BI 121 Lecture 7

I. **Announcements** Exam I one week from today, Oct 29th!

   10 am Lab → 5 KLA, 11 am → 129 HUE, AEC, All others here!
   Discussion + Review, Sunday Oct 27th, 6-7:30 pm, here! Q?

II. **Gastrointestinal Physiology** DC Mod 3 pp 17-23, LS ch 15+

   A. Organ-by-organ review LS tab 15-1 pp 440-1 +...
   B. Zymogen? = Inactive precursor LS fig 15-9 p 452...
   D. Small intestine? Ulcers? Energy nutrient digestion LS
      *Beyond the Basics*, fig 15-20,15-22 pp 456, 467-8, Mayo Clinic
   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 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+…
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

7. **Large Intestine**
   - Dehydration
   - Secretion + absorption
   - Storage + peristalsis
Where does enzymatic digestion of protein begin?
Zymogen = an inactive precursor

Autocatalysis

Pepsinogen

Pepsin

Digestion

Gastric lumen

HCl

Protein

Peptide fragments

= Various amino acids

= Enzymatic splitting of a chemical bond

LS 2012 fig 15-9 p 452
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?
Stomach (partly removed to show underlying pancreas)

Liver

Gallbladder

Duodenum

Pancreas

Common bile duct

Pancreatic duct
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.
What is the major function of the small intestine? Absorption!!
https://www.mayoclinic.org/diseases-conditions/peptic-ulcer/symptoms-causes/syc-20354223
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>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></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
Time-out for Questions!

+ Brief Break!
Cardiovascular (CV) = Heart + Vessels + Blood!
**NB:** Figure-8 loop

- **Pulmonary**
  - Pulmonary arteries
  - Vena cavae
- **Systemic**
  - Right ventricle
  - Left ventricle
  - Arterioles
  - Venules
  - 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 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!
Experiments: 1-way system of venous valves!
Skeletal Muscle Pump
The Heart: The Living Pump

https://ed.ted.com/lessons/how-the-heart-actually-pumps-blood-edmond-hui#review
Human ♥ = 4-chambered box?
2 separate pumps?

Upper = Atria
Lower = Ventricles

Pulmonary | Systemic
---|---
RA | LV
RV | LA

Primer Pumps
Power Pumps

R | L
(a) Location of the heart valves in a longitudinal section of the heart

- Aorta
- Superior vena cava
- Pulmonary valve
- Pulmonary veins
- Left atrium
- Left AV valve
- Aortic valve
- Chordae tendineae
- Papillary muscle
- Left ventricle
- Right atrium
- Right AV valve
- Right ventricle
- Inferior vena cava
- Septum
Heart Valves Ensure Unidirectional Blood Flow!

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

Mom's valve!

Valves must be normal & healthy to work well!

- **Right atrium**
- **Right AV valve**
- **Direction of backflow of blood**
- **Chordae tendineae**
- **Septum**
- **Right ventricle**
- **Papillary muscle**

(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
FIGURE 9-6
Mitral and aortic valves.
Cardiac Cycle

**Systole**
- Contract
- & Empty

**Diastole**
- Relax
- & Fill
Veins ➔ Atria ➔ Ventricles ➔ Arteries

https://www.nhlbi.nih.gov/health-topics/how-heart-works
https://www.youtube.com/watch?v=zJXAIh9VDDU
Patent or still open!
Foramen ovale!
Patent or still open! Ductus arteriosus!
Heart Murmurs? An unusual or extra heart sound lub-dup, lub-dup vs lub-gurgle-dup, lub-swish-dup...

S1 = lub

S2 = dup

https://www.thinklabs.com/heart-sounds