**Bl 121 Lecture 3** …Anatomy & Physiology Lab Thurs! Fun again!

I. *Announcements* Q from last time? Office hr &/or e-mail Q.

II. *Connections* Q re: Homeostatic Model for BP? Active work!

III. *Cell Anatomy, Physiology & Compartmentalization* LS ch 2

A. How big? What boundaries? Why compartments?pp19-21

B. Basic survival skills ch 1 p 3

C. Organelles ≡ Intracellular specialty shops w/membranes
1. Endoplasmic Reticulum (ER) 2. Golgi 3. Lysosomes
4. Peroxisomes & 5. Mitochondria. LS 2012 pp 20-34
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?

IV. *Anaerobic vs Aerobic Metabolism Overview* Many sources!
Mathews & Fox 1976...LS 2012 pp 26-33, fig 2-15 p 33

V. *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

F. Genetic code? pp A-22, A-23

G. How are proteins made? fig C-7, C-9

# *Blood Pressure Homeostasis*

BP ↓

Venous Pooling

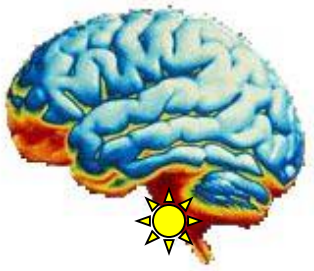
*I*

*R*

Baroreceptors/Pressure Receptors
eg, in Carotids & Aorta

Electrochemical Signal
*I'*

CV Control Center
Brain Stem

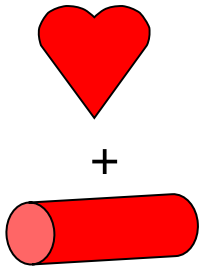


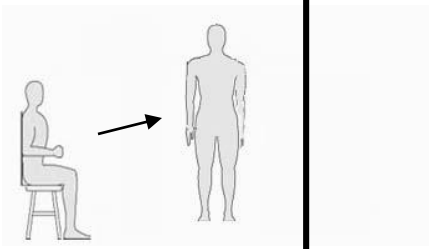
*C*

*O*

Electrochemical Signal
eg, Symp Accel N

*E*





Seated to Standing

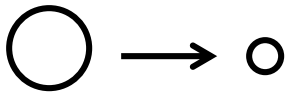
***NB*: Corrective Change Δ**
**Opposes Original Input *I***

**Short-term vs long-term!**

BP ↑

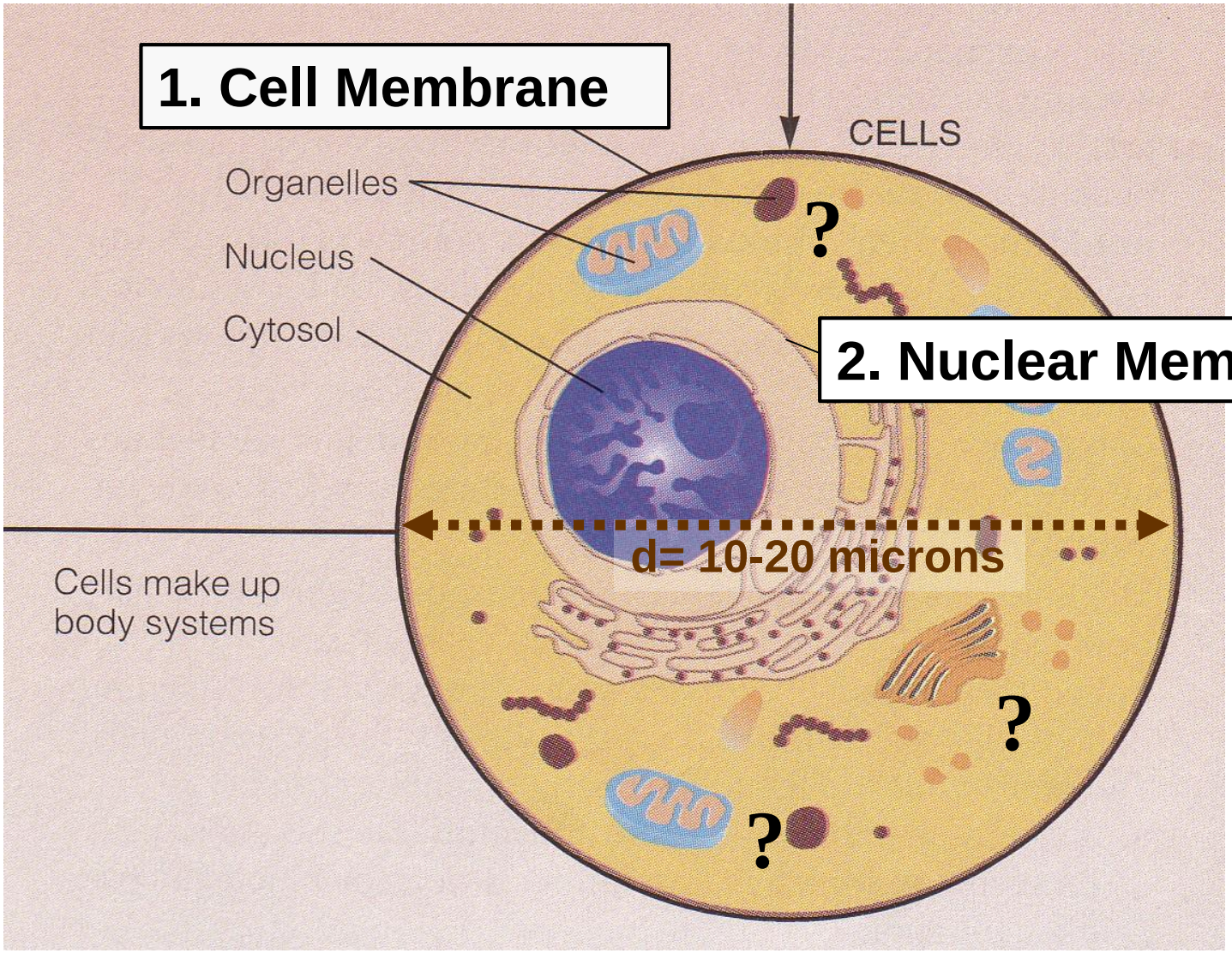
*Ef*

↑ HR
+
↑ VC



# Active Learning
# Group Work

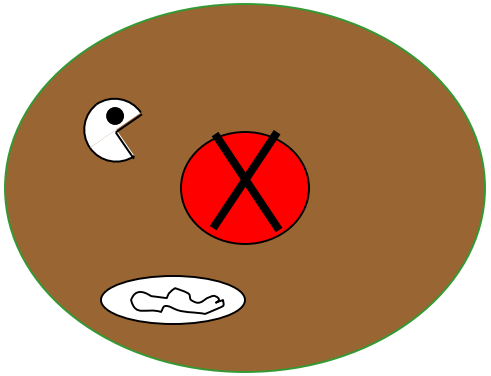
# *How Big? 100 Cells Lengthwise = 1 mm!!*




***http://opb.pbslearningmedia.org/resource/tdc02.sci.life.cell.nucleus/nucleus-cytoplasm-membrane/***

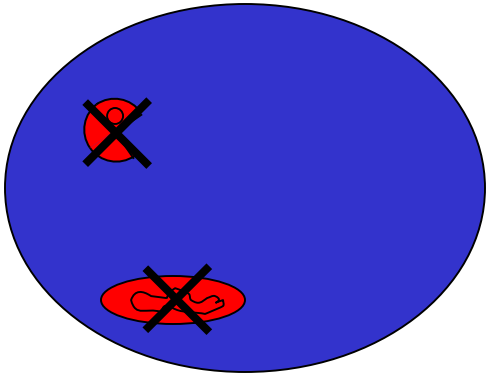
## Cytoplasm = Cell - Nucleus

**[Extract nucleus; includes organelles]**



## Cytosol = Cytoplasm - Organelles

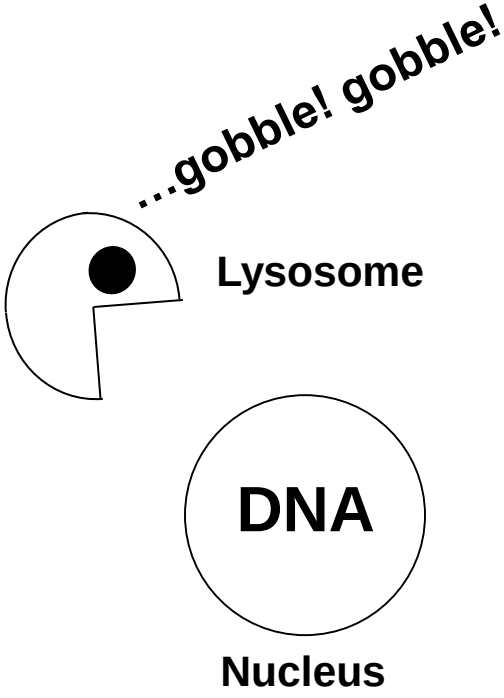
**[Extract organelles; complex gel-liquid]**



# *Why Compartments? Advantage?*

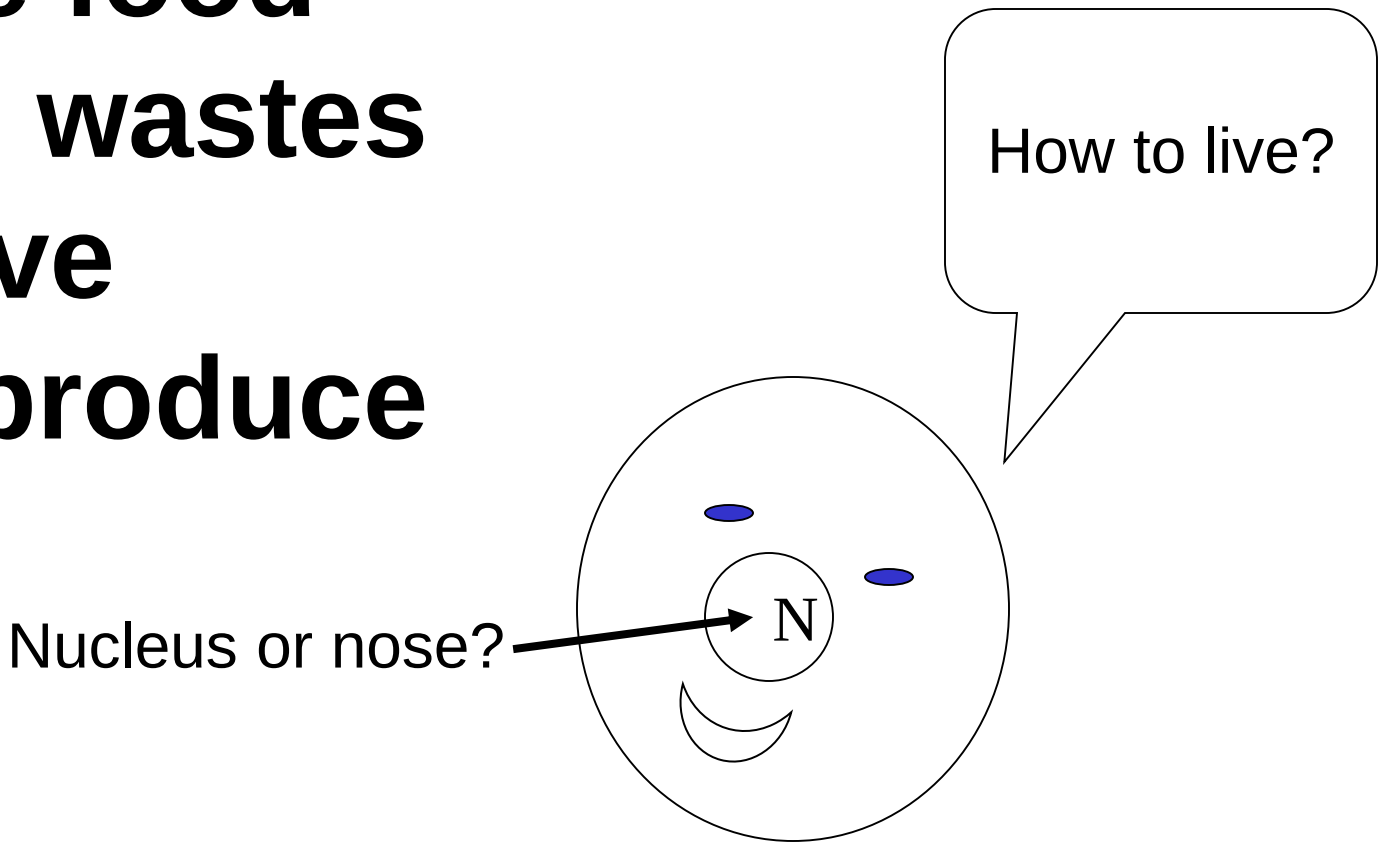
**<u>*Incompatible*</u> reactions can take place**

**<u>*Simultaneously*</u>!!**



# *Basic Cell Survival Skills?*

1. **Get food**
2. **Use food**
3. **Rid wastes**
4. **Move**
5. **Reproduce**



# 1 Sample Cartoon of 100 Trillion ($100 \times 10^{12}$) Cells!

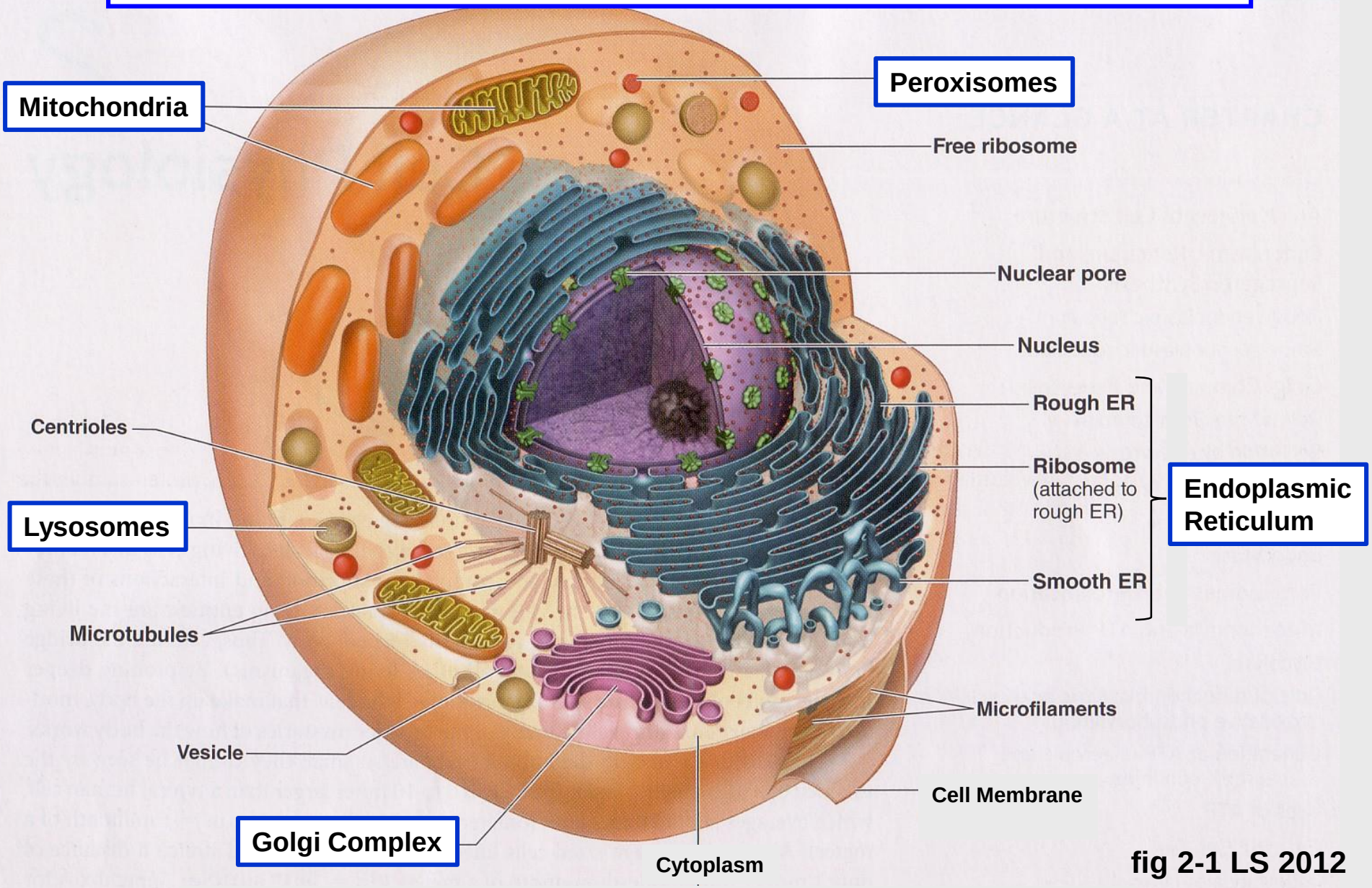



fig 2-1 LS 2012

http://opb.pbslearningmedia.org/resource/tdc02.sci.life.cell.organelles/organelles-in-the-cytoplasm/

