I. **Announcements**: Please check & sign attendance roster. Not on list? See Pat during a break or after class. *Lab 1 Histology* tomorrow in 130 HUE: 12 n & 1 pm sections.

II. **Introduction**: Staff, office hr, required sources, course overview, grading, expectations & success. Q?

III. **Human Physiology** LS ch 1, DC Module 1
   A. What? cf: Anatomy LS p 1
   B. Where? Body Levels of Organization LS pp1-6, DC pp1-5
   C. How? Different Study Approaches LS p 1

IV. **Homeostasis** LS ch 1, DC Module 1
   A. What? Maintenance of ECF LS p 8
   B. Where? ECF = Plasma + Interstitium LS fig 1-4 p 8
   C. How? Simplified Homeostatic Model cf: LS fig 1-7 p 14 Balances LS p 9, DC pp 5-6
   D. Why? Cell survival! LS fig 1-5 p 9, DC p 5
Structure begets function!
Structure gives rise to function!
Structure & function are inseparable!
Preoperative Diagnoses: R Knee Degenerative Joint Disease (DJD) = arthritis
Varus malalignment = bow-leg

Procedures:
Arthroscopy & microfracture
High Tibial Osteotomy (HTO)
Packing bone graft substitute

Blocks/Medications:
Femoral n. block
General anesthesia
IV Morphine, Oral Oxycontin + Oxycodone,
Tylenol, Injectable Lovenox (enoxaparin Na)
1. Arthroscopy clean-up
2. Debridement complete
3. Microfracture with awl
4. Punctuate bleeding
High-Tibial Osteotomy (HTO) to Realign the Joint

1. Oscillating saw cut
2. R plate/scaffolding insert
3. Align, stabilize w/screws & pack defect
Body Levels of Organization

1. Molecular
2. Cellular
3. Tissue
4. Organ
5. System

Entire Organism, like you & me!
Nerve conducts

Muscle contracts

Connective connects!!

Epithelial covers
Epithelial tissue gives rise to glands: (a) exocrine & (b) endocrine
Organs are made up ≥ 2 tissue types

**Organ:**
Body structure that integrates different tissues and carries out a specific function

- **Epithelial tissue**: protection, secretion, absorption
- **Connective tissue**: structural support
- **Muscle tissue**: movement
- **Nervous tissue**: communication, coordination, control
Which body systems?
Homeostasis is essential for cell survival!

Body systems

Maintain

Homeostasis

Make up

Is essential for survival of

Cells
Maintenance of a relative constancy in the Internal environment = ECF = fluid outside of cells

milieu interieur?

100 trillion cells working intimately

Claude Bernard

Walter B. Cannon
I. **Announcements** Lab today 12 n & 1 pm. Q last time?

II. **Connections** Extracellular fluid (ECF) & Homeostasis
   A. ECF: Plasma vs. Interstitium?
   B. Dr Evonuk Balances LS pp 5 - 15
   C. *Physiology in the News* Are we like watermelons?
   D. Simplified Model DO Norris cf: fig 1- 8 LS
   E. Negative feedback? Positive feedback? LS pp 14 - 15
   F. Balances & e.g. H₂O, T°C, BP Dr Evonuk + LS pp 8 - 10

III. **Cell Anatomy, Physiology & Compartmentalization** ch 2 (LS)
   B. Basic survival skills ch 1 p 3
   C. Organelles ≡ Membranous, cytoplasmic specialty shops!
      1. Endoplasmic Reticulum (ER) 2. Golgi 3. Lysosomes
      fig 2-1, 2-2, 2-3, 2-4, 2-5, 2-6, 2-7, 2-8 pp 20-7 tab 2-1 p 36
   D. *Physiol News* Moms eggs execute Dad’s mitochondria?
   E. What about vaults? LS 2006, p 32 + *Science News*
ECF = Extracellular

Plasma (within CV System)

Interstitium (eg, between muscle cells)

ICF = Intracellular
Dr. Evonuk’s 6 Balances

Metabolic

ANA-  CATA-

H₂O  ToC

O₂/CO₂  Ion±/

Carbon Dioxide  Electricity  Captain Calcium  Electricity

Bicarbonate and pH Balance
Drink about 1 L per 1000 calories energy expenditure!!

