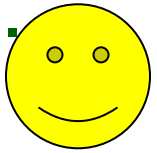
BI 121 Lecture 3 **Anatomy & Physiology Lab tomorrow!...**



I. ***Announcements*** **Q from lecture or lab?**

II. ***Cell Physiology Connections*** **LS ch 2**

- **A. Compartment advantage + Cell survival skills!**
- **B. Organelles ≡ ICF specialty shops: 1. ER– rough & smooth 2. Golgi+ 3. Lysosomes 4. Peroxisomes 5. Mitochondria pp 20-34, fig 2-1 thru 2-8, pp 20-7, tab 2-1 p 36**
- **C. *Physiol News* Moms eggs execute Dad's mitochondria?**
- **D. What about vaults? LS 2006, p 32 + *Science News***

III. ***Anaerobic vs Aerobic Metabolism Summary*** **LS ch 2 pp 26-33**

- **A. Key differences fig 2-15 + vpl**
- **B. Selected details: Glycolysis, CAC, ETC, fig 2-9 thru 2-12**

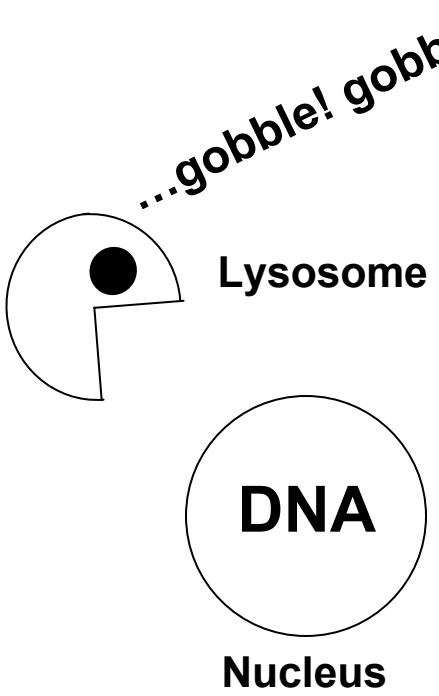
IV. ***Introduction to Genetics*** **LS 2012 ch 2 p 20-1 + Appendix C**

- **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**

Why Compartments? Advantage?

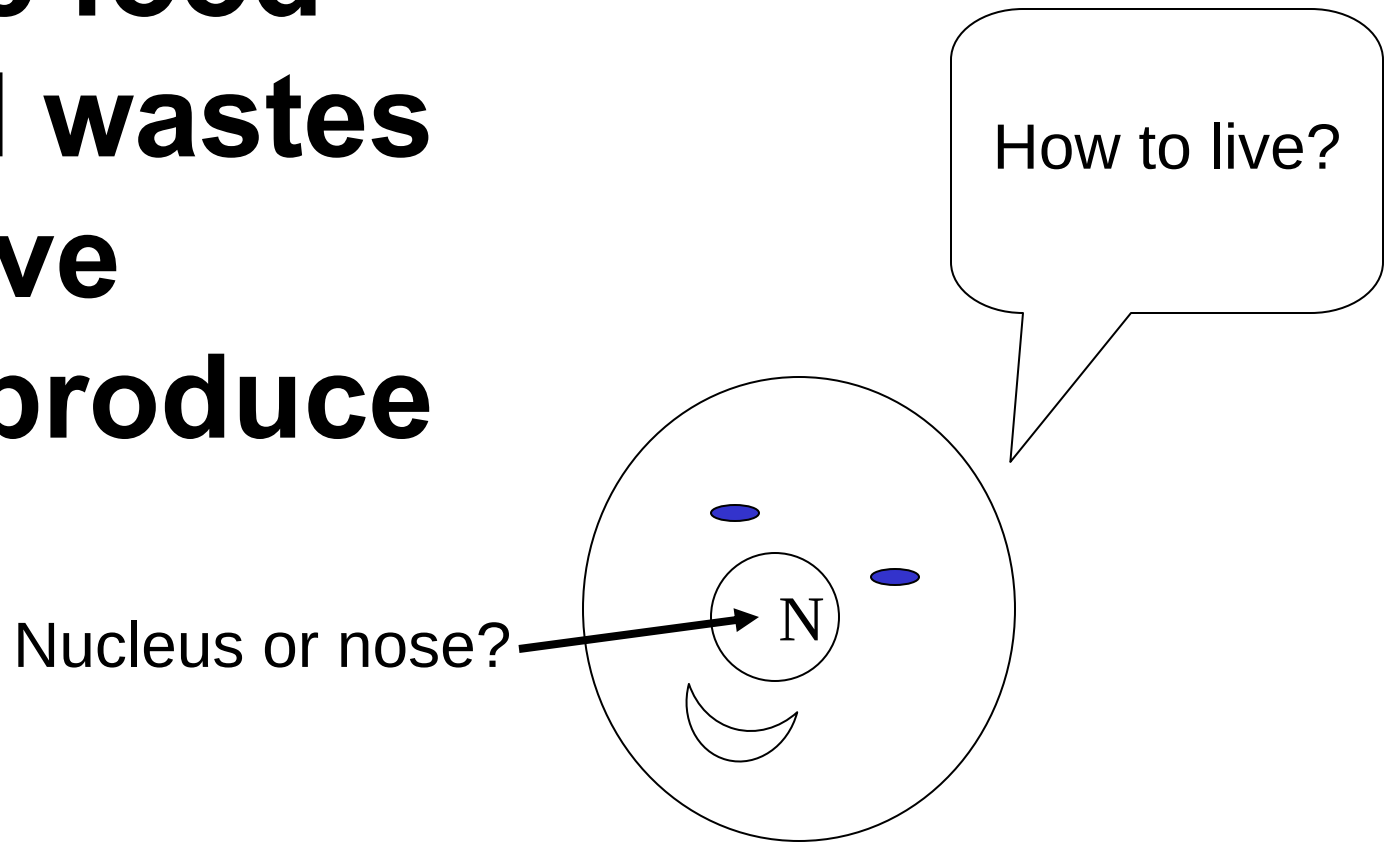
<u>*Incompatible*</u> reactions can take place

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



Basic Cell Survival Skills?

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



1 e.g. Cell of 100 Trillion!

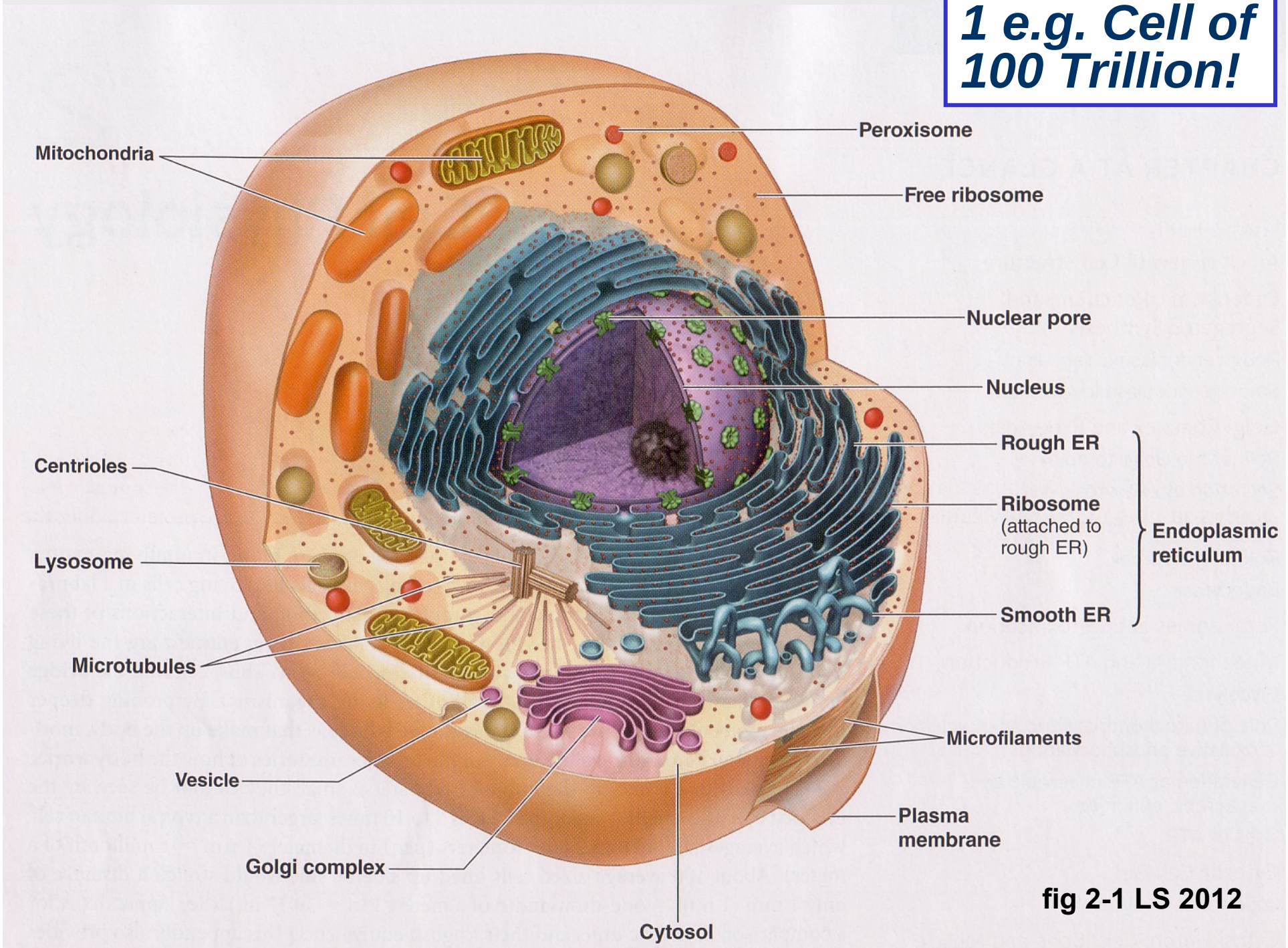
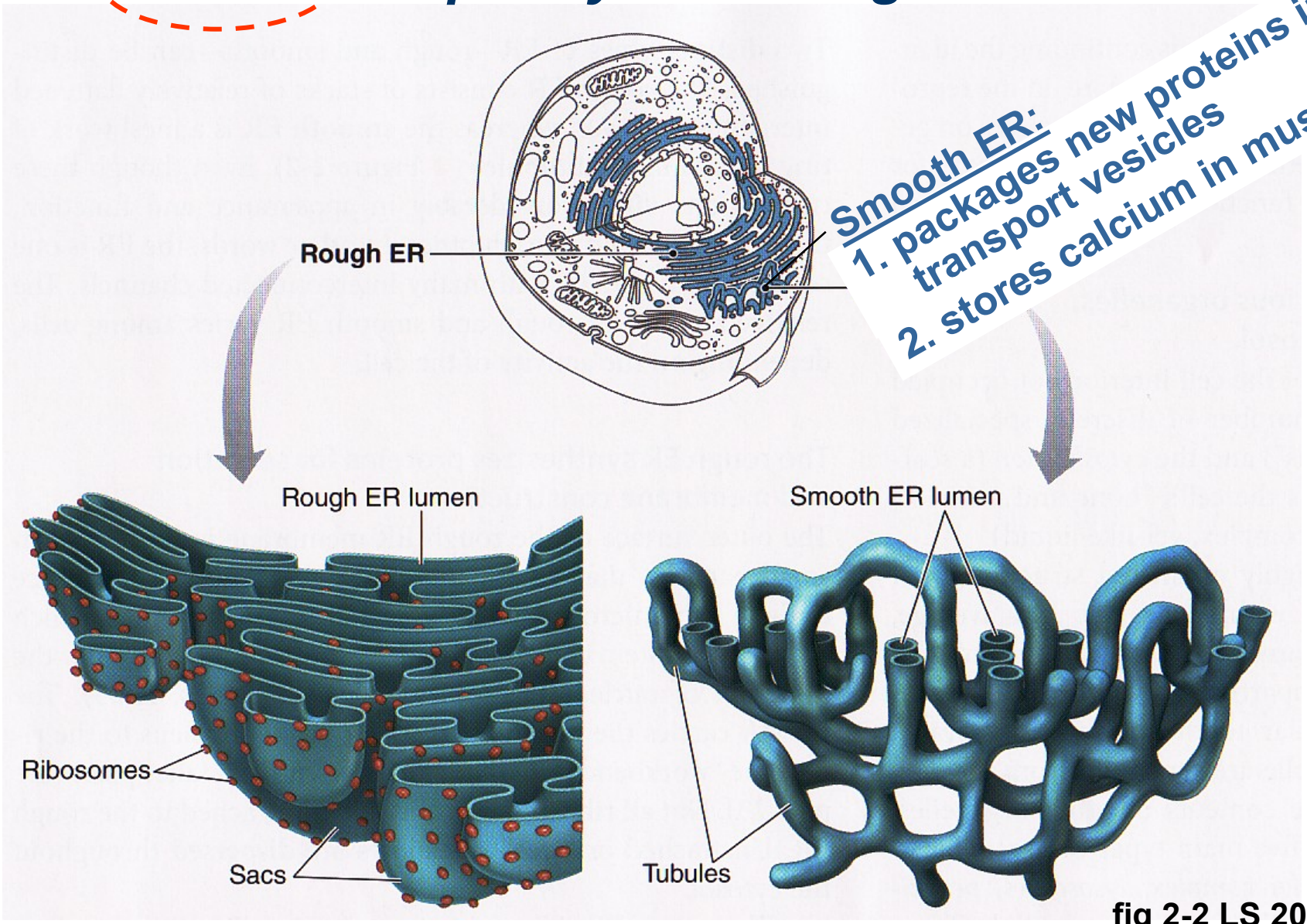


