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 $\rightarrow$ 3 oz

or

\[ 1 \text{ c} \]

\[ 1/3 \text{ c} \]

\[ 1/4 \text{ c} \]

\[ 1 \text{ oz} \]

\[ 1.5 \text{ oz} \]

Deck of Cards

raw $\rightarrow$ cooked
Lysosomes vs. Peroxisomes

Hydrolytic enzymes

Oxidative enzymes

Peroxisome

Lysosome

fig 2-6 LS 2012
Phagocytosis: Cell Eating!

(a)

Particle → Surface receptor site → Endocytotic pouch → Endocytotic vesicle

(b)

White blood cell → Phagocytic vesicle

Lysosome → Residual body
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

![Diagram of Mitochondria](image)

- Proteins of electron transport system
- Inner mitochondrial membrane
- Matrix
- Outer mitochondrial membrane
- Cristae
- Intermembrane space

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 biospecies 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 engine through a microscope. But if it were contaminated with objects that shrug off the stain, that sea would be dotted with white islands. Rome likens the strategy to finding an invisible person by looking for an unexplained shadow in the beam of a spotlight.

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

That shape also hints that vaults may pick up their unknown cargo at the nuclear membrane, the barrier that separates the cell’s cytoplasm from its nucleus. The nucleus is a fluid-filled sac containing DNA and the machinery required to translate the instructions encoded by that DNA into molecules called messenger RNA. These mRNA strands, as well as other molecules, must somehow exit out of the cell.
AEROBIC
w/O₂

= MITOCHONDRION

ANAEROBIC
without O₂

= CYTOSOL

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

I’M CHAMP!
% ATP Supplied

Cytosol

ATP-PC/Immediate
15 - 30 s

Glycolysis
1.5 – 3 m

Mitochondria

Oxygen System
≥ 3 – 5 m

Anaerobic

Aerobic

Performance Time

Power Output

Modified after Mathews & Fox
ATP = Adenosine Tri Phosphate
The Common Energy Currency
or the Cash Cells Understand!!
Cleave One High Energy Phosphate Bond To Do Work!!

7 – 10 KiloCalories/KCal

Adenosine

PP

P

P

Pi

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
  - Pyruvate to acetate
  - Acetyl-CoA
  - Citric acid cycle
  - Electrons carried by NADH and FADH$_2$
  - 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!

Cytosol

Outer mitochondrial membrane

Rod Capaldi
U of O Biology

fig 2-12 LS 2012
Goals of Aerobic Metabolism

AEROBIC w/O$_2$ = MITOCHONDRION

CITRIC ACID CYCLE

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

“cash in”

ELECTRON TRANSPORT CHAIN

for ATP Energy!!
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 → Transcription → RNA → Translation → Protein

Replication

Transcription

Translation @ ribosomes

Nucleus

Cytoplasm

cf: LS fig C-6
<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>4. Self-replicative (can copy itself)</td>
<td>4. Needs DNA as template</td>
</tr>
<tr>
<td>5. Nucleus (+mitochondria)</td>
<td>5. 1° 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>
<tr>
<td>First base of codon</td>
<td>Second base of codon</td>
<td>Third base of codon</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>U</td>
<td>UUU, UUC, UUA, UUG</td>
<td>Phe</td>
</tr>
<tr>
<td></td>
<td>UCU, UCC, UCA, UCG</td>
<td>Ser</td>
</tr>
<tr>
<td></td>
<td>AU, UAC, UAA, UAG</td>
<td>Tyr, Stop</td>
</tr>
<tr>
<td>C</td>
<td>CUU, CUC, CUA, CUG</td>
<td>Leu</td>
</tr>
<tr>
<td></td>
<td>CCU, CCA, CCA, CCG</td>
<td>Pro</td>
</tr>
<tr>
<td></td>
<td>CAU, CAC, CAA, CAG</td>
<td>His, Gln</td>
</tr>
<tr>
<td></td>
<td>CGU, CGC, CGA, CGG</td>
<td>Arg</td>
</tr>
<tr>
<td>A</td>
<td>AUU, AUC, AUA, AUG</td>
<td>Ile, Met, Start</td>
</tr>
<tr>
<td></td>
<td>ACU, ACC, ACA, ACG</td>
<td>Thr</td>
</tr>
<tr>
<td></td>
<td>AAU, AAC, AAA, AAG</td>
<td>Asn, Lys</td>
</tr>
<tr>
<td></td>
<td>AGU, AGC, AGA, AGG</td>
<td>Ser, Arg</td>
</tr>
<tr>
<td>G</td>
<td>GUU, GUC, GUA, GUG</td>
<td>Val</td>
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<tr>
<td></td>
<td>GCU, GCC, GCA, GCG</td>
<td>Ala</td>
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<td></td>
<td>GAU, GAC, GAA, GAG</td>
<td>Asp, Glu</td>
</tr>
<tr>
<td></td>
<td>GGU, GGC, GGA, GGG</td>
<td>Gly</td>
</tr>
</tbody>
</table>

Translation? Ribosomes Make Proteins

Translation of mRNA into proteins involves ribosomes. Each ribosome is composed of a large subunit and a small subunit. During translation, the ribosome binds to the mRNA, and each codon on the mRNA is read. An amino acid from the tRNA is attached to the mRNA at each codon, and the ribosome moves along the mRNA, reading each codon and adding the corresponding amino acid to the growing protein. The process is repeated until the ribosome reaches a stop codon, which signals the end of translation.
Transfer RNA (tRNA)
A Polyribosome. Which Way is Synthesis?
Class Skit on Translation!

What’s a ribosome?

A protein synthesizing factory, where translation takes place!

What’s a ribosome?

You rock, baby!
Questions + Discussion