BI 121 Lecture 4

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. Physiology in the News + Connections  
Mom’s eggs execute dad’s mitochondria? What’s a vault? Science News

III. Anaerobic vs Aerobic Metabolism Summary  
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

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

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

Structure-function = fun!
4 oz $\rightarrow$ 3 oz

Deck of Cards

1 c

1 oz

http://blogs.uoregon.edu/bi121/fall-2014/

raw $\rightarrow$ cooked

1/3 c

1.5 oz

1/4 c
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 cell's less glamorous but still essential players, which can be seen 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 vaults 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 pass through the protective screen of the membrane.
AEROBIC = MITOCHONDRION
w/O_2

ANAEROBIC = CYTOSOL
without O_2
1. Immediate/ATP-PC
2. Glycolysis
WOW!

I’m CHAMP!
ATP Supplied

Performance Time

Power Output

ATP-PC/Immediate

Glycolysis

Anaerobic

Oxygen System

Mitochondria

Cytosol

15 - 30 s

1.5 - 3 m

3 - 5 m

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

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

2. Membrane Transport
   Move things! Microscopic!

3. Mechanical Work
   Move things! Macroscopic!

Adenosine
**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

fig 2-15 LS 2012
AEROBIC w/O₂

ANAEROBIC Immediate/ATP-PC

Glycolysis

MITOCHONDRIA

CYTOSOL

Immediate/ATP-PC
Stages of Cellular Metabolism/Respiration

**Anaerobic Glycolysis Cytosol**
- Glycolysis: Glucose and other fuel molecules → Pyruvate → Pyruvate to acetate → Acetyl-CoA
- **2 ATP**

**Aerobic Metabolism Mitochondria**
- Citric acid cycle: Electrons carried by NADH and FADH$_2$
- Oxidative phosphorylation: (electron transport system and chemiosmosis) → 28 ATP

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**fig 2-9 LS 2012**
Glycolysis "sugar dissolving/splitting" produces small amounts of ATP.
Citric Acid Cycle produces pairs of electrons for cashing in at the nearby electron transport chain (ETC)
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 = MITOCHONDRION

w/O₂

CITRIC ACID CYCLE

harvest electrons

"cash in"

ELECTRON TRANSPORT CHAIN

for ATP Energy!!
Cytoskeleton: Cell "Bone & Muscle"

Microtubule

Intermediate filament

Microfilament

Tubulin subunit

Polypeptide strand

Actin subunit

LS 2012 fig 2-17
Microtubular Highway!!
4th Component: Microtrabecular Lattice?
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 @ ribosomes → Protein

Replication

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)
6. mRNA, rRNA, tRNA

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**

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Translation? Ribosomes Make Proteins

LS 2012 fig C-7
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!

You rock, baby!
Questions + Discussion