fig 2-1 LS 2012

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

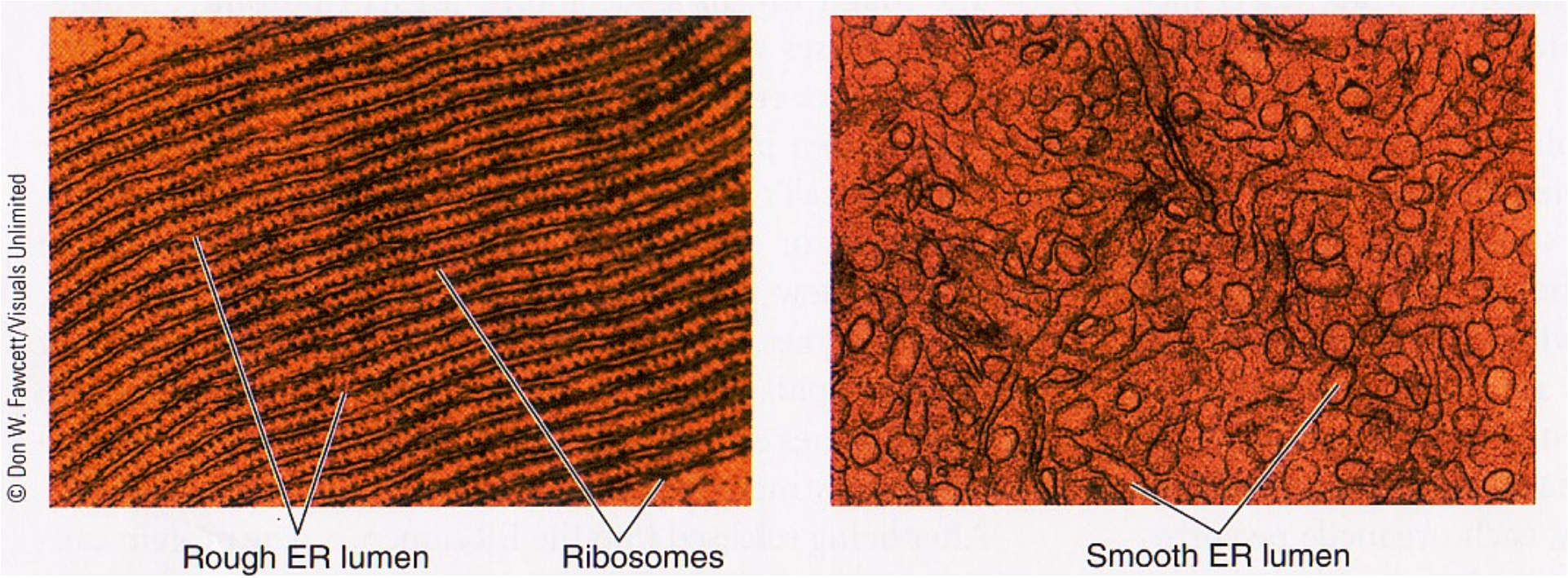


fig 2-2 LS 2012

Secretion of Proteins Produced by ER

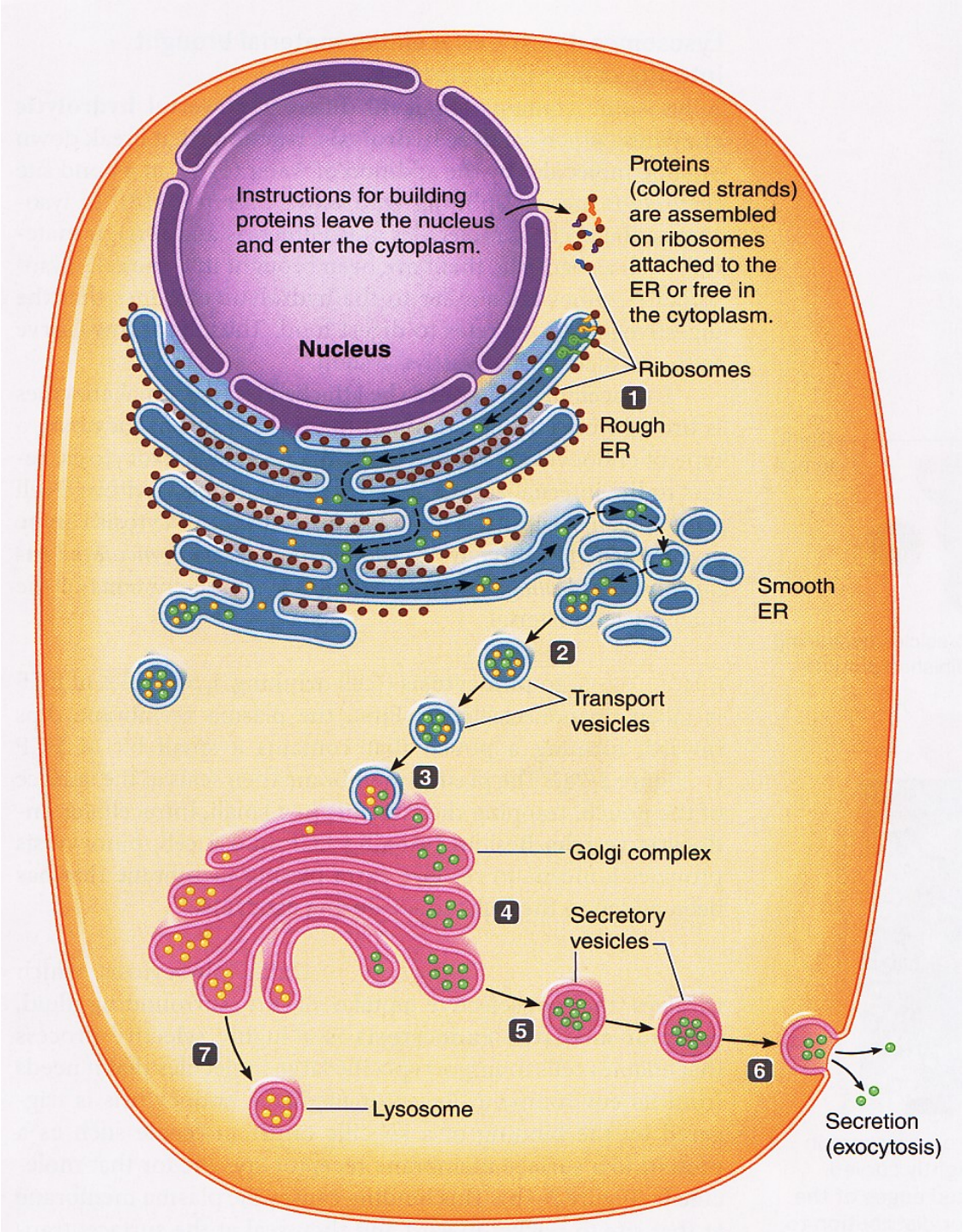


fig 2-3 LS 2012

Golgi Complex: Final Processing, Packaging & Distribution

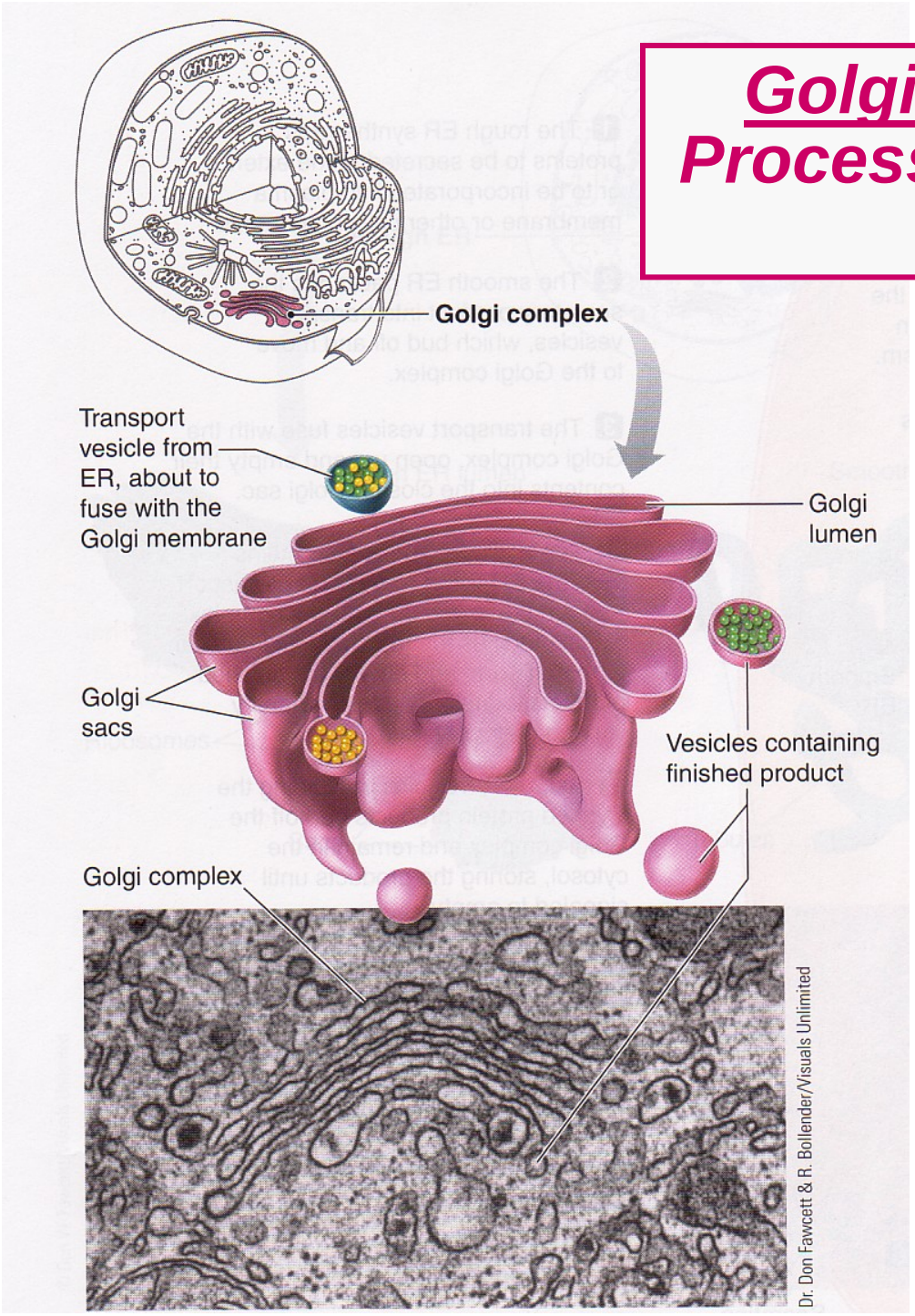
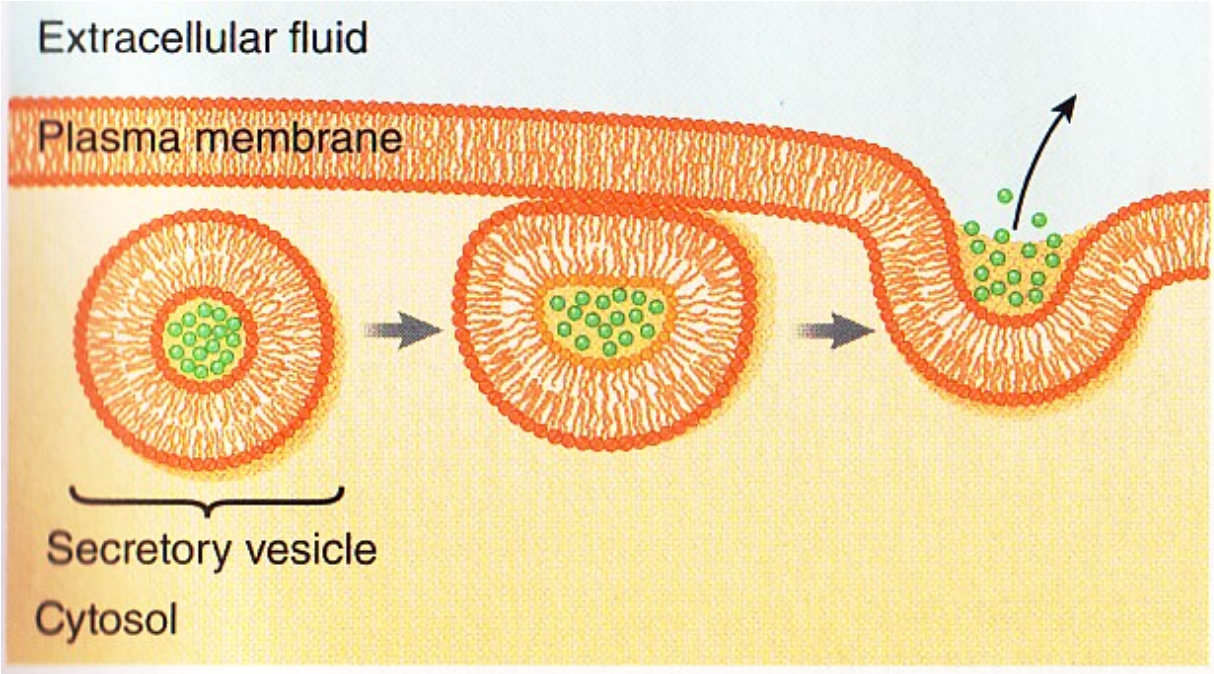


