BI 121 Lecture 1

I. **Announcements**: Please check & sign attendance roster. Not on list? See Pat during break/class. *Lab 1 Histology Thursday in 130 HUE: 10 am → 5 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
Which body systems?
Maintenance of a relative constancy in the Internal environment = ECF = fluid outside of cells
ICF = Intracellular

ECF = Extracellular

Plasma (within CV System)

Interstitium (eg, between muscle cells)

https://www.youtube.com/watch?v=B658Yn3lNYc
I. **Announcements** Lab 1 Histology today! 130 Huestis (HUE) Fun! Worksheets. Readings:  DC, LS, LM? **NB**: UO Biology blog vs. Canvas  
http://blogs.uoregon.edu/bi121/fall-2019/

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; °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
Homeostasis or Homeokinesis?

https://www.khanacademy.org/partner-content/mit-k12/chem-and-bio/v/homeostasis
Dr. Evonuk’s 6 Balances

- Metabolic
  - ANA-
  - CATA-

- H₂O
- Temp (°C)

- O₂/CO₂
- Ion+/-
- pH

- Carbon Dioxide
- Electricity
- Captain Calcium
- Bicarbonate and pH Balance
Drink about 1 L per 1000 calories energy expenditure!!

Human ~ \( \frac{2}{3} \) \( H_2O \)  
\(~ 60 – 70 \% \)

= \(~ 40 – 48 \) kg \( H_2O \)

NB: So 2000 kcal \( \rightarrow \) drink 2000 mL  
\( \equiv 67.63 \) fl oz  
\( \equiv \sim 8 \) 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

Time of Day

https://www.khanacademy.org/partner-content/mit-k12/chem-and-bio/v/homeostasis
**Blood Pressure Homeostasis**

- **Venous Pooling**: Decrease in blood pressure (BP) $I$
- **Baroreceptors/Pressure Receptors**: eg, in Carotids & Aorta
- **CV Control Center**: Brain Stem
- **Electrochemical Signal**: $I'$
- **Seated to Standing**: Short-term vs long-term!
- **NB**: Corrective Change $\Delta$ Opposes Original Input $I$
- **Blood Pressure Homeostasis**: $\uparrow$ BP
- **HR**: Heart Rate
- **VC**: Venous Pooling

Short-term vs long-term!
BI 121 Lecture 3

I. **Announcements** Q from last time? **Come to office hr!**

II. **Connections** Homeostatic model: BP regulation

III. **Cell Anatomy, Physiology & Compartmentalization** LS ch 2
   B. Basic survival skills ch 1 p 3
   C. Organelles ≡ Intracellular specialty shops LS pp 21-34
      1. Endoplasmic reticulum (ER) fig 2-1, 2-2, 2-3
      2. Golgi complex fig 2-3, 2-4
      3. Lysosomes fig 2-5, 2-6
      4. Peroxisomes fig 2-6
      5. Mitochondria fig 2-8 LS 2012 pp 20-34, tab 2-1 p 36
   D. **Physiol News** Moms eggs execute Dad’s mitochondria?

IV. **Anaerobic vs Aerobic Metabolism Overview** Many sources!
   Mathews & Fox 1976...LS 2012 pp 26-33, fig 2-15 p 33
   A. ATP-PC Immediate, Glycolytic & Aerobic Energy Systems

...Anatomy & Physiology Lab Thurs! Fun again!
How Big? 100 Cells Lengthwise = 1 mm!!

1. Cell Membrane

2. Nuclear Membrane

Why Compartments? Advantage?

*Incompatible* reactions can take place *Simultaneously!!*
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

Rough ER

Rough ER lumen

Ribosomes

Sacs

Tubules

Smooth ER lumen

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. Golgi complex
4. Secretory vesicles
5. Secretory vesicles
6. Secretion (exocytosis)

fig 2-3 LS 2012
Exocytosis: Primary Means of Secretion
Lysosomes vs. Peroxisomes
Catalase Enzyme Reaction in Peroxisomes
Neutralize Toxin at Production Site!

\[ 2H_2O_2 \rightarrow 2H_2O + O_2 \]
Mitochondria: Energy Organelles

![Diagram of mitochondria with labeled parts: Intermembrane space, Cristae, Proteins of electron transport system, Inner mitochondrial membrane, Matrix, Outer mitochondrial membrane, Cristae.]

fig 2-8 LS 2012
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 bi-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.

