I. **Announcements** Exam I one week from today, Oct 24th!
Summary & Review, Sunday Oct 22nd, 6-7:30 pm, here! Q?

II. **Gastrointestinal Physiology** DC Module 3 pp 17-23, LS ch 15+
B. How is the gut controlled?
C. Organ-by-organ review A&P LS tab 15-1 pp 440-1 +...
D. 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
G. 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+…
Digestion Steps

1. Ingestion
2. Mechanical Digestion
3. Chemical Digestion
4. Peristalsis
5. Absorption
6. Storage
7. Defecation

Hi gang!!
You need me for digestion!!

\[ \text{H}_2\text{O} + \text{Enzyme} \]
What’s missing?

**FIGURE 15-1** An example of hydrolysis. In this example, the disaccharide maltose (the intermediate breakdown product of polysaccharides) is broken down into two glucose molecules by the addition of $\text{H}_2\text{O}$ at the bond site.
Polymer to Monomer (Many to One)

Carbohydrate → Glucose

Protein + Fat → Amino Acids

Fatty Acids + Glycerol
GI-DONUT ANALOGY

GI LUMEN

BODY
Common Control Mechanisms

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

Circular $\rightarrow$ ↓d or Width

Duct of large accessory digestive gland (i.e., liver or pancreas) emptying into digestive-tract lumen
Myenteric motor plexus!

Meissner’s sensory & secretory plexus!

Serosa

Epithelium

Submucosa

Lumen

Lamina Propria

Circular Muscle

Longitudinal Muscle

Glands

Muscularis Externa

H Howard 1990

cf: G&H fig 62-2
# 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. H$_2$O, 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
   - Mucus secretion

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

**Pulmonary**

![Diagram of the pulmonary circuit with labels for pulmonary arteries, veins, capillary beds, and systemic circulation.](D Chiras 2013 fig 4-1b)
Dual Pump Action & Parallel Circulation

- **Venae cavae**
- **Right atrium**
- **Right ventricle**
- **Pulmonary artery**
- **Pulmonary circulation**
- **Systemic circulation**
- **Left ventricle**
- **Left atrium**
- **Pulmonary veins**

- **Other systemic organs**
- **Brain**
- **Digestive tract**
- **Kidneys**
- **Muscles**
- **Aorta**
- **Lungs**
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

LS 2012 fig 10-21 p 283
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

Open valve

Closed valve
The Heart

The Living Pump
Human **❤️ = 4-chambered box?**

2 separate pumps?

- **Upper** = Atria
- **Lower** = Ventricles

<table>
<thead>
<tr>
<th>Pulmonary</th>
<th>Systemic</th>
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<tbody>
<tr>
<td>RA</td>
<td>LA</td>
</tr>
<tr>
<td>RV</td>
<td>LV</td>
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**Primer Pumps**

- **R**
- **L**

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

Right AV valve

Left AV valve

Aortic or pulmonary valve

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

Right atrium

Right AV valve

Direction of backflow of blood

Chordae tendineae

Septum

Right ventricle

Papillary muscle

(c) Prevention of eversion of AV valves

**FIGURE 9-4** Heart valves.
Human $\heartsuit$ = 4 unique valves? 2 valve sets?

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

1. Pulmonic/Pulmonary
2. Aortic

**AV** = *Atrioventricular*

3. $\bigcirc R$ AV = Tricuspid
4. $\bigcirc L$ AV = Mitral/Bicuspid
Heart Valve Orientation & Scaffolding

- Pulmonary ring
- Aortic ring
- Mitral ring
- Tricuspid ring
- Muscle fiber
Mitral and aortic valves.
Veins → Atria → Ventricles → Arteries

http://www.nhlbi.nih.gov/health/health-topics/topics/hhw/contraction.html
Patent or still open! Foramen ovale!
Patent or still open! Ductus arteriosus!

SI Fox 2009 fig 13.17 p 420