I. **Announcements**: Please check & sign attendance roster. Not on list? See Pat during break/class. *Lab 1 Histology* Thursday, 10 am – 5 pm sections in 130 HUE. Much fun!!

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

---

...Welcome to Human Physiology – what makes us tick!
ANATOMY vs PHYSIOLOGY
STRUCTURE vs FUNCTION
WHAT? vs HOW?
WHERE? vs WHY?
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
Which body systems?
Which body systems?
Homeostasis is essential for cell survival!
BI 121 Lecture 2

I. **Announcements**  

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

... Thanks for signing attendance roster & noting late arrival or early departure time!
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
Where is extracellular fluid?
ICF = Intracellular

ECF = Extracellular

Plasma (within CV System)

Interstitium (eg, between muscle cells)
Dr. Evonuk’s 6 Balances

Metabolic

\[ \text{ANA-} \quad \text{CATA-} \]

\[
\begin{align*}
\text{H}_2\text{O} & \quad \text{ToC} \\
\text{O}_2/\text{CO}_2 & \quad \text{Ion}^{+/-} \\
\end{align*}
\]
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!
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% H₂O = 49L

+ ICF = 35L

ECF = 14L
- Interstitium = 11L
- Plasma = 3L

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

H₂O

BALANCE!
Controller = Hypothalamus with Set Point

True Diurnal Variation

Mild Hypothermia

Profound Hypothermia

Protein Denaturation

Set Point

110°F

98.6°F

0600 1400 0600 1400

Time of Day
Venous Pooling

Electrochemical Signal $I'\rightarrow C$

Baroreceptors/Pressure Receptors eg, in Carotids & Aorta

Seated to Standing

NB: Corrective Change Opposes Original Input

$\uparrow$ BP $\rightarrow R$

CV Control Center Brain Stem

$O \downarrow$

Electrochemical Signal eg, Symp Accel N

$\uparrow$ BP $\rightarrow Ef$

$\uparrow$ HR $\rightarrow +$

$\uparrow$ VC $\rightarrow$
I. Announcements UWGS Mentor? Registration? Q? Office hr?

II. Cell Anatomy, Physiology & Compartmentalization LS ch 2
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. What about vaults? LS 2006, p 32
E. 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
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

**Rough ER:**
- Ribosomes attached
- Sacs

**Smooth ER:**
- Packages new proteins in transport vesicles
- Stores calcium in muscles

*fig 2-2 LS 2012*
Secretion of Proteins Produced by ER.
Golgi Complex: Final Processing, Packaging & Distribution

Golgi complex

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

Golgi sacs

Golgi lumen

Vesicles containing finished product

Dr. Don Fawcett & R. Boller/Visuals Unlimited

fig 2-4 LS 2012
**Exocytosis**: Primary Means of Secretion
Endocytosis: Primary Means of Ingestion
Lysosomes vs. Peroxisomes
Phagocytosis: Cell Eating!
Catalase Enzyme Reaction in Peroxisomes
Neutralize Toxin at Production Site!

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

- Proteins of electron transport system
- Inner mitochondrial membrane
- Matrix
- Outer mitochondrial membrane
- Intermembrane space
- Cristae
I. **Announcements**  
Anatomy & Physiology Lab today!  
Be sure to complete p 3-7 dietary record in LM < lab next wk!  
Help with estimating serving sizes for Nutrition Lab 3. Q?

II. **Medical Moment**  
Structure-Function in Clinical Practice

III. **Physiology News**  
♀ vs ♂ Mitochondria; Vaults? Sci News

IV. **Anaerobic vs Aerobic Metabolism Connections**  
LS ch 2 pp 26-33  
A. Take-home points + key differences fig 2-15 + vpl  
B. Few details: Glycolysis, CAC, ETC fig 2-9, 2-10, 2-11, 2-12

V. **Cytoskeleton**  
LS 2012 fig 2-17, 2-18 + LS 2006 fig 2-20

VI. **Introduction to Genetics**  
LS pp 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? Class skit! fig C-7, C-9
R Ankle Too Many Toes Posterior View, Medial View

Too many toes!

Tibia

Medial Malleolus

Tibialis Posterior Tendon

Hindfoot valgus

Navicular tuberosity

Fibula

Interosseous membrane
Impression: Tendinosis w/significant tenosynovitis. Diffuse thickening of t. posterior tendon & plantar aponeurosis → chronic inflammation & fasciitis. Diffuse articular cartilage degeneration of ankle & subtalar joints.
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.