fig 2-4 LS 2012

Exocytosis: Primary Means of Secretion



(a) Dr. Birgit Satir, Albert Einstein College of Medicine

fig 2-5a LS 2012

Endocytosis: Primary Means of Ingestion

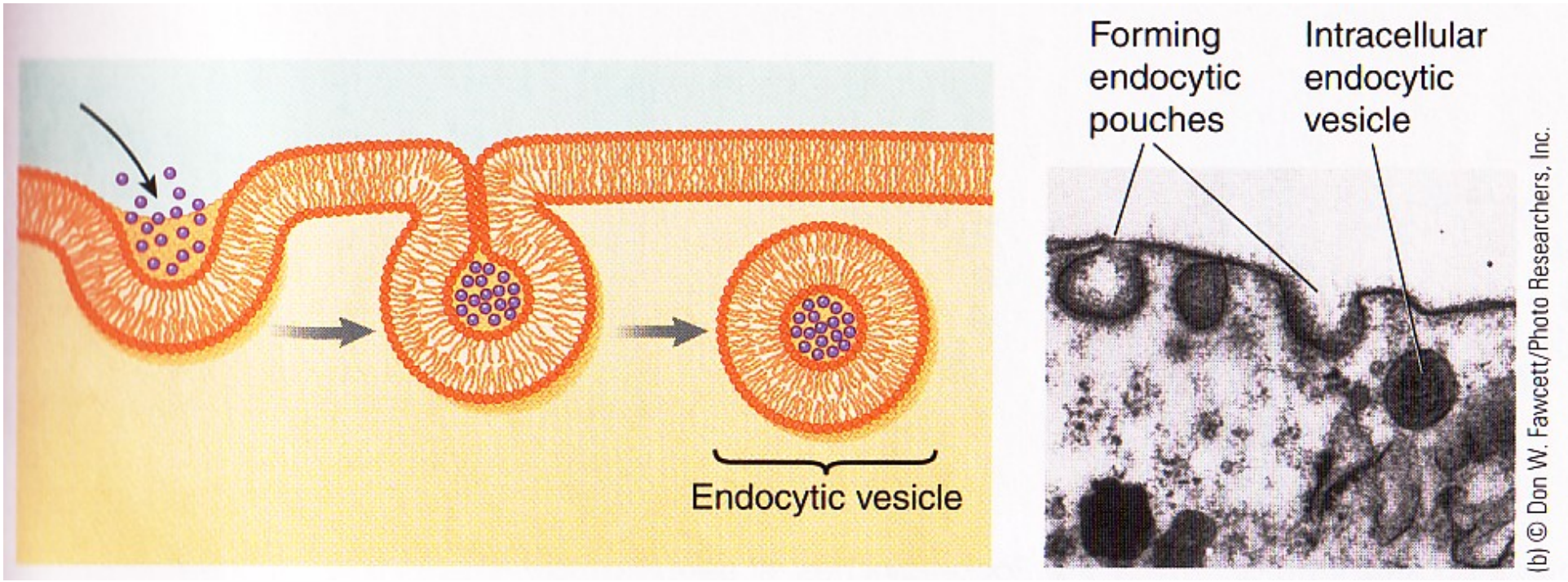


fig 2-5b LS 2012

Lysosomes *vs.* *Peroxisomes*

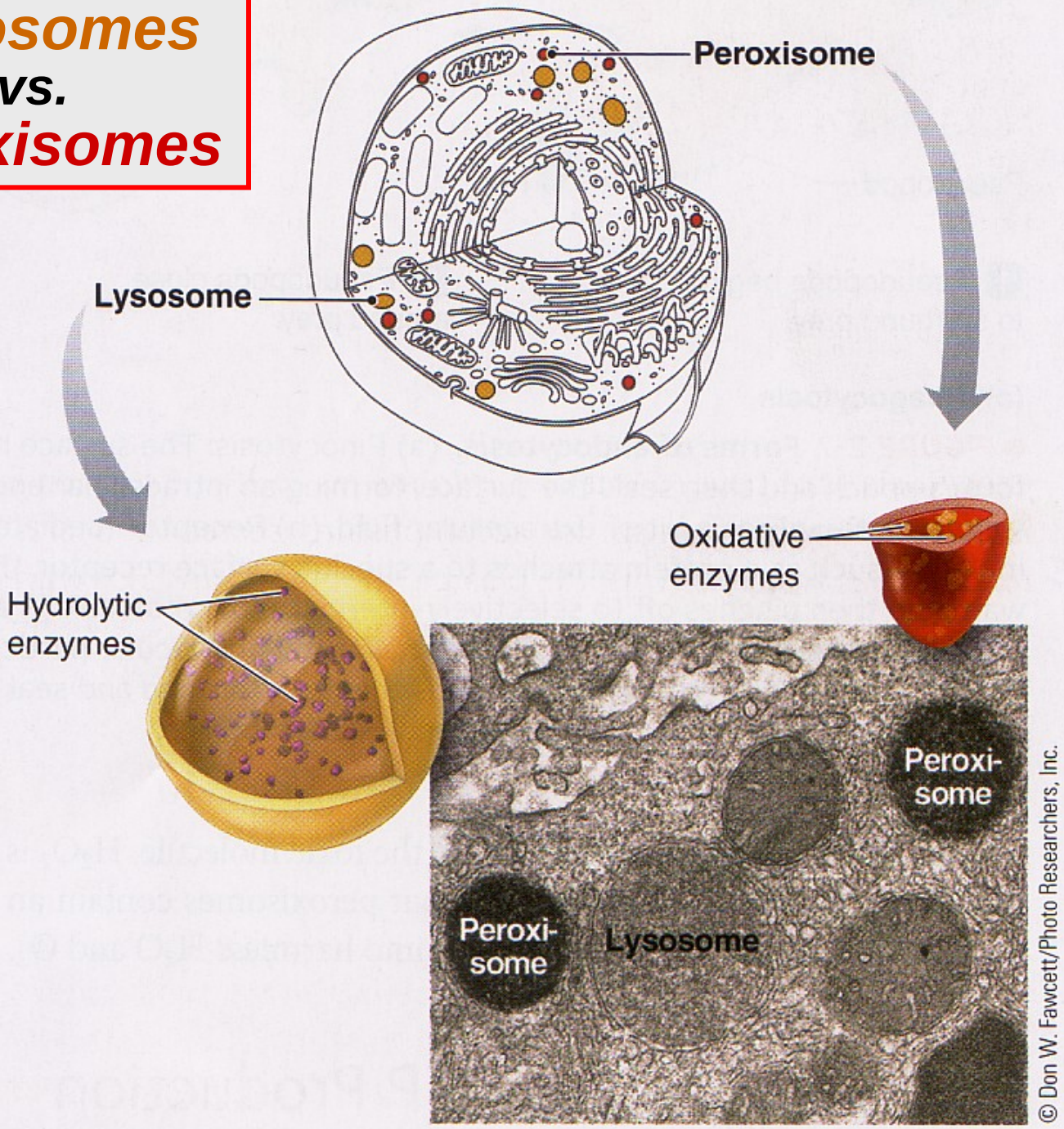


fig 2-6 LS 2012

Phagocytosis: Cell Eating!

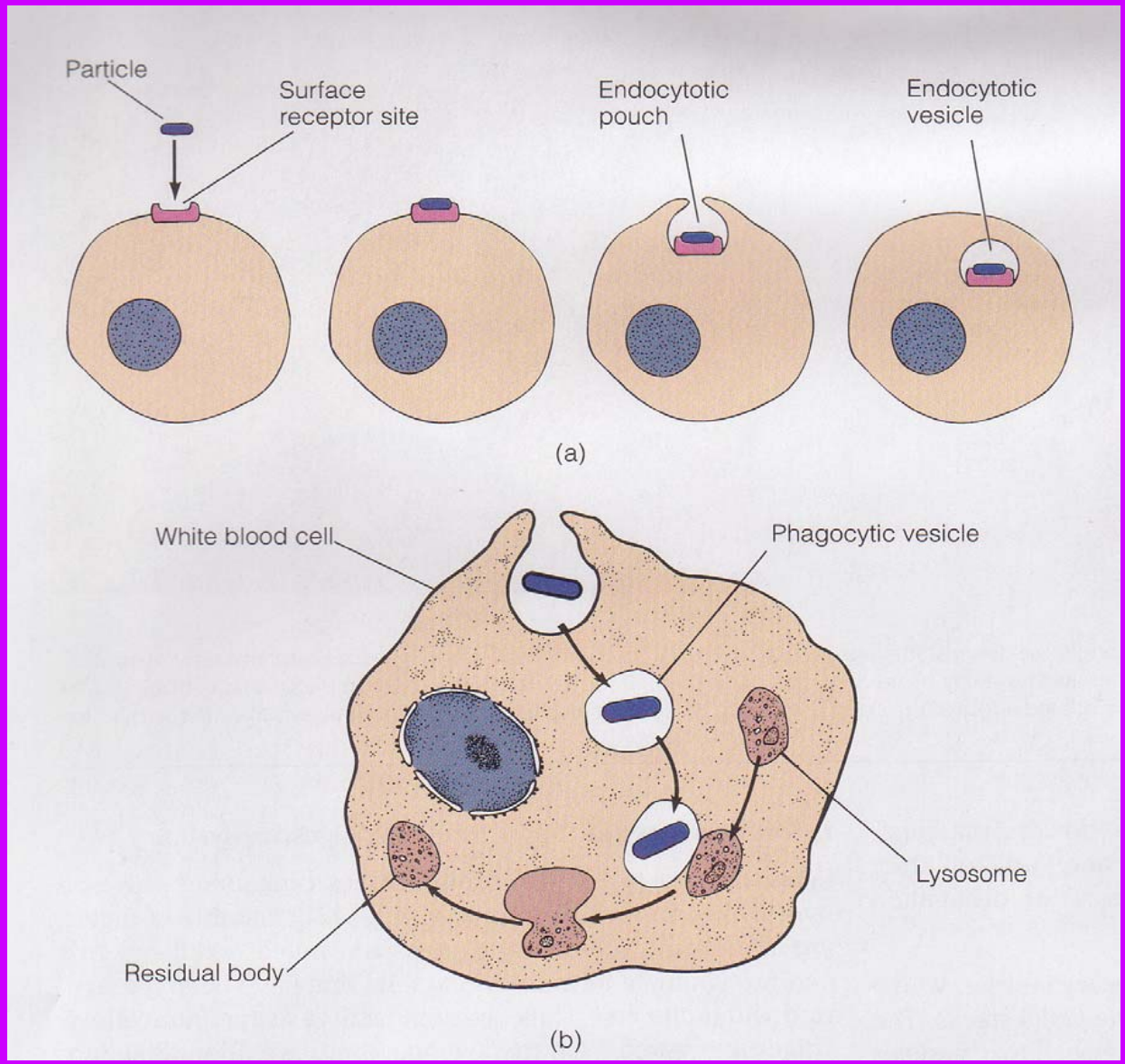
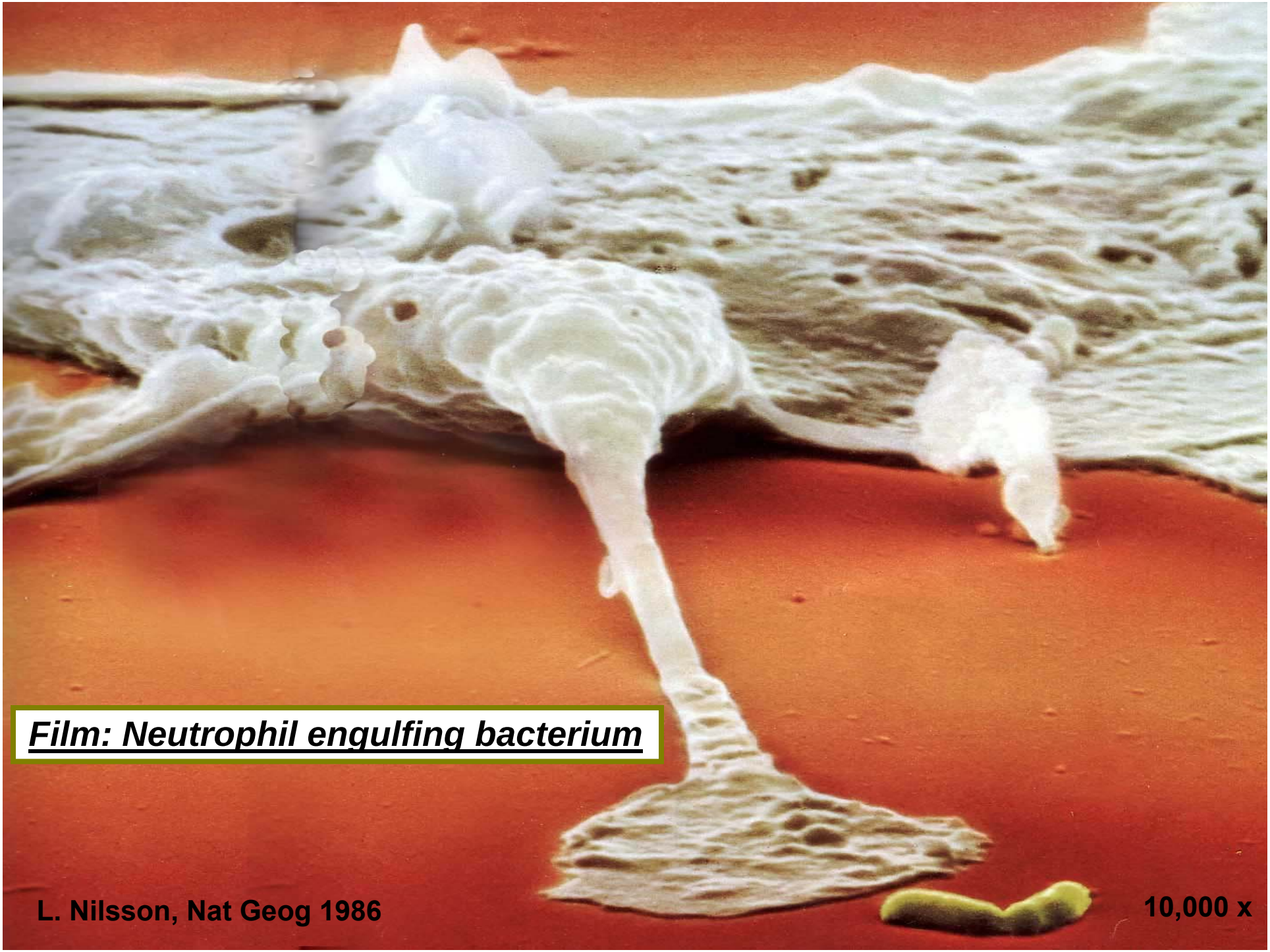
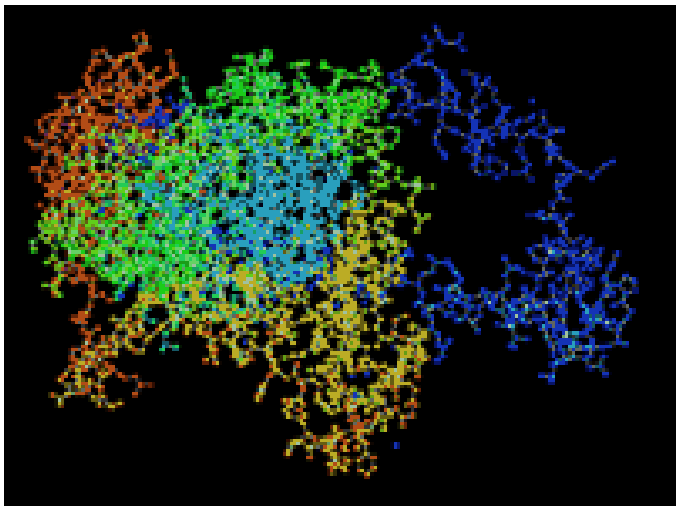


fig 2-7 LS 2006


Film: Neutrophil engulfing bacterium
L. Nilsson, Nat Geog 1986
10,000 x

Catalase Enzyme Reaction in Peroxisomes Neutralize Toxin at Production Site!



