I. **Announcements**: Please check & sign attendance roster. Not on list? See Pat during break/> class. *Lab 1 Histology* tomorrow in 130 HUE: 12 n & 1 pm sections. Much fun!!

II. **Introduction**: Staff, office hr, required sources, overview, grading, expectations & success. Anything goes 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

*...Welcome to Human Physiology – what makes us tick!*
ANATOMY vs PHYSIOLOGY
STRUCTURE vs FUNCTION
WHAT? vs HOW?
WHERE? vs WHY?
L Hip Osteonecrosis & L Hip Replacement

Shortening of Neck!

Fraying!

1.5 cm proud!
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 \( \geq 2 \) 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

*LS fig 1-2 p 4*
Which body systems?
Homeostasis is essential for cell survival!
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
ICF = Intracellular

ECF = Extracellular

Plasma (within CV System)

Interstitium (eg, between muscle cells)

https://www.youtube.com/watch?v=B658Yn3INYc
Dr. Evonuk’s 6 Balances

- Metabolic
  - ANA-
  - CATA-

- Water ($H_2O$)

- Temperature ($^oC$)

- Oxygen to Carbon Dioxide ($O_2/CO_2$)

- Ion $^+/-$

- pH

II. **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. **Homeostatic Balances**? LS p 9, DC pp 5-6
D. **Why**? Cell survival! LS fig 1-5 p 9, DC p 5
E. **Physiology in the News** H₂O? Are we like watermelons?
F. **How** are balances maintained? Simplified Homeostatic Model *cf*: LS fig 1-7 p 14; T°C + BP balance e.g. + vs. - FB

III. **Cell Anatomy, Physiology & Compartmentalization** LS ch 2
B. Basic survival skills LS ch 1 p 3
C. Organelles ≡ Intracellular specialty shops
   Endoplasmic Reticulum (ER), Golgi, Lysosomes, Peroxisomes & Mitochondria, LS fig 2-1, 2-2, 2-3 pp 20-3
Drink about 1 L per 1000 calories energy expenditure!!

Human ~ 2/3 H₂O
~ 60 – 70 %

= ~40 – 48 kg H₂O

NB: So 2000 kcal → drink 2000 mL
≡ 67.63 fl oz
≡ ~ 8 cups!
National Academy of Medicine 2018
~9 ½ cups of fluid per day for women
~12 cups per day for men

That includes all fluids: water, coffee, tea, juice, milk, but doesn’t include the 2-3 cups of liquid you get from your food!

Invariably, Negative Feedback

Feedback loop
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
**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: \(2000\ mL\)

**BALANCE!**
Controller = Hypothalamus with Set Point

True Diurnal Variation

Protein Denaturation

Mild Hypothermia

Profound Hypothermia

Set Point

https://www.khanacademy.org/partner-content/mit-k12/chem-and-bio/v/homeostasis
Venous Pooling

Electrochemical Signal

CV Control Center
Brain Stem

Baroreceptors/Pressure Receptors
eg, in Carotids & Aorta

Seated to Standing

NB: Corrective Change
Opposes Original Input

BP

Ef

I'

R

C

O

E

BP

HR

VC

+ +
HOW BIG? 100 CELLS LENGTHWISE = 1 mm!!

1. Cell/Plasma membrane
   - Organelles
   - Nucleus
   - Cytosol

2. Nuclear Membrane
   - Cells make up body systems
     - d = 10-20 microns
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

Nucleus or nose?

How to live?
BI 121 Lecture 3

I. Announcements
Q from last time? Office hr &/or e-mail Q.

II. Cell Anatomy, Physiology & Compartmentalization LS ch 2
A. Cell organelle overview; 100 Trillion!
B. Organelles ≡ Intracellular specialty shops w/membranes
   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
C. What about vaults? LS 2006, p 32
D. Physiol News Moms eggs execute Dad’s mitochondria?