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 gas 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 coil 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,
AEROBIC\text{ w/O}_2 \Rightarrow \text{ MITOCHONDRIUM}

ANAEROBIC\text{ without } O_2 \Rightarrow 1. \text{ Immediate/ATP-PC} \\
\hspace{2cm} 2. \text{ Glycolysis} \\
\Rightarrow \text{ CYTOSOL}
ATP Supplied

Performance Time

Power Output

ATP-PC/Immediate

Glycolysis

Anaerobic

Mitochondria

Oxygen System

> 3 – 5 m

Cytosol

15 - 30 s

1.5 – 3 m

Modified after Mathews & Fox
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!
**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

Immediate/ATP-PC

Glycolysis

MITOCHONDRIA

CYTOSOL

PRIMARY FUEL

ACTIVITY

TIME (Min:Sec)

% AEROBIC
(Oxidative Energy System)

% ANAEROBIC
(Immediate & Non-Oxidative Energy Systems)

Marathon
Cross-Country Skiling

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

135:00

29:00

14:00

9:00

3:45

1:30

0:50

0:20

0:10

FAT,
CARBOHYDRATE & PROTEIN
(Small Amounts)

CARBOHYDRATE
(Glucose & Glycogen)

ATP, ADP &
Creatine Phosphate (CP)
Stages of Cellular Metabolism/Respiration

**Anaerobic Glycolysis**
- Cytosol
- Glycolysis
- Glucose and other fuel molecules → Pyruvate → ATP

**Aerobic Metabolism**
- Mitochondria
- Pyruvate to acetate → Acetyl-CoA → Citric acid cycle
  - Mitochondrial matrix
  - Electrons carried by NADH and FADH$_2$ → 2 ATP
- Oxidative phosphorylation
  - Mitochondrial inner membrane
  - (electron transport system and chemiosmosis) → 28 ATP

fig 2-9 LS 2012
Goals of Aerobic Metabolism

AEROBIC w/O₂ = MITOCHONDRION

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*

Gene    DNA Double Helix

Histones

Supercoiling

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

DNA → Replication → RNA → Translation @ ribosomes → Protein

Transcription

Nucleus → Cytoplasm

cf: LS fig C-6
I. Announcements  Nutrition Analysis Lab this Thursday! Please record diet on p 3-7 LM & begin analysis using https://www.supertracker.usda.gov/ Bring flash drive? Q?

II. Introduction to Genetics  LS 2012 ch 2 p 20-1 + Appendix C
A. How does DNA differ from RNA? pp A-20 thru A-22
C. How & where are proteins made? fig C-7, C-9
D. Class skit: Making proteins @ ribosomes!

III. Nutrition Primer  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. Beware of Nutrition Quackery S. Kleiner & Monaco 1990!

IV. Nutrition in the News  Gain weight by drinking calories?

V. Introduction to Digestion  Steps + hydrolysis
<table>
<thead>
<tr>
<th>DNA vs RNA?</th>
<th>DNA</th>
<th>RNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Double-stranded</td>
<td>1. Single-stranded</td>
<td></td>
</tr>
<tr>
<td>2. Deoxyribose (without oxygen)</td>
<td>2. Ribose (with oxygen)</td>
<td></td>
</tr>
<tr>
<td>4. Self-replicative (can copy itself)</td>
<td>4. Needs DNA as template</td>
<td></td>
</tr>
<tr>
<td>5. Nucleus (+mitochondria)</td>
<td>5. 1° Cytoplasm (but Nucleus origin)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. mRNA, rRNA, tRNA</td>
<td></td>
</tr>
</tbody>
</table>
DNA | mRNA | tRNA
--- | --- | ---
**code word** | codon | anti-codon
TAT | AUA | UAU
ACG | UGC | ACG
TTT | AAA | UUU
TAC | AUG | UAC

*Triplets of bases code for amino acids, the building blocks of proteins*
Translation? Ribosomes Make Proteins

1. Large subunit
2. Small subunit
3. tRNA
4. Anticodon
5. mRNA
6. Leader sequence
7. First codon
8. Second codon
9. First ribosomal binding site
10. Second ribosomal binding site

Steps 5 through 8 are repeated.