# Rough & Smooth Endoplasmic Reticulum (ER): Protein & Lipid Synthesizing Factories

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

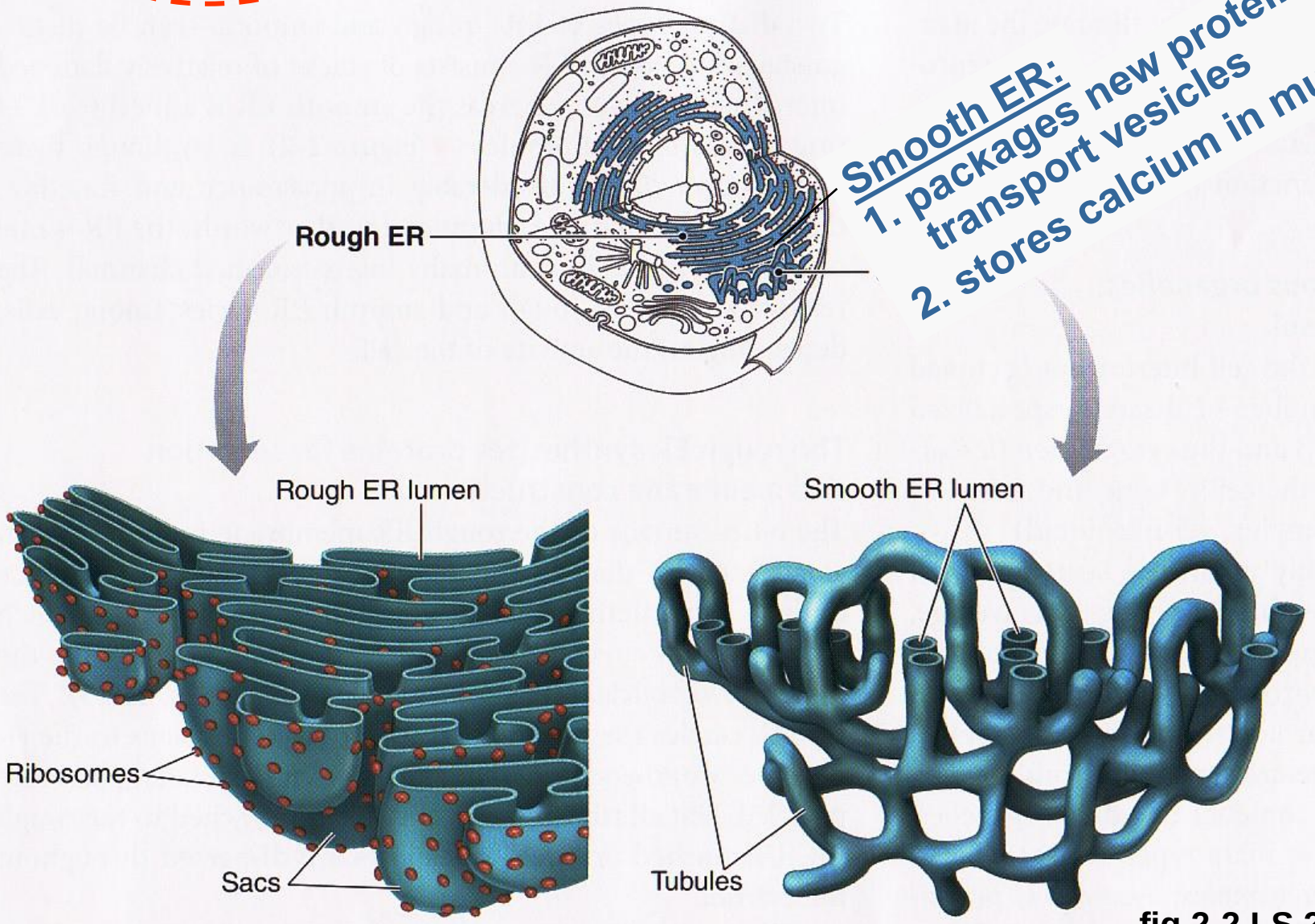



fig 2-2 LS 2012

# *Electron Micrographs of Rough vs. Smooth ER*

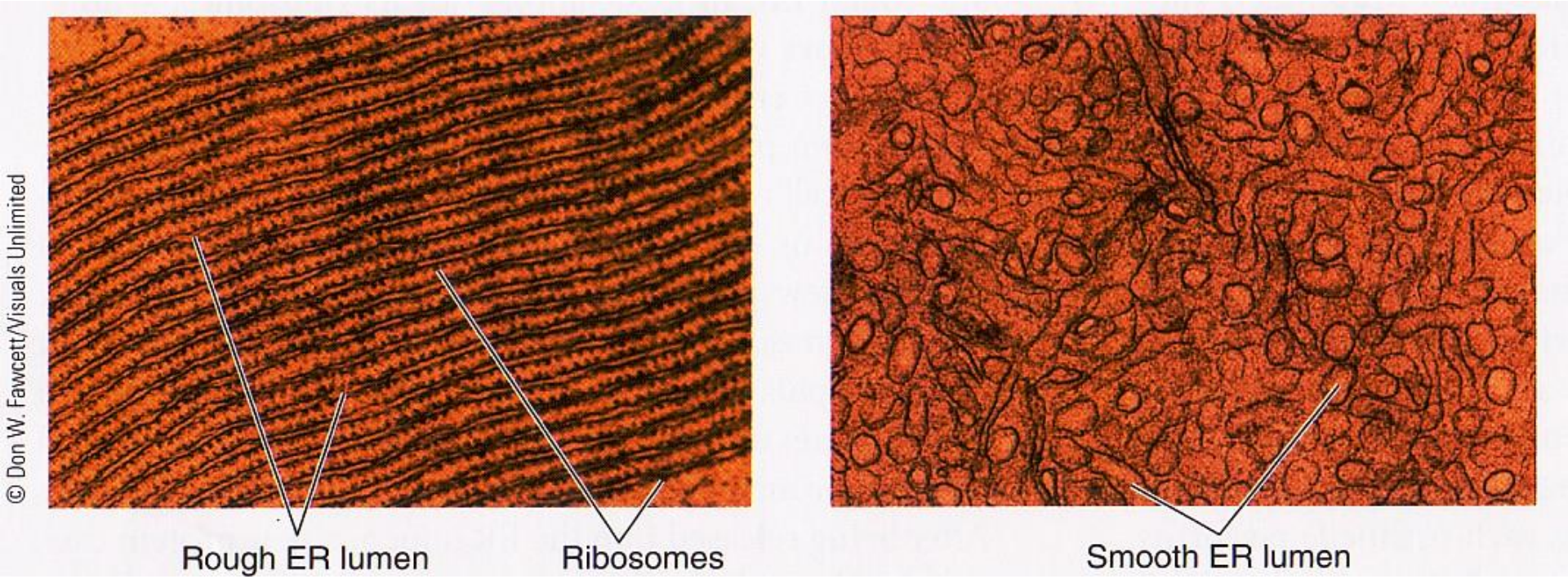



**fig 2-2 LS 2012**

# Secretion of Proteins Produced by ER

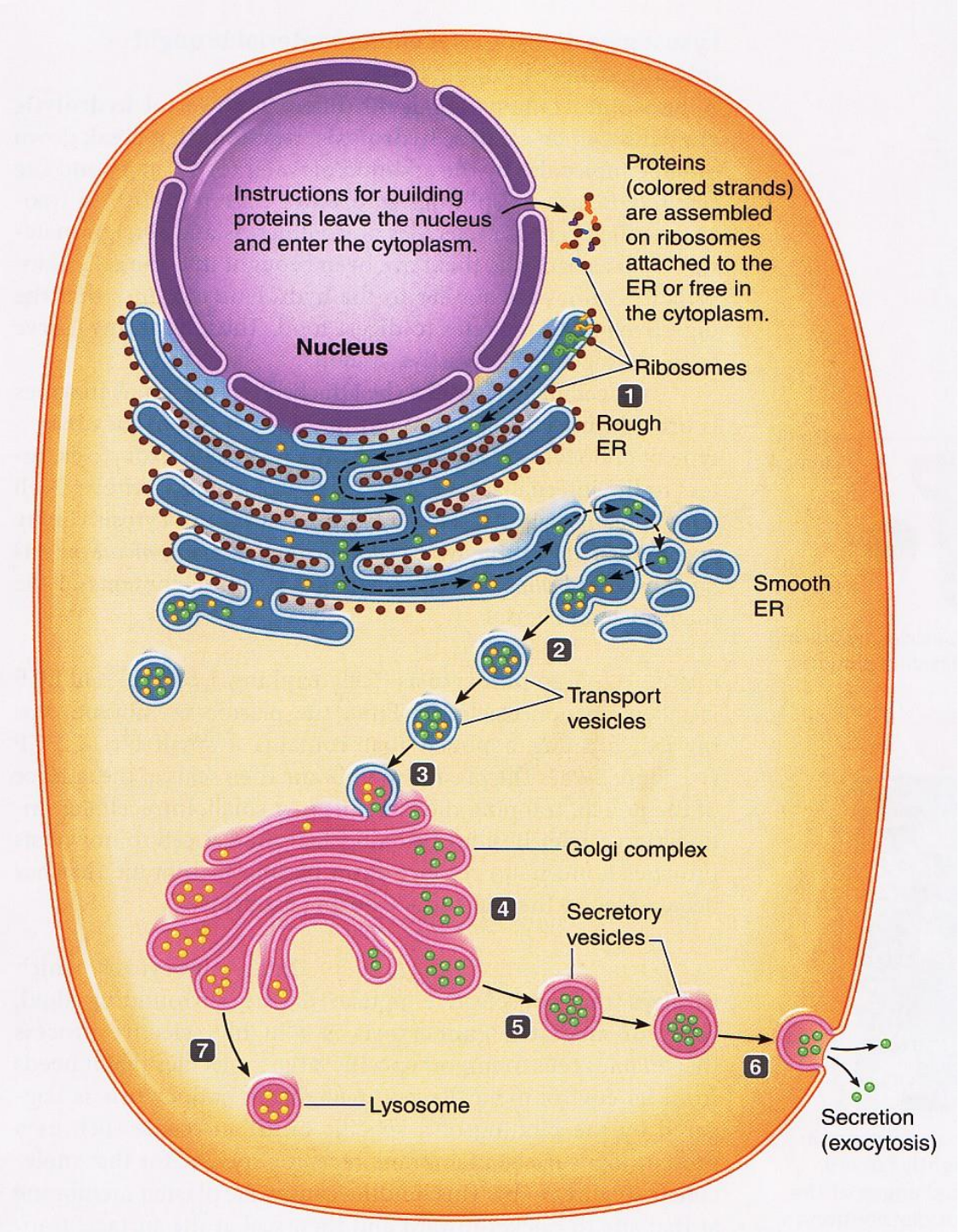



fig 2-3 LS 2012

# Golgi Complex: Final Processing, Packaging & Distribution

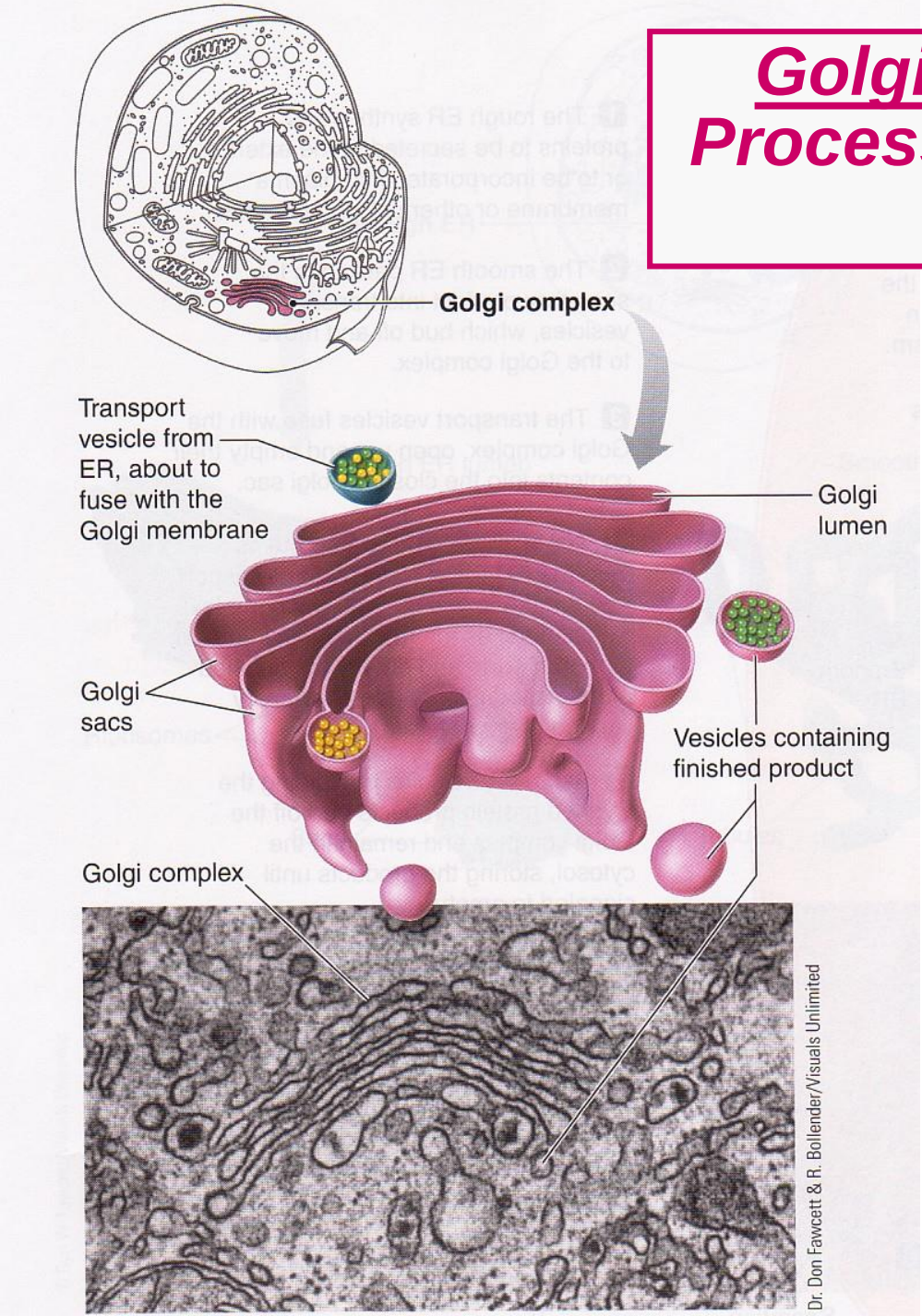
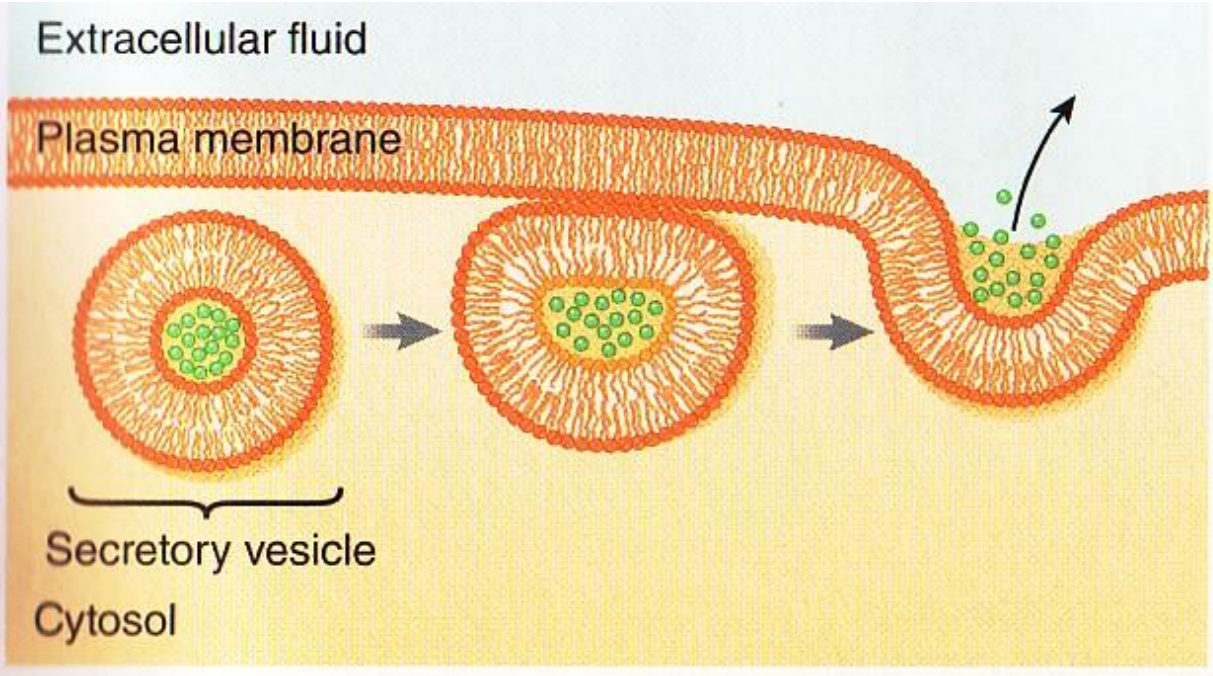



fig 2-4 LS 2012

# *Exocytosis: Primary Means of Secretion*



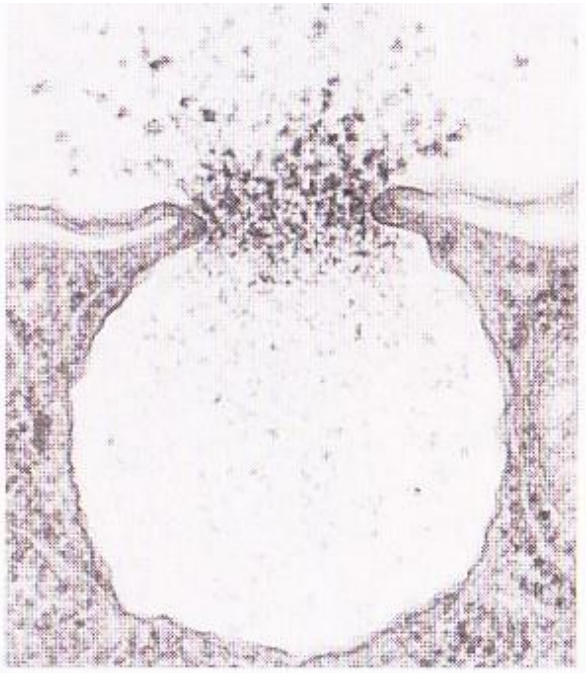
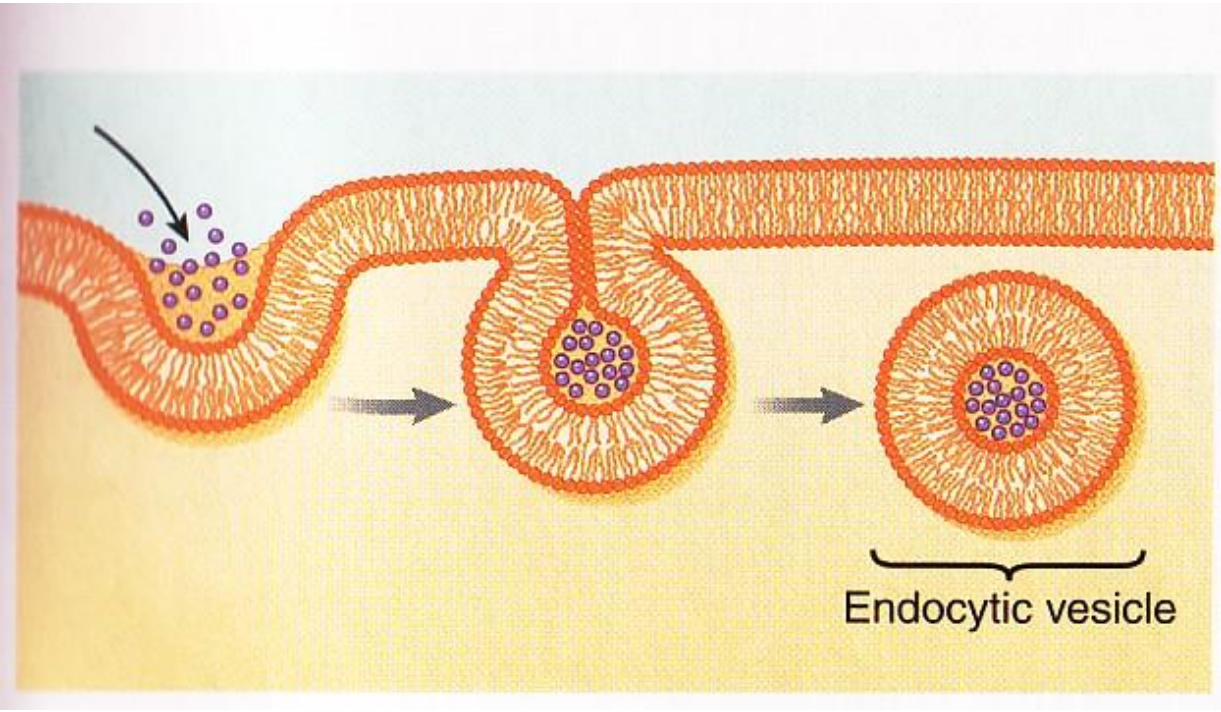




