Road Map to the Finish

No Review this Friday

Today 11/29 Finish digestion/accessory organs

Wednesday 12/1 Immune System I

Monday 12/6 Immune System II

Wednesday 12/8 Group Oral Presentations

Wednesday lab take practical at 12:20, come to class after practical

Paneth Cells

- base of intestinal glands
- large
- intense acidophilic granules
- phagocytose bacteria
- secrete lysozyme - digests bacterial cell wall

Epithelial Renewal in Stomach and Small Intestine

Large Intestine

Simple columnar epithelium
Absorption of water and electrolytes

Columnar absorptive cells
Crypts of Lieberkuhn
Goblet cells

www.kumc.edu/~his/histo/histoweb/gitract/gi21.htm
Must coordinate ingestion with secretion & motility

1) For each of the following decide where it is released and what it accomplishes.
   - Saliva
   - Digestive enzymes
   - Hydrochloric Acid (HCl)
   - Bile from gall bladder

2) Identify where proteins, carbohydrates, lipids and nucleic acids are digested and absorbed.

What signals might trigger and coordinate the release of saliva, digestive enzymes, etc.?

Gastrin secretion: release from stomach enteroendocrine cells (G cells) is stimulated by
1) peptides and amino acids in stomach lumen
2) distention of stomach wall
3) sensory inputs --> neural innervation (GRP)
   - Parietal cells have gastrin receptors

Gastrin stimulates Parietal Cells and Enterochromaffin-like cell=ECL Cell

HCl produced by parietal cell

Gastrin produced by G cell
**Cholecystokinin (CCK):** hormone released from enteroendocrine cells of small intestine is stimulated by presence of H⁺, amino acids, and fatty acids

- Pancreatic cells have CCK receptors** (may act through neurons innervating the pancreas in humans)

**CCK RELEASE (INTESTINAL ENDOENDOCRINE CELLS)**

**PANCREATIC DIGESTIVE ENZYME RELEASE**

**DIGESTION OF CARBOHYDRATES, PROTEINS, LIPIDS IN SMALL INTESTINE**

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**PANCREAS: Endocrine / Exocrine Gland**

<table>
<thead>
<tr>
<th>Organ</th>
<th>Function</th>
<th>Cell type</th>
<th>Secretion</th>
<th>Compartment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pancreas</td>
<td>Endocrine</td>
<td>Islet</td>
<td>Insulin, Glucagon, Somatostatin</td>
<td>Blood</td>
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<tr>
<td>Pancreas</td>
<td>Exocrine</td>
<td>Acinar, Ductal</td>
<td>Digestive enzyme, Water, Bicarbonate</td>
<td>Pancreatic duct → Duodenum</td>
</tr>
</tbody>
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**PANCREAS: Exocrine Gland**

Terminal ductule

Acinar lumen – Basal portion

Diagramatic view of three acini
Cholecystokinin (CCK)

- Gall Bladder smooth muscle cells have CCK receptors

CCK RELEASE (INTESTINAL ENDOCRINE CELLS)

GALL BLADDER CONTRACTION

RELEASE OF BILE INTO LUMEN OF SMALL INTESTINE

FACILITATED DIGESTION OF LIPIDS
**GALL BLADDER**
- lumen lined by simple columnar epithelium
- microvilli, tight junctions, mitochondria
- smooth muscle
- concentrates bile (Na\(^+\) actively pumped out of lumen in exchange for H\(^+\), water follows)
- stores bile until release

**Pancreas: Endocrine Gland**

**PANCREAS: Endocrine Gland**

Islet of Langerhans: most numerous tail of pancreas, 2% volume
Pancreas: Endocrine Function

**β Cells**: secretion of insulin in response to high blood glucose, causes uptake and storage of glucose into liver and skeletal muscle; *diabetes mellitus Type I and II*

**α Cells**: secretion of glucagon in response to low blood glucose, causes synthesis of glucose and breakdown of glycogen in liver

**δ Cells**: secretion of somatostatin; inhibits insulin and glucagon release

Pancreas: Islets of Langerhans

Blood Supply: Fenestrated capillaries

*Cascading Perfusion: portal-like*

α and δ cells on periphery → β cells centrally

*Acini of exocrine pancreas*

Insulin: stimulates exocrine secretion
Glucagon & somatostatin: inhibits exocrine

Pancreas: Islets of Langerhans

Nervous Innervation of Islets:

10% cells directly innervated

Gap Junctions spread stimulus to other cells

Sympathetic Innervation: ↑Insulin ↓Glucagon

Parasympathetic Innervation: ↑Insulin ↑Glucagon

LIVER

Right side

Beneath diaphragm

"Hepatic"

Resources:

http://www.vivo.colostate.edu/hbooks/pathphys/digestion/liver/anatomy.html
http://education.vetmed.vt.edu/curriculum/vm8054/lab/Lab201LAB201HTM
http://anatomyforme.blogspot.com/2008/05/liver-and-gallbladder-where-fat-really.html
**LIVER FUNCTIONS**
- Produce of bile
- Process and store of nutrients
- Phagocytose debris and bacteria
- Synthesize blood proteins and coagulation factors
- Detoxify & inactivate drugs and toxic substances
- Stores, modifies Vitamins A, D, K
- Participate in iron metabolism
- Modify hormones (thyroxine, growth hormone etc)

**LIVER: BLOOD FLOW**

*TO LIVER: PORTAL VEIN:* from stomach, pancreas, spleen, & intestines.

*HEPATIC ARTERY:* brings oxygen rich blood

*HEPATIC SINUSOIDS* (2nd capillary bed-portal system)

*LIVER: Classic Hepatic Lobule*

Hexagonal; connective tissue septa

Bounded by Portal Triads:
1) a branch of the hepatic artery
2) a branch of the portal vein
3) a bile ductule
4) lymphatic vessel (not always present)

Central vein (terminal hepatic venule) in center
LIVER: Classic Hepatic Lobule

LIVER: SINUSOIDS
Discontinuous capillaries; Squamous endothelial cells
Little or no basal lamina
Space of Disse
**LIVER: HEPATOCYTE**

Hepatocyte: 60% of all liver cells

Responsible for:
- Production of bile
- Processing and storage of nutrients
- Synthesis of blood proteins and coagulation factors
- Detoxify & inactivate drugs and toxic substances
- Produce hormones

**LIVER: SINUSOIDS**

Kupffer Cells: protrude into sinusoids and contribute to endothelial lining
- Mononuclear phagocytic system
- Macrophages
- Remove blood cells, bacteria

Kupffer cells labeled with India Ink
**LIVER: SINUSOIDS**

Ito Cells (hepatic stellate cell):
- In perisinusoidal space
- Stores Vitamin A to form photopigment (rhodopsin) in eye
- Respond to liver inflammation and injury --> scar

**LIVER: LIVER ACINUS**

Liver Acinus: Correlates with blood perfusion, metabolic activity and liver pathology; oriented around afferent vascular system

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NORMAL LIVER

LIVER INJURY
LIVER: LIVER ACINUS
Zones correspond to distance from blood supply
Zone 1: closest to arterioles, highest oxygen, 1st toxin exposure, necrosis due to toxins, first to regenerate
Zone 3: farthest from arterioles, poorest supply of oxygen, necrosis due to ischemia

LIVER: BILE PRODUCTION
Bile Canaliculus: channel between adjoining hepatocytes
carries bile to bile duct

Flow of bile is opposite that of blood flow

LIVER: PORTAL LOBULE
Portal Lobule: Region of bile production drained by axial bile duct