AEROBIC

w/O₂

= MITOCHONDRIUM

ANAEROBIC

without O₂

= CYTOSOL

1. Immediate/ATP-PC
2. Glycolysis
ATP Supplied

Performance Time

Power Output

% ATP Supplied

Cytosol

Anaerobic

15 - 30 s

ATP-PC/Immediate

Glycolysis

1.5 – 3 m

Oxygen System

≥ 3 – 5 m

Mitochondria

Modified after Mathews & Fox

Aerobic
I. **Announcements**  
Anatomy & Physiology Lab today! Fun! Remember to complete p 3-7 dietary record in LM before Lab 3 next Thursday! Estimating serving sizes. Q?

II. **Adenosine Triphosphate (ATP)**  
ATP parts? Uses/functions?

III. **Anaerobic vs. Aerobic Metabolism**  
LS ch 2 pp 26-33, fig 2-15+  
A. Cytosol vs. Mitochondria  
B. Anaerobic: ATP-PC, Glycolysis  
C. Aerobic: Mitochondrial matrix vs. cristae  
   Citric acid cycle vs. ETC purpose

IV. **Genetics Introduction**  
LS 2012 ch 2 pp 20-1 + Appendix C  
A. What’s a gene? Where located? 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? Class skit! LS Appendix C
Cleave One High Energy Phosphate Bond To Do Work!!

7 – 10 KiloCalories/KCal

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

2. **Membrane Transport**
   - Move things! Microscopic!

3. **Mechanical Work**
   - Move things! Macroscopic!

[Diagram showing the process with Adenosine splitting into P, PP, and P, with arrows pointing to each step.]
**Anaerobic vs. Aerobic Metabolism**

**NB**: ATP-PC also anaerobic, also in cytosol!

**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

MITOCHONDRIA

CYTOSOL

Glycolysis

Immediate/ATP-PC
Stages of Cellular Metabolism/Respiration

Anaerobic Glycolysis

Cytosol

Glycolysis
- Glucose and other fuel molecules
- Pyruvate

Aerobic Metabolism

Mitochondria

Pyruvate to acetate
- Acetyl-CoA
- Electrons carried by NADH and FADH$_2$

Citric acid cycle

Oxidative phosphorylation (electron transport system and chemiosmosis)

Matrix

Inner Membrane

LS 2012 fig 2-9
Goals of Aerobic Metabolism

AEROBIC = MITOCHONDRION

w/O₂

CITRIC ACID CYCLE

harvest electrons e⁻ e⁻ e⁻ e⁻ e⁻ e⁻ e⁻ e⁻

“cash in”

ELECTRON TRANSPORT CHAIN

for ATP Energy!!
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
What does DNA do, day-to-day?

DNA → Transcription → RNA → Translation → Protein

Replication

Nucleus → Cytoplasm

@ ribosomes

cf: LS fig C-6
## DNA vs RNA?

<table>
<thead>
<tr>
<th>DNA</th>
<th>RNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Double-stranded</td>
<td>1. Single-stranded</td>
</tr>
<tr>
<td>2. Deoxyribose (without oxygen)</td>
<td>2. Ribose (with oxygen)</td>
</tr>
<tr>
<td>Thymine</td>
<td>Uracil</td>
</tr>
<tr>
<td>4. Self-replicative (can copy itself)</td>
<td>4. Needs DNA as template</td>
</tr>
<tr>
<td>5. Nucleus (+mitochondria)</td>
<td>5. 1⁰ Cytoplasm (but Nucleus origin)</td>
</tr>
<tr>
<td></td>
<td>6. 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

LS 2012 fig C-7
BI 121 Lecture 5

I. **Announcements** Nutrition Analyses this Thursday! Please record diet on p 3-7 LM. Bring flash drive. Q?

II. **Genetics Connections** LS 2012 ch 2 p 20-1 + Appendix C
   A. How & where are proteins made? fig C-7, C-9
   B. Class skit: Making proteins @ ribosomes!

III. **Nutrition Primer** DC Module 2, S&W Price Science Library
   A. Essential Nutrients: H$_2$O, 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. How much protein? Protein & disease?
   G. TMAO, Neu5GC & inflammation?
   H. Carbohydrate confusion. Why plants & whole grains?
   I. Exercise, carbohydrates & fats
   J. Fasting? Intermittent fasting?
   K. Successful dieting? National Weight Control Registry
   L. Exercise vs. Diet vs. Combination, Zuti & Golding
Macronutrients & Micronutrients Essential for Life

**Macronutrients**

- H₂O/Water
- 1° Carbohydrates
- 2° Fats/Triglycerides/Lipids
- 3° Proteins

**Sample Food Sources**

- Water, other drinks, fruits & vegetables
- Grains, vegetables, fruits, dairy products
- Meats, full-fat dairy products, oils
- Meats, legumes, dairy vegetables

**Micronutrients**

- Vitamins (A, D, E, K; C + B)
- Minerals (K⁺, Na⁺, Ca²⁺, Mg²⁺, Fe²⁺, Zn²⁺,...)