Mitochondria: Energy Organelles

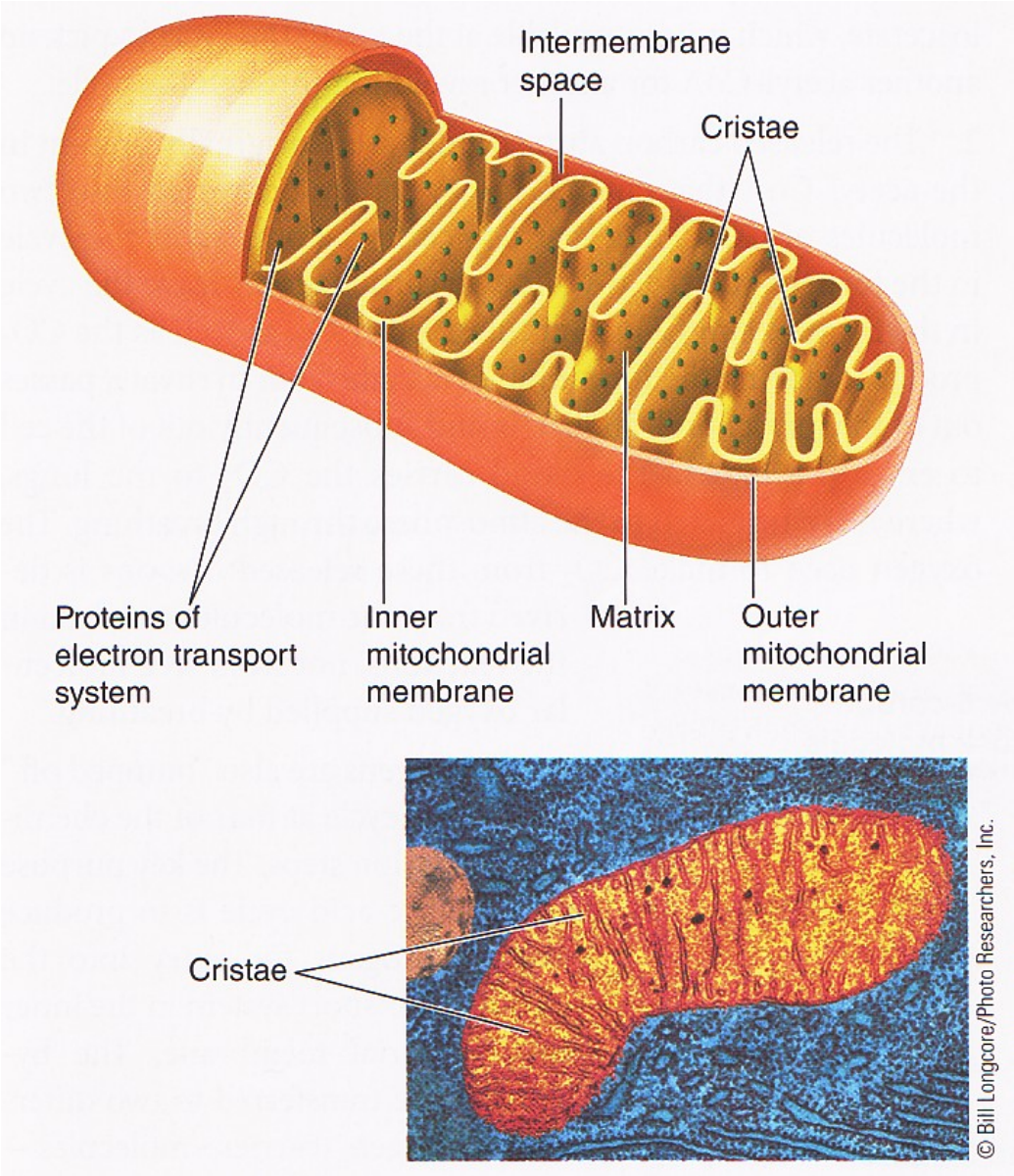
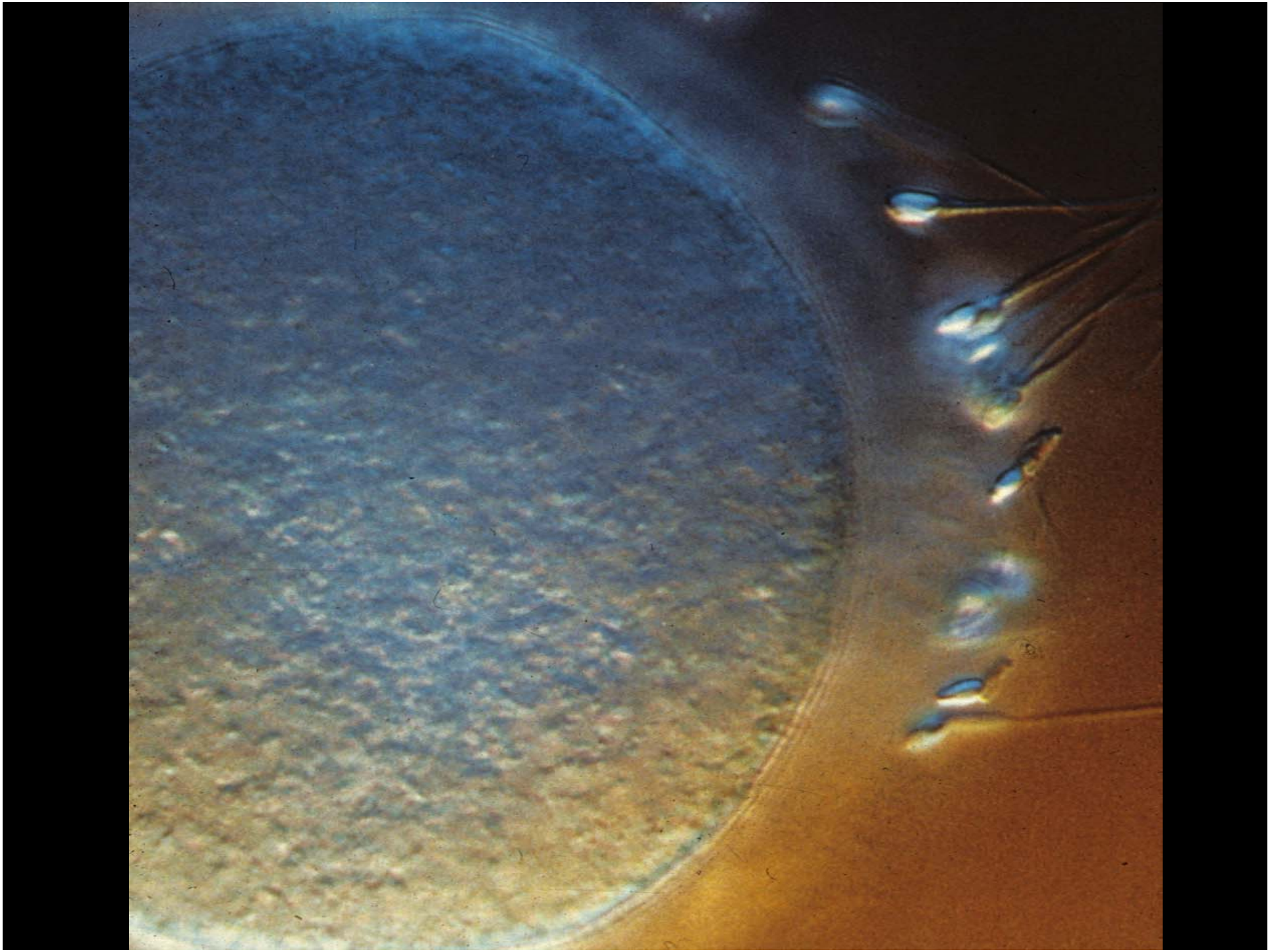


fig 2-8 LS 2012



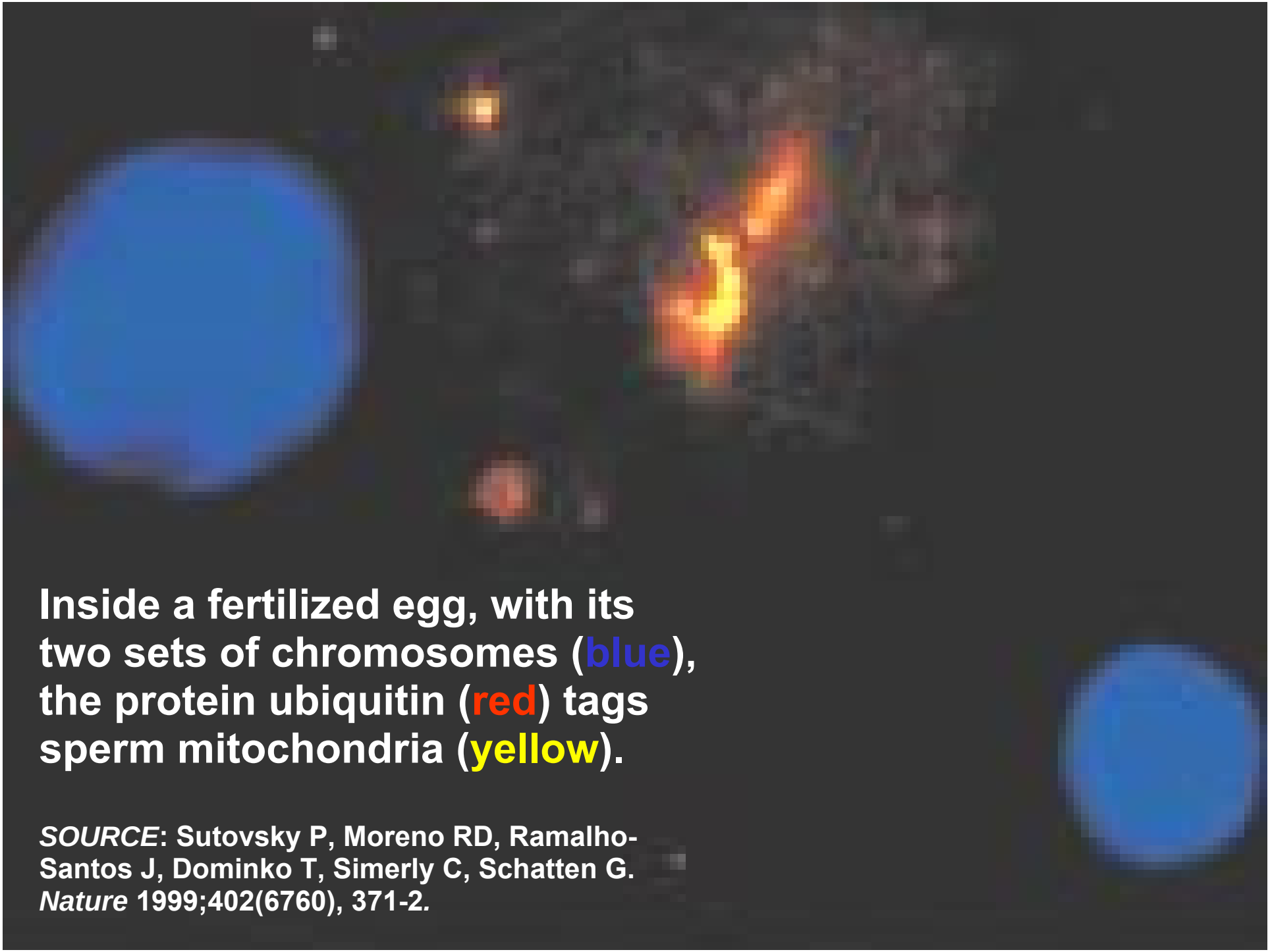
Mom's eggs execute Dad's mitochondria

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
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.

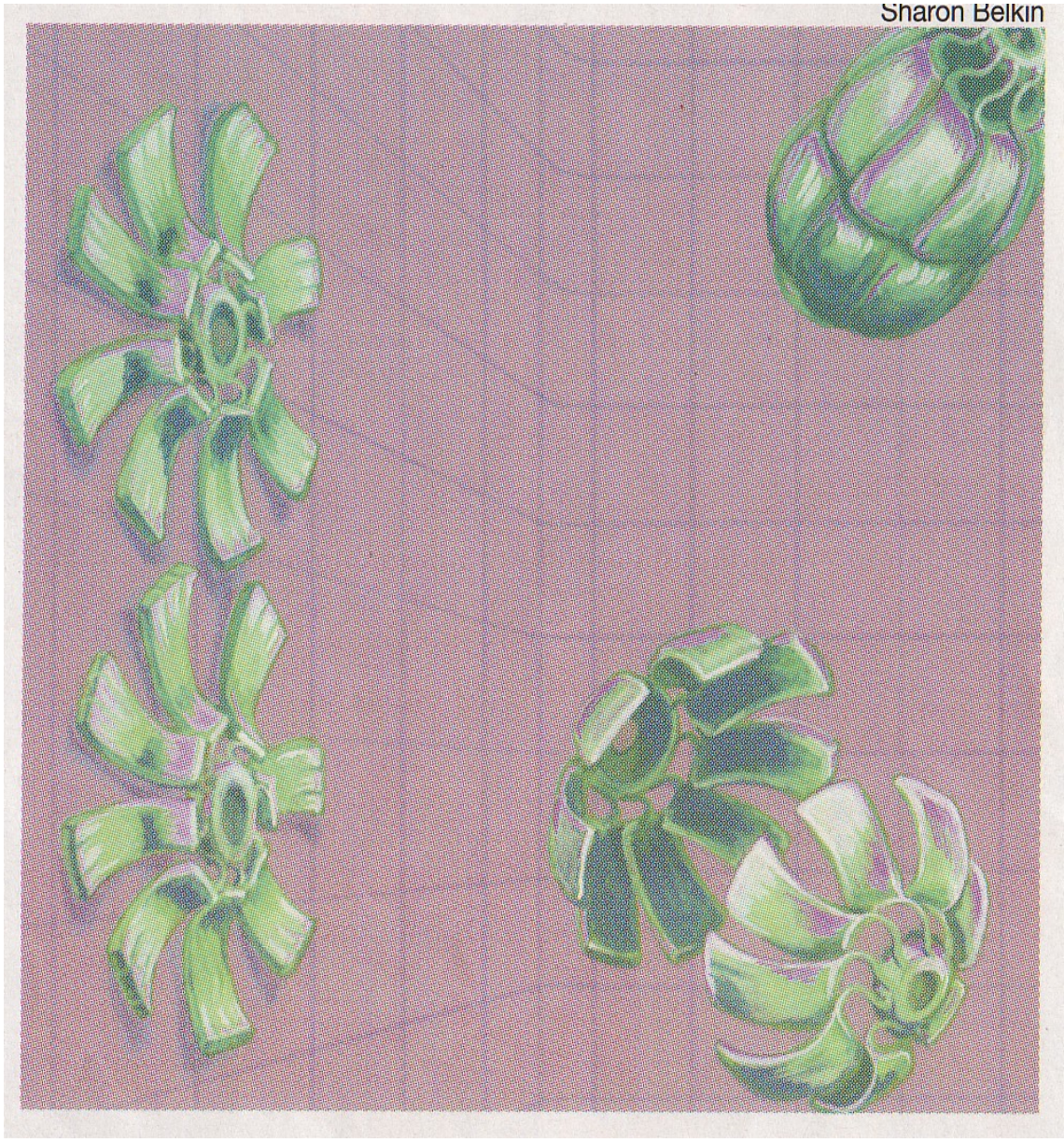
Yet cell biologists may soon have to acknowledge an equally unimaginable oversight in their field. For decades, their powerful microscopes have failed to spot a basic cell component of animals and perhaps any organism with a nucleus. Known as vaults, the barrel-shaped particles are three times the size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