III. Anaerobic vs Aerobic Metabolism Overview Many sources!
Mathews & Fox 1976...LS 2012 pp 26-33, fig 2-15 p 33

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
G. How are proteins made? fig C-7, C-9

…Anatomy & Physiology Lab Thurs! Fun again!
1 Sample Cartoon of 100 Trillion (100 x 10^{12}) Cells!

Rough & Smooth Endoplasmic Reticulum (ER): Protein & Lipid Synthesizing Factories

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

fig 2-2 LS 2012
Secretion of Proteins Produced by ER

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. Transport vesicles
3. Smooth ER
4. Golgi complex
5. Secretery vesicles
6. Lysosome
7. Secretion (exocytosis)

https://www.youtube.com/watch?v=URUJD5NEXC8
Golgi Complex: Final Processing, Packaging & Distribution

Transport vesicle from ER, about to fuse with the Golgi membrane

Golgi lumen

Golgi sacs

Vesicles containing finished product

Golgi complex

fig 2-4 LS 2012
Phagocytosis: Cell Eating!

(a) Phagocytic process:
- Particle binds to surface receptor site.
- Formation of endocytotic pouch.
- Endocytotic vesicle formation.

(b) Final stages:
- Phagocytic vesicle and lysosome interaction.
- Residual body formation.
Catalase Enzyme Reaction in Peroxisomes
Neutralize Toxin at Production Site!

\[ 2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2 \]
Mom’s eggs execute Dad’s mitochondria

In “Hamlet,” Rosencrantz and Guildenstern deliver a letter to the rulers of England that carries the ill-fated duo’s own death sentence. Perhaps Shakespeare knew a bit about reproductive biology.

Scientists have now found that during a sperm’s creation, its mitochondria—energy-producing units that power all cells—acquire molecular tags that mark them for destruction once the sperm fertilizes an egg. This death sentence, a protein called ubiquitin, may explain why mammals inherit the DNA within mitochondria only from their mothers, a species mitochondrial inheritance. Sperm mitochondria sometimes avoid destruction when two different species of mice mate, and Schatten’s team has shown this also holds true in cattle. It’s hard to understand how an egg distinguishes between paternal mitochondria of closely related species, says Schon.

When paternal mitochondria escape destruction in normal mating, the resulting embryo may suffer. Schatten notes that a colleague has found sperm mitochondria in some defective embryos from infertility clinics.

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, the easy-through a microscope. But if it were contaminated with objects that shrugged 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’s 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

Cytosol

Mitochondria

ATP-PC/Immediate

15 - 30 s

Glycolysis

1.5 – 3 m

Oxygen System

≥ 3 – 5 m

Anaerobic

Aerobic

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

7 – 10 KiloCalories/KCal

Synthesis of Macromolecules

Make big things from little things!

Membrane Transport

Move things! Microscopic!

Mechanical Work

Move things! Macroscopic!
I. **Announcements** Nutrition Analysis Lab next Tuesday!
Thanks for recording your diet on p 3-7 in LM. Estimating serving sizes, hints for recording (do sooner vs. later)…Q?

II. **Cell Physiology, Mitochondria & Metabolism Connections**
LS 2012 fig 2-9 thru 2-12, 2-15 +…Mathews & Fox 1976!

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: H$_2$O, $^1$ Carbohydrates,
   $^2$ Fats, $^3$ Proteins, Vitamins, Minerals; Macro- vs Micro-?
B. Dietary Guidelines: USDA, AICR, Eat Like the *Rainbow*!
C. **Blue Zones?** Pondering Paleo, Marlene Zuk, NAHL 2015…
D. Carbohydrate confusion. Minimize what? Simple sugars
Anaerobic vs. Aerobic Metabolism

**Anaerobic Glycolysis**
"sugar dissolving" without O\textsubscript{2}. Net of 2 ATP per molecule of glucose

**Aerobic Metabolism**
+ mitochondrial processing of glucose with O\textsubscript{2}. Net of 32 ATP per molecule of glucose
Goals of Aerobic Metabolism

AEROBIC \( w/O_2 \) = MITOCHONDRION

CITRIC ACID CYCLE

harvest electrons \( e^- \) "cash in"

ELECTRON TRANSPORT CHAIN

for ATP Energy!!
What does DNA look like? Double-helix!!
Gene = \textit{Stretch of DNA that codes for a protein}
What does DNA do, day-to-day?