**NB: Need only minute quantities!**

- Vegetables, vegetable oils, fruits, citrus, grains, dairy
- Fruits, vegetables, grains, nuts, dairy, meats, processed foods

**Energy nutrients = yield ATP**
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!

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

http://health.gov/dietaryguidelines/2015/
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!

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!

https://en.wikipedia.org/wiki/Blue_Zone
https://bluezones.com/
OKINAWA LONGEVITY DIET

70% Sweet Potatoes
12% Rice
7% Grains & Wheat
6% Soy & legumes
4% Additional vegetables
3% Fruit
2% Oils
1% Nuts (Protein)
1% Other potatoes
1% Seaweed
1% Sugars
1% Fish
1% Dairy
1% Eggs
1% Pork-Meat
1% Flavorings & Alcohol

85% Carbohydrates
9% Protein
6% Fat
85-10-5
1785 Calories

96% Vegan Diet
98% Vegetarian
99% PescaVeg
<4% Animal Prod
<1% Fish
<1% Meat-Pork

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

Dietary Choline & L-Carnitine

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

Choline

Gut Flora

Hepatic FMOs

TMA = Trimethyl Amine

TMAO

Heart Failure

Kidney Disease

Atherosclerosis

Red Meat-Derived Glycan Promotes Inflammation & Disease

http://m.pnas.org/content/112/2/542.long
BI 121 Lecture 6  Nutrition Lab 3 today! More personal data…

I. **Announcements** Data + flash drive/e-mail for today’s lab! To have your notebook returned to study for Exam I on Tues Oct 29\textsuperscript{th}, best to submit prior to lecture next Tues Oct 22\textsuperscript{nd}. Review Session Sunday Oct 27\textsuperscript{th}, 6-7:30 pm. Sample Exam Q? Be sure to see *Active Learning Questions!* Drink your calories?

II. **Nutrition Connections** Plants, Whole Grains, Exercise, Dieting?

III. **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 $\rightarrow$ Monomer: Central Themes!
   - LS p 438, SI Fox 2009 + …
D. Gut control mechanisms
E. Histology of the gut LS fig 15-2, 15-3 p 442-3
F. Organ-by-organ review
G. Stomach protein digestion + zymogens? LS fig 15-7, 15-9
   - Beyond the Basics LS p 456, Mayo Clinic on Ulcers
J. Summary of chemical digestion LS tab 15-5 p 466
K. Large intestine? LS fig 15-24 pp 472-4
5 times per wk? \( \equiv \) 106,600 calories/yr \( \equiv \) \pm 30.5 lb fat/yr

Better choices!
Carbohydrate Confusion

Should you avoid carbs at all costs?

No, ↑ complex
↓ simple!

Emphasize a plant-based diet!
I prefer glucose!

Me too!

Me three!

Me too!
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!

*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**
- ↑ O₂ 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/eathealthy/grains](https://www.choosemyplate.gov/eathealthy/grains)
With the right food choices, physical activity, and not smoking, we could prevent about 90% of diabetes, 80% of heart disease and 70% of strokes!
**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

eg, Atkins!

High-fat diet
Normal mixed diet
High-carbohydrate diet

~ 1/3 endurance!

Maximum endurance time:
57 min
114 min
167 min
To Help Lower Body Wt & %Fat
EXERCISE!! + Minimize These!!

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Calories/g</th>
</tr>
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<tbody>
<tr>
<td>FAT</td>
<td>9</td>
</tr>
<tr>
<td>ETOH</td>
<td>7</td>
</tr>
<tr>
<td>CARB</td>
<td>4</td>
</tr>
<tr>
<td>PRO</td>
<td>4</td>
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</table>

**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

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

Fat \(<\ \frac{1}{4}\) total wt loss!
Human Intermittent Fasting Studies

- ~100 overweight or obese women
- ½ cut 25% kcal every day
- ½ ate normally 5 d, but only 650 kcal/d for 2 d/wk
- After 3 – 6 mo, each group lost ~ same amount of wt but women on 5:2 diet had better insulin function!
- Likely easier for most humans to restrict for only 2 d/wk!