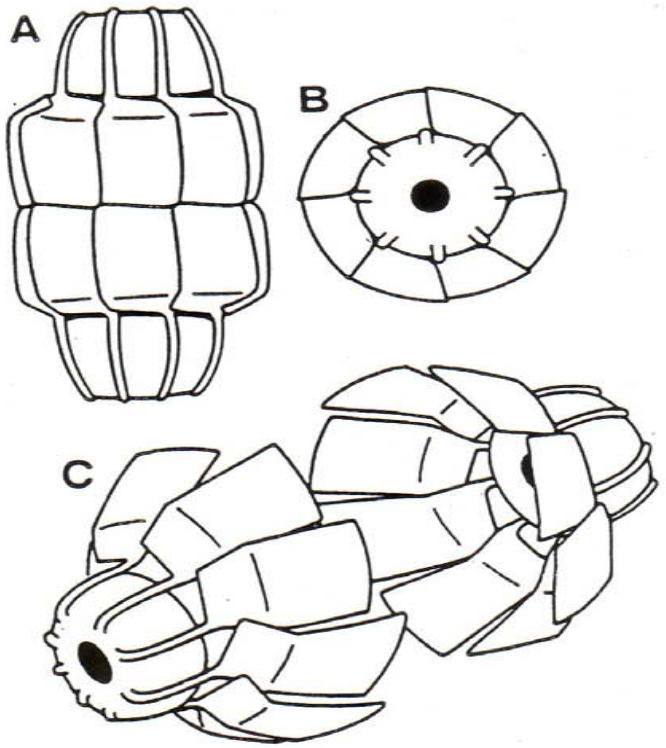
through a microscope. But if it were contaminated with objects that shrug off the stain, that sea would be dotted with white islands. Rome likens the strategy to finding an invisible person by looking for an unexplained shadow in the beam of a spotlight.

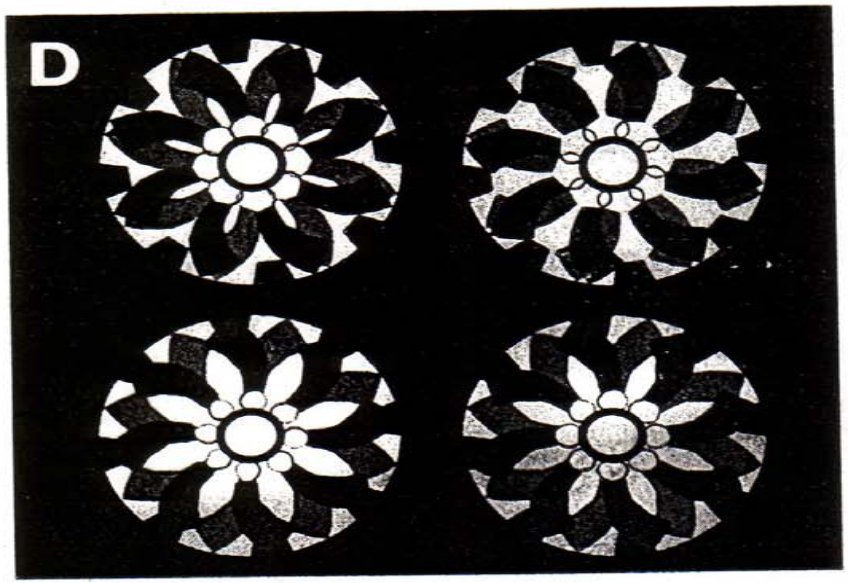
To Kedersha's surprise, unstained ovoid objects appeared among her coated vesicles. Since some of the stain settled into furrows on top of the unexpected shapes, the negative staining revealed fine details of the exterior of these mysterious interlopers, including arches that reminded Rome and Kedersha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

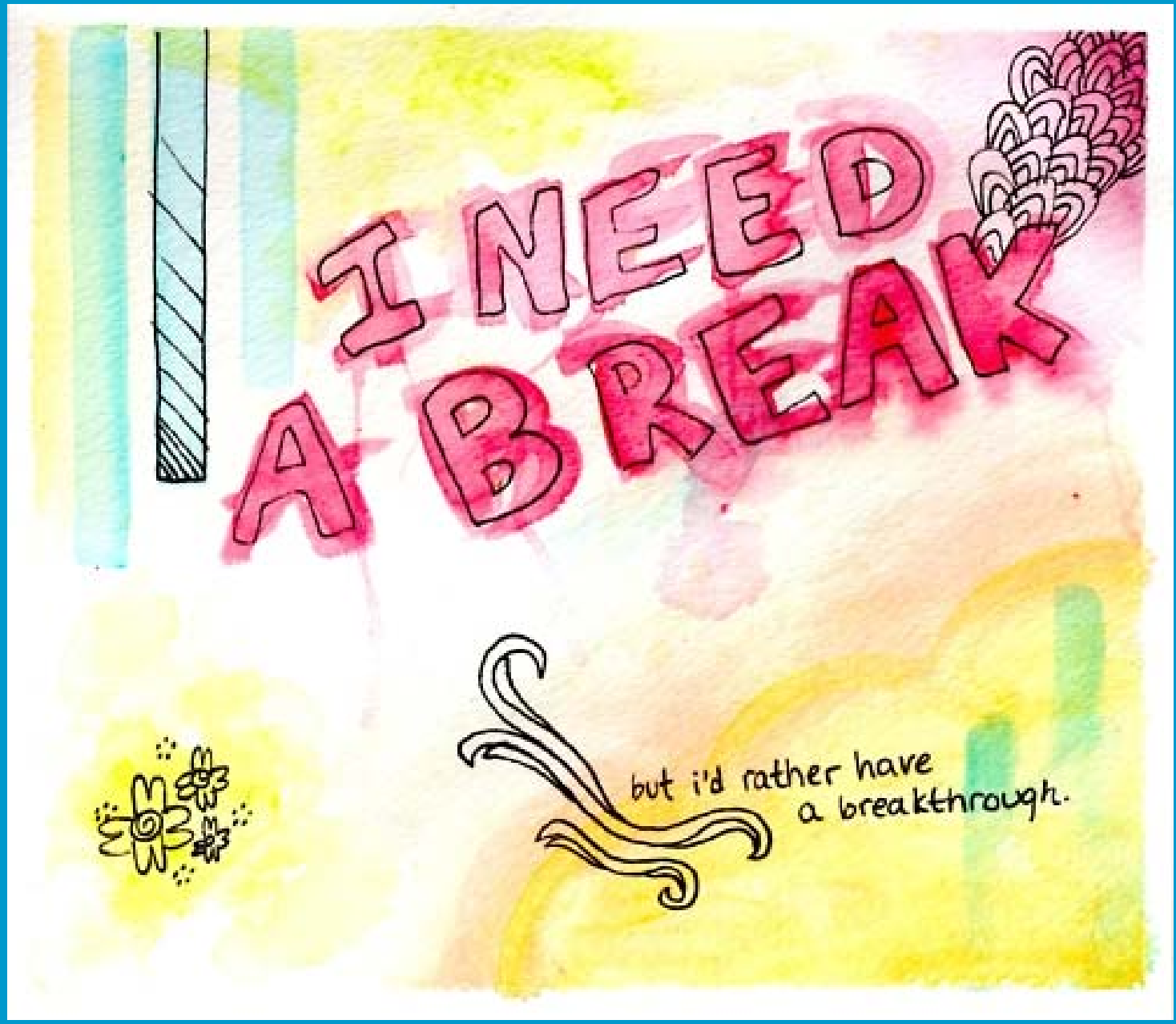
us something by this incredible structure. And the one thing we might surmise from the structure [of vaults] is that they might contain something," says Rome.

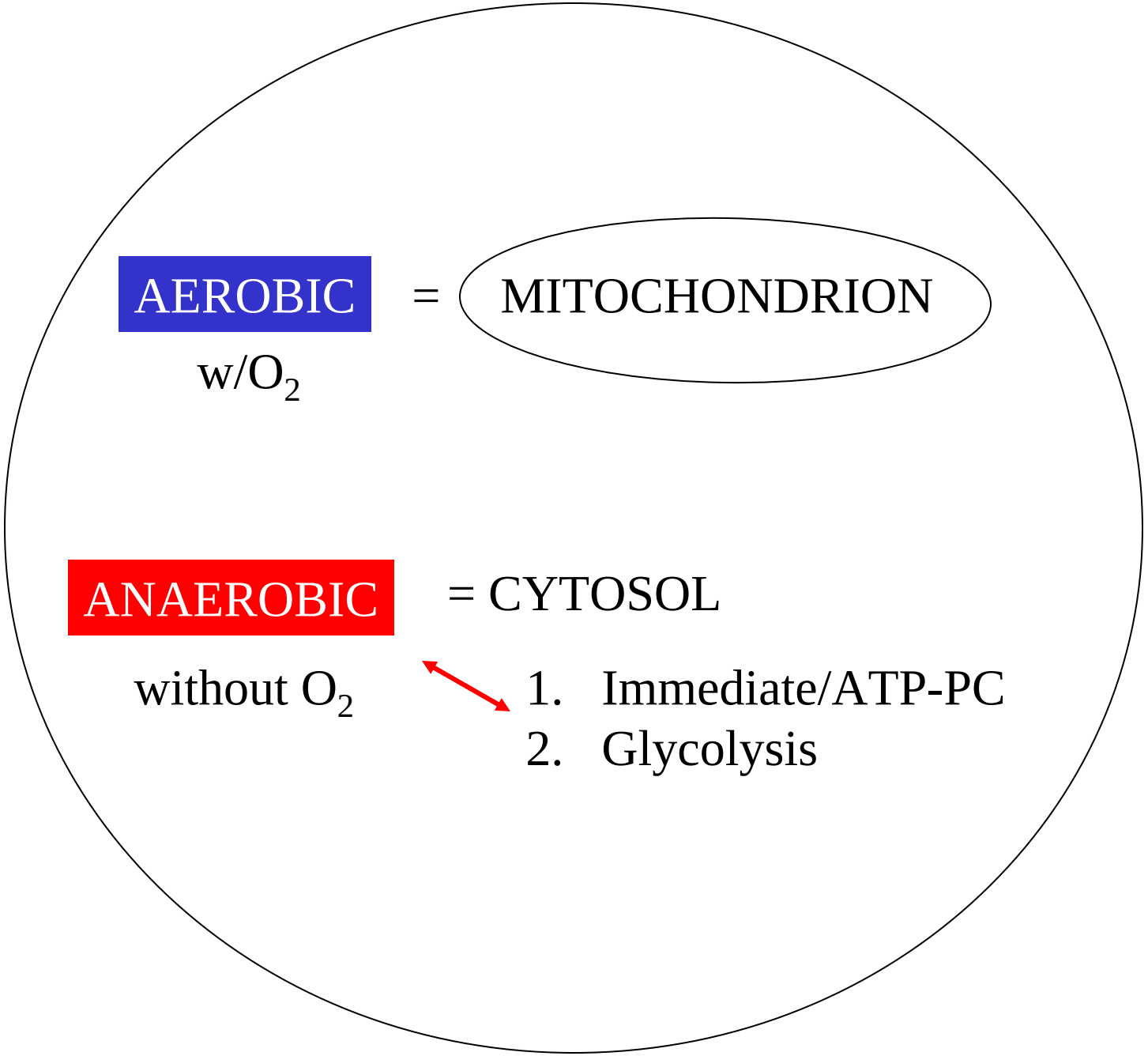
That shape also hints that vaults may pick up their unknown cargo at the nuclear membrane, the barrier that separates the cell's cytoplasm from its nucleus. The nucleus is a fluid-filled sac containing DNA and the machinery required to translate the instructions encoded by that DNA into molecules called 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/O_2
ANAEROBIC
= CYTOSOL
without O_2
1. Immediate/ATP-PC
2. Glycolysis


CREATINE
MONOHYDRATE


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

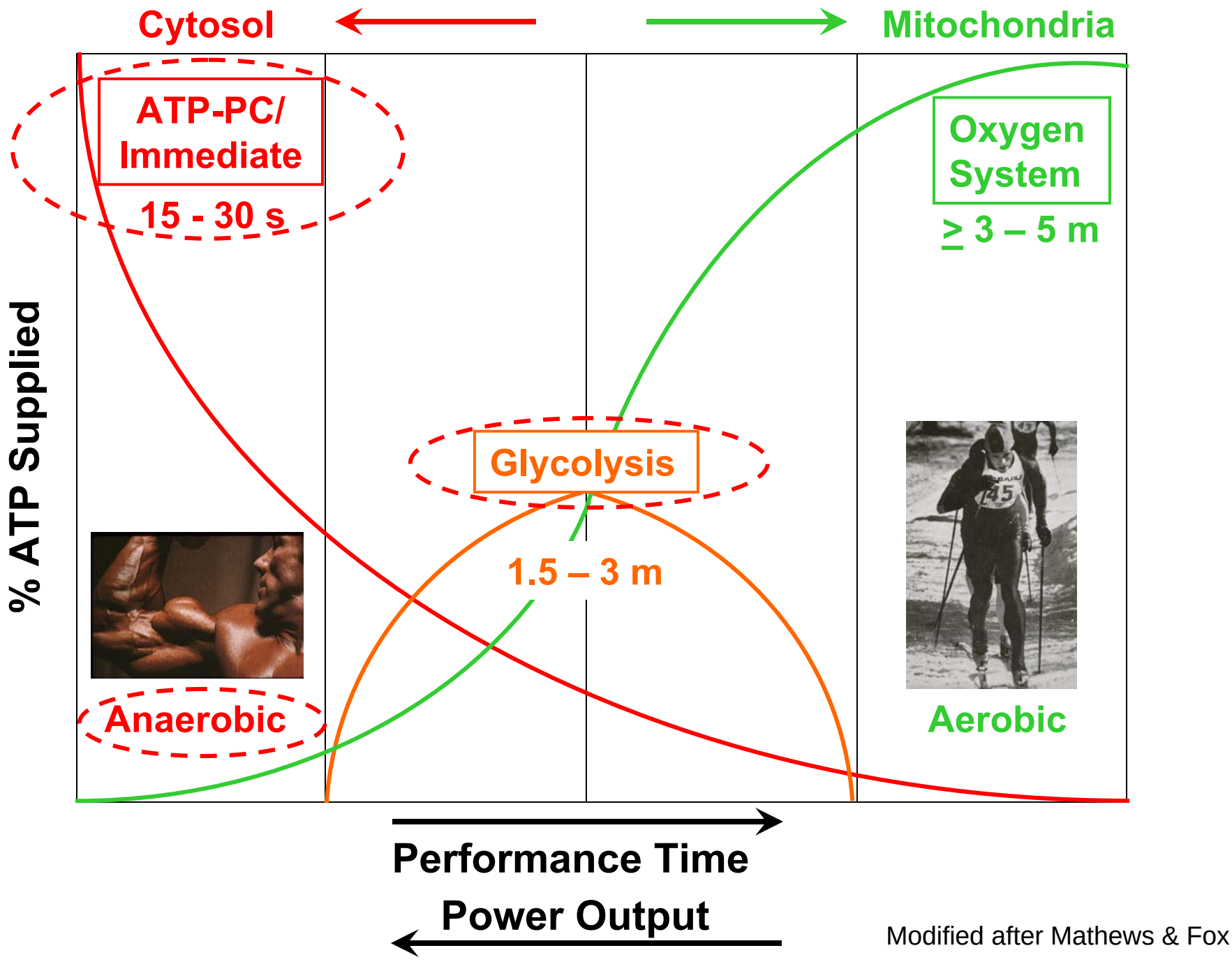

ULTIMATE
NUTRITION
crea
pure
BOVOLUMIZING
1000g (1kg)


BALANCE
100%
PURE
CREATINE
MONOHYDRATE

WOW!