CGUCCGAUGUCUCAU GUAG
CGUCCGAUGUCUCAU GUAG
CGUCCGAUGUCUCAU GUAG
CGUCCGAUGUCUCAU GUAG

LS 2012 fig C-7
A Polyribosome. Which Way is Synthesis?
# 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>1° Carbohydrates</td>
<td>Grains, vegetables, fruits, dairy products</td>
</tr>
<tr>
<td>2° Fats/Triglycerides/Lipids</td>
<td>Meats, full-fat dairy products, oils</td>
</tr>
<tr>
<td>3° Proteins</td>
<td>Meats, legumes, dairy vegetables</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Micronutrients</th>
<th></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
US Modifications to 1992 Food Pyramid 2005

- Use fats, oils, and sweets sparingly.
- “good” fats! eg, fish, nuts
- saturated & trans fats!
- 2-3 servings
- Vegetable group
  - 3-5 servings
- Fruit group
  - 2-4 servings
- Meat, poultry, fish, dry beans, eggs, and nuts group
  - 2-3 servings
- Bread, rice, pasta, and cereal group
  - 6-11 servings

Regular Physical Activity: Exercise! Exercise!!

1/2 whole grain 4 or more!

3 or more!

5 or more!
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!

---

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)

NB: Each group 500 kcal deficit/day, 16 weeks
BI 121 Lecture 6

I. **Announcements** *Got Data?* Crucial for today’s lab! Q?
   If you want notebook to study for Exam I on Oct 27th, turn in prior lecture next Tuesday, Oct 20st. Sample Exam Q.

II. **Nutritional Physiology in the News** Shake the salt habit! Gain weight by drinking your calories? Coconuts are on a roll? *UCB Identifying Nutrition Quackery*, Kleiner & Monaco

III. **Nutrition Connections** DC Mod 2, Sizer & Whitney (S&W) Sci Lib
   A. Diet & endurance? What’s the best path to losing weight?
   B. Low-carbohydrate dieting? What about fasting?
   C. Balanced approach, Dr. Sacks *AHA NPAM Council*

IV. **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
More Reasons to Shake the Salt Habit

①↓blood vessel vasodilation w/in 30 min by ingesting 1500 mg Na+!
②↑Ca²⁺ excretion ↑bone loss, risk of osteoporosis & fractures.
③May directly impair kidney function & ↑risk of kidney stones.
④GI cancer risk, inflammation?

Stop me!

UCB Wellness Letter Jun 2011 p 5
5 times per wk? \(\equiv\) 106,600 calories/yr \(\equiv\) \(\pm\) 30.5 lb fat/yr

Better choices!

Starbucks Cinnamon Dolce Latte, whipped cream
Venti (20 oz.)

410 calories

Jogging | 50 min.

Better choices!
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.
Coconut Oil
Nutritional Wonder?

Claims?
http://coconutoil.com/about-us/

Review articles: calves, hamsters, mice... rare humans

The bottom line?
http://www.cspinet.org/nah/articles/coconut-oil.html
http://health.clevelandclinic.org/2012/05/heart-healthy-cooking-oils-101/
http://en.wikipedia.org/wiki/Smoke_point
Dietary Composition & Physical Endurance

eg, Atkins!

High-fat diet

Normal mixed diet

High-carbohydrate diet

Maximum endurance time:
57 min
114 min
167 min

~ 1/3 endurance!
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

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

Fat $< \frac{1}{4}$ total wt loss!
LOWER CARBOHYDRATE

ELIMINATE CALORIES or FOOD GROUPS
ENCOURAGE FASTING

LOWER FAT

ADEQUACY BALANCE
CONSISTENCY & MODERATION

AHA + DASH + ❤

NOT PEER-REVIEWED = TRADE BOOKS

PEER-REVIEWED = TEXTS → RESEARCH
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

The ENZYME data bank
Polymer to Monomer (Many to One)

Carbohydrate

Protein + Fat

Fat + Protein

Glucose

Amino Acids

Fatty Acids + Glycerol
GI-DONUT ANALOGY

GI LUMEN

BODY
Longitudinal → Shortens L
Circular → ↓ d or Width

Body wall
Serosa
Submucosa
Outer longitudinal muscle
Inner circular muscle
Muscularis externa
Mucosa
Lumen
Duct of large accessory digestive gland (i.e., liver or pancreas) emptying into digestive-tract lumen
Myenteric plexus
Submucous plexus
## 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. $\text{H}_2\text{O}$, 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
BI 121 Lecture 7  Exam I one week from today! I’ll be ready!...

