BI 121 Lecture 7  Exam I one week from today! I’ll be ready!...

I. **Announcements** Lab Notebooks? Q? from last time?

II. **GI Physiology Connections** DC Module 3 pp 17-23, LS ch 15+
   A. How is the gut controlled? Common control mechanisms
   B. Gut layers LS fig 15-2 pp 439-43 DC p 23
   D. Organ-by-organ review A&P LS tab 15-1 pp 440-1 +...
   E. Zymogen? = Inactive precursor LS fig 15-9 p 452...
      [http://www.cdc.gov/ulcer](http://www.cdc.gov/ulcer) Beyond the Basics LS p 456
   H. Large intestine? LS fig 15-24 pp 472-4

III. **Cardiovascular System** DC Mod 4, LS ch 9, Torstar, G&H+…
   A. Circulatory vs. Cardiovascular (CV)? CV vs. Lymphatic
      CV Pulmonary & Systemic circuits DC pp23-31+LS p229+
      DC fig 4-1 p 24, LS fig 9-2b p 231
   B. Arteries, capillaries, veins, varicosities? G&H, Torstar, DC
   C. ❤ layers, box, chambers, valves, inlets, outlets
      LS fig 9-4 p 233, fig 9-2a p 231; DC pp 23-6
   D. Normal vs. abnormal blood flow thru ❤ & CVS LS, Fox+…
Common Control Mechanisms

1. Local (autoregulation)
2. Nervous (rapidly-acting)
3. Hormonal (slower-acting/reinforcing)
Longitudinal $\rightarrow$ Shortens L

Circular $\rightarrow$ $\downarrow d$ or Width
Myenteric motor plexus!

Meissner’s sensory & secretory plexus!

Serosa
cf: G&H fig 62-2

Epithelium
Submucosa
Lumen
Lamina Propria
Longitudinal Muscle
Circular Muscle
H Howard 1990

Muscularis Externa
Glands
# Gut Secretions

<table>
<thead>
<tr>
<th>Secretion</th>
<th>Release Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mucus</td>
<td>into GI Lumen</td>
</tr>
<tr>
<td>2. Enzymes</td>
<td>into GI Lumen</td>
</tr>
<tr>
<td>3. H₂O, acids, bases+</td>
<td>into GI Lumen</td>
</tr>
<tr>
<td>4. Hormones</td>
<td>into Blood</td>
</tr>
</tbody>
</table>
1. **Mouth**

*Ingestion* entry way
salivary gland secretion
mucus + enzymes
enzymatic digestion: carbohydrate
mastication = chewing
deglutition = swallowing

2. **Esophagus**

*Rapid transit*
peristalsis
secretion mucus

3. **Liver** - **Gall Bladder**

*Emulsification* =
detergent action of bile + secretion

4. **Stomach**

*Mixing*
peristalsis
secretion mucus + HCl + enzymes
enzymatic digestion:
protein + butter fat!

5. **Pancreas**

*Secretion*
mucus + NaHCO₃ + enzymes
enzymatic digestion:
carbohydrate, fat, protein

6. **Small Intestine**

*Absorption*
Secretion mucus + enzymes
enzymatic digestion:
carbohydrate, fat, protein
Peristalsis

7. **Large Intestine**

*Dehydration*
secretion + absorption
storage + peristalsis
Where does enzymatic digestion of protein begin?
Zymogen = an inactive precursor

[Diagram showing the conversion of pepsinogen to pepsin with autocatalysis and digestion processes, labeled with gastric lumen, HCl, and various amino acids and peptide fragments.]
Why is the pancreas so unique?
Endocrine + Exocrine functions; Makes enzymes for digesting all 3 energy nutrients!
What are other accessory organs of digestion, that is, off-shoots of the primary tube?
Liver: Amazing Recycling of Bile Salts!

1. Secreted bile salts consist of 95% old, recycled bile salts and 5% newly synthesized bile salts.

3. Reabsorbed bile salts are recycled by enterohepatic circulation.

4. 5% of bile salts are lost in feces.

2. 95% of bile salts are reabsorbed by terminal ileum.

KEY
- = Enterohepatic circulation of bile salts
What is the major function of the small intestine? Absorption!!
Ulcer Facts

• Most ulcers are caused by an infection, not spicy food, acid or stress.
• The most common ulcer symptom is burning pain in the stomach.
• Your doctor can test you for *H. pylori* infection.
• Antibiotics are the new cure for ulcers.
• Eliminating *H. pylori* infections with antibiotics means that your ulcer can be cured for good.
Clipping a Duodenal Ulcer

Peering through the pylorus into the duodenum, we see some blood and a vessel sticking out of the wall, just at the front edge of a small but deep ulcer.

