I. Announcements Lab today 12 n & 1 pm. Q last time?

II. Connections Extracellular fluid (ECF) & Homeostasis
   A. ECF: Plasma vs. Interstitium?
   B. Dr Evonuk Balances LS pp 5 - 15
   C. *Physiology in the News* Are we like watermelons?
   D. Simplified Model DO Norris *cf:* fig 1-8 LS
   E. Negative feedback? Positive feedback? LS pp 14 - 15
   F. Balances & e.g. H₂O, T°C, BP Dr Evonuk + LS pp 8 - 10

III. Cell Anatomy, Physiology & Compartmentalization ch 2 (LS)
   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. *Physiol News* Moms eggs execute Dad’s mitochondria?
   E. What about vaults? LS 2006, p 32 + *Science News*
Where is extracellular fluid?
Where is extracellular fluid?

As long as between/outside cells, ECF everywhere?

G&H 2011
ICF = Intracellular

ECF = Extracellular

Plasma (within CV System)

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

- Metabolic: ANA- CATA-
- Water ($H_2O$)
- Ion +/-
- Oxygen ($O_2$)/Carbon Dioxide ($CO_2$)
- Temperature ($T_0C$)
- Electrolytes
- Bicarbonate and pH Balance
No, we’re not watermelons, but H₂O is definitely critical!!

because you’re 98% water.

≠
Drink about 1 L per 1000 calories energy expenditure!!

Human ~ 2/3 H₂O  
~ 60 – 70 %

150 lb /68 kg

= ~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
**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!**

70% H2O = 49L

ICF = 35L

ECF = 14L

- Interstitium = 11L
- Plasma = 3L

70 kg

H2O
Controller = Hypothalamus with Set Point

True Diurnal Variation

Protein Denaturation

Mild Hypothermia

Profound Hypothermia

Time of Day

Set Point

98.6°F

110°F

Lethal

42°C

37°C

35°C

33°C

< 30°C

0600 1400 0600 1400

29°C
Venous Pooling

$\downarrow$ BP $I$

Seated to Standing

Baroreceptors/Pressure Receptors
eg, in Carotids & Aorta

NB: Corrective Change Opposes Original Input

$\uparrow$ BP

Electrochemical Signal $I'$

CV Control Center Brain Stem

$O$

Electrochemical Signal eg, Symp Accel N

+ HR

+ VC

↓ Venous Pooling

↓ $I$

$E$

$Ef$

$C$
Group Discussion + Break!
HOW BIG? 100 CELLS LENGTHWISE = 1 mm!!

1. Cell/Plasma membrane
   - Organelles
   - Nucleus
   - Cytosol

2. Nuclear Membrane
   - d = 10-20 microns
Cytoplasm = Cell - Nucleus

[Extract nucleus; includes organelles]

Cytosol = Cytoplasm - Organelles

[Extract organelles; complex gel-liquid]
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

Smooth ER:
1. packages new proteins in transport vesicles
2. stores calcium in muscles

fig 2-2 LS 2012
Electron Micrographs of Rough vs. Smooth ER

fig 2-2 LS 2012
Secretion of Proteins Produced by ER

1. Proteins (colored strands) are assembled on ribosomes attached to the ER or free in the cytoplasm.
2. Transport vesicles
3. Rough ER
4. Golgi complex
5. Secretory vesicles
6. Lysosome
7. Secretion (exocytosis)
Golgi Complex: Final Processing, Packaging & Distribution

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

Golgi sacs

Golgi complex

Vesicles containing finished product

Dr. Don Fawcett & R. Bollero/Visuals Unlimited

fig 2-4 LS 2012
Exocytosis: Primary Means of Secretion
Endocytosis: Primary Means of Ingestion
Phagocytosis: Cell Eating!
Film: Neutrophil engulfing bacterium

L. Nilsson, Nat Geog 1986 10,000 x
Catalase Enzyme Reaction in Peroxisomes
Neutralize Toxin at Production Site!

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

Proteins of electron transport system

Intermembrane space

Cristae

Inner mitochondrial membrane

Matrix

Outer mitochondrial membrane

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 biological mystery known as maternal 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 cellus 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,