- DNA → Transcription → RNA → Translation → Protein
- Replication → Nucleus
- Translation @ ribosomes → Cytoplasm

cf: LS fig C-6
DNA vs RNA?

1. Double-stranded
2. Deoxyribose (without oxygen)
3. A, T, C, G
   Thymine
4. Self-replicative (can copy itself)
5. Nucleus (+mitochondria)

1. Single-stranded
2. Ribose (with oxygen)
3. A, U, C, G
   Uracil
4. Needs DNA as template
5. \(^1\) Cytoplasm (but Nucleus origin)
6. mRNA, rRNA, tRNA
**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. mRNA
2. Large subunit
3. Small subunit
4. Amino acid
5. tRNA
6. Anticodon
7. Leader sequence
8. First codon
9. Second codon

Steps 5 through 8 are repeated.

First ribosomal binding site
Second ribosomal binding site

LS 2012 fig C-7
BI 121 Lecture 5

I. **Announcements** Data + Flashdrive for Nutrition Lab! Q?

II. **Sample Exam Q + Q about Exam?**

III. **Nutrition Primer** DC Module 2, Sizer & Whitney (S&W) Sci Lib

A. Essential Nutrients: \(H_2O\), \(1^0\) Carbohydrates, \(2^0\) Fats, \(3^0\) Proteins, Vitamins, Minerals; Macro- vs Micro-?

B. Dietary Guidelines: HHS-USDA, AICR, Eat the **Rainbow**!

C. **Blue Zones?** Habits of longest lived people?

D. Okinawan Longevity Diet?

E. Pondering Paleo? Marlene Zuk, U Minn

F. Animals vs. Plants? Protein, WHO, Meat?

G. TMAO, Neu5GC and Inflammation?

H. Carbohydrate Confusion. Why Plants & Whole Grains?

I. Exercise, Carbohydrates & Fats

J. How Optimal % Body Fat US Wt Registry, Zuti & Golding

IV. **GI (Gut) Structure & Function** DC Module 3, LS 2012 ch 15

A. Gut Doughnut Analogy + Secretions L Brilla WWU

B. Digestion Steps Dr. Evonuk + LS pp 437-439; DC p 23

C. Hydrolysis + Polymer → Monomer: Central Themes!

LS p 438, SI Fox 2009 + …
### Macronutrients & Micronutrients

**Essential for Life**

<table>
<thead>
<tr>
<th>Macronutrients</th>
<th>Micronutrients</th>
<th>Sample Food Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H₂O/Water</strong></td>
<td><strong>Vitamins (A, D, E, K; C + B)</strong></td>
<td>Water, other drinks, fruits &amp; vegetables</td>
</tr>
<tr>
<td>✓ 1° Carbohydrates</td>
<td><strong>Minerals (K⁺, Na⁺, Ca²⁺, Mg²⁺</strong></td>
<td>Grains, vegetables, fruits, dairy products</td>
</tr>
<tr>
<td>✓ 2° Fats/Triglycerides/Lipids</td>
<td><strong>Fe²⁺, Zn²⁺,…</strong></td>
<td>Meats, full-fat dairy products, oils</td>
</tr>
<tr>
<td>✓ 3° Proteins</td>
<td></td>
<td>Meats, legumes, dairy vegetables</td>
</tr>
</tbody>
</table>

**NB**: Need only minute quantities!

- **Energy nutrients** = yield ATP
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*
A healthy eating pattern includes:

- **Variety of vegetables** from all subgroups: dark green, red & orange, legumes, starchy & other
- **Fruits**, especially whole fruits
- **Grains**, at least half of which are whole grains
- **Fat-free or low-fat dairy**, including milk, yogurt, cheese &/or fortified soy beverages
- **Variety of protein foods** including seafood, lean meats & poultry, eggs, legumes & nuts, seeds & soy products
- **Oils** (healthy)

A healthy eating pattern limits:

- **Saturated fats** & **trans fats**, added **sugars** & **sodium**
- **Balance calories with physical activity** to manage weight.