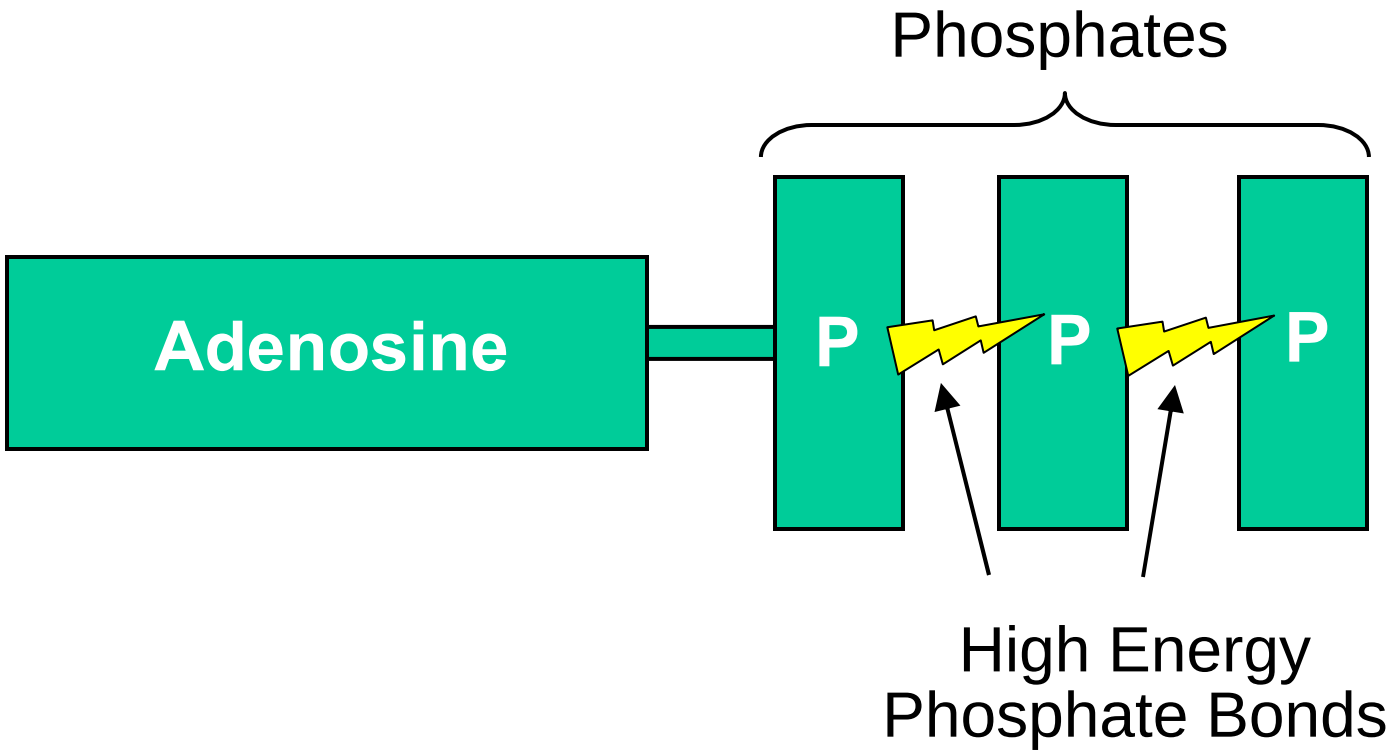
I’M CHAMP!


PUMP



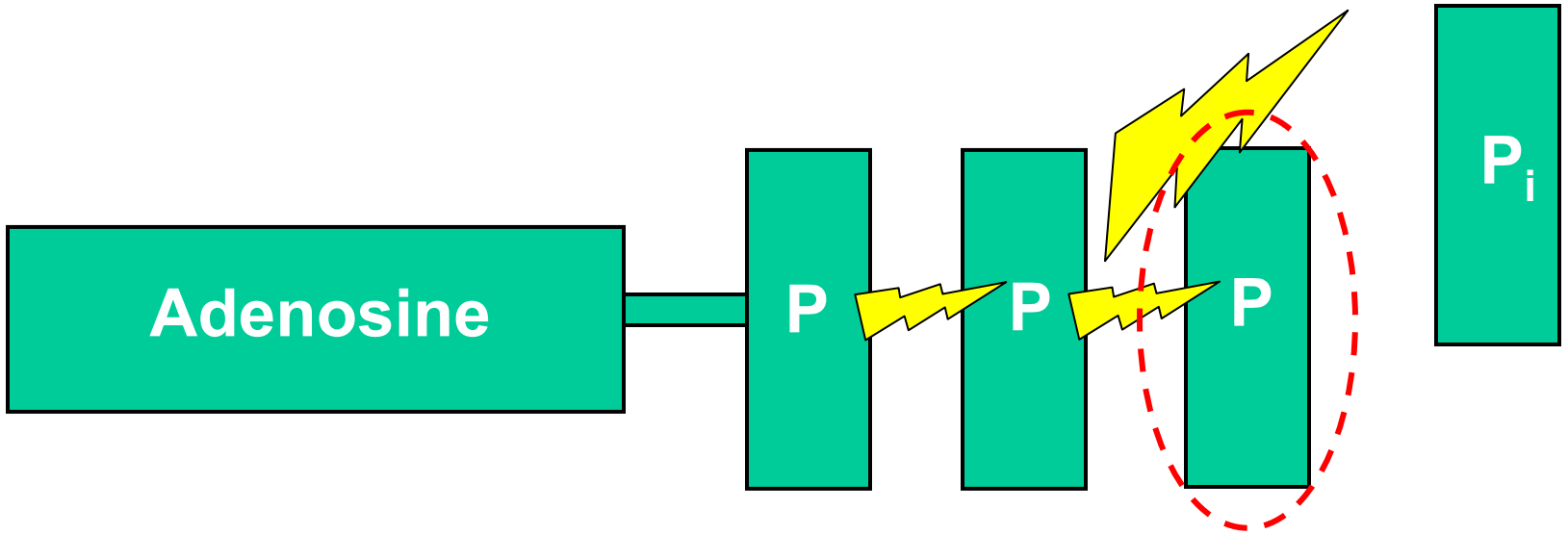
Modified after Mathews & Fox

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

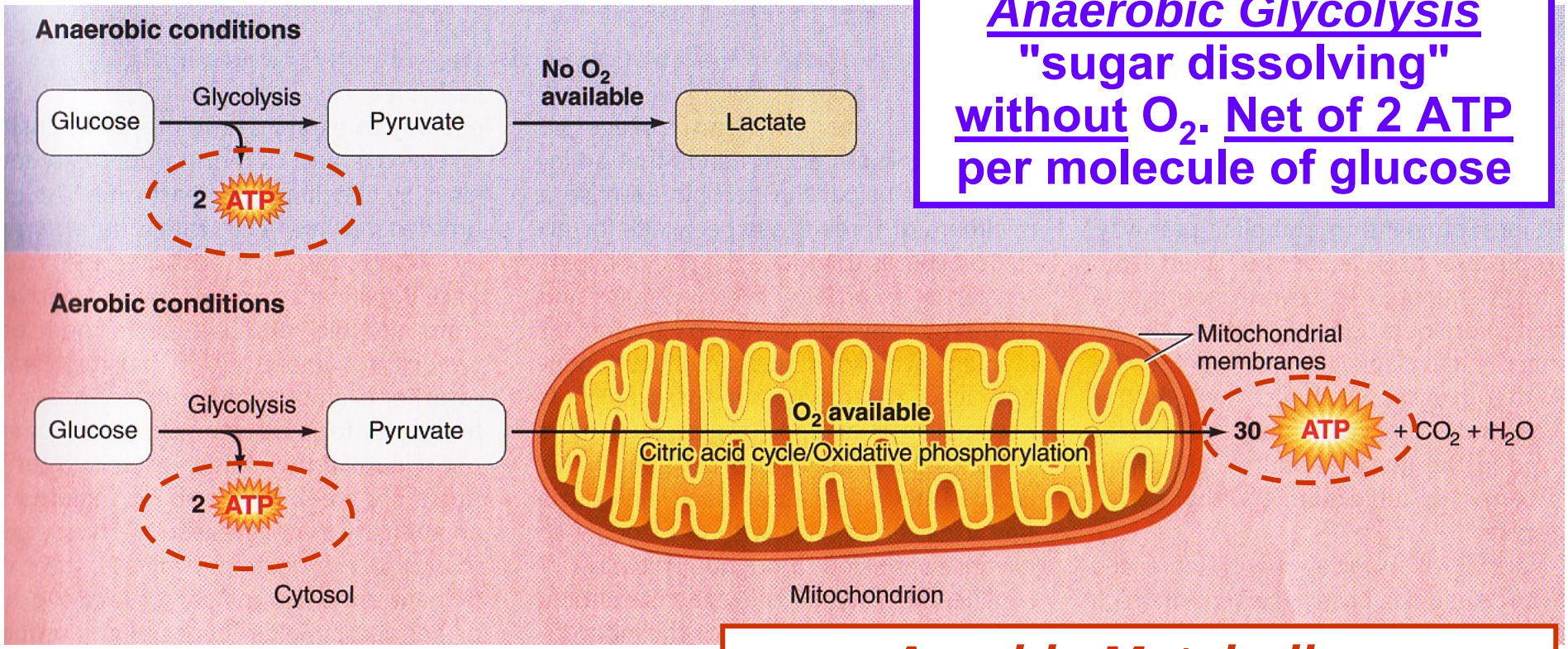


1. *Synthesis of Macromolecules*
2. *Membrane Transport*
3. *Mechanical Work*

Make big things from little things!

Move things! Microscopic! ⟷ Move things! Macroscopic!

Anaerobic vs. Aerobic Metabolism

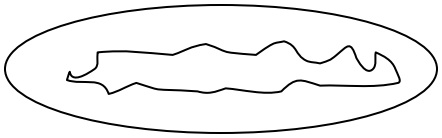


Anaerobic Glycolysis
"sugar dissolving" without O_2. Net of 2 ATP per molecule of glucose

