of Vitamin K, B complex vitamins, and water
  - Responsible for the production of gas and feces
  - Colonized with diverse bacterial species

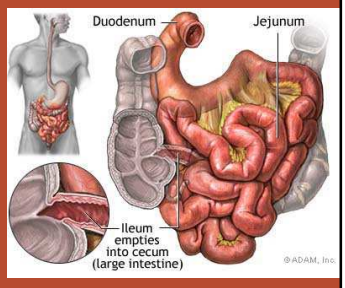


Alimentary Canal

- Large Intestine
  - Four regions
  - Ascending colon
    - Hepatic flexure
  - Transverse colon
    - Splenic flexure
  - Descending colon
  - Sigmoid colon

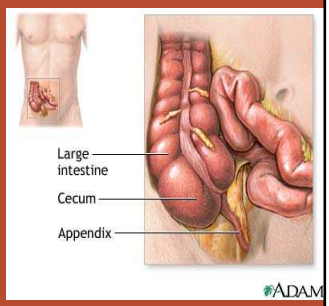
Alimentary Canal

- Ileocecal valve
  - Regulates the movement of chyme from small intestine into large intestine



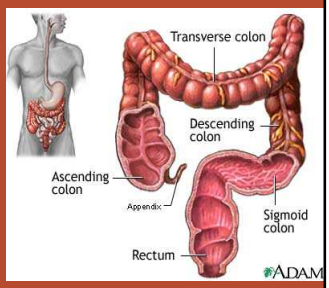
Alimentary Canal

- Appendix
  - Evolutionary leftover that is commonly infected
  - Thought to serve a role in bone digestion in cave man days
  - May serve as a lymphoid organ in humans



Alimentary Canal

- Rectum and Anus
  - Used in excretion of left over material that contains no nutritive value for humans
    - Feces
  - Anus is regulated by two shincters
    - Internal
    - External
  - Innervated by vagus nerve

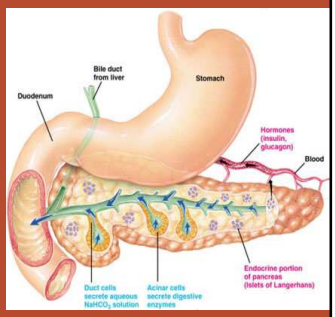


Accessory Organs of Digestion

- Pancreas
- Liver
- Gall Bladder

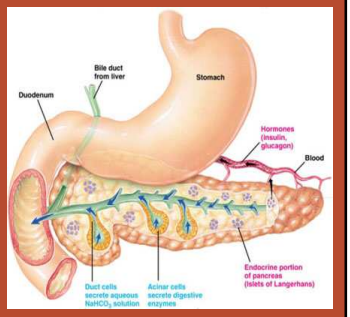
Accessory Organs of Digestion

- Pancreas
  - Important organ for digestion and endocrine regulation of blood sugar
  - Acinar cells
    - Secrete digestive enzymes
  - Duct cells
    - Secrete sodium bicarbonate
    - Basic solution that neutralizes pH of duodenum



Accessory Organs of Digestion

- Digestive enzymes of pancreas
  - Trypsin
  - Pancreatic amylase
  - Pancreatic lipase
- Enzymes are released into a duct and enter the small intestine through the common bile duct at the hepatopancreatic ampulla (Ampulla of Vater)

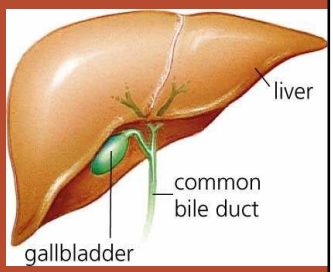


Functions of pancreatic enzymes

Enzyme	Polymer	Monomer
Trypsin	Proteins	Amino Acids
Pancreatic Amylase	Starch/ Glycogen	Glucose molecules
Pancreatic Lipase	Fat/ Triglycerides	Glycerol + fatty acids

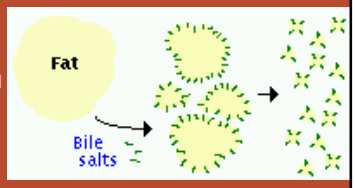
Accessory Organs of Digestion

- Gall Bladder
  - Stores and concentrates bile made by the liver
  - Releases bile into duodenum under the influence of cholecystokinin
  - Food high in fats stimulates the release of cholecystokinin



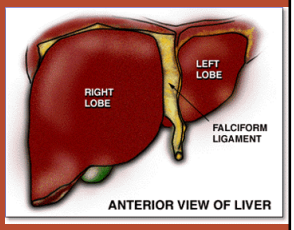
Accessory Organs of Digestion

- Role of Bile in Fat Digestion
  - Bile has hydrophilic and hydrophobic domains
  - Hydrophobic domains bind to the fat and hydrophilic domains orient themselves towards the water
  - Serves to make fat water soluble