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)
The World’s Longest-Lived People!

Blue Zones!

- Lomo Linda, CALIFORNIA
- Sardinia, ITALY
- Okinawa, JAPAN
- Nicoya, COSTA RICA
- Ikaria, GREECE


M Poulain & Coworkers. Experimental Gerontology, Sep 2004
1. Eat a little bit better!
2. Move a little bit more!
3. Socialize more!
4. Strong sense of purpose!

Loma Linda, United States

Plant-based!

Sardinia, Italy

Okinawa, Japan

https://en.wikipedia.org/wiki/Blue_Zone
https://bluezones.com/
85% Carbohydrates
9% Protein
6% Fat
85-10-5
1785 Calories

Note: These are the Actual Food Measurements of the Centenarians, not the diet of all island Okinawans or the ones who died, but the ones who lived.
Pondering Paleo?

Evolutionary Biologist
Behavioral Ecologist
U Minnesota

http://www.nutritionaction.com/daily/how-to-diet/pondering-paleo/
How much protein do you need?

Not much! 0.8 g/kg or 0.36 g/lb of body wt/d

50 kg or 110 lb female? ~ 40 g/d
80 kg or 176 lb male? ~ 64 g/d

Boneless, skinless, cooked chicken breast 6-8 oz, 53 - 70 g of protein!

Average US woman gets 35% > RDA!
Average US man 65% > RDA!
Red Meat, Processed Meat & Cancer Incidence

Total cancer mortality & cancers of:

Colon & rectum
Esophagus
Liver
Pancreas
Kidney
Prostate
Lung
Breast

The pathway linking diet, gut microbes and TMAO to a growing collection of disease states

Red Meat-Derived Glycan Promotes Inflammation & Disease

N-GlycolylNeuramic acid (Neu5GC)

Ab to Neu5GC
Neu5GC Ab

Atherosclerosis
Cancer

Chronic Inflammation
Amyloid-A +
Acute Phase Proteins
IL-6

Xeno Auto-Antigen!
Anti-Neu5GC Ab

http://m.pnas.org/content/112/2/542.long
Nutrition Action

Carbohydrate Confusion

Should you avoid carbs at all costs?

Our Planet AT RISK

The Best SPREADS

3 Veggie Dips

No, ↑ complex simple!
Emphasize a plant-based diet!
Phytochemicals ≡ Plant chemicals

1. **Anti-oxidants**
   - Protect DNA from oxidative damage

2. **Protein synthesis**
   - Regulation/control

3. **Hormone-like action**
   - Endocrine mimicry

4. **Blood effects**
   - Modify blood chemistry

Potential regulators of health!

10s of thousands!

Phytochemicals ≡ Plant chemicals

Aroma, color, taste
**Why Eat Whole Grains?**

Based on existing evidence, eating whole grains is definitely good for our health.

*Shengmin Sang, Professor of Food Science & Human Health North Carolina A&T*

- **Fiber**
  - ↑ fullness, motility, beneficial bacteria, wt control
  - ↓ cholesterol, insulin response, inflammation, diabetes and CVD risk...

- **B-vitamins**
  - thiamin, niacin, riboflavin ↑ energy metabolism

- **Folate**
  - ↑ red blood cells, ↓ neural tube defects

- **Iron**
  - ↑ O$_2$ carrying, ↓ iron-deficiency anemia in women

- **Magnesium**
  - ↑ bone building & muscle energy release

- **Selenium**
  - an anti-oxidant, protects body cells & ensures a healthy immune system...

[https://www.choosemyplate.gov/grains-nutrients-health](https://www.choosemyplate.gov/grains-nutrients-health)
With the right food choices, physical activity, and not smoking, we could prevent about 90% of diabetes, 80% of heart disease, about & 70% of stroke!
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...
Dietary Composition & Physical Endurance

- High-fat diet: ~ 1/3 endurance!
- Normal mixed diet: 57 min
- High-carbohydrate diet: 114 min
- Maximum endurance time: 167 min

eg, Atkins!
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!!