**fig 2-5a LS 2012**

# *Endocytosis: Primary Means of Ingestion*



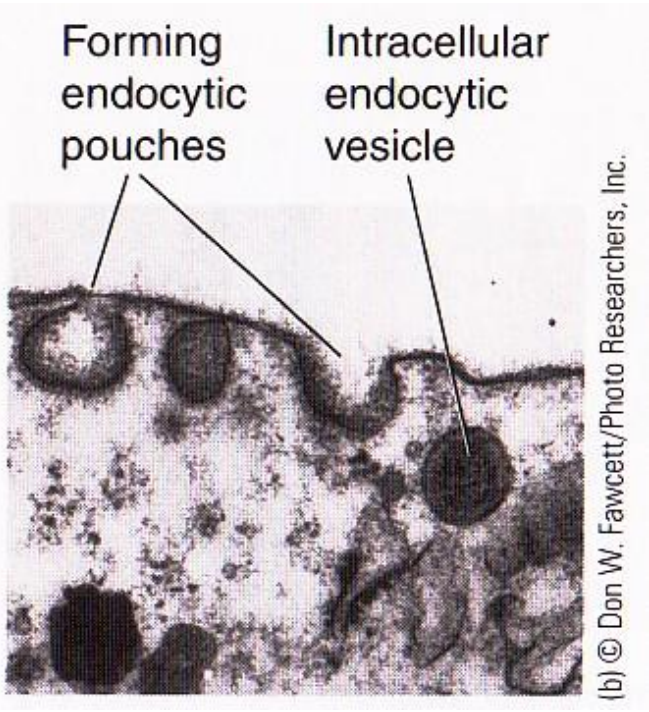




**fig 2-5b LS 2012**

# *Lysosomes* vs. *Peroxisomes*

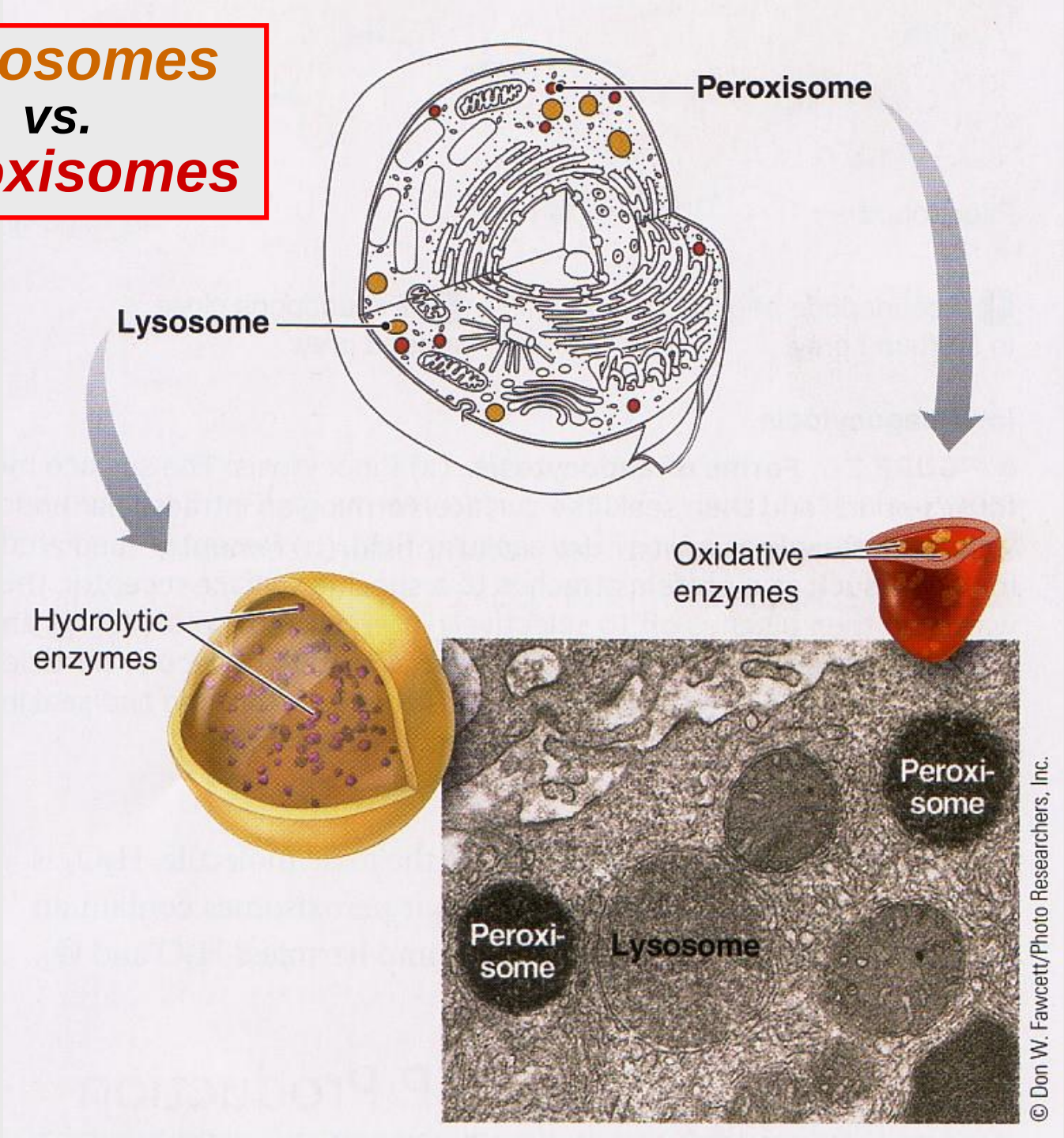



fig 2-6 LS 2012

# Phagocytosis: Cell Eating!

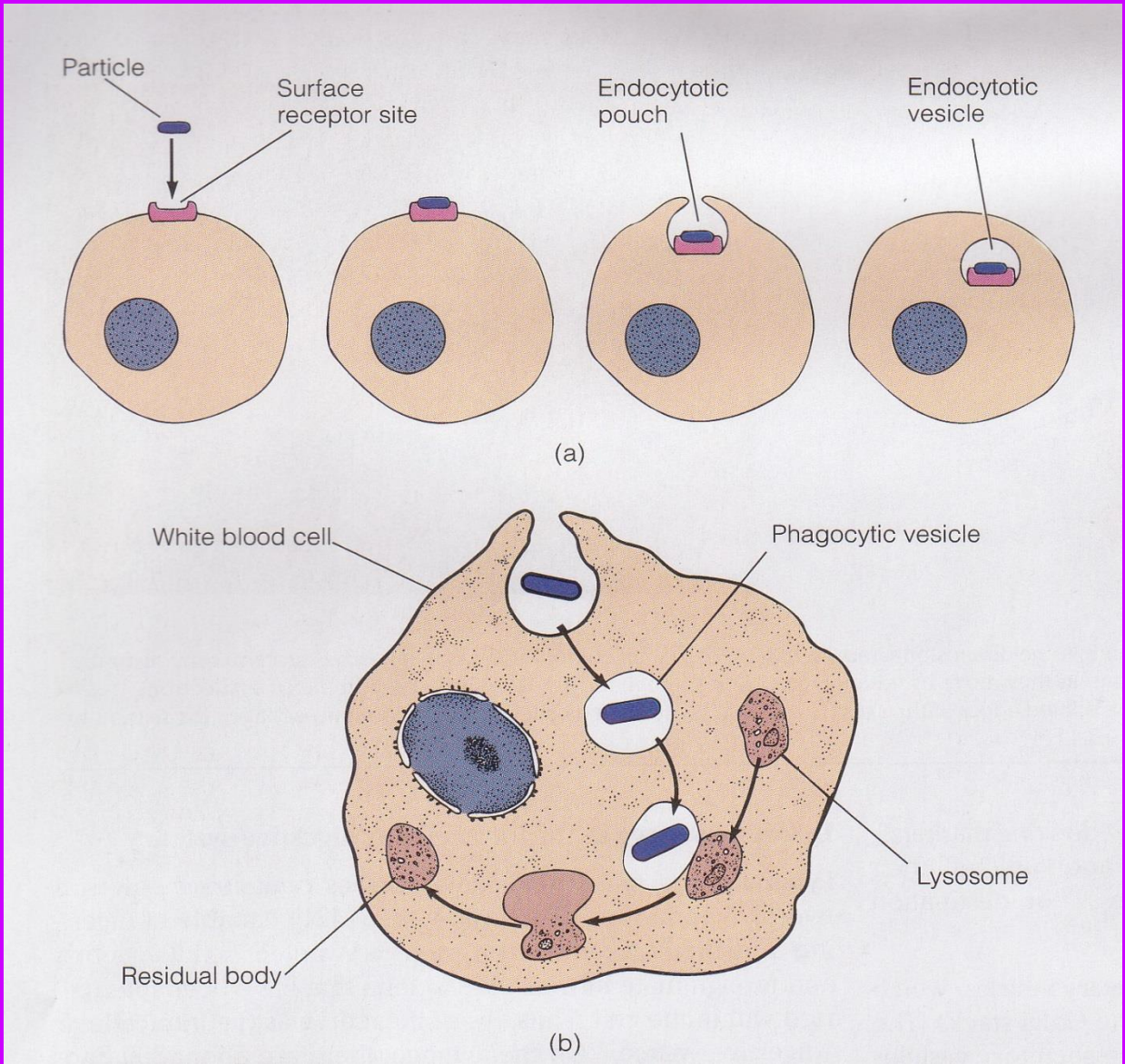
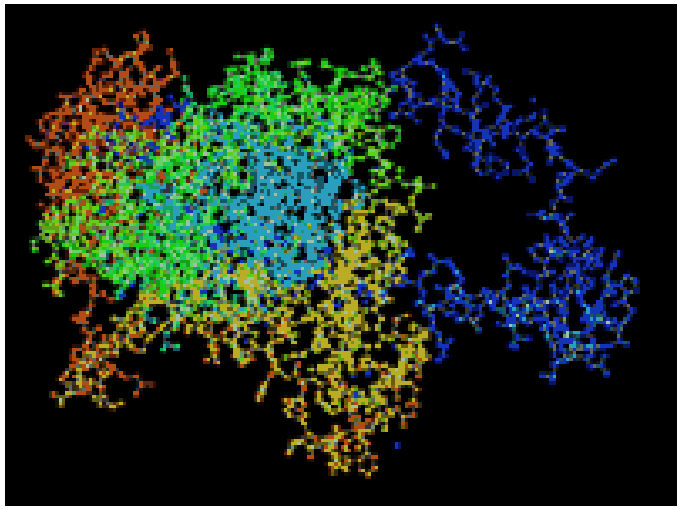



fig 2-7 LS 2006


Film: Neutrophil engulfing bacterium
http://devreotes.johnshopkins.edu/videos
L. Nilsson, Nat Geog 1986
10,000 x

# *Catalase Enzyme Reaction in Peroxisomes Neutralize Toxin at Production Site!*



$$2H_2O_2 \xrightarrow{\textit{Catalase}} 2H_2O + O_2$$

# *Mitochondria: Energy Organelles*

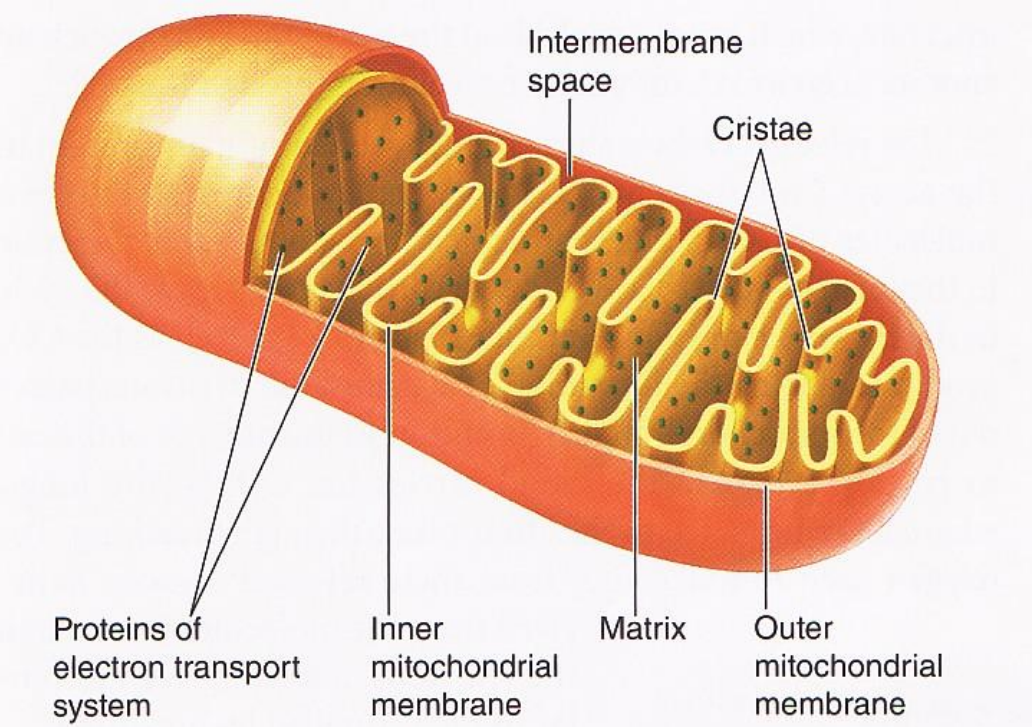
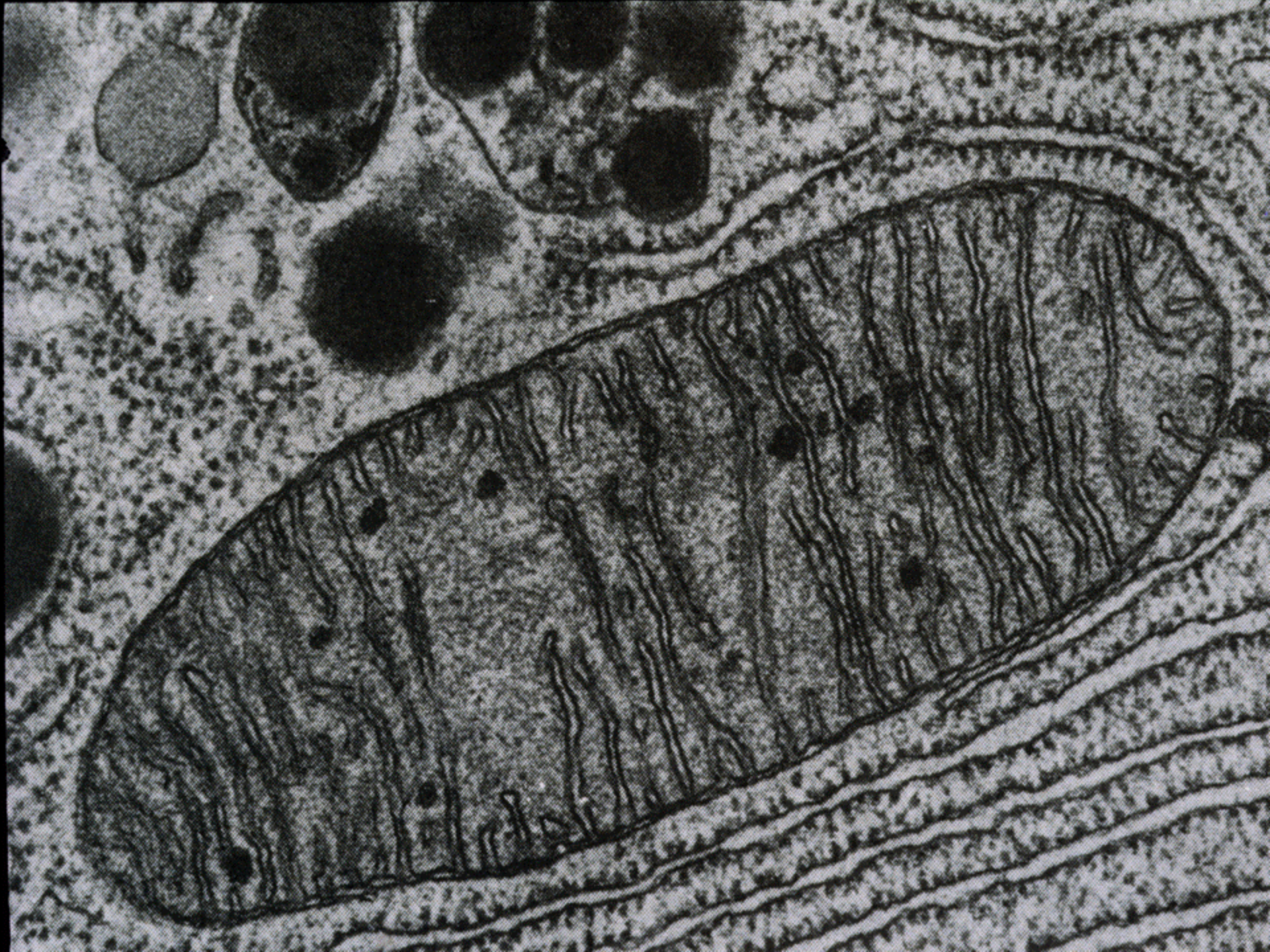
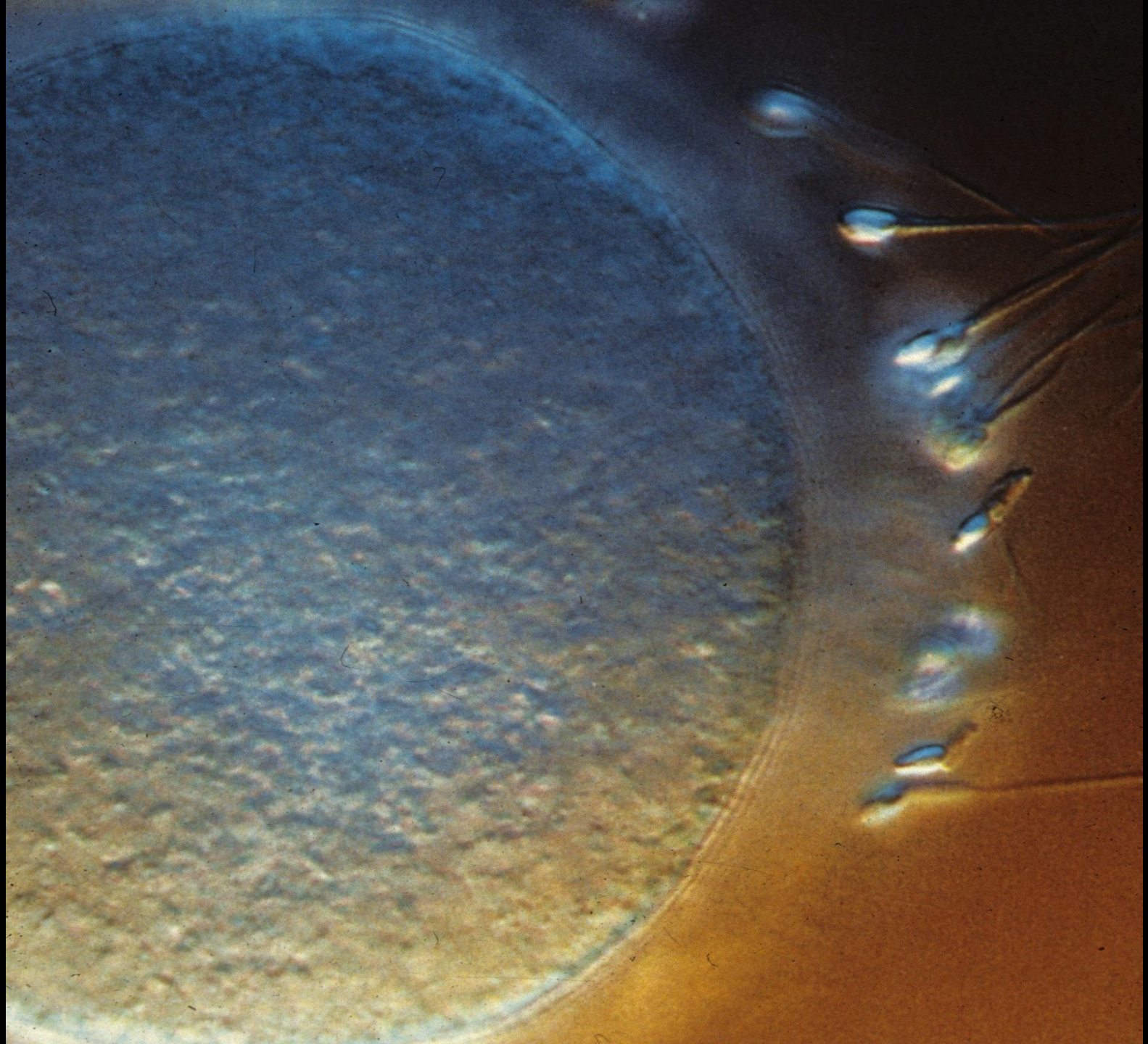



**fig 2-8 LS 2012**





# 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 bio-

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.

