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. **Cell Organelle Connections**  Little organs or specialty shops!

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. **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
4 oz → 3 oz

Equals

raw → cooked

Deck of Cards

or

Equals

1 c

Equals

1/3 c

Equals

1 oz

Equals

1.5 oz
Lysosomes vs. Peroxisomes

- Lysosome contains hydrolytic enzymes.
- Peroxisome contains oxidative enzymes.

fig 2-6 LS 2012
**Phagocytosis: Cell Eating!**

(a) Particle interacts with surface receptor site.

(b) White blood cell ingests particles, forming phagocytic vesicles and residual bodies, which are ultimately processed by lysosomes.
Film: Neutrophil engulfing bacterium

http://devreotes.johnshopkins.edu/videos
Catalase Enzyme Reaction in Peroxisomes
Neutralize Toxin at Production Site!

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

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

Vaults Hold Cell Mystery

An organelle?
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 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'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 get out of the nucleus...
AEROBIC
w/O₂

= MITOCHONDRION

ANAEROBIC
without O₂

= CYTOSOL

1. Immediate/ATP-PC
2. Glycolysis
WOW!

I’M CHAMP!
ATP Supplied

Performance Time

Power Output

- **ATP-PC/Immediate**
  - 15 - 30 s

- **Glycolysis**
  - 1.5 – 3 m

- **Mitochondria**
  - Oxygen System
    - ≥ 3 – 5 m

- **Cytosol**
  - Anaerobic

Modified after Mathews & Fox
ATP = Adenosine Tri Phosphate
The Common Energy Currency or the Cash Cells Understand!!

Phosphates

High Energy Phosphate Bonds
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
Stages of Cellular Metabolism/Respiration

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

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

fig 2-9 LS 2012
Cashing in electrons at the Electron Transport Chain (ETC) produces an abundance of ATP energy molecules!

Rod Capaldi
U of O Biology
**Goals of Aerobic Metabolism**

**AEROBIC**

\( w/O_2 \)

\[ e^- \quad e^- \quad e^- \quad e^- \quad e^- \quad \text{“cash in”} \]

**MITOCHONDRION**

**CITRIC ACID CYCLE**

**ELECTRON TRANSPORT CHAIN**

for ATP Energy!!
Time-out for questions!
What are DNA’s major functions? Heredity + Day-to-Day Cell Function
What does DNA look like? Double-helix!!
Gene = Stretch of DNA that codes for a protein
What does DNA do, day-to-day?

DNA → RNA → Protein

Replication

Transcription

Translation @ ribosomes

Nucleus

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. 1⁰ Cytoplasm (but Nucleus origin)
6. mRNA, rRNA, tRNA
**Triplets of bases code for amino acids, the building blocks of proteins**

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<th>mRNA codon</th>
<th>tRNA anti-codon</th>
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Translation? Ribosomes Make Proteins

1. Ribosome
2. mRNA
3. Amino acid
4. tRNA
5. Anticodon
6. Leader sequence
7. First codon
8. Second codon
9. Steps 5 through 8 are repeated

LS 2012 fig C-7
Transfer RNA (tRNA)

Region of base pairing

Amino acid attaches here

Anticodon

Codon

mRNA

LS fig C-8
A Polyribosome. Which Way is Synthesis?
What's a ribosome?

A protein synthesizing factory, where translation takes place!

You rock, baby!
Questions + Discussion