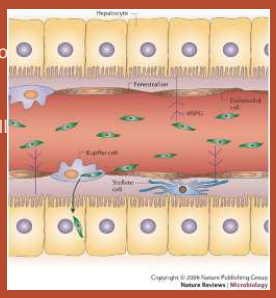
Accessory Organs of Digestion

- Liver
  - Largest organ in the body
  - Manufactures bile
    - Bile comes from the destruction of RBC's
  - Produces glycogen
  - Detoxifys alcohol and many drugs
  - Creates many plasma proteins and clotting factors
  - Prepares urea from break down of amino acids
  - Stores vitamins A, D, and B complexes
  - Breaks down hormones
  - Removes worn out RBC's



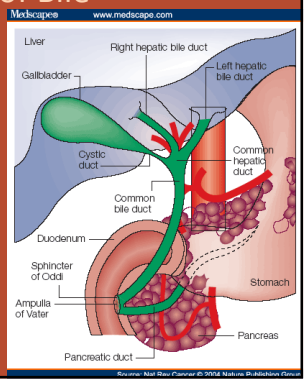
Accessory Organs of Digestion

- Liver
  - Tissue of liver is organized into sinusoids
  - Blood moves through sinusoids and hepatocytes pull out damaged RBC's and toxic substances
  - Capillaries in sinusoids are fenestrated capillaries
    - "Leaky"
  - Liver is susceptible to many viruses and medications
    - Evaluation of liver function is essential to good health



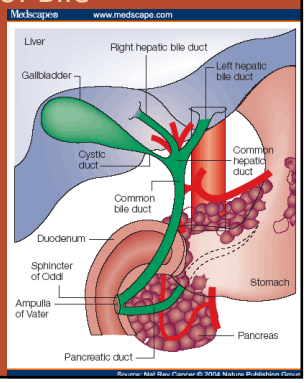
Flow of Bile

- Bile is made in liver and travels to the common bile duct
  - Bile made in right lobe enters the right hepatic bile duct and them the common bile duct
- Common bile duct empties into duodenum at the hepatopancreatic ampulla



Flow of Bile

- If excess bile is made, it travels up the cystic duct into the gall bladder for storage and concentration
- If gall bladder is removed, the common bile duct enlarges to hold excess bile



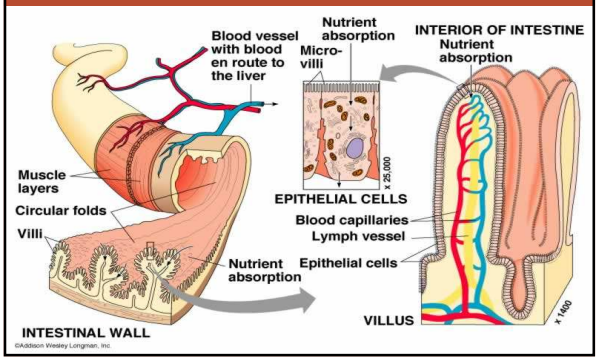
Digestion and Absorption

- Mouth - Physical and chemical digestion begins and bolus of food travels the esophagus to the stomach
- Stomach - Bolus is liquified and nutrients are further digested
  - Only a few medications and alcohol are absorbed in the stomach
  - Bolus remains in stomach for 2 -4 hours
  - Acidity of stomach breaks down some organic compounds including proteins

Digestion and Absorption

- Small Intestine – Majority of digestion and absorption occur in the duodenum
  - Fats are emulsified by bile
  - Pancreatic enzymes digest fats, proteins, and complex carbohydrates
  - Intestinal enzymes digest disaccharides
- Chyme remains in small intestine for up to 8 hours
- Simple organic molecules are absorbed into the blood through the villi in the small intestine

Villus Absorption



Villus Absorption

- Small intestine is surrounded with venules of the portal system
  - Carbohydrates and amino acids are absorbed into the portal vein and taken to the liver
- Small intestine is surrounded with lymphatic vessels
  - Fats are absorbed into the lymphatic system and transported to the subclavian vein

Large Intestine

- Water found in much of the food eaten, is absorbed into the blood in the colon
- Vitamins K and B complexes absorbed in colon
  - Bacterial flora actually synthesize many of vitamins needed by humans
- Colon is innoculated with large amounts of bacteria that continue to break down chyme and extract all useful substances from it
- Waste product is dried out and excreted in the form of fecal material
- Gas production occurs from bacterial action
  - Most people produce 1 -3 pints of methane per day!

Disorders of GI system

- GI system is responsible for nutrient absorption and thus is exposed to many potential infectious agents
- There are many pathologies of GI system
  - Ulcers
  - Stenosis of sphincters
  - Infections
  - Reflux
  - Crohn's disease
  - Pancreatitis
  - Hepatitis