***SOURCE*: John Travis, *Science News* 2000;157(1), 5.**

**Inside a fertilized egg, with its two sets of chromosomes (blue), the protein ubiquitin (red) tags sperm mitochondria (yellow).**

***SOURCE*: Sutovsky P, Moreno RD, Ramalho-Santos J, Dominko T, Simerly C, Schatten G. *Nature* 1999;402(6760), 371-2.**

The Weekly Newsmagazine of Science

# SCIENCE NEWS

July 27, 1996
Vol. 150, No. 4
Pages 49-64

## Vaults Hold Cell Mystery

# 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.

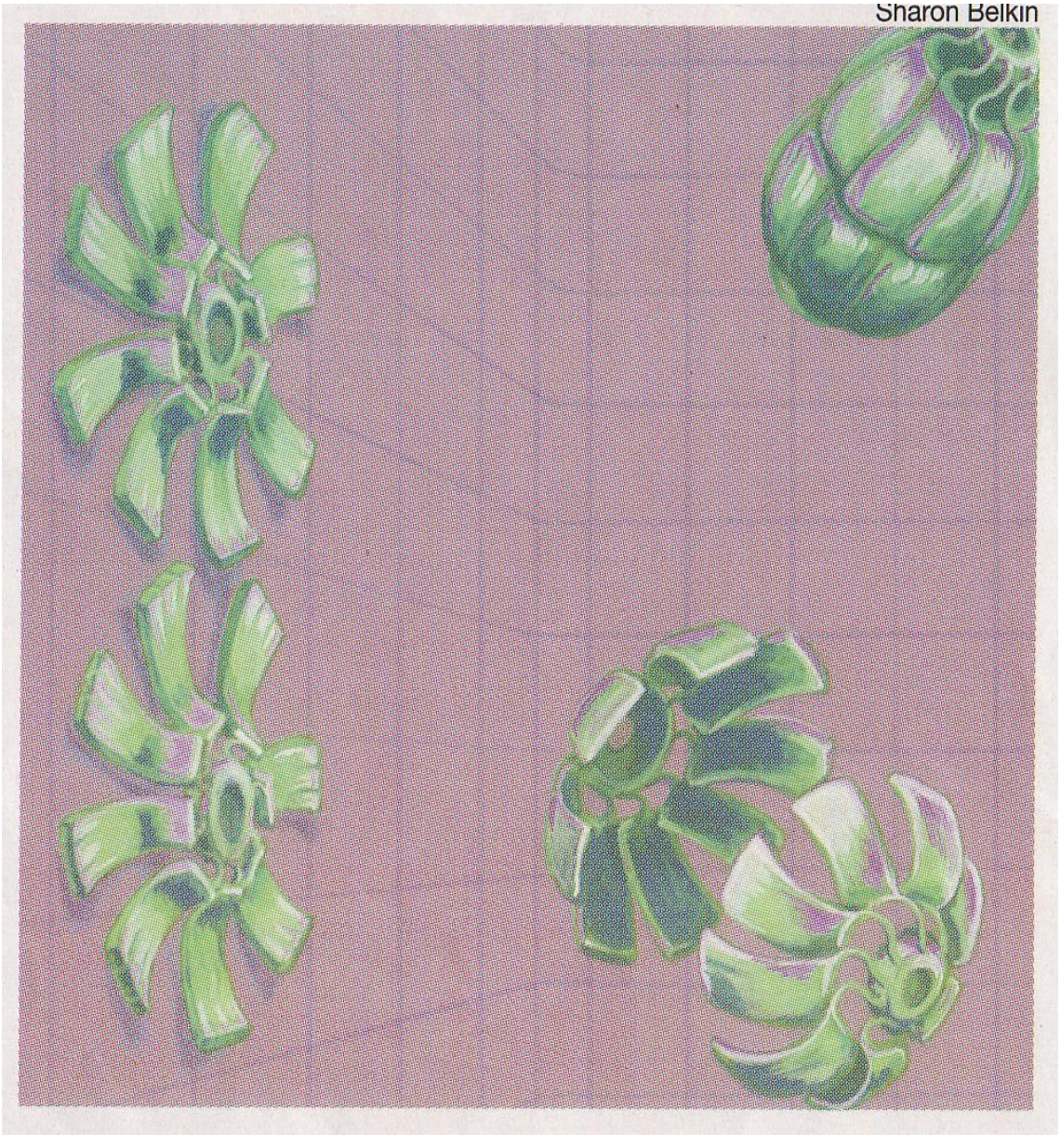
Yet cell biologists may soon have to acknowledge an equally unimaginable oversight in their field. For decades, their powerful microscopes have failed to spot a basic cell component of animals and perhaps any organism with a nucleus. Known as vaults, the barrel-shaped particles are three times the size of ribosomes, the eas-

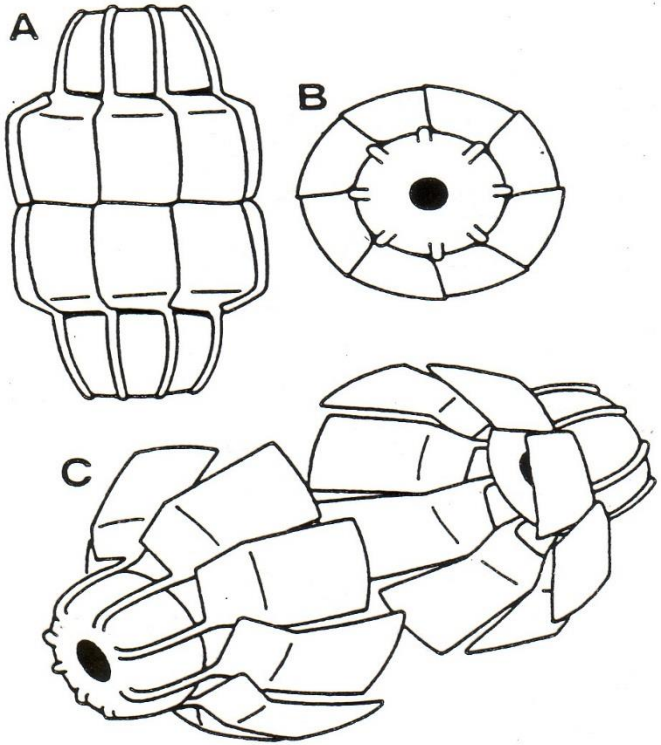
through a microscope. But if it were contaminated with objects that shrug off the stain, that sea would be dotted with white islands. Rome likens the strategy to finding an invisible person by looking for an unexplained shadow in the beam of a spotlight.

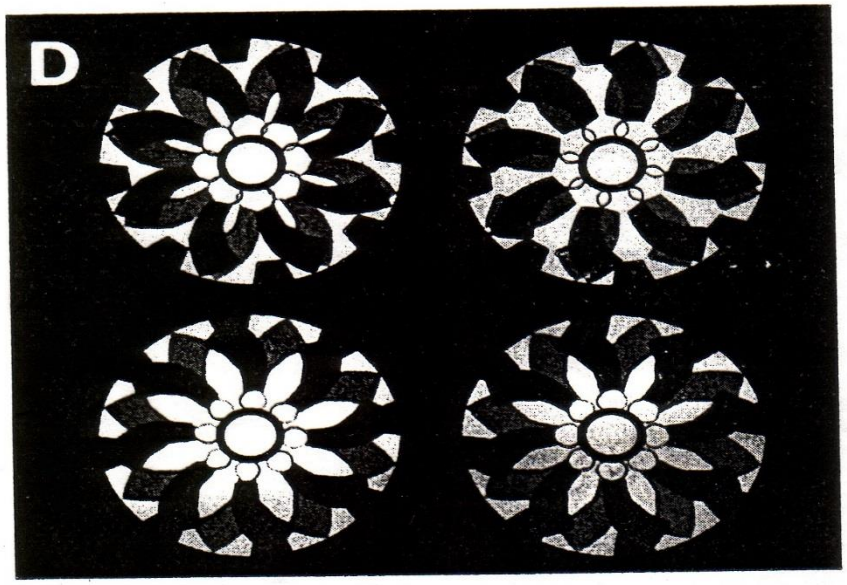
To Kedersha's surprise, unstained ovoid objects appeared among her coated vesicles. Since some of the stain settled into furrows on top of the unexpected shapes, the negative staining revealed fine details of the exterior of these mysterious interlopers, including arches that reminded Rome and Kedersha of the coil

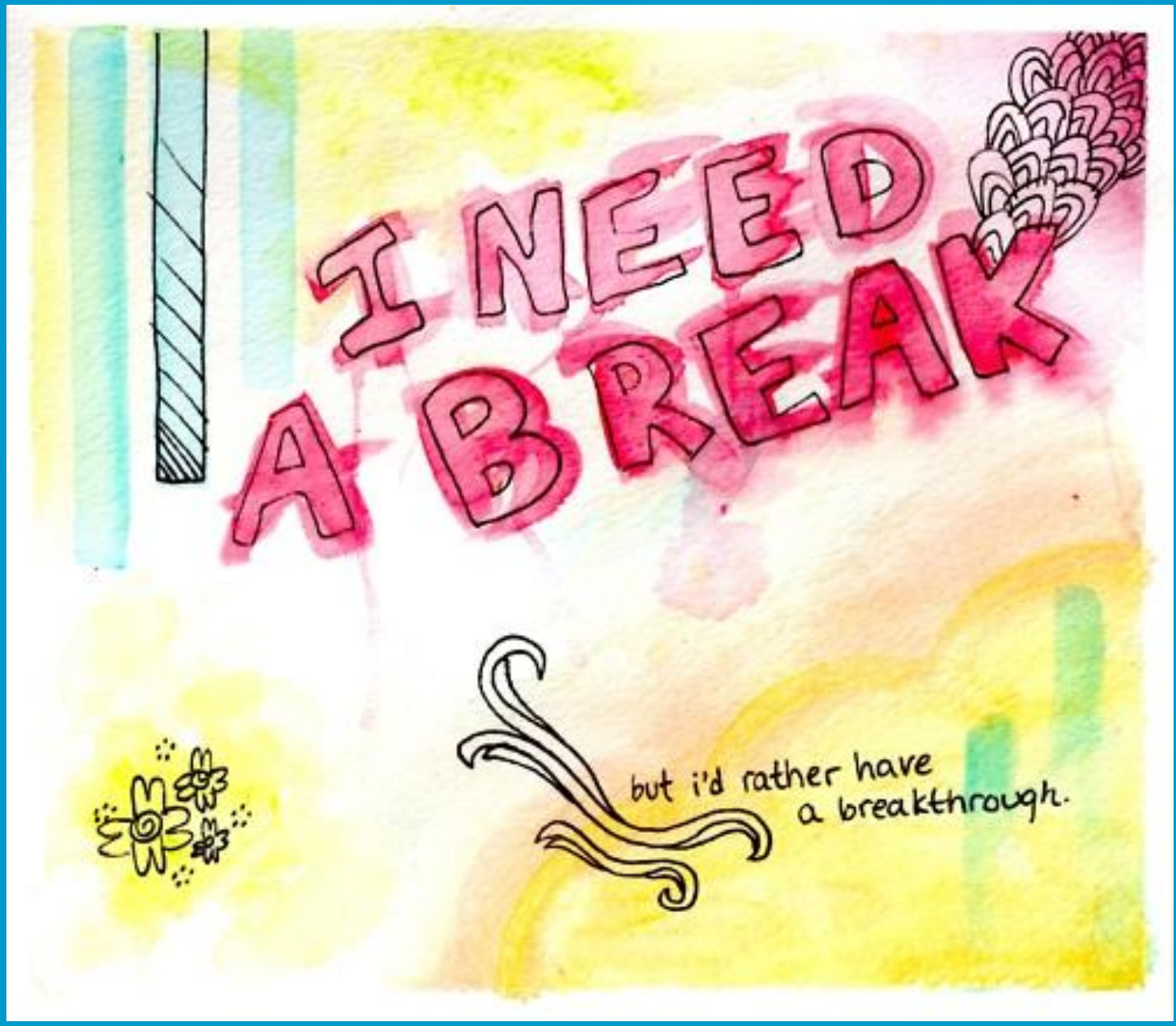
us something by this incredible structure. And the one thing we might surmise from the structure [of vaults] is that they might contain something," says Rome.

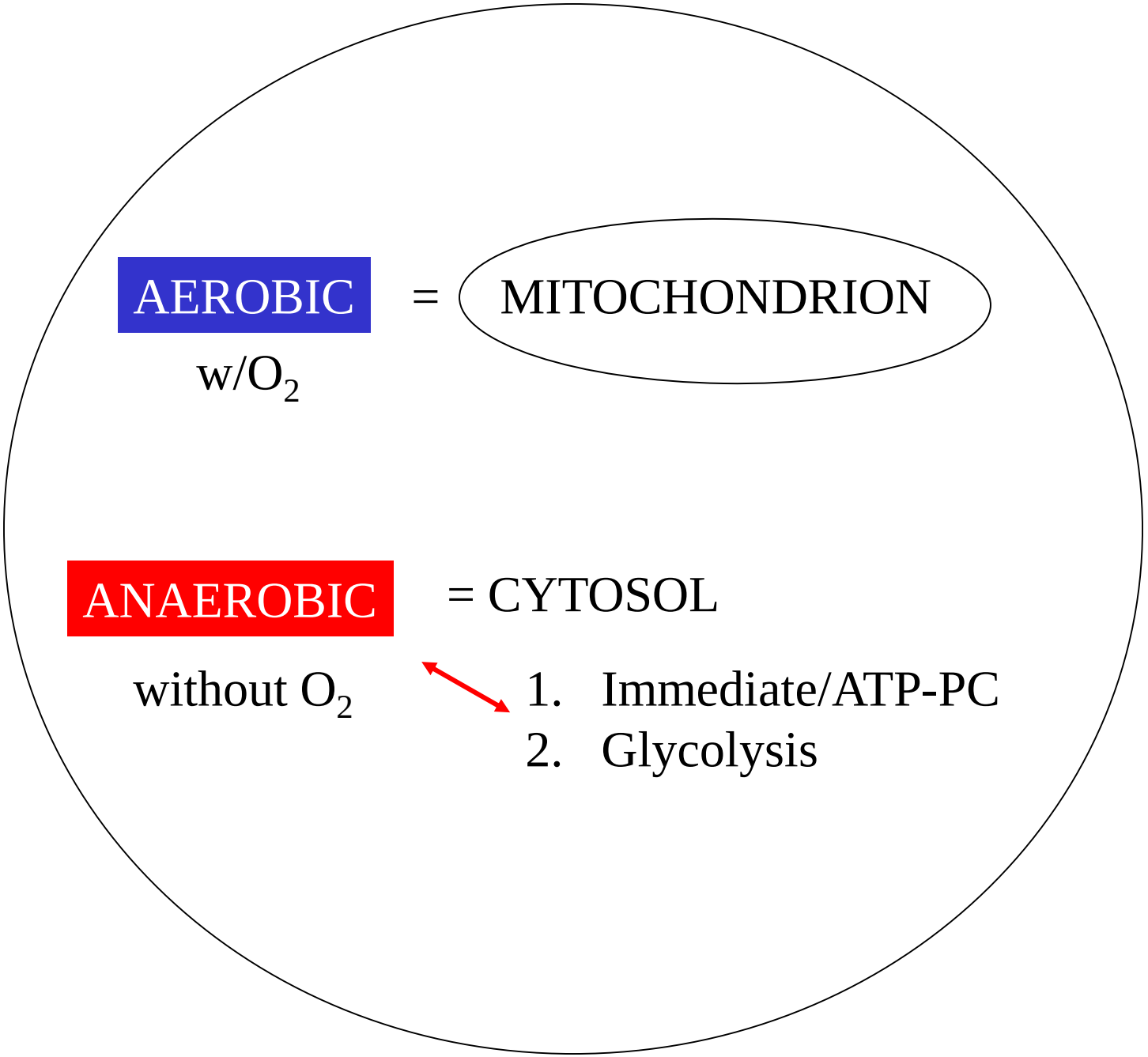
That shape also hints that vaults may pick up their unknown cargo at the nuclear membrane, the barrier that separates the cell's cytoplasm from its nucleus. The nucleus is a fluid-filled sac containing DNA and the machinery required to translate the instructions encoded by that DNA into molecules called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


Sharon Belkin


A
B
C


D


I NEED A BREAK
but i'd rather have a breakthrough.