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

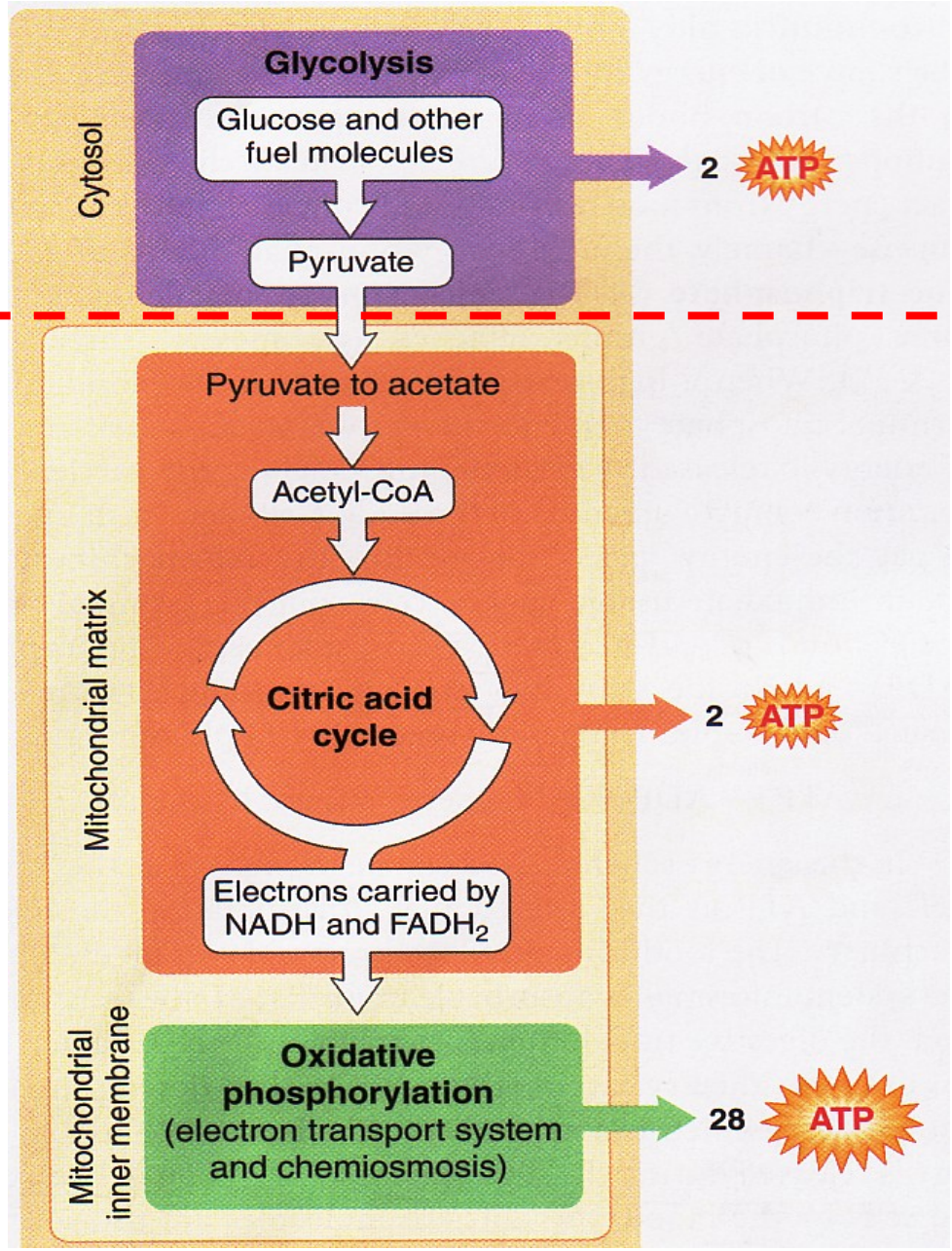
Immediate/ATP-PC

PRIMARY FUEL	ACTIVITY	% AEROBIC (Oxidative Energy System)	% ANAEROBIC (Immediate & Non-Oxidative Energy Systems)	TIME (Min:Sec)
	Marathon Cross-Country Skiing	100	0	135:00
	10-K Run	90	10	29:00
FAT, CARBOHYDRATE & PROTEIN (Small Amounts)	3-Mile Run	80	20	14:00
	2-Mile Run 800-Meter Swim	70	30	
		60	40	9:00
	1-Mile Run			3:45
CARBOHYDRATE (Glucose & Glycogen)	Boxing 200-Meter Swim	50	50	
	Circuit Weight Training	40	60	
	Soccer Lacrosse	30	70	1:30
	Tennis	20	80	0:50
ATP, ADP & Creatine Phosphate (CP)	Basketball Volleyball 200-Meter Dash Football	10	90	0:20
	Conventional Weight Training	0	100	0:10

Stages of Cellular Metabolism/Respiration

Anaerobic
Glycolysis
Cytosol

Aerobic
Metabolism
Mitochondria



Matrix

Inner Membrane

fig 2-9 LS 2012

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

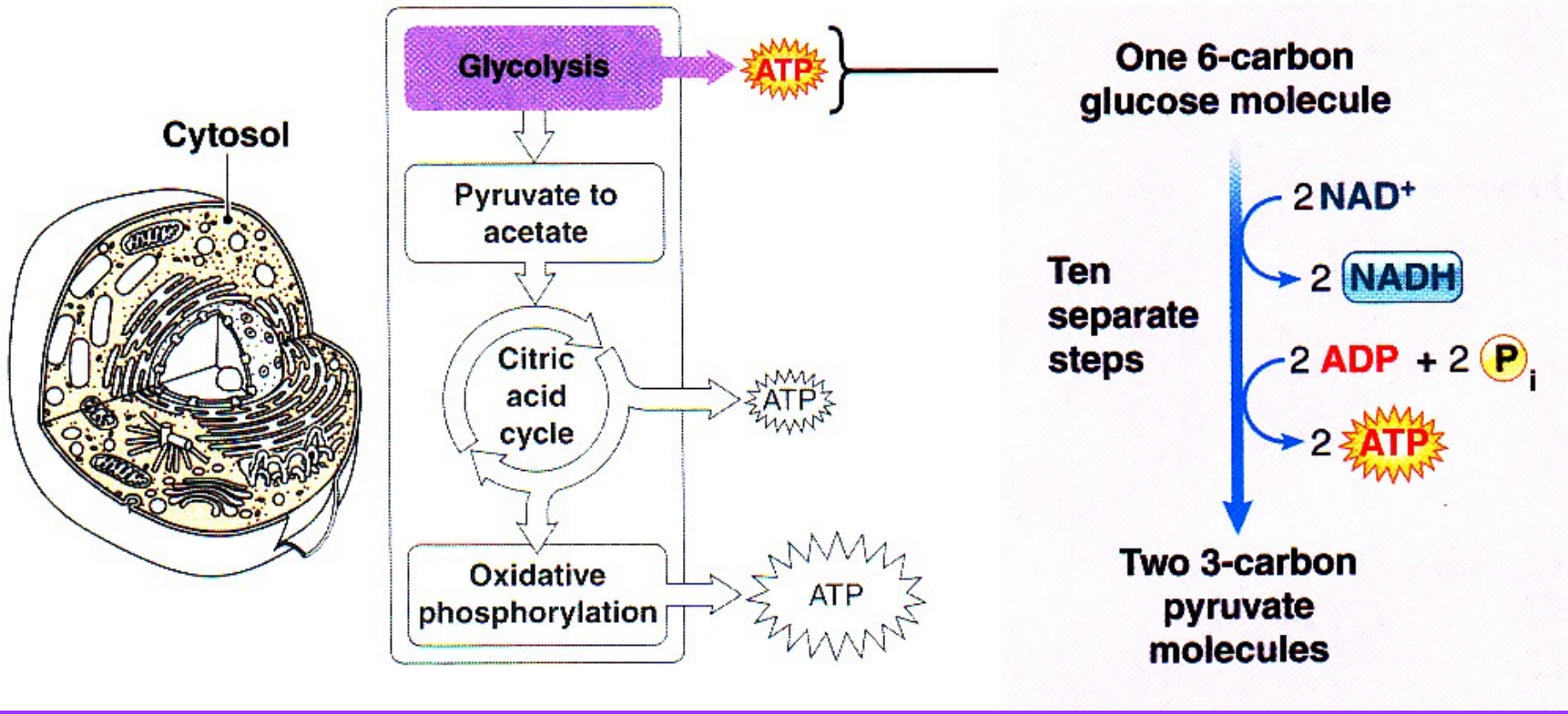
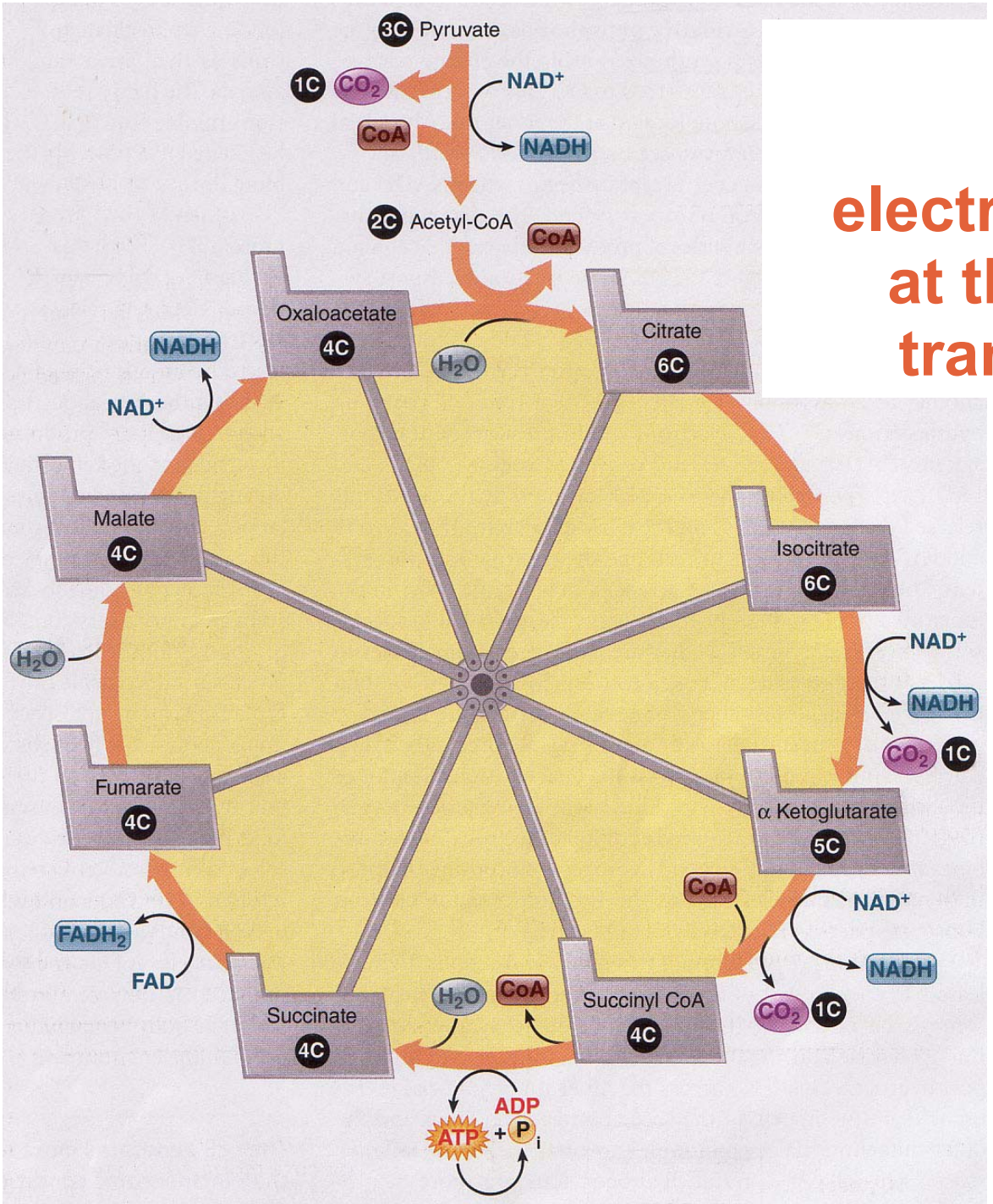


