BI 121 Lecture 7

I. **Announcements** Exam I one week from today, Oct 25th! Summary & Review, Sunday Oct 23rd, 6-7:30 pm, here! Q?


III. **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

IV. **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+…

…Put Lab Notebook in box based on your lab time. Thanks!!
LOWER CARBOHYDRATE

ELIMINATE CALORIES or FOOD GROUPS

ENCOURAGE FASTING

LOWER FAT

ADEQUACY
BALANCE
CONSISTENCY
& MODERATION

AHA + DASH + ♥

PEER-REVIEWED = TRADE BOOKS

PEER-REVIEWED = TEXTS ➔ RESEARCH

NOT PEER-REVIEWED = TRADE BOOKS

PEER-REVIEWED = TRADE BOOKS

PEER-REVIEWED = TRADE BOOKS
Kleiner's & Monaco's Top 10 Hit List for Nutrition Quackery

1. Treatment based on unproven theory calling for non-toxic, painless therapy.

2. Author's/purveyor's credentials aren't recognized in scientific community.

3. No reports in scientific, peer-reviewed literature but rather mass media used for marketing.

4. Purveyors claim medical establishment is against them & play on public's paranoia about phantom greed of medical establishment.

5. Treatments, potions, drugs manufactured according to secret formula.

6. Excessive claims promising miraculous cures, disease prevention or life extension.

7. Emotional images rather than facts used to support claims.

8. Treatments require special nutritional support including health food products, vitamins and/or minerals.

9. Clients are cautioned about discussing program to avoid negative.

10. Programs based on drugs or treatments not labeled for such use.
With the right food choices, physical activity, and not smoking, we could prevent about ~90% of diabetes, 80% of heart disease & 70% of stroke!
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!!

H₂O + Enzyme

Hydrolysis of Energy Nutrients
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 $H_2O$ at the bond site.
Polymer to Monomer (Many to One)

- Carbohydrate + Protein + Fat
  - Glucose
  - Amino Acids
  - Fatty Acids + Glycerol

...Central-linking theme!!
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 $\rightarrow$ $\downarrow$ d or Width

Body wall

Serosa

Submucosa

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

Outer longitudinal muscle

Inner circular muscle

Mucosa

Lumen

Muscularis externa

Myenteric plexus

Submucous plexus
Myenteric motor plexus!

Meissner’s sensory & secretory plexus!

Muscularis Externa

Glands

Lamina Propria

Lumen

Submucosa

Epithelium

Serosa

Longitudinal Muscle

Circular Muscle

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. 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. **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

**Diagram:**
- **Pepsinogen** is converted to **Pepsin** through **Autocatalysis**.
- **HCl** in the **Gastric lumen** leads to digestion of **Protein** into **Peptide fragments**.

**Legend:**
- Various amino acids
- Enzymatic splitting of a chemical bond

**References:**
- 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.

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

- Enterohepatic circulation of bile salts

LS 2012 fig 15-11 p 462
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><strong>Carbohydrates</strong></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</td>
<td>Exocrine pancreas</td>
<td>Small-intestine lumen</td>
<td>Hydrolyze disaccharides to monosaccharides</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(maltase, sucrase, lactase)</td>
<td>Small-intestine epithelial cells</td>
<td>Small-intestine brush border</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Proteins</strong></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, carboxy- peptidase</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><strong>Fats</strong></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
Cardiovascular (CV) = Heart + Vessels + Blood!
NB: Figure-8 loop

Pulmonary

8

Systemic

Capillary beds of lungs where gas exchange occurs

Pulmonary circuit

Pulmonary arteries

Vena cavae

Aorta and branches

Right ventricle

Left ventricle

Systemic circuit

Arterioles

Capillary beds of all body tissues where gas exchange occurs

Venules

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

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!

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

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

Upper = Atria

Lower = Ventricles

RA

RV

LA

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!

Mom's valve!

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. \( \mathbb{R} \) AV = Tricuspid
4. \( \mathbb{L} \) AV = Mitral/Bicuspid
Heart Valve Orientation & Scaffolding

- Pulmonary ring
- Aortic ring
- Mitral ring
- Tricuspid ring
- Muscle fiber

Torstar Books 1984
FIGURE 9-6
Mitral and aortic valves.
Veins → Atria → Ventricles → Arteries

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

SI Fox 2009 fig 13.17 p 420