AEROBIC
=
MITOCHONDRION
w/O2
ANAEROBIC
= CYTOSOL
without O2
1. Immediate/ATP-PC
2. Glycolysis


CREATINE
MONOHYDRATE


FREE
4 Extra Servings!
ISS
RESEARCH
COMPLETE
Creatine
EFFERVESCENT
ADVANTAGE
24 (17 gram) Servings
individually packaged

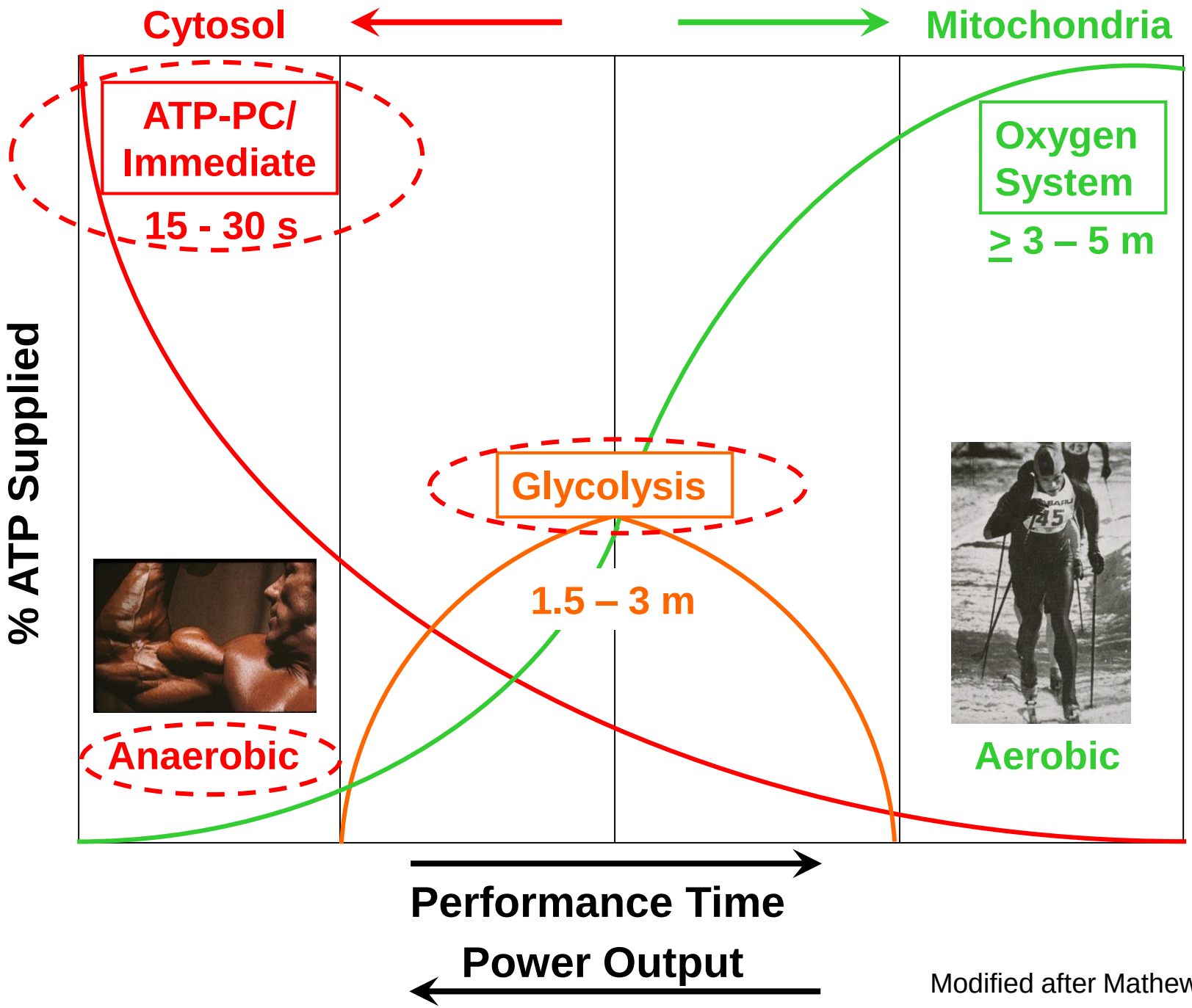

ULTIMATE
NUTRITION
crea
pure
BIOVOLUMIZING
1000g (1kg)


BALANCE
PURE
CREATINE
MONOHYDRATE

WOW!

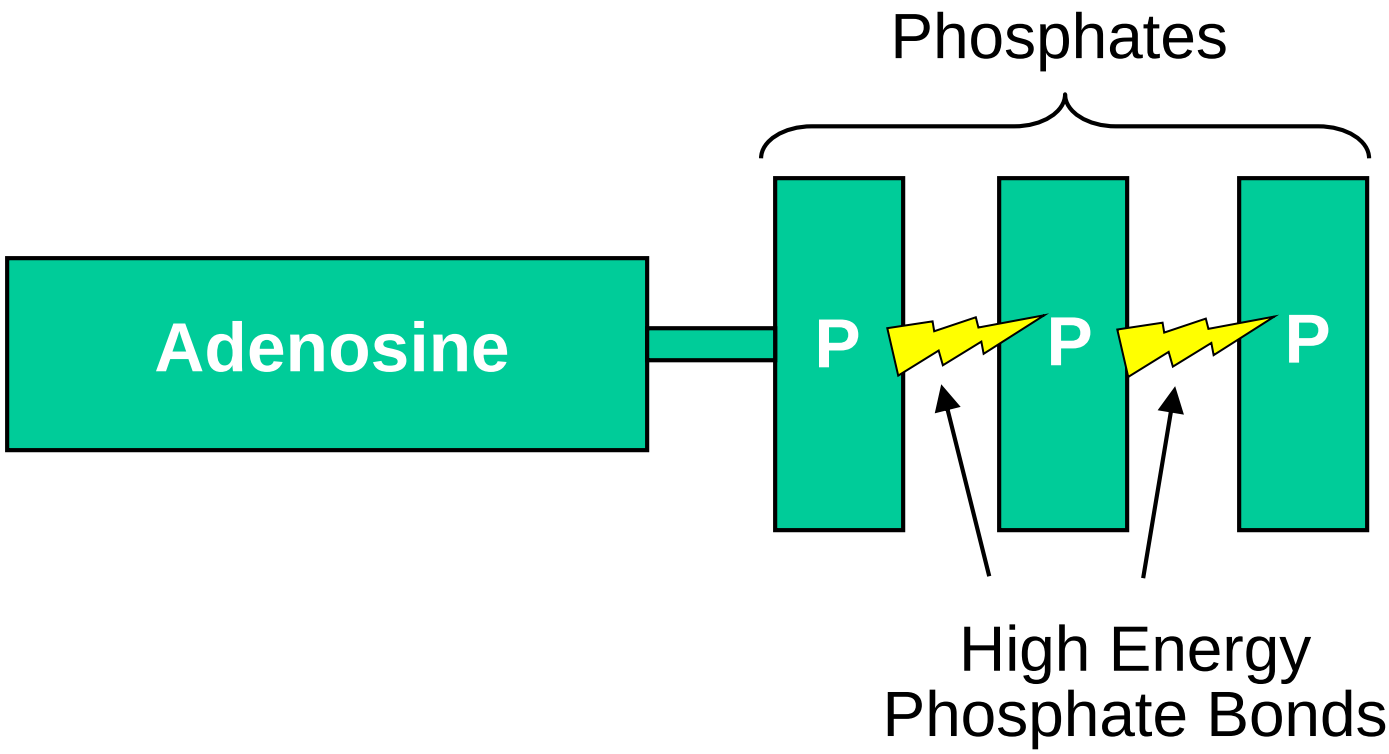
I'M CHAMP!


PUMP



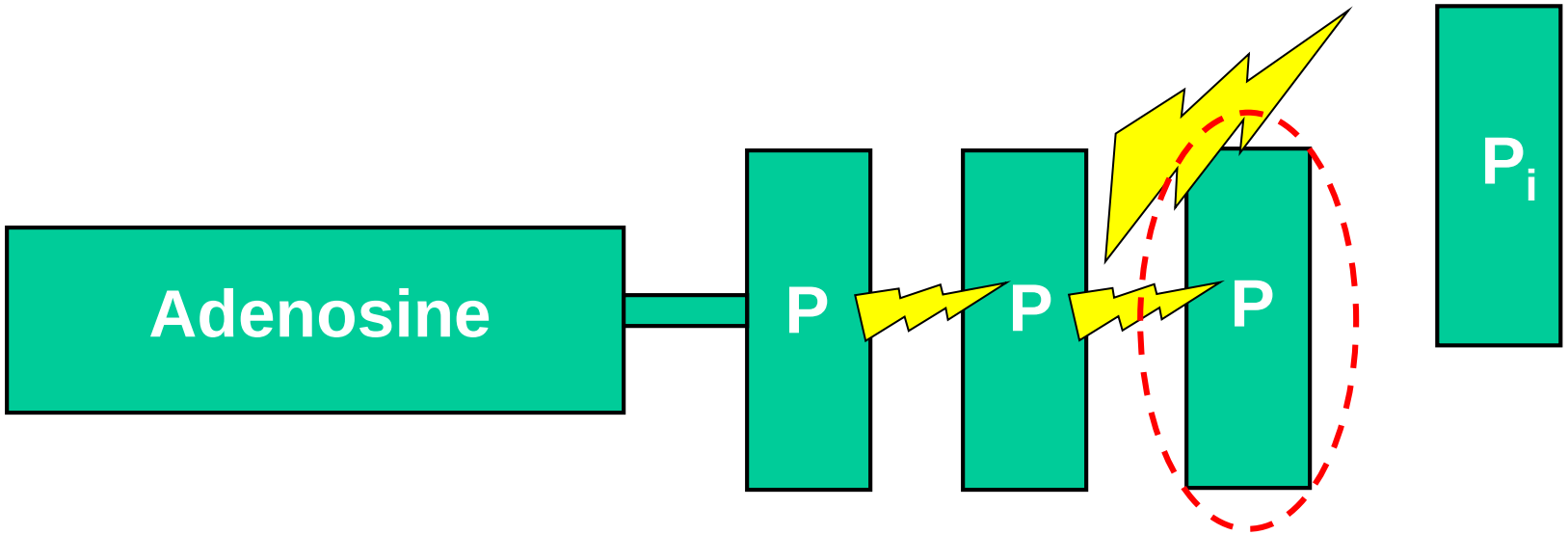

Modified after Mathews & Fox

# ***ATP = Adenosine Tri Phosphate***
# ***The Common Energy Currency***
# ***or the Cash Cells Understand!!***



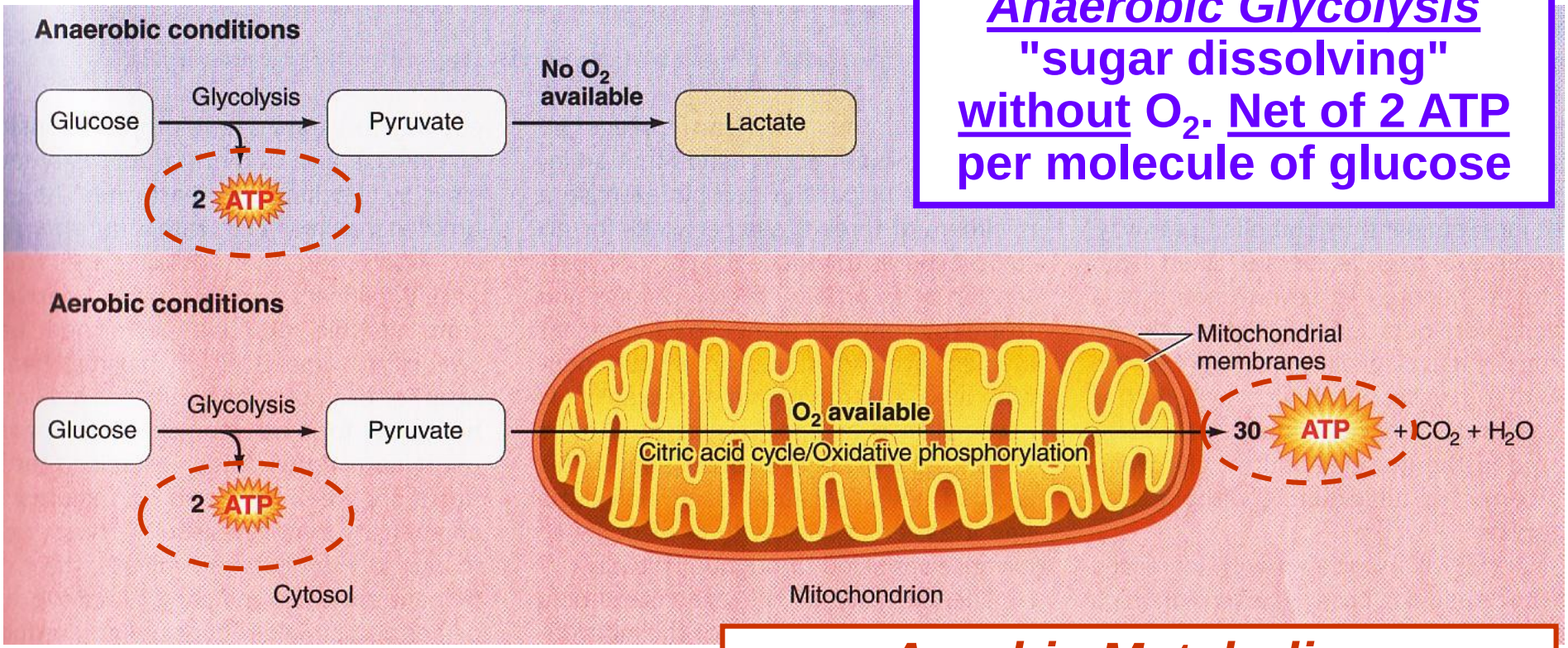
# *Cleave One High Energy Phosphate Bond To Do Work!!*

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!