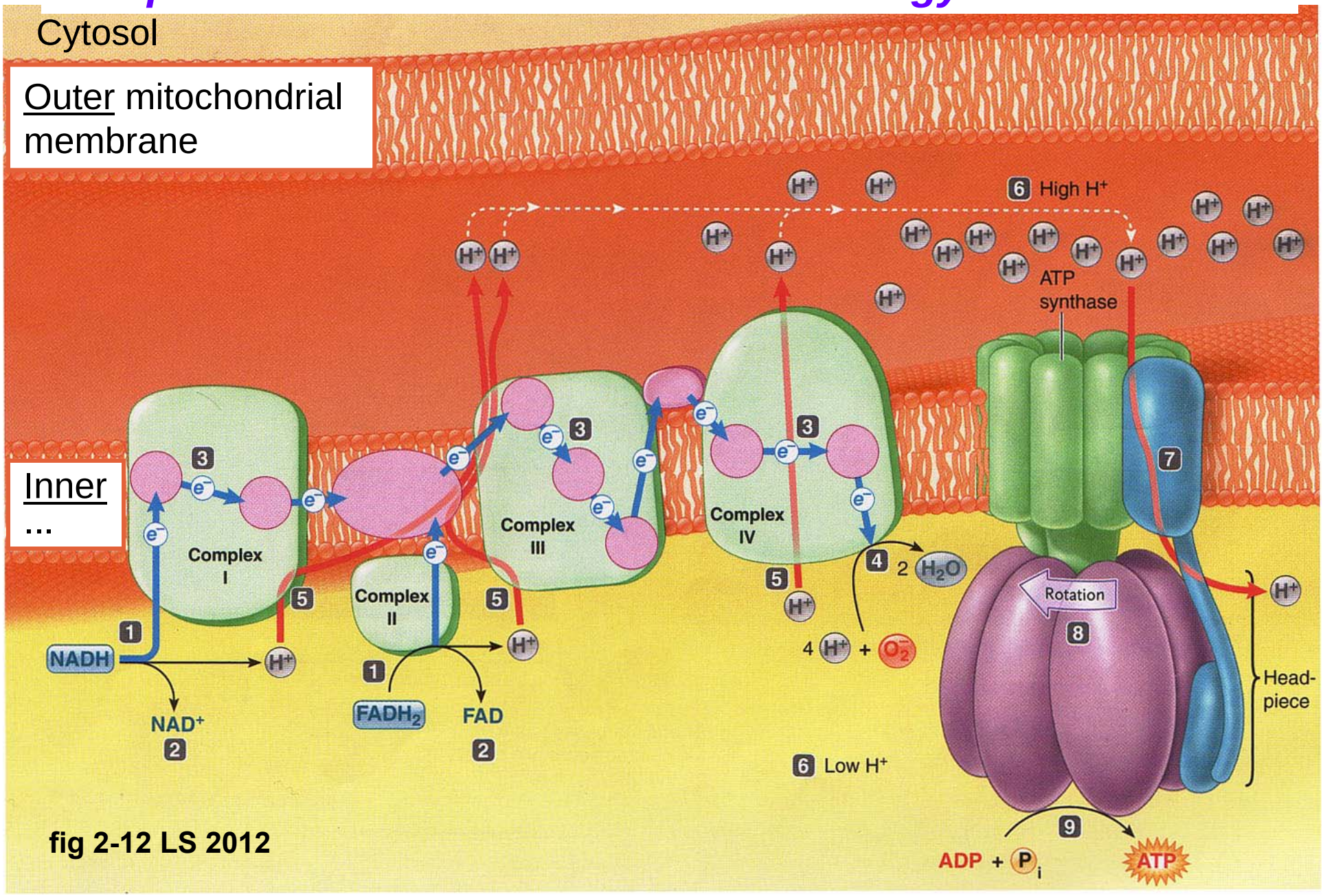
fig 2-10 LS 2012



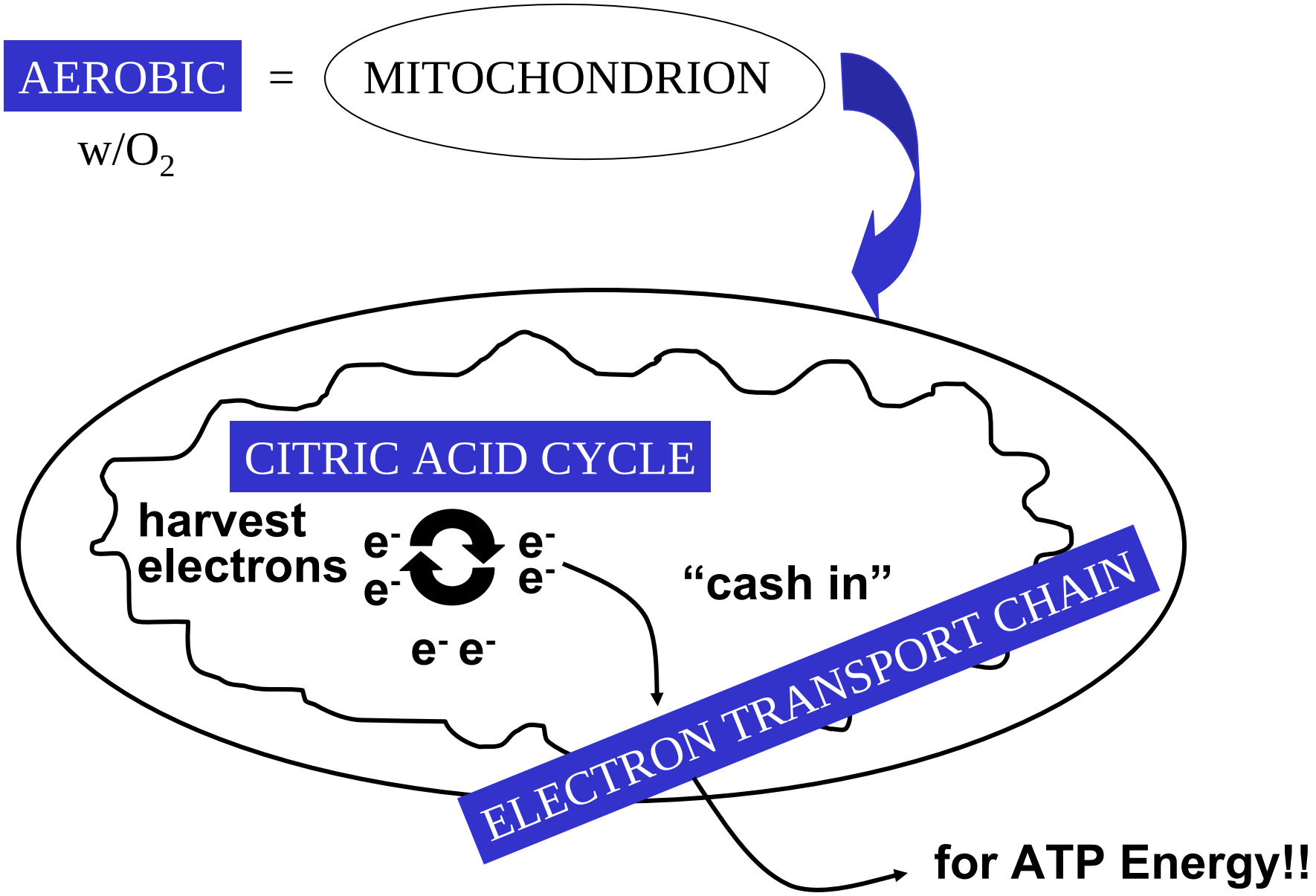
Citric Acid Cycle produces pairs of electrons for cashing in at the nearby electron transport chain (ETC)

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

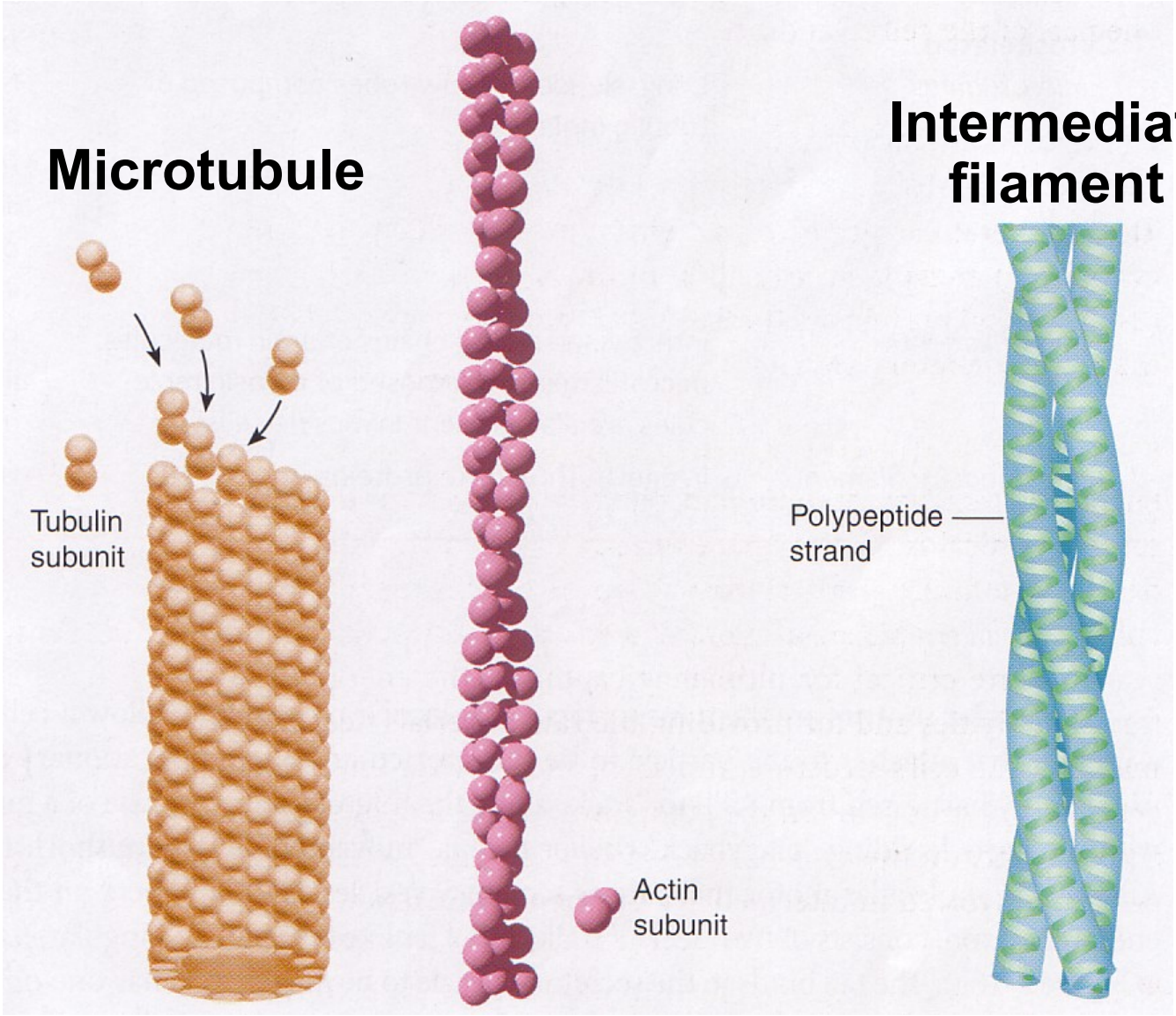
Cashing in electrons at the Electron Transport Chain (ETC) produces an abundance of ATP energy molecules!



Goals of Aerobic Metabolism

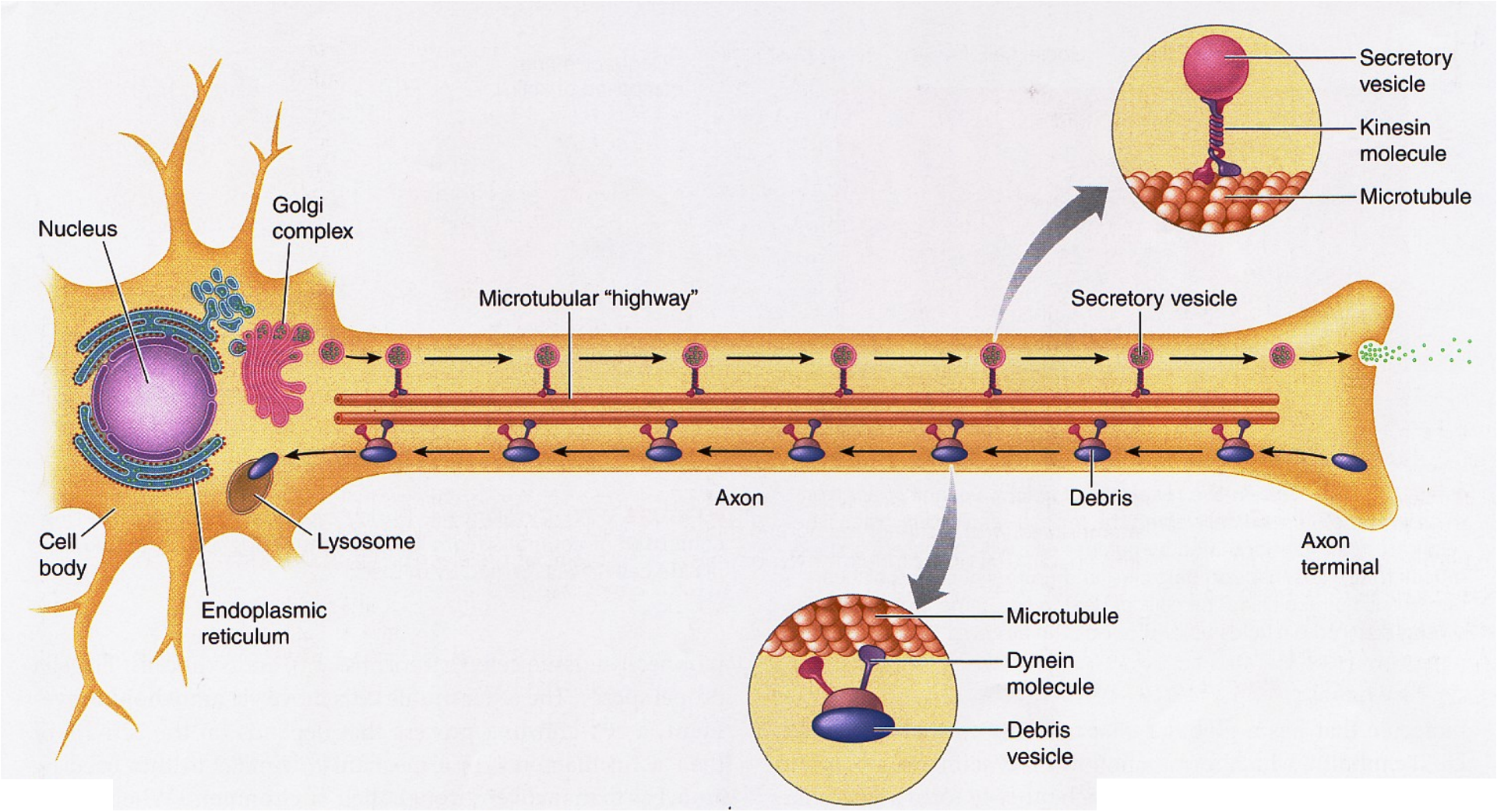


Cytoskeleton: Cell "Bone & Muscle"



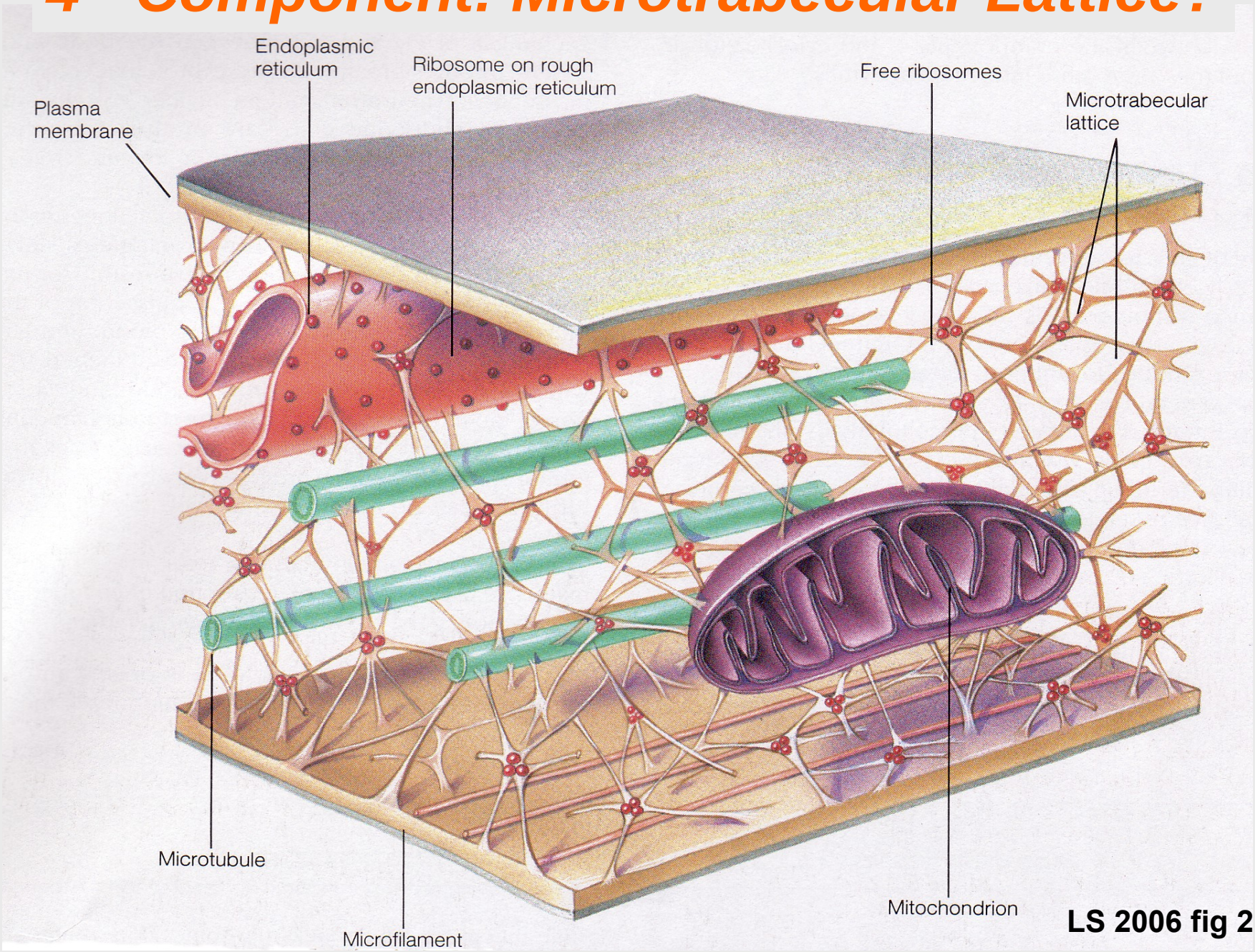
LS 2012 fig 2-17

Microtubular Highway!!