I. **Announcements**  Lab Notebooks? Q? from last time?

II. **GI Physiology Connections**  DC Module 3 pp 17-23, LS ch 15+
   A. Organ-by-organ review SI Fox, LS tab 15-1 pp 440-1 +...
   B. 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
   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. ♥ 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+…
Zymogen = an inactive precursor
**Endocrine + Exocrine functions;**

Makes enzymes for digesting all 3 energy nutrients!

- Endocrine portion of pancreas
  - Islets of Langerhans
- Exocrine portion of pancreas
  - (Acinar and duct cells)
  - Duct cells secrete aqueous NaHCO₃ solution
  - Acinar cells secrete digestive enzymes

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 15-5  Digestive Processes for the Three Major Categories of Nutrients

<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></td>
<td>Exocrine pancreas</td>
<td>Small-intestine lumen</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disaccharidases (maltase, sucrase, lactase)</td>
<td>Small-intestine epithelial cells</td>
<td>Small-intestine brush border</td>
<td>Hydrolyze disaccharides to monosaccharides</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></td>
</tr>
<tr>
<td></td>
<td>Trypsin, chymotrypsin, carboxypeptidase</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>
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

Pulmonary veins

Right ventricle

Left ventricle

Arterioles

Capillary beds of all body tissues where gas exchange occurs

Veneses

Oxygen-poor, CO₂-rich blood

Oxygen-rich, CO₂-poor blood

D Chiras 2013 fig 4-1b
Dual Pump Action & Parallel Circulation

[Diagram showing the circulation system with labels for venae cavae, right atrium, right ventricle, pulmonary artery, systemic circulation, pulmonary circulation, left ventricle, left atrium, and pulmonary veins.]
Lymphatic System Blockage in Elephantiasis from Mosquito-borne Parasitic Filaria Worm
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!
Human heart = 4-chambered box?
2 separate pumps?

Upper = Atria
RA
RV

Lower = Ventricles
LA
LV

Pulmonary
Systemic

Primer Pumps
Power Pumps
LS 2012 fig 9-4a p 233

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

Valves must be normal & healthy to work well!

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

(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. $\mathcal{R}$ AV = Tricuspid
4. $\mathcal{L}$ AV = Mitral/Bicuspid
I. **Announcements**

Exam I next session; 12 n lab section go directly to 129 Huestis (HUE). All others here (100 WIL)!

Review: Sunday, 6 pm here (100 WIL)! Lab notebooks. Q?

II. **Cardiovascular Connections**

LS 2012 ch 9, Torstar Books+

III. **CV Physiology in News**

AHA + NHLBI websites. Nic? ACSM, AHA, DHHS Healthy people exercise guidelines!

IV. **CV Pathophysiology & Risk Reduction**

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:
   - Exercise, Diet, Drugs+Surgery

D. Food choices make a difference?
   - What’s HAPOC?
Cardiac Cycle

Systole
  Contract
  & Empty

Diastole
  Relax
  & Fill
Veins → Atria → Ventricles → Arteries

http://www.nhlbi.nih.gov/health/health-topics/topics/hhw/contraction.html
American Heart Association (AHA) & National Heart, Lung & Blood Institute

http://www.heart.org/

http://www.nhlbi.nih.gov/health/

Department of Health and Human Services · National Institutes of Health

National Heart Lung and Blood Institute

People Science Health
Continuous exercise
> 50% muscle mass
> Conversational pace
20-60 min/session
3-5 days/wk

Guidelines: Healthy Adults < 65 yr

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
Area of cardiac muscle deprived of blood supply if coronary vessel is blocked at point A:

Right coronary artery

Right ventricle

Area of cardiac muscle deprived of blood supply if coronary vessel is blocked at point B:

Left coronary artery

Left ventricle

**FIGURE 9-35**

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

NB: Last blasted resort!!

- Exercise
- Drugs/Surgery
- Dietary Modification
Coronary Artery By-pass Graft
300/200

KA-BOOM!

Hg
An LDL to HDL ratio *greater than* 5 to 1 in men or 4.5 to 1 in women

*Increased risk of heart disease*
Pick an abundance of whole grains, legumes, nuts, vegetables & fruits!
Fish Oil Intakes & Cardiovascular Death Rates

![Bar chart showing cardiovascular deaths per 100,000 population for Ireland, USA, France, and Japan. Ireland has the highest rate at 0.09%, followed by the USA at 0.13%, France at 0.14%, and Japan at 0.37%.]

S&W 2011
fig 5-12 p 167
Healthy Oils to Minimize Atherosclerosis

HAPOC?