# *Anaerobic vs. Aerobic Metabolism*

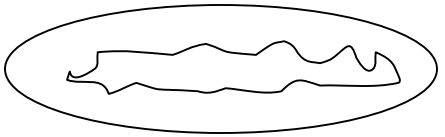



***Anaerobic Glycolysis***
**"sugar dissolving" without $O_2$. Net of 2 ATP per molecule of glucose**

***Aerobic Metabolism***
**+mitochondrial processing of glucose with $O_2$. Net of 32 ATP per molecule of glucose**

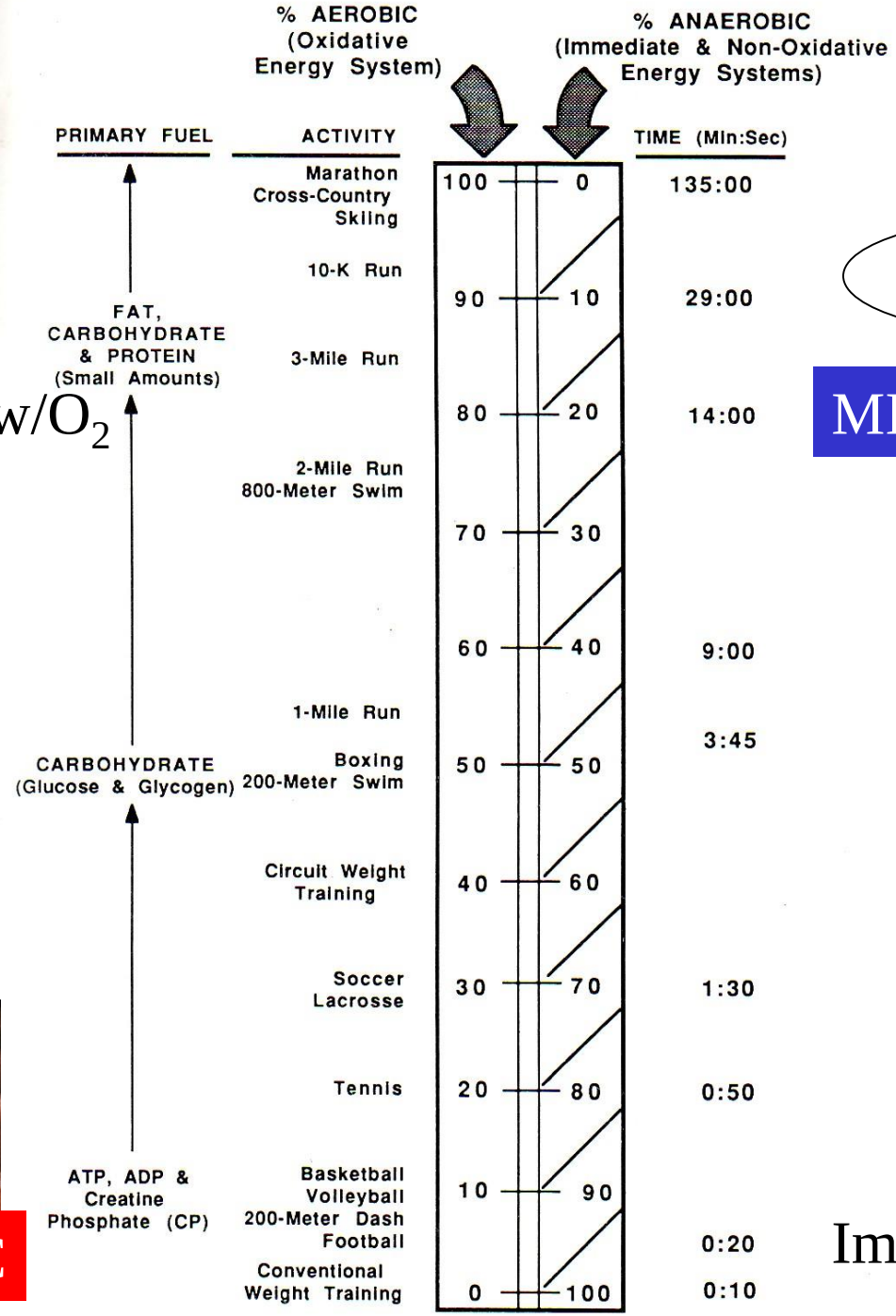
**fig 2-15 LS 2012**

AEROBIC w/$O_2$



MITOCHONDRIA

ANAEROBIC




CYTOSOL

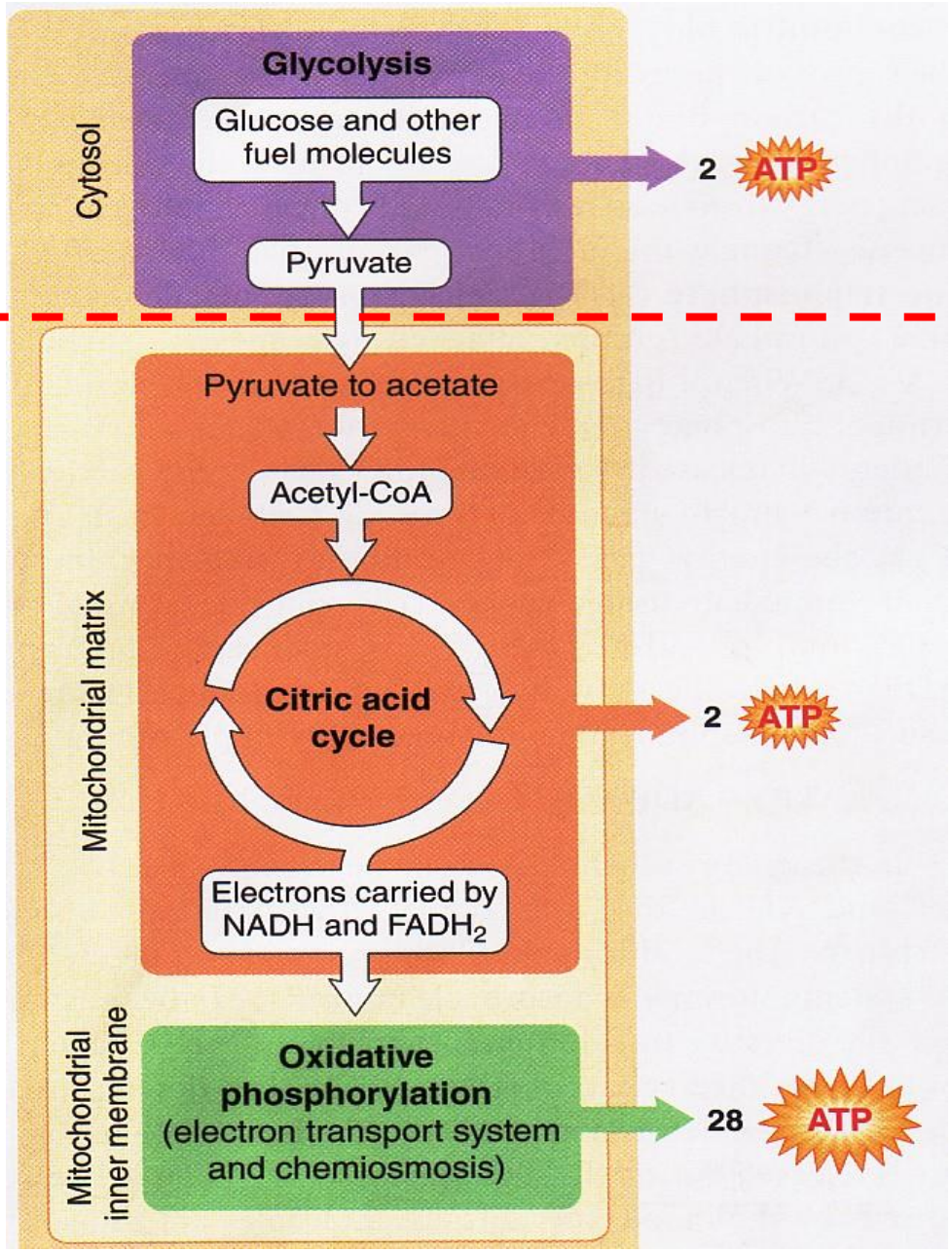
Glycolysis

Immediate/ATP-PC

# *Stages of Cellular Metabolism/Respiration*

**<u>Anaerobic</u>**
**Glycolysis**
**Cytosol**

**<u>Aerobic</u>**
**Metabolism**
**Mitochondria**




**Matrix**

**Inner Membrane**

**fig 2-9 LS 2012**

# *Glycolysis* "sugar dissolving/splitting" produces small amounts of ATP

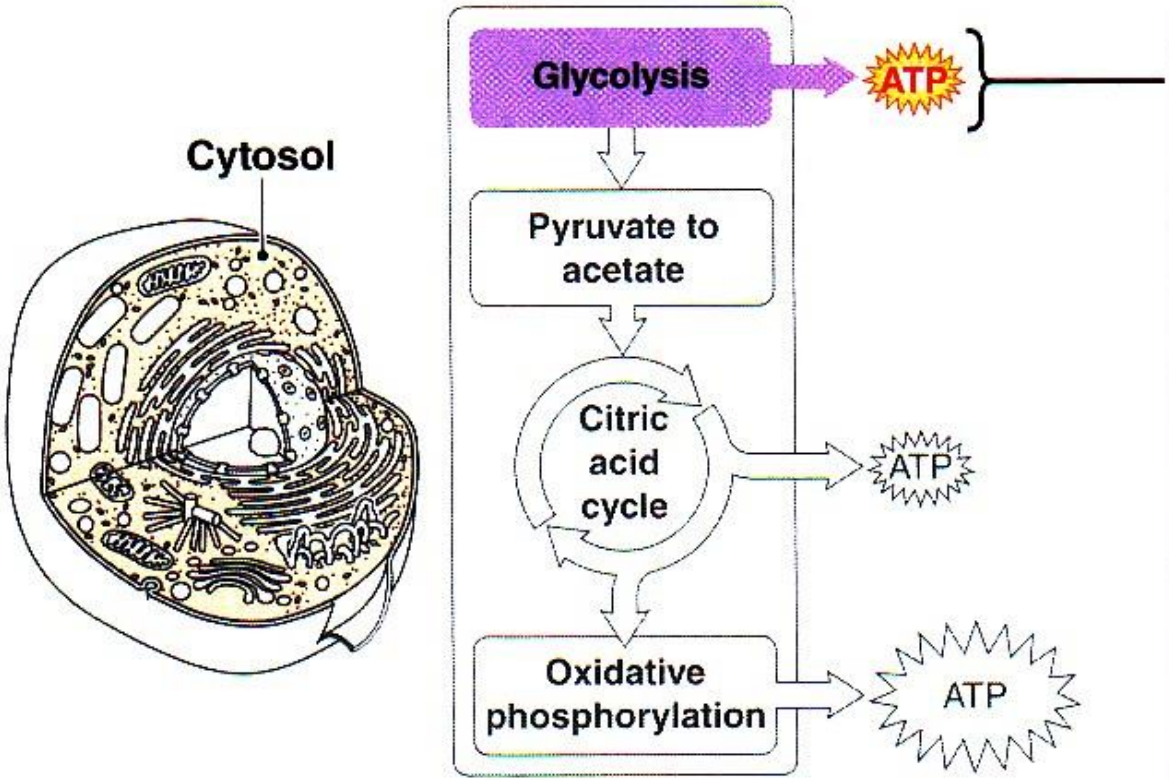



fig 2-10 LS 2012

# *Citric Acid Cycle* produces pairs of electrons for cashing in at the nearby electron transport chain (ETC)

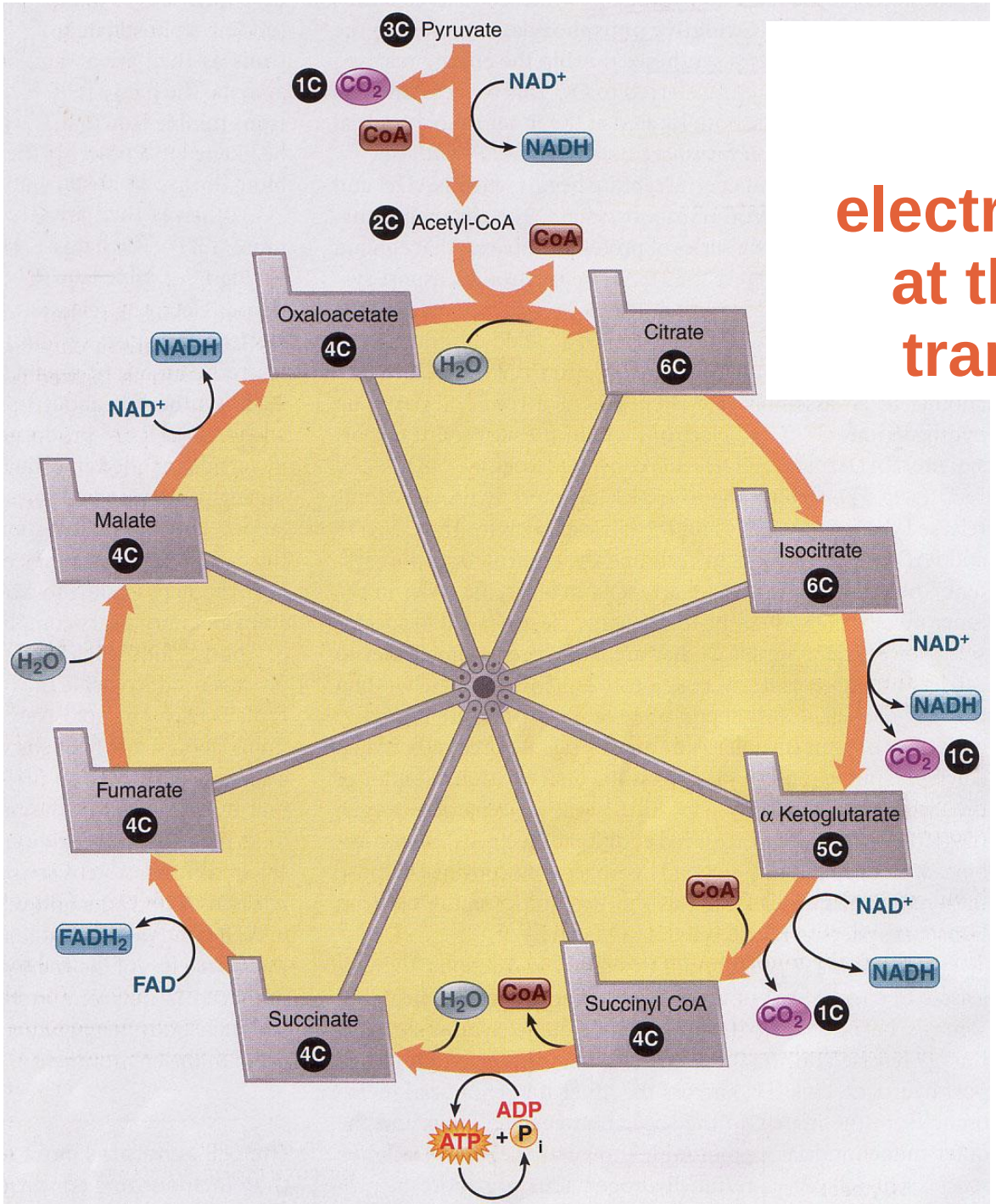



fig 2-11 LS 2012
+ David Oganesyan
http://pixdaus.com

# *Cashing in electrons at the Electron Transport Chain (ETC) produces an abundance of ATP energy molecules!*

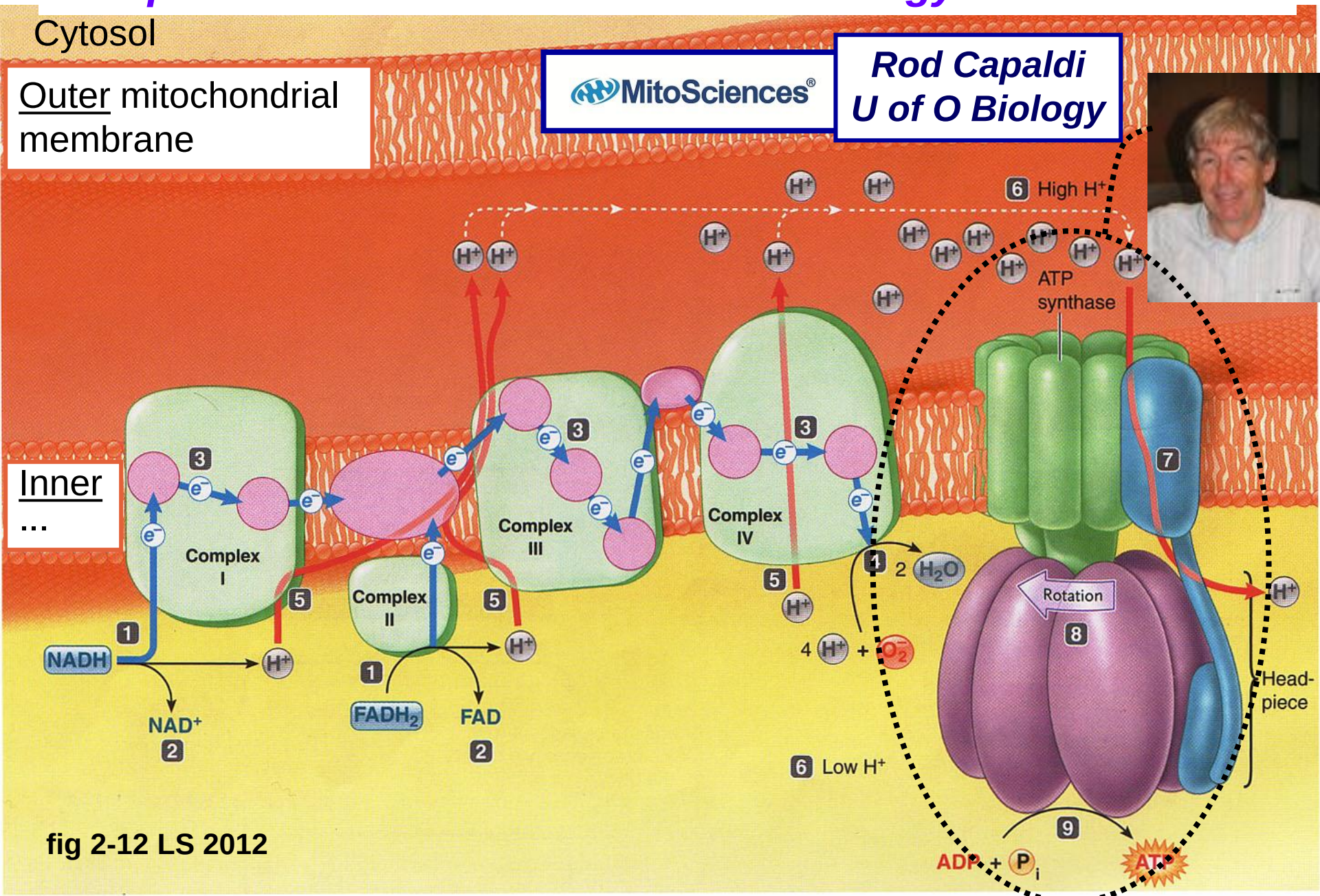
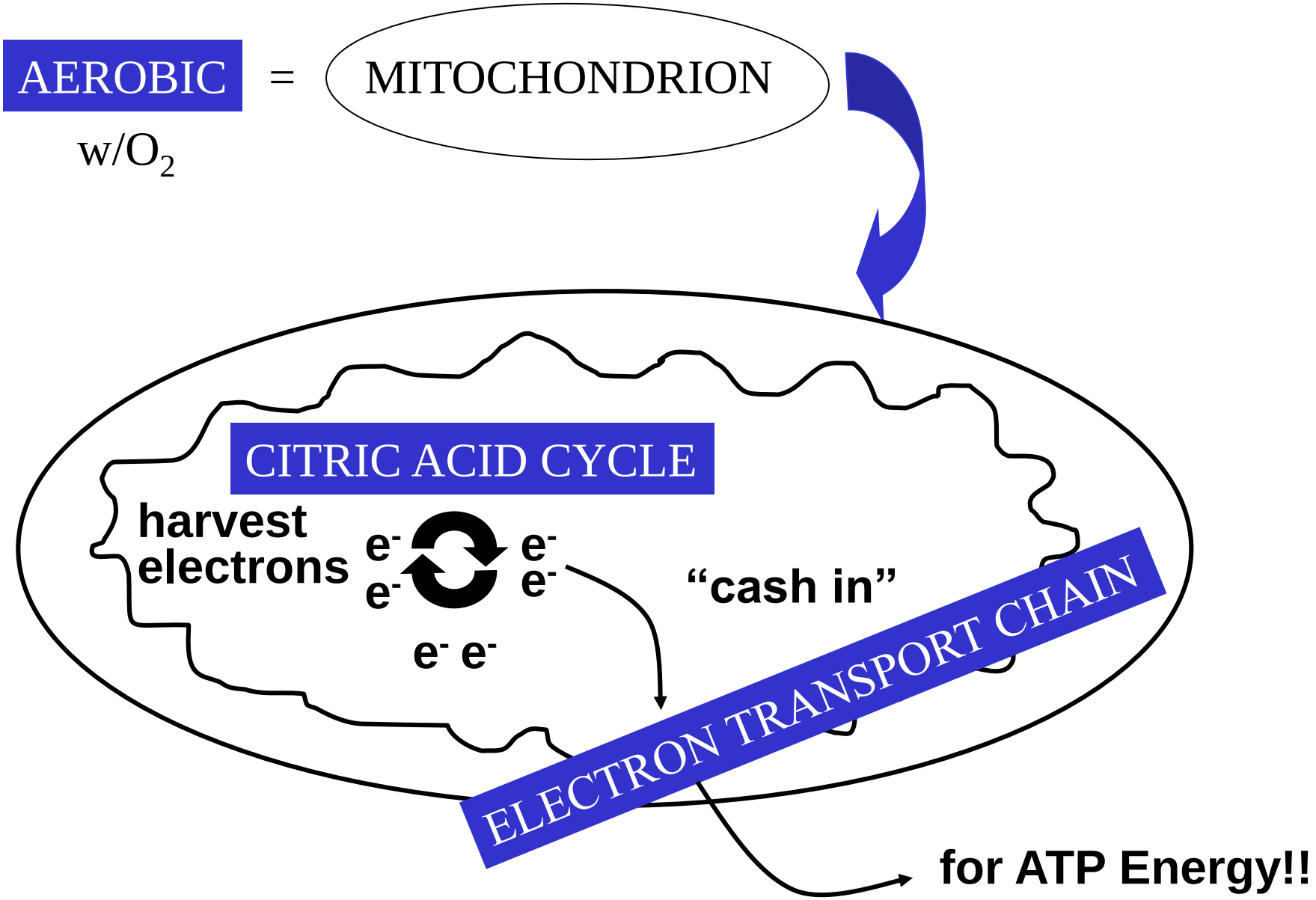
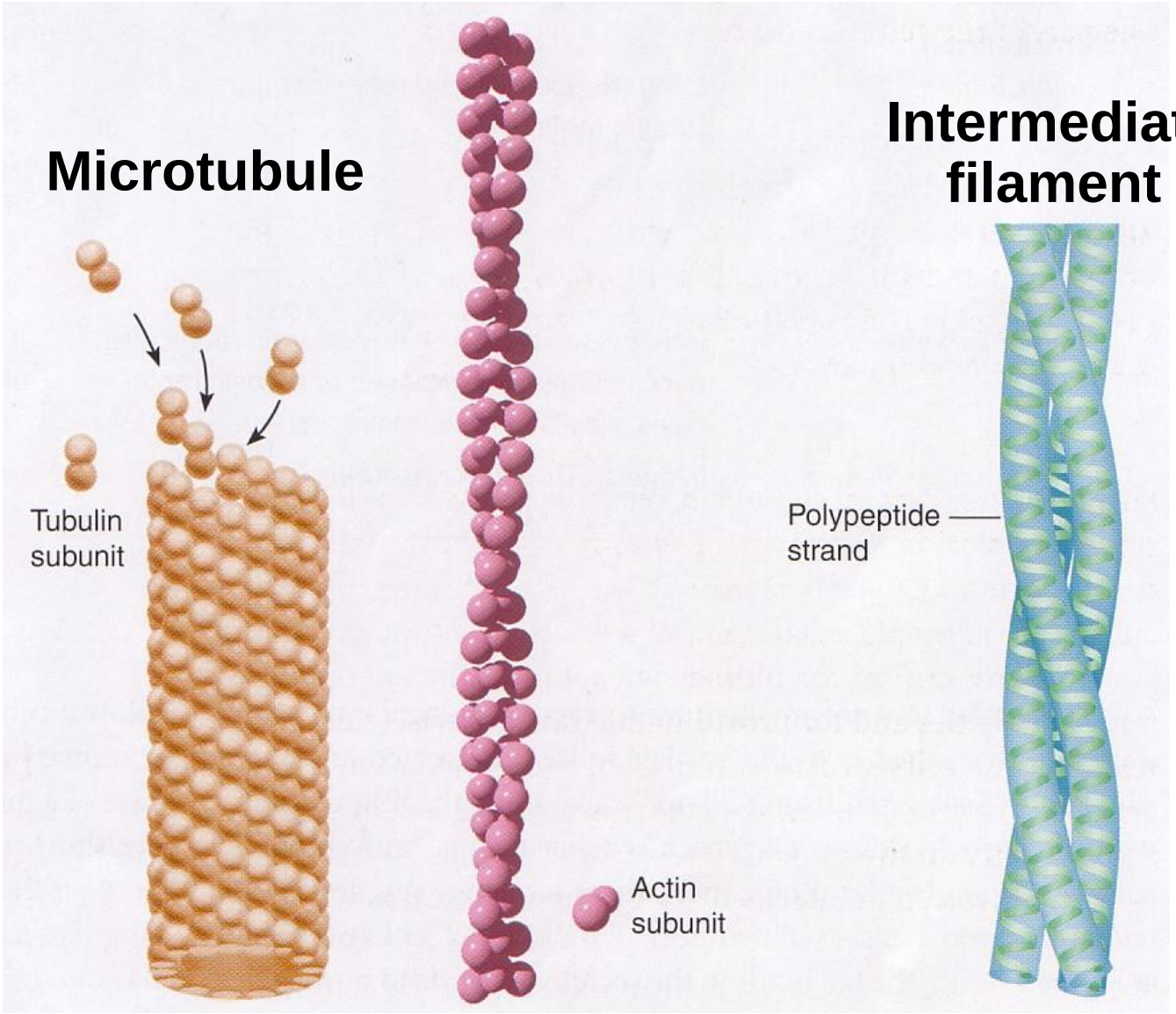