DIETFITS (2018) + Pounds Lost Trial (2009) indicate that reducing overall calories is more important than macronutrient composition of the diet!

60-day Fast???

Lost 60 lb!! Wow!!

Yet

\[
\begin{aligned}
26 \text{ lb Water} \\
20 \text{ lb Lean Body Mass} \\
14 \text{ lb Fat}
\end{aligned}
\] $\geq \frac{3}{4}$

Fat $< \frac{1}{4}$ total wt loss!
Successful Dieting – National Weight Control Registry

- 5000 people, ≥ 30 lb weight loss, ≥ 5 yr
- High-carbohydrate (55-60%), low-fat (24%) diet with the rest (~16-21%) from protein
- Wholesome vs. high-sugar carbohydrates including fruits, vegetables, high-fiber foods
- Conscious of calories knowing that total calories count, no matter what diet type
- Eight of 10 ate breakfast daily which may help better manage calories during the day
- Self-monitor, weigh themselves ≥ 1x/wk & many still keep food dairies
- Much planned physical activity, 60-90 min/d, 10,000 walking + looked for other ways to be active

http://www.nwcr.ws/Research/published%20research.htm
UC Berkeley Wellness Engagement Calendar, September 2013
Which Diets are Best?

Not Plant-based
Low Carbohydrate

Peer-Reviewed = Text Books → Research

Not Peer-Reviewed = Trade Book → Opinion

Plant-based
Lower Fat

Mediterranean Diet

Drink water
Wine in moderation

Heat
SWEETS
Eggs
POULTRY
FISH & SEAFOOD

Cheese & Yogurt

Olive Oil
Fruits
Legumes & Nuts
Vegetables
Wholegrain Bread, Pasta, Rice, Couscous, Polenta, Quinoa, Other Grains & Potatoes

Daily Physical Activity

Monthly
Weekly
Daily

The DASH Diet
Action Plan

The Paleo Diet
4 Blood Types, 4 Diets
Eat Right 4 Your Type

The South Beach Diet

Weight Watchers

The Mayo Clinic Diet

Nutrition and Physical Degeneration

REVISED AND UPDATED
4 Blood Types, 4 Diets
Eat Right 4 Your Type

The Paleo Diet

The South Beach Diet

Weight Watchers

The Mayo Clinic Diet

**NB:** Each group 500 kcal deficit/day, 16 weeks
GI-Doughnut Analogy

GI Lumen

Body

Me?
## 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>
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
Polymer to Monomer
(Many to One)

Carbohydrate
- Glucose

Protein + Fat
- Amino Acids
- Fatty Acids + Glycerol

...Central-linking theme!!
BI 121 Lecture 6

I. **Announcements** Next session Q? ~½ review, then Exam I.

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

III. **GI Connections** LS ch 15, DC Module pp 17-23
   A. Gut control mechanisms
   B. Histology of the gut LS fig 15-2, 15-3 p 442-3
   C. Organ-by-organ review
   D. Stomach protein digestion + zymogens? LS fig 15-7, 15-9
   E. 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
   G. Summary of chemical digestion LS tab 15-5 p 466
   H. Large intestine? LS fig 15-24 pp 472-4
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 $\leq 96\%$!

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 in a day!** Cook small portions/kebabs.
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
Zymogen = an inactive precursor

LS 2012 fig 15-9 p 452
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.
<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></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Small-intestine epithelial cells</td>
<td>Small-intestine brush border</td>
<td>Hydrolyze disaccharides to monosaccharides</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Protein</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>Proteins</td>
<td>Exocrine pancreas</td>
<td>Small-intestine lumen</td>
<td>Attack different peptide fragments</td>
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<td>Small-intestine brush border</td>
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<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>
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<td></td>
<td></td>
<td></td>
<td>Small-intestine lumen</td>
<td></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