Human ~ 2/3 $\text{H}_2\text{O}$
~ 60 – 70 %

$= \approx 40 – 48 \text{ kg H}_2\text{O}$

$\text{NB: So 2000 kcal} \rightarrow$
$\text{drink 2000 mL}$
$\equiv 67.63 \text{ fl oz}$
$\equiv \approx 8 \text{ cups}$!
Invariably, Negative Feedback
NB: Though most often **negative** feedback, there are exceptions:

**Selected +FB eg:**

- LH Surge + Ovulation
- Oxytocin + Uterine Contraction
- Blood Clotting Cascade
- cAMP Cascade
- Na⁺ influx during AP
70% $\text{H}_2\text{O}$

= 49L

INPUT

Dietary Drink
1200 mL

Dietary Eat
400 mL

Oxidation
400 mL

Total = 2000 mL

OUTPUT

Urine
1000 mL

Sweat + Insensible
900 mL

Feces
100 mL

Total = 2000 mL

ECF = 14L

Interstitium = 11L

Plasma = 3L

$\text{H}_2\text{O}$ BALANCE!
Controller = Hypothalamus with Set Point

True Diurnal Variation

Protein Denaturation

Mild Hypothermia

Profound Hypothermia

Set Point

98.6°F

110°F

Time of Day

0600  1400  0600  1400

< 30°C

Lethal

29°C

Lethal

37°C

35°C

33°C

ToC

ToC

98.6°F

110°F
Venous Pooling

Baroreceptors/Pressure Receptors eg, in Carotids & Aorta

NB: Corrective Change Opposes Original Input

Seated to Standing

↑ BP

↓ BP

Electrochemical Signal

CV Control Center Brain Stem

O

Electrochemical Signal eg, Symp Accel N

I

I'

R

C

E

Ef

+ HR

+ VC

Seated to Standing
I. **Announcements** Q from lecture or lab?

II. **Cell Physiology Connections** LS ch 2 pp 20-34, fig 2-1…2-8


   B. Exocytosis vs. Endocytosis fig 2-5 a & b, p 25

   C. **Physiol News** Moms eggs execute Dad’s mitochondria?


III. **Anaerobic vs Aerobic Metabolism Summary** LS ch 2 pp 26-33

   A. Key differences fig 2-15 + vpl

   B. Selected details: Glycolysis, CAC, ETC, fig 2-9 thru 2-12

IV. **Introduction to Genetics** LS 2012 ch 2 p 20-1 + Appendix C

   A. What’s a gene? Where? p A-18, fig C-2, C-3

   B. Why are genes important? p A-18

   C. What’s DNA & what does it look like? pp A-18 thru A-20

   D. How does information flow in the cell? fig C-6

   E. How does DNA differ from RNA? pp A-20 thru A-22

HOW BIG? 100 CELLS LENGTHWISE = 1 mm!!

1. **Cell/Plasma membrane**
2. **Nuclear Membrane**

- **Organelles**
- **Nucleus**
- **Cytosol**

Cells make up body systems

\(d = 10-20 \text{ microns}\)
Cytoplasm = Cell - Nucleus

[Extract nucleus; includes organelles]

Cytosol = Cytoplasm - Organelles

[Extract organelles; complex gel-liquid]
Why Compartments? Advantage?

*Incompatible* reactions can take place

*Simultaneously!!*
Basic Cell Survival Skills?

1. Get food
2. Use food
3. Rid wastes
4. Move
5. Reproduce

How to live?

Nucleus or nose?
1 e.g. Cell of 100 Trillion!
Rough & Smooth Endoplasmic Reticulum (ER): Protein & Lipid Synthesizing Factories

Smooth ER:
1. packages new proteins in transport vesicles
2. stores calcium in muscles

Rough ER

Rough ER lumen

Smooth ER lumen

Ribosomes

Sacs

Tubules

fig 2-2 LS 2012
Instructions for building proteins leave the nucleus and enter the cytoplasm.

Proteins (colored strands) are assembled on ribosomes attached to the ER or free in the cytoplasm.

1. Rough ER
2. Smooth ER
3. Transport vesicles
4. Golgi complex
5. Secretory vesicles
6. Secretion (exocytosis)
7. Lysosome
Lysosomes vs. Peroxisomes

- Lysosome
- Peroxisome
- Hydrolytic enzymes
- Oxidative enzymes
Catalase Enzyme Reaction in Peroxisomes
Neutralize Toxin at Production Site!

\[
2\text{H}_2\text{O}_2 \rightarrow \text{2H}_2\text{O} + \text{O}_2
\]
Mitochondria: Energy Organelles

- Intermembrane space
- Cristae
- Proteins of electron transport system
- Inner mitochondrial membrane
- Matrix
- Outer mitochondrial membrane
- Cristae
Inside a fertilized egg, with its two sets of chromosomes (blue), the protein ubiquitin (red) tags sperm mitochondria (yellow).