fig 2-12 LS 2012

# Goals of Aerobic Metabolism

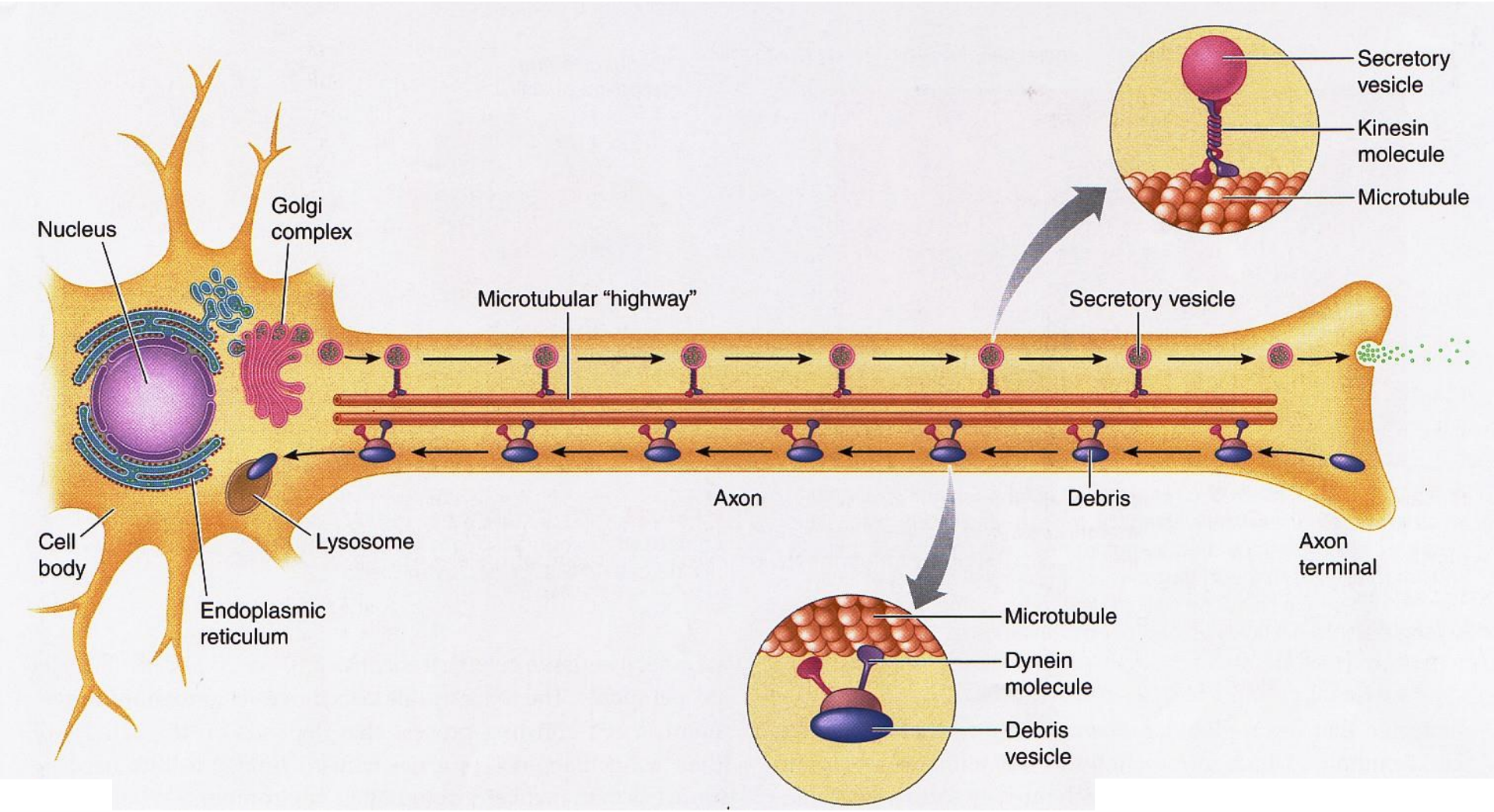


# *Cytoskeleton: Cell "Bone & Muscle"*



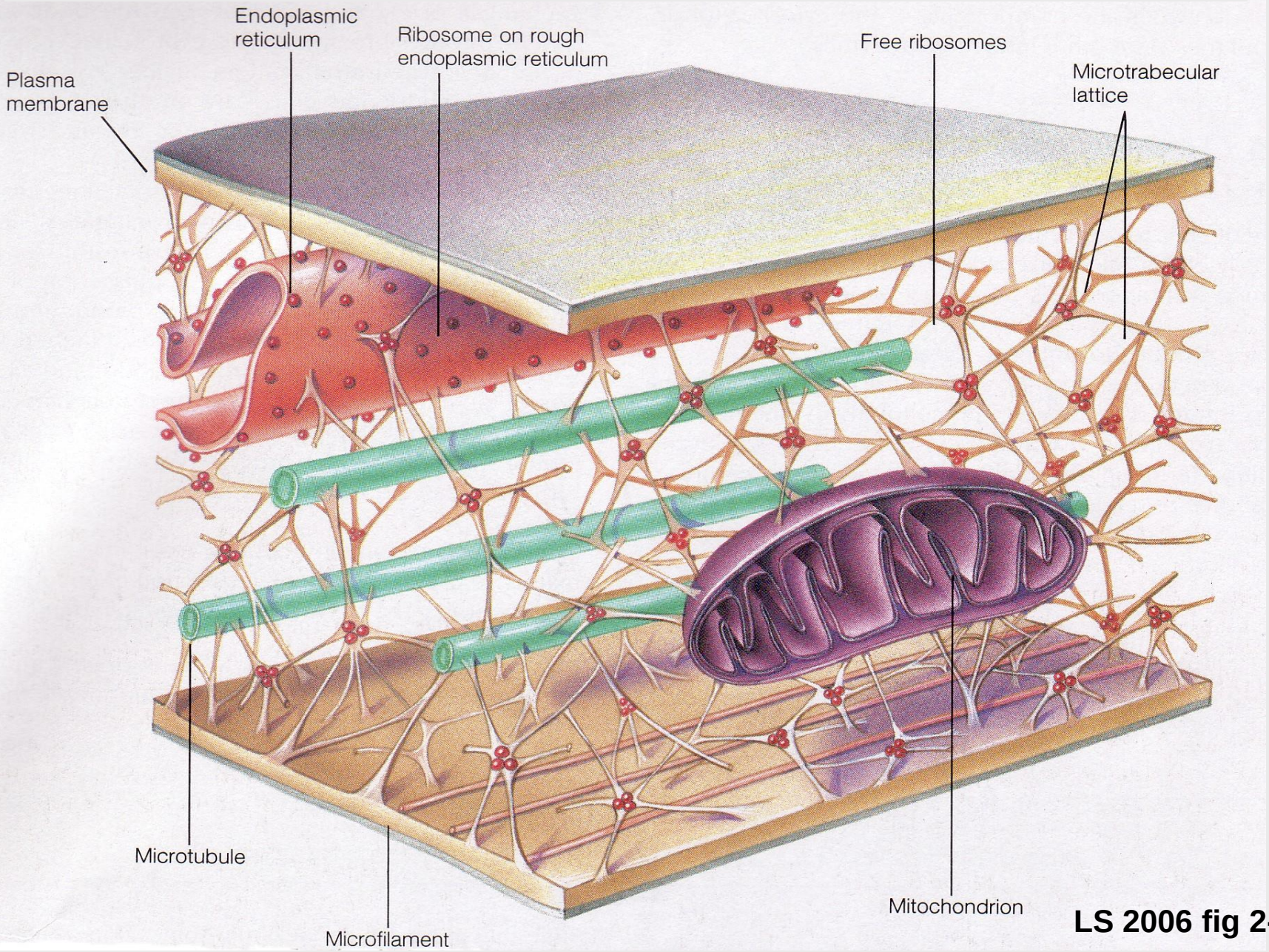

LS 2012 fig 2-17

# Microtubular Highway!!



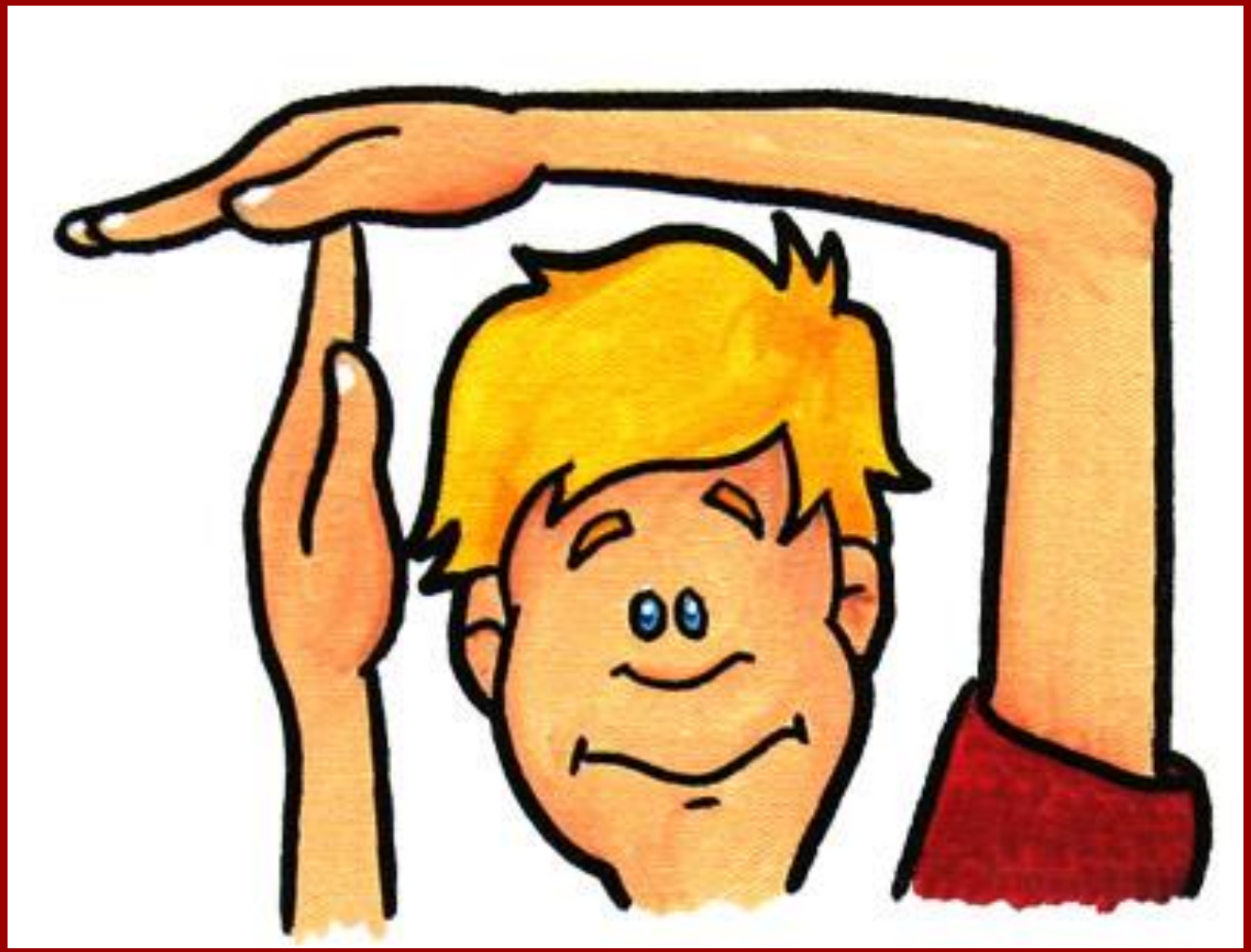

LS 2012 fig 2-18

# 4th Component: Microtrabecular Lattice?



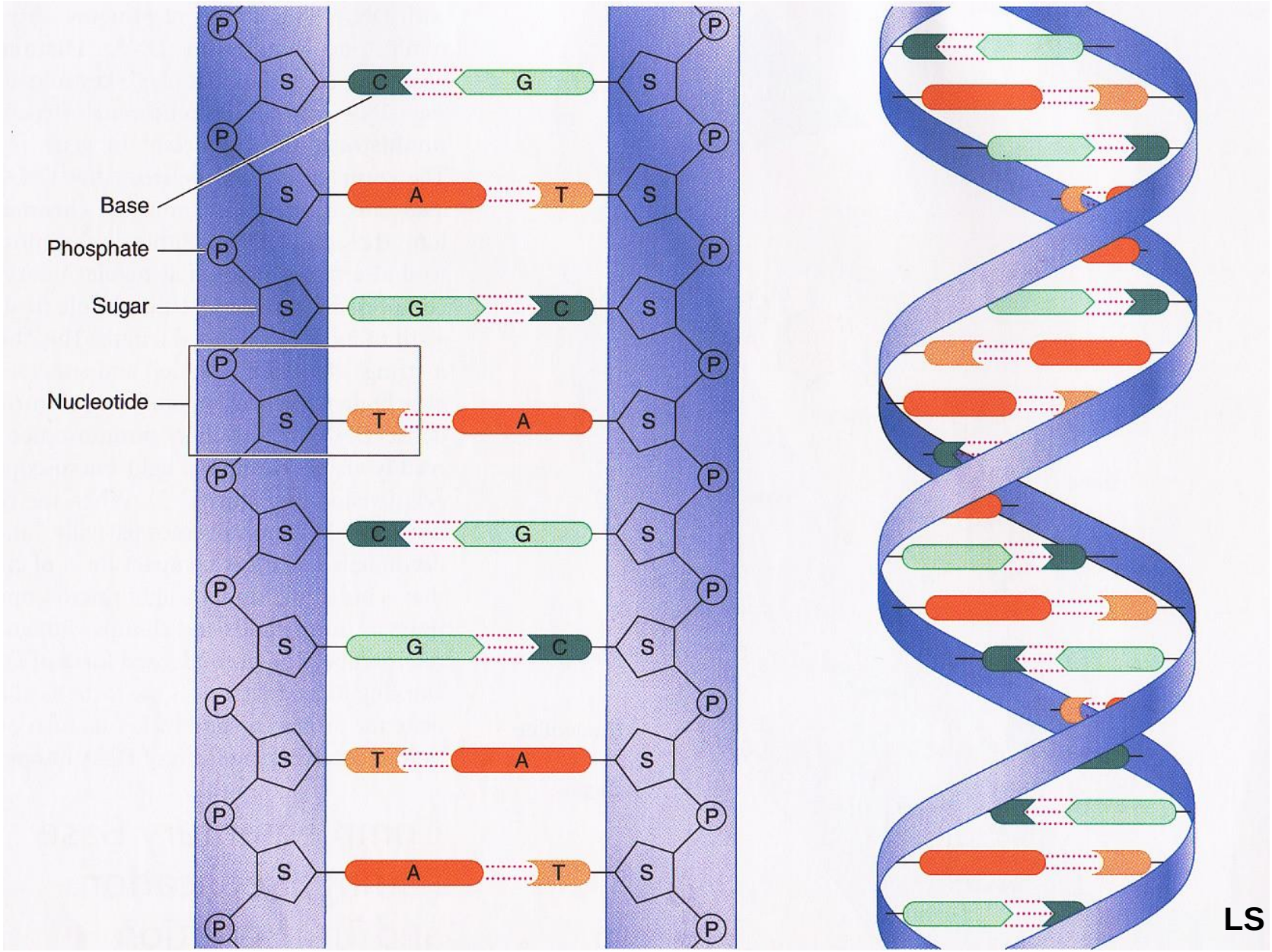

LS 2006 fig 2-20

# *Time-out for questions!*



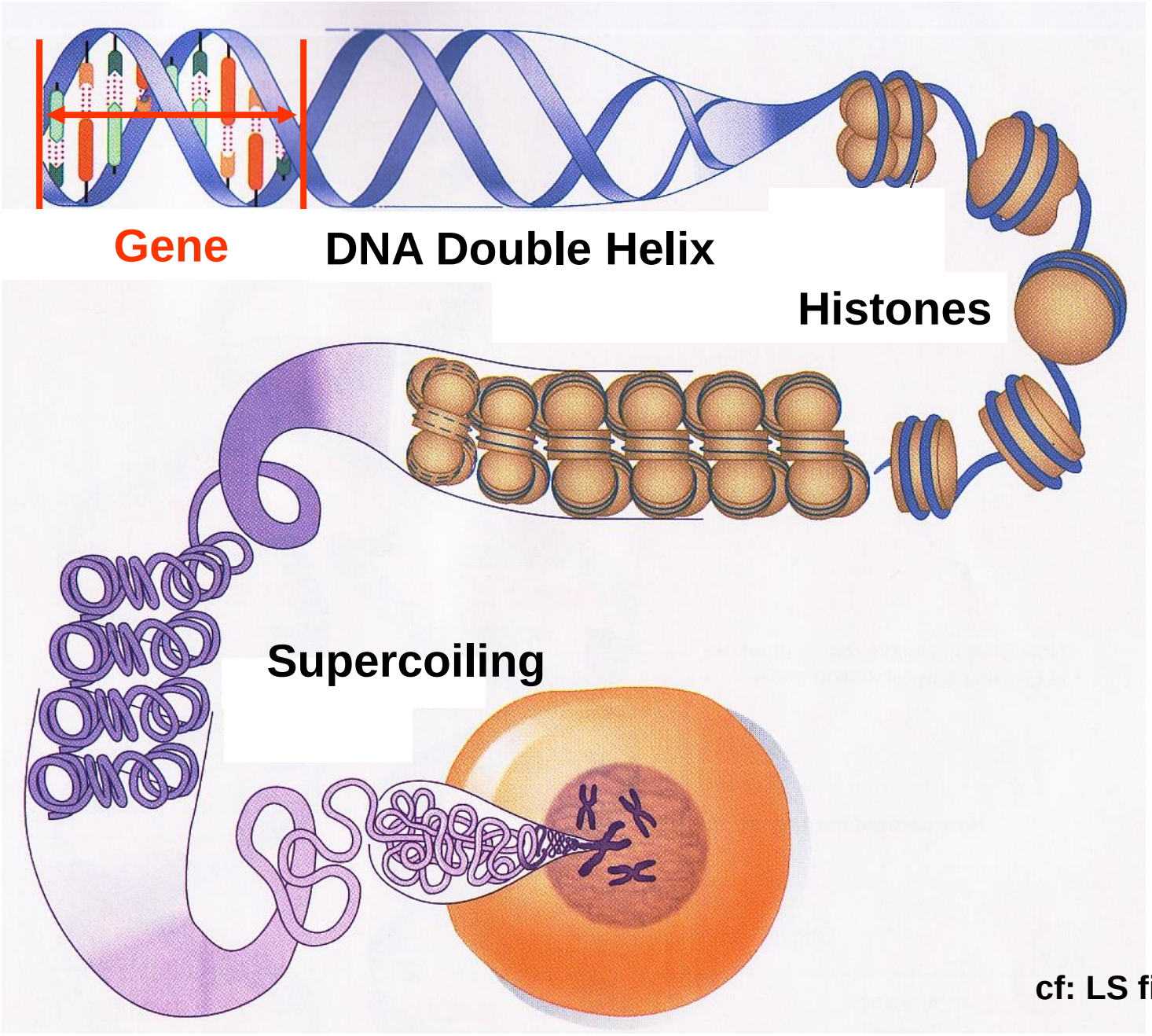
# What are DNA's major functions?
# Heredity + Day-to-Day Cell Function