In the second photograph, a disposable metal clip is applied to the ulcer. The patient remained well and left hospital three days later.
<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Enzymes for Digesting the Nutrients</th>
<th>Source of Enzymes</th>
<th>Site of Action of Enzymes</th>
<th>Action of Enzymes</th>
<th>Absorbable Units of the Nutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td>Amylase</td>
<td>Salivary glands</td>
<td>Mouth and (mostly) body of stomach</td>
<td>Hydrolyzes polysaccharides to disaccharides (maltose)</td>
<td>Monosaccharides, especially glucose</td>
</tr>
<tr>
<td></td>
<td>Disaccharidases (maltase, sucrase, lactase)</td>
<td>Exocrine pancreas</td>
<td>Small-intestine lumen</td>
<td>Hydrolyze disaccharides to monosaccharides</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Small-intestine epithelial cells</td>
<td>Small-intestine brush border</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proteins</td>
<td>Pepsin</td>
<td>Stomach chief cells</td>
<td>Stomach antrum</td>
<td>Hydrolyzes protein to peptide fragments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trypsin, chymotrypsin, carboxypeptidase</td>
<td>Exocrine pancreas</td>
<td>Small-intestine lumen</td>
<td>Attack different peptide fragments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aminopeptidases</td>
<td>Small-intestine epithelial cells</td>
<td>Small-intestine brush border</td>
<td>Hydrolyze peptide fragments to amino acids</td>
<td>Amino acids</td>
</tr>
<tr>
<td>Fats</td>
<td>Lipase</td>
<td>Exocrine pancreas</td>
<td>Small-intestine lumen</td>
<td>Hydrolyzes triglycerides to fatty acids and monoglycerides</td>
<td>Fatty acids and monoglycerides</td>
</tr>
<tr>
<td></td>
<td>Bile salts (not an enzyme)</td>
<td>Liver</td>
<td>Small-intestine lumen</td>
<td>Emulsify large fat globules for attack by pancreatic lipase</td>
<td></td>
</tr>
</tbody>
</table>
Large Intestine Structure & Function

- Transverse colon
- Haustra
- Descending colon
- Ascending colon
- Ileocecal valve
- Cecum
- Appendix
- Rectum
- Sigmoid colon
- Internal anal sphincter (smooth muscle)
- External anal sphincter (skeletal muscle)
- Anal canal

LS 2012 fig 15-24 p 472
Cardiovascular (CV) = Heart + Vessels + Blood!
**NB:** Figure-8 loop

**Pulmonary**

8

**Systemic**

Capillary beds of lungs where gas exchange occurs

Pulmonary veins

Vena cavae

Pulmonary arteries

Aorta and branches

Right ventricle

Left ventricle

Systemic circuit

Systemic circulation

Arterioles

Capillary beds of all body tissues where gas exchange occurs

Venules

Oxygen-poor, CO$_2$-rich blood

Oxygen-rich, CO$_2$-poor blood

D Chiras 2013 fig 4-1b
Dual Pump Action & Parallel Circulation
Lymphatic System

1. Lymph Nodes
2. Vessels
3. Lymph

No pump!
Lymphatic System

Alternative System of Circulation or Drainage System

Lymph Vessels || Veins
Lymphatic System Blockage in Elephantiasis from Mosquito-borne Parasitic Filaria Worm
Lymphatics collect run-off & are parallel to venules/small veins!
Microcirculation Exchange: 10 Billion Capillaries!

No cell > 25-50 μ away from a capillary! Like having bus stops @ every other block!
Harvey Experiments: 1-way system of venous valves!
The Heart

The Living Pump
Human ❤️ = 4-chambered box?
2 separate pumps?

Upper = Atria
Lower = Ventricles

RA | LA
---|---
RV | LV

Pulmonary | Systemic

Primer Pumps
Power Pumps
(a) Location of the heart valves in a longitudinal section of the heart
Heart Valves Ensure Unidirectional Blood Flow!

**Valves must be normal & healthy to work well!**

- Right AV valve
- Left AV valve
- Aortic or pulmonary valve

(b) Heart valves in closed position, viewed from above

(c) Prevention of eversion of AV valves

*FIGURE 9-4 Heart valves.*
Human ♥ = 4 unique valves?
2 valve sets?

Semilunar = Half-moon shaped
1. Pulmonic/Pulmonary
2. Aortic

AV = Atrioventricular
3. R AV = Tricuspid
4. L AV = Mitral/Bicuspid

More rigid
More flimsy
Heart Valve Orientation & Scaffolding

- Pulmonary ring
- Aortic ring
- Mitral ring
- Tricuspid ring
- Muscle fiber
FIGURE 9-6
Mitral and aortic valves.
Veins ➔ Atria ➔ Ventricles ➔ Arteries

Superior vena cava (from head)

Right atrium

Inferior vena cava (from body)

Right ventricle

Left atrium

Left ventricle

Aorta

Endocardium

Myocardium

Pericardium

http://www.nhlbi.nih.gov/health/health-topics/topics/hhw/contraction.html
Septal defect in atria
Patent or still open!

SI Fox 2009 fig 13.17 p 420