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 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  Lower Carbohydrate

Plant-based  Lower Fat

Not Peer-Reviewed = Trade Book  →  Opinion

Peer-Reviewed = Text Books  →  Research

Mediterranean Diet

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

GI Lumen

Body

Me?
### Gut Secretions

<table>
<thead>
<tr>
<th>Secretion</th>
<th>Release Site</th>
</tr>
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<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>

- **Gut Secretions**
- **Secretion**
  - 1. Mucus
  - 2. Enzymes
  - 3. H₂O, acids, bases+
  - 4. Hormones
- **Release Site**
  - into GI Lumen
  - into GI Lumen
  - into GI Lumen
  - into Blood
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!!

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

Carbohydrate

Protein + Fat

Fat

Carbohydrate

Protein

Amino Acids

Fatty Acids

Glycerol

Glucose
BI 121 Lecture 7

I. **Announcements** Exam I one week from today, Oct 29\textsuperscript{th}!
   10 am Lab \(\rightarrow\) 5 KLA, 11 am \(\rightarrow\) 129 HUE, AEC, All others here!
   Discussion + Review, Sunday Oct 27\textsuperscript{th}, 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. \(\heartsuit\) 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 \(\heartsuit\) & 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
Zymogen = an inactive precursor

LS 2012 fig 15-9 p 452
Endocrine + Exocrine functions; Makes enzymes for digesting all 3 energy nutrients!

Exocrine portion of pancreas (Acinar and duct cells)

Duct cells secrete aqueous NaHCO₃ solution

Acinar cells secrete digestive enzymes

Hormones (insulin, glucagon)

Endocrine portion of pancreas (Islets of Langerhans)

Bile duct from liver

Blood

The glandular portions of the pancreas are grossly exaggerated.
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>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></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>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

- 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 circuit

Systemic circuit

Pulmonary arteries
Pulmonary veins
Vena cavae
Aorta and branches
Right ventricle
Left ventricle
Arterioles
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
Lymphatics collect run-off & are parallel to venules/small veins!
Lymphatic System Blockage in Elephantiasis from Mosquito-borne Parasitic Filaria Worm
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
Human 🏠 = 4-chambered box? 2 separate pumps?

Upper = Atria

Lower = Ventricles

RA  LA

RV  LV

Pulmonary  Systemic

Primer Pumps

Power Pumps
Human ♥ = 4 unique valves?
2 valve sets?

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

1. Pulmonic/Pulmonary
2. Aortic

**AV** = **Atrioventricular**

3. ⬗ AV = Tricuspid
4. ⬗ AV = Mitral/Bicuspid
Cardiac Cycle

**Systole**
- Contract
- & Empty

**Diastole**
- Relax
- & Fill
Patent or still open!
Foramen ovale!
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
I. **Announcements** Exam I next time: 10 & 11 am lab sections go directly to 5 KLA & 129 HUE. All others (except AEC) here, 100 WIL! Review: Sun, 6 pm 100 WIL! Lab Manuals. Q?

II. **Cardiovascular Connections** DC Module 4, LS ch 9, Torstar+…

III. **CV Physiology in News** AHA + ACSM exercise guidelines!

IV. **CV Pathophysiology & Risk Reduction** LS ch 9, 10 +…

A. AMI, CVA, CVD, PVD, TIA, HTN? + surgical treatments

B. Atherosclerosis? LS fig 9-27, 9-25, 9-26 pp 266-8

C. How to minimize risk of CVDs? Treatment triad:
   1. Exercise, 2. Diet, 3. Drugs+Surgery

D. Food choices make a difference?
   Plant-based diet!

What’s HAPOC?
Do moderately intense aerobic exercise
30 min/d, 5 d/wk

OR

Do vigorously intense aerobic exercise
20 min/d, 3 d/wk

AND

Do 8-10 strength-training exercises
8-12 repetitions/each exercise, 2 d/wk
**FIGURE 9-35**

Extent of myocardial damage as a function of the size of the occluded vessel
Treatment Triad

- Exercise
- Dietary Modification
- Drugs/Surgery

NB: Last blasted resort!!
CABG
Coronary Artery Bypass Graft
*Apple* type of obesity predisposed to CVD!

*Pear* type of fat pattern…

implies lower disease risk!

Eat more apples…

to help prevent the apple type of obesity!
Fish Oil Intakes & Cardiovascular Death Rates

<table>
<thead>
<tr>
<th>Country</th>
<th>Cardiovascular Deaths per 100,000 Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ireland</td>
<td>800</td>
</tr>
<tr>
<td>USA</td>
<td>600</td>
</tr>
<tr>
<td>France</td>
<td>400</td>
</tr>
<tr>
<td>Japan</td>
<td>200</td>
</tr>
</tbody>
</table>

Ireland: 0.09%, USA: 0.13%, France: 0.14%, Japan: 0.37%
Healthy Oils to Minimize Atherosclerosis

HAPOC?