# What does DNA look like? Double-helix!!



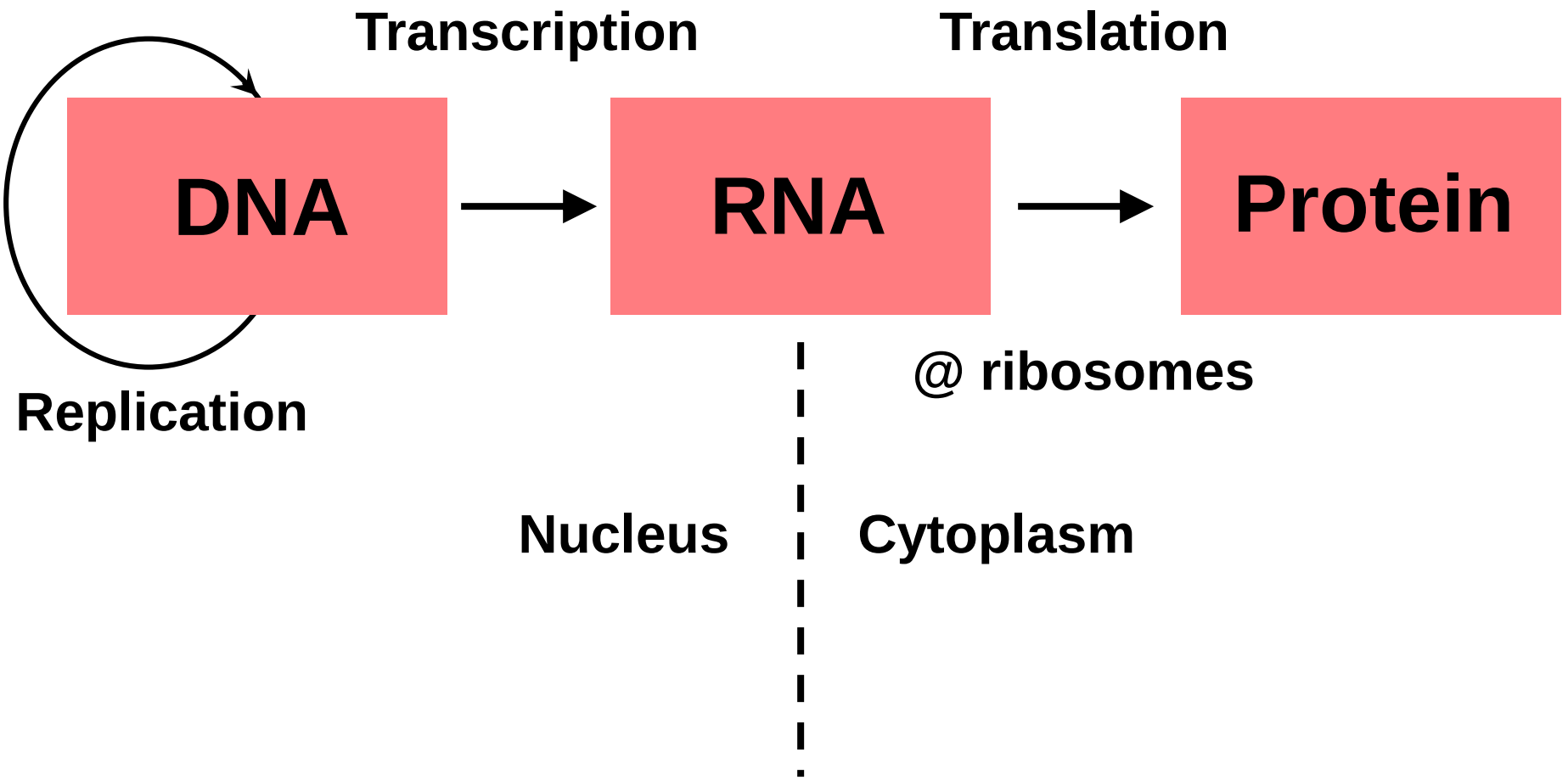

LS fig C-2

# Gene = *Stretch of DNA that codes for a protein*




cf: LS fig C-3

# *What does DNA do, day-to-day?*




cf: LS fig C-6

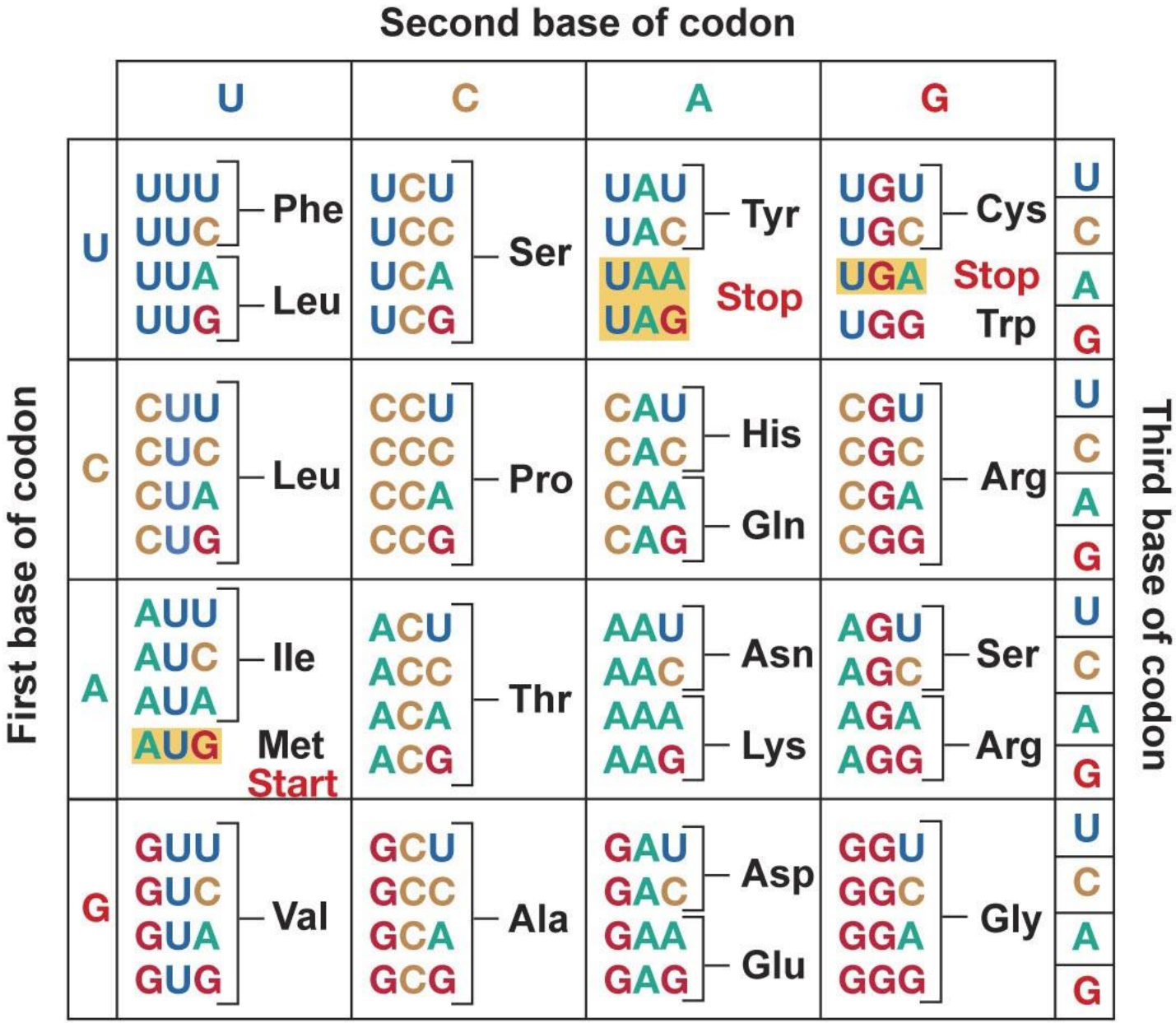
# DNA vs *RNA*?

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. $1^0$ Cytoplasm (but Nucleus origin)
6. mRNA, rRNA, tRNA

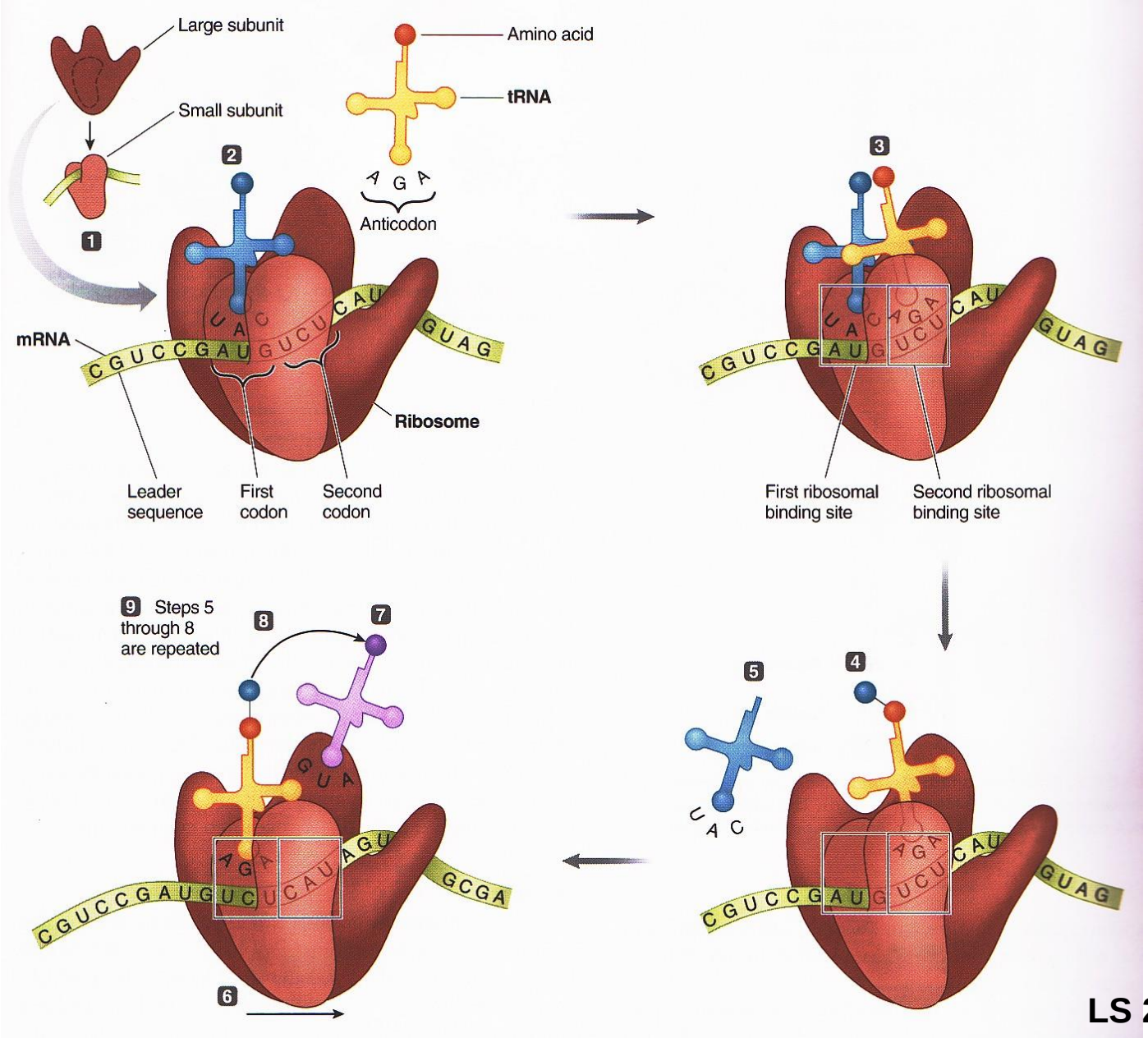
# *Triplets of bases code for amino acids, the building blocks of proteins*

| DNA | mRNA | tRNA |
|---|---|---|
| code word | codon | anti-codon |
| TAT | AUA | UAU |
| ACG | UGC | ACG |
| TTT | AAA | UUU |
| TAC | AUG | UAC |



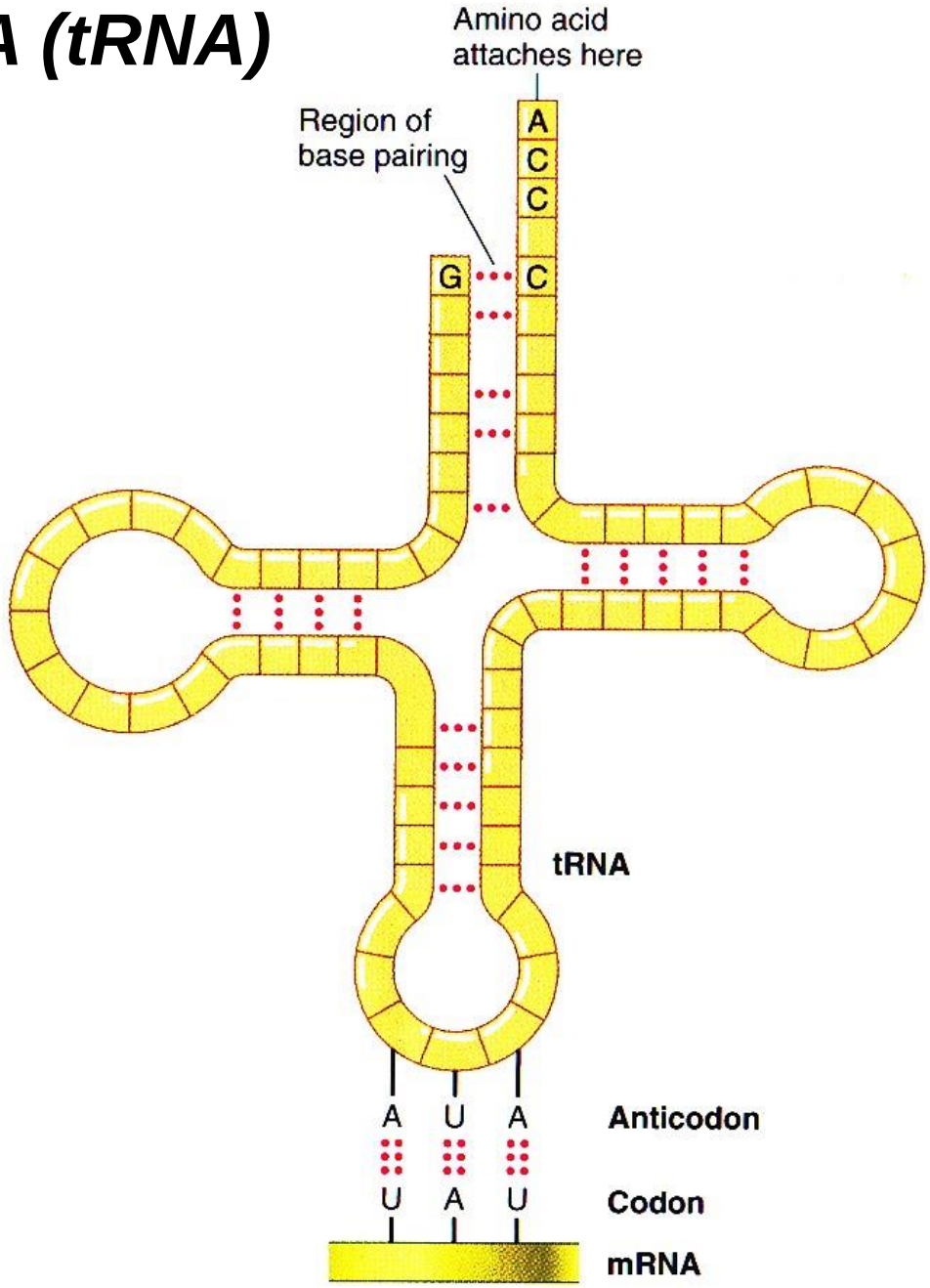

D. Silverthorn, *Physiology: An Integrated Approach.* San Francisco: Pearson Education, 2010.

# Translation? Ribosomes Make Proteins



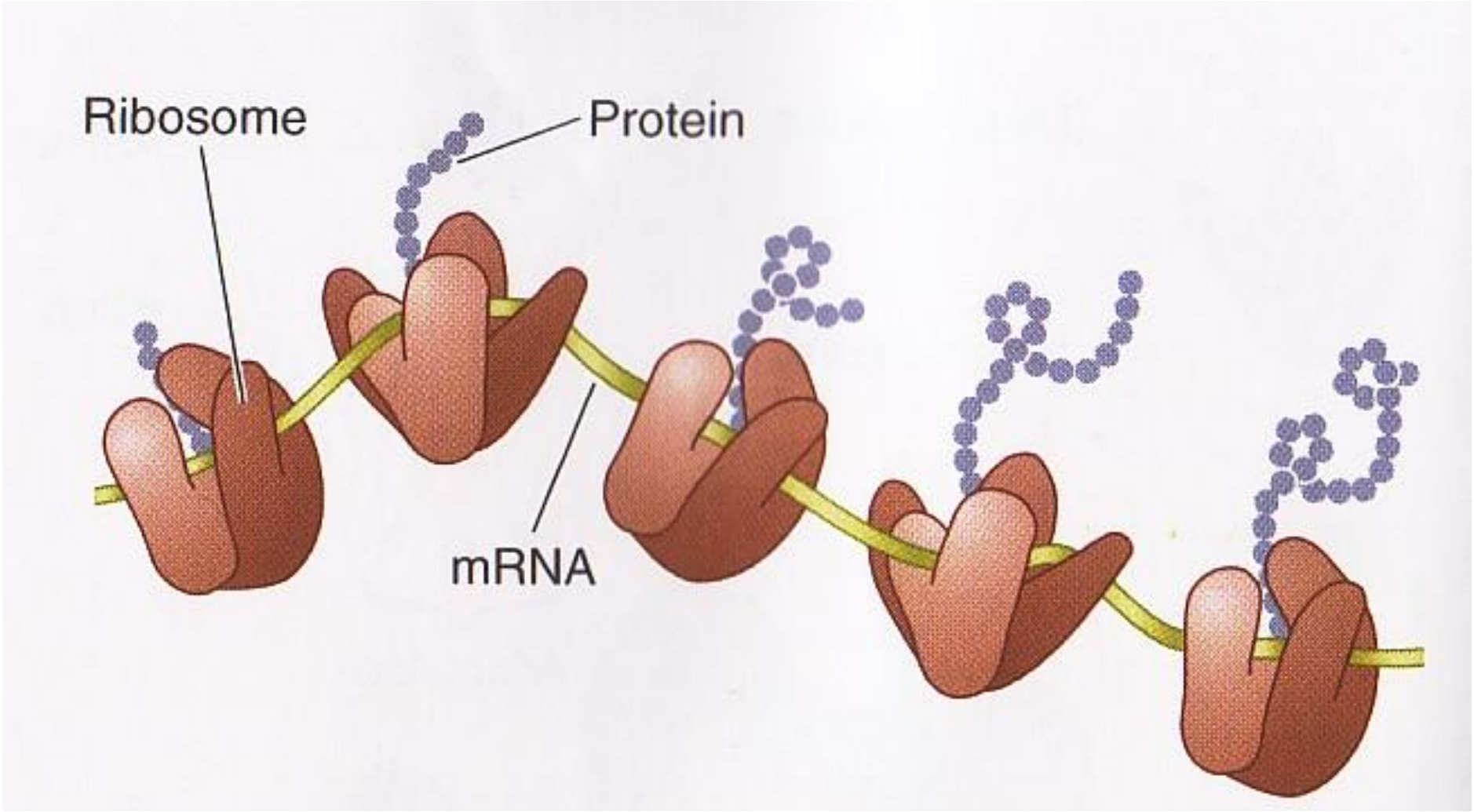

LS 2012 fig C-7

# *Transfer RNA (tRNA)*




**LS fig C-8**

# A Polyribosome. Which Way is Synthesis?




LS fig C-9

# Questions + Discussion