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. Organ-by-organ review SI Fox, LS tab 15-1 pp 440-1 +...
B. Zymogen? = Inactive precursor LS fig 15-9 p 452...
   http://www.cdc.gov/ulcer **Beyond the Basics** LS p 456
E. 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 pp 23-31+LS p 229+
   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+...
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. **Stomach**
   - *Mixing*
   - peristalsis
   - secretion mucus + HCl
   - + enzymes
   - enzymatic digestion:
     - protein + butter fat!

4. **Liver-Gall Bladder**
   - *Emulsification*
   - = detergent action of bile
   - + secretion

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

LS 2012 fig 15-9 p 452
Why is the pancreas so unique?
**Endocrine + Exocrine** functions; Makes enzymes for digesting all 3 energy nutrients!

- **Endocrine portion of pancreas (Islets of Langerhans)**
- **Exocrine portion of pancreas (Acinar and duct cells)**

Duct cells secrete aqueous NaHCO₃ solution

Acinar cells secrete digestive enzymes

Hormones (insulin, glucagon)

The glandular portions of the pancreas are grossly exaggerated.
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.

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

3. Reabsorbed bile salts are recycled by enterohepatic circulation.

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

KEY

- White arrows: Enterohepatic circulation of bile salts
- Black arrow: From terminal ileum to liver
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></td>
<td>Exocrine pancreas</td>
<td>Small-intestine lumen</td>
<td>Hydrolyze disaccharides to monosaccharides</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disaccharidases (maltase, sucrase, lactase)</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>Amino acids</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

Ileocelecal 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 Systemic

Pulmonary arteries

Vena cavae

Right ventricle

Left ventricle

Pulmonary veins

Aorta and branches

Arterioles

Venules

Capillary beds of lungs where gas exchange occurs

Capillary beds of all body tissues where gas exchange occurs

Oxygen-poor, CO₂-rich blood

Oxygen-rich, CO₂-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 runoff & 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!

1 Capillary

Guyton & Hall 2011 fig 1-2
Harvey Experiments: 1-way system of venous valves!
Skeletal Muscle Pump

Open valve

Closed valve
The Heart
The Living Pump
Human \( \heartsuit \) = 4-chambered box? 2 separate pumps?

Upper = Atria

Lower = Ventricles

Pulmonary

Systemic

RA

LA

RV

LV

R \heartsuit

L \heartsuit

Primer Pumps

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

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

(c) Prevention of eversion of AV valves

*FIGURE 9-4 Heart valves.*

Valves must be normal & healthy to work well!
Human $\heartsuit$ = 4 unique valves?
2 valve sets?

**Semilunar** = **Half-moon shaped**

1. Pulmonic/Pulmonary
2. Aortic

**AV** = **Atrioventricular**

3. $\text{R}^\circ$ AV = Tricuspid
4. $\text{L}^\circ$ AV = Mitral/Bicuspid
Heart Valve Orientation & Scaffolding

- Pulmonary ring
- Aortic ring
- Mitral ring
- Tricuspid ring
- Muscle fiber
FIGURE 9–6
Mitral and aortic valves.

MITRAL VALVE
- Cusp
- Chordae tendineae
- Papillary muscles

AORTIC VALVE
- Cusp
Veins ➔ Atria ➔ Ventricles ➔ Arteries

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

AO  Ductus arteriosus  PA