What’s in the Vault?

An ignored cell component may often account for why chemotherapy fails

By JOHN TRAVIS

Can you imagine exploring the anatomy of the human body and missing the heart, the organ that sends life-giving blood coursing through the body? Of course not. Or not noticing the brain, the custodian of memories and creator of thoughts? Don’t be ridiculous.

Yet cell biologists may soon have to acknowledge an equally unimaginable oversight in their field. For decades, their powerful microscopes have failed to spot a basic cell component of animals and perhaps any organism with a nucleus. Known as vaults, the barrel-shaped particles are three times the size of ribosomes, theeasy-to-find structures that bring proteins into the cell through a microscope. But if it were contaminated with objects that shrug off the stain, that sea would be dotted with white islands. Rome likens the strategy to finding an invisible person by looking for an unexplained shadow in the beam of a spotlight.

To Kedersha’s surprise, unstained ovoid objects appeared among her coated vesicles. Since some of the stain settled into furrows on top of the unexpected shapes, the negative staining revealed fine details of the exterior of these mysterious interlopers, including arches that reminded Rome and Kedersha of the cell us something by this incredible structure. And the one thing we might surmise from the structure [of vaults] is that they might contain something,” says Rome.

That shape also hints that vaults may pick up their unknown cargo at the nuclear membrane, the barrier that separates the cell’s cytoplasm from its nucleus. The nucleus is a fluid-filled sac containing DNA and the machinery required to translate the instructions encoded by that DNA into molecules called messenger RNA. These mRNA strands, as well as other molecules, must somehow exit out of the nucl
1. Immediate/ATP-PC
2. Glycolysis
ATP Supplied

Performance Time

Power Output

ATP-PC/Immediate

15 - 30 s

Immediate

Anaerobic

Glycolysis

1.5 – 3 m

Oxygen System

≥ 3 – 5 m

Mitochondria

Cytosol

Modified after Mathews & Fox
Cleave One High Energy Phosphate Bond To Do Work!!

7 – 10 KiloCalories/KCal

Adenosine

1. Synthesis of Macromolecules
   - Make big things from little things!

2. Membrane Transport
   - Move things! Microscopic!

3. Mechanical Work
   - Move things! Macroscopic!
Anaerobic vs. Aerobic Metabolism

**Anaerobic Glycolysis**

"sugar dissolving" without $O_2$. Net of 2 ATP per molecule of glucose

**Aerobic Metabolism**

+ mitochondrial processing of glucose with $O_2$. Net of 32 ATP per molecule of glucose
AEROBIC
w/O₂

ANAEROBIC

% AEROBIC (Oxidative Energy System)

Primary Fuel

- FAT, CARBOHYDRATE & PROTEIN (Small Amounts)

Activity

- Marathon Cross-Country Skilling
- 10-K Run
- 3-Mile Run
- 2-Mile Run 800-Meter Swim
- 1-Mile Run
- Boxing 200-Meter Swim
- Circuit Weight Training
- Soccer Lacrosse
- Tennis
- Basketball Volleyball
- 200-Meter Dash Football
- Conventional Weight Training

% ANAEROBIC (Immediate & Non-Oxidative Energy Systems)

Activity

- Immediate/ATP-PC

Time (Min:Sec)

- 135:00
- 29:00
- 14:00
- 9:00
- 3:45
- 1:30
- 0:50
- 0:20
- 0:10

CYTOSOL

Glycolysis

MITOCHONDRIA
I. **Announcements** Nutrition Analysis Lab next Tuesday! Please record your diet on p 3-7 LM & begin analysis using https://www.supertracker.usda.gov/ Estimating quantities. Q?

II. **Cell Metabolism Connections** LS 2012 fig 2-9 thru 2-12 +…

III. **Introduction to Genetics** LS ch 2 p 20-1 + Appendix C
B. How does information flow in the cell? fig C-6
C. How does DNA differ from RNA? pp A-20 thru A-22
E. How & where are proteins made? fig C-7, C-9
F. Class skit: Making proteins @ ribosomes!

IV. **Nutrition Primer** DC Module 2, Sizer & Whitney(S&W) Sci Lib
A. Essential Nutrients: H₂O, ¹ Carbohydrates, ² Fats, ³ Proteins, Vitamins, Minerals; Macro- vs Micro-?
B. Dietary Guidelines: USDA, AICR, Eat Like the Rainbow!
D. Nutrition Quackery, Balanced Approach Kleiner, Monaco+
Goals of Aerobic Metabolism

AEROBIC w/O$_2$ = MITOCHONDRION

CITRIC ACID CYCLE

harvest electrons $e^-$ $e^-$ $e^-$ $e^-$ $e^-$ $e^-$

“cash in”

ELECTRON TRANSPORT CHAIN

for ATP Energy!!
Microtubular Highway!!
What are DNA’s major functions?
Heredity + Day-to-Day Cell Function
What does DNA look like? Double-helix!!

LS fig C-2
Gene = *Stretch of DNA that codes for a protein*

cf: LS fig C-3
What does DNA do, day-to-day?

DNA → RNA → Protein

Replication → Transcription → Translation @ ribosomes

Nucleus → Cytoplasm

cf: LS fig C-6
<table>
<thead>
<tr>
<th>DNA vs RNA?</th>
<th>DNA vs RNA?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Double-stranded</td>
<td>1. Single-stranded</td>
</tr>
<tr>
<td>2. Deoxyribose</td>
<td>2. Ribose</td>
</tr>
<tr>
<td>(without oxygen)</td>
<td>(with oxygen)</td>
</tr>
<tr>
<td>Thymine</td>
<td>Uracil</td>
</tr>
<tr>
<td>(can copy itself)</td>
<td>template</td>
</tr>
<tr>
<td>5. Nucleus</td>
<td>5. 1° Cytoplasm</td>
</tr>
<tr>
<td>(+mitochondria)</td>
<td>(but Nucleus origin)</td>
</tr>
<tr>
<td></td>
<td>mRNA, rRNA, tRNA</td>
</tr>
</tbody>
</table>
**Triplets of bases code for amino acids, the building blocks of proteins**

<table>
<thead>
<tr>
<th>DNA code word</th>
<th>mRNA codon</th>
<th>tRNA anti-codon</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAT</td>
<td>AUA</td>
<td>UAU</td>
</tr>
<tr>
<td>ACG</td>
<td>UGC</td>
<td>ACG</td>
</tr>
<tr>
<td>TTT</td>
<td>AAA</td>
<td>UUU</td>
</tr>
<tr>
<td>TAC</td>
<td>AUG</td>
<td>UAC</td>
</tr>
</tbody>
</table>
Translation? Ribosomes Make Proteins

1. Large subunit
2. Small subunit
3. Amino acid
4. tRNA
5. Anticodon

mRNA
Leader sequence
First codon
Second codon
Ribosome

First ribosomal binding site
Second ribosomal binding site

Steps 5 through 8 are repeated

LS 2012 fig C-7
A Polyribosome. Which Way is Synthesis?

II. **Nutritional Physiology in the News**
Gain weight by drinking your calories? PEBB Newsletter
Salt–beyond hypertension *UCB Wellness Letter*, June 2011

III. **Nutrition Primer** DC Module 2, Sizer & Whitney (S&W) Sci Lib
A. Dietary Guidelines: USDA, AICR, Eat Like the **Rainbow**!
C. *Nutrition Quackery, Balanced Approach* Kleiner, Monaco+

IV. **Digestion** LS 2012 ch 15, pp 437-9, DC Module 3 pp 17-23
A. Steps of digestion Dr. Evonuk + LS pp 437-9; DC p 23
B. Hydrolysis: the central linking theme! LS p 438, Fox 2009
C. What’s missing? LS fig 15-1 p 438
D. GI-Donut analogy? Dr. Lorraine Brilla WWU
F. Organ-by-organ review LS tab 15-1 pp 440-1 + DC fig 3-1
5 times per wk? ≡ 106,600 calories/yr ≡ ± 30.5 lb fat/yr

Better choices!

Starbucks Cinnamon Dolce Latte, whipped cream | 410 calories
Jogging | 50 min.
More Reasons to Shake the Salt Habit

Stop me!

1. Blood vessel vasodilation within 30 min by ingesting 1500 mg Na+!

2. Calcium excretion, bone loss, risk of osteoporosis & fractures.


4. GI cancer risk, inflammation?

UCB Wellness Letter Jun 2011 p 5
# Macronutrients & Micronutrients Essential for Life

<table>
<thead>
<tr>
<th>Macronutrients</th>
<th>Sample Food Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂O/Water</td>
<td>Water, other drinks, fruits &amp; vegetables</td>
</tr>
<tr>
<td>1⁰ Carbohydrates</td>
<td>Grains, vegetables, fruits, dairy products</td>
</tr>
<tr>
<td>2⁰ Fats/Triglycerides/Lipids</td>
<td>Meats, full-fat dairy products, oils</td>
</tr>
<tr>
<td>3⁰ Proteins</td>
<td>Meats, legumes, dairy vegetables</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Micronutrients</th>
<th>Sample Food Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamins (A, D, E, K; C + B)</td>
<td>Vegetables, vegetable oils, fruits, citrus, grains, dairy</td>
</tr>
<tr>
<td>Minerals (K⁺, Na⁺, Ca²⁺, Mg²⁺, Fe²⁺, Zn²⁺,...)</td>
<td>Fruits, vegetables, grains, nuts, dairy, meats, processed foods</td>
</tr>
</tbody>
</table>

NB: Need only minute quantities!

Energy nutrients = yield ATP
1. ↑ emphasis on ↓ kcal + ↑ exercise.
2. 9-A-Day! 4 fruit + 5 vegetable servings.
3. ≥ 3 of 6 whole grains → ½ whole grains!
4. 3 servings of dairy, eg 3 c fat-free milk.
5. ↓ saturated + trans fats + ↑ unsaturated/“good” fats, eg Ω-3 fish, walnuts.
6. Drink in moderation if at all.
7. Practice food safety.

Hooray!
1. **Vary your veggies.** Fill ½ your plate with fruits & vegetables!

2. **Focus on fruits.** Whole fruit preferable to juice, but any fruit counts! Fill ½ your plate with fruits & vegetables!

3. **Make at least ½ of your grains whole grains!**

4. **Go lean with protein.** Keep protein to < ¼ plate! Nuts, beans, peas, seeds, poultry, lean meat, seafood,…

5. **Get your calcium-rich foods.** Buy skim or 1% milk. Go easy on cheese!

*MyPlate launched June 2, 2011*
Diet & Health Guidelines for Cancer Prevention

1. Choose a diet rich in variety of plant-based foods.
2. Eat plenty of vegetables & fruits.
3. Maintain a healthy weight & be physically active.
4. Drink alcohol only in moderation, if at all.
5. Select foods low in fat & salt.

And always, remember...

Do not smoke or use tobacco in any form.

American Institute for Cancer Research (AICR)
Eating the Rainbow Hawaiian Style!!

Your plate should be the size of a Frisbee, not a manhole cover.

When it comes to colorful foods, Fruit Loops don’t count.

A surprising number of people get 1/5 of their calories from sodas or other liquids.

If you look at the label & need a chemistry degree to read it, put the item back on the shelf!


NB: Each group 500 kcal deficit/day, 16 weeks
Exercise is better than dieting in lowering body fat & preserving muscles!
Dietary Composition & Physical Endurance

eg, Atkins!

High-fat diet

Normal mixed diet

High-carbohydrate diet

~ 1/3 endurance!

Maximum endurance time:

- 57 min
- 114 min
- 167 min
Negative Effects of Low Carbohydrate

1. ↑ fatigue/exhaustion
central & peripheral!

2. ↓ glucose – brain+spinal
cord, rbcs thrive upon.

3. ↓ variety which reduces
intake of phytochemicals,
vitamins, minerals & fiber.

4. ↑ risk of respiratory
infections.

+ gall stones,
↓ thermoregulation...
To Help Lower Body Wt & %Fat
EXERCISE!! +Minimize These!!

FAT  9 Kcal/g
ETOH 7 Kcal/g
CARB 4 Kcal/g
PRO 4 Kcal/g

NB: Minimize not Eliminate!
Moderation not Abstinence!!
60-day Fast???

Lost 60 lb!! Wow!!

Yet

\[
\begin{align*}
26 \text{ lb Water} \\
20 \text{ lb Lean Body Mass} \\
14 \text{ lb Fat}
\end{align*}
\]

Fat < $\frac{1}{4}$ total wt loss!
**Dr. Sacks’ Conclusions:**

We conclude that healthful diets with varying emphases on carbohydrate, fat & protein levels can all achieve clinically meaningful weight loss & maintenance of weight loss over a 2-yr period. The results give people who need to lose weight the flexibility to choose a diet that they can stick with, as long as it’s heart healthy. Such diets can also be tailored for individuals based on their personal & cultural preferences & in this regard may have the best chance for long-term success.
US Dietary Recommended Intakes (DRI) Committee Acceptable Macronutrient Distribution Ranges (AMDR)!

<table>
<thead>
<tr>
<th>Energy Nutrient</th>
<th>% Total Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>45-65%</td>
</tr>
<tr>
<td>Fat</td>
<td>20-35%</td>
</tr>
<tr>
<td>Protein</td>
<td>10-35%</td>
</tr>
</tbody>
</table>
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.
LOWER CARBOHYDRATE

ELIMINATE CALORIES or FOOD GROUPS

ENCOURAGE FASTING

AHA + DASH + MAYO CLINIC

PEER-REVIEWED = TEXTS → RESEARCH

NOT PEER-REVIEWED = TRADE BOOKS

LOWER FAT

ADEQUACY BALANCE CONSISTENCY & MODERATION
Digestion Steps

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

Hydrolysis of Energy Nutrients

Hi gang!!
You need me for digestion!!

Hydrolysis of Energy Nutrients

\[ \text{H}_2\text{O} + \text{Enzyme} \]
Polymer to Monomer (Many to One)

Carbohydrate → Glucose

Protein + Fat

Amino Acids
Fatty Acids + Glycerol

...Central-linking theme!!
GI-DONUT ANALOGY

GI LUMEN

BODY
# 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. ( \text{H}_2\text{O}, \text{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 + NaHCO$_3$ + 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
Common Control Mechanisms

1. Local (autoregulation)
2. Nervous (rapidly-acting)
3. Hormonal (slower-acting/reinforcing)
BI 121 Lecture 6 + Q + ½ Midterm Review

I. **Announcements** Next session Q? ~½ review, then Midterm. Fun Lab 3 Nutrition today! Sample Suisse Calculation? Q?

II. **Nutrition in the News** Be a whiz at healthy grilling! American Institute for Cancer Research, Grilling Quiz!

III. **Digestion Connections** LS ch 15, DC Module pp 17-23
A. Histology of the gut LS fig 15-2, 15-3 p 442-3
B. Stomach protein digestion + zymogens? LS fig 15-7, 15-9
C. Accessory organs: Pancreas & Liver + Recycling!
   LS pp 457-63
   [http://www.cdc.gov/ulcer](http://www.cdc.gov/ulcer) Beyond the Basics LS p 456
E. Summary of chemical digestion LS tab 15-5 p 466
F. Large intestine? LS fig 15-24 pp 472-4

IV. **Midterm Review** Discussion + Q?

Hey – I'll be ready because I book it!!
### How Do I Calculate the % of Total Calories from Carbohydrate, Fat & Protein?

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Amount (g)</th>
<th>Calories (kcal/g)</th>
<th>Total Calories (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>46</td>
<td>4</td>
<td>184</td>
</tr>
<tr>
<td>Fat</td>
<td>39</td>
<td>9</td>
<td>351</td>
</tr>
<tr>
<td>Protein</td>
<td>8</td>
<td>4</td>
<td>32</td>
</tr>
</tbody>
</table>

**Total Calories:**

\[ \sum = 567 \text{ kcal} \]

- **% Carbohydrate**
  \[ \frac{184}{567} = 0.326 \equiv \sim 33\% \]
- **% Fat**
  \[ \frac{351}{567} = 0.619 \equiv \sim 62\% \]
- **% Protein**
  \[ \frac{32}{567} = 0.056 \equiv \sim 6\% \]
American Institute for Cancer Research (AICR) Healthy Grilling Quiz Summary

1. **Marinade, marinade, marinade!** By doing so, you can decrease carcinogens formed during grilling by < 96%!

2. **Cover the grill with aluminum foil**, turn gas down or wait for low-burning embers, cook to the side.

3. **Best choices for grilling include vegetables and fruits** (no HCAs + enzymes to inactivate HCAs!), and lean meats (*e.g.*, fish & skinless chicken ↓ PAHs).

4. **Flip meat every minute** to reduce charring & remove charred portions prior to eating.

5. **To limit cancer risk, eat no more than 3 oz grilled red meat.** Cook small portions/kebabs.

AICR Newsletter, Summer 2006
Zymogen = an inactive precursor

Autocatalysis

Pepsinogen → Pepsin

Digestion

HCl

Protein

Peptide fragments

Gastric lumen

LS 2012 fig 15-9 p 452

Various amino acids

Enzymatic splitting of a chemical bond
Endocrine + Exocrine functions; Makes enzymes for digesting all 3 energy nutrients!
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.
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
Lab 3: Nutritional Analyses via 2 Programs

ChooseMyPlate.gov

https://www.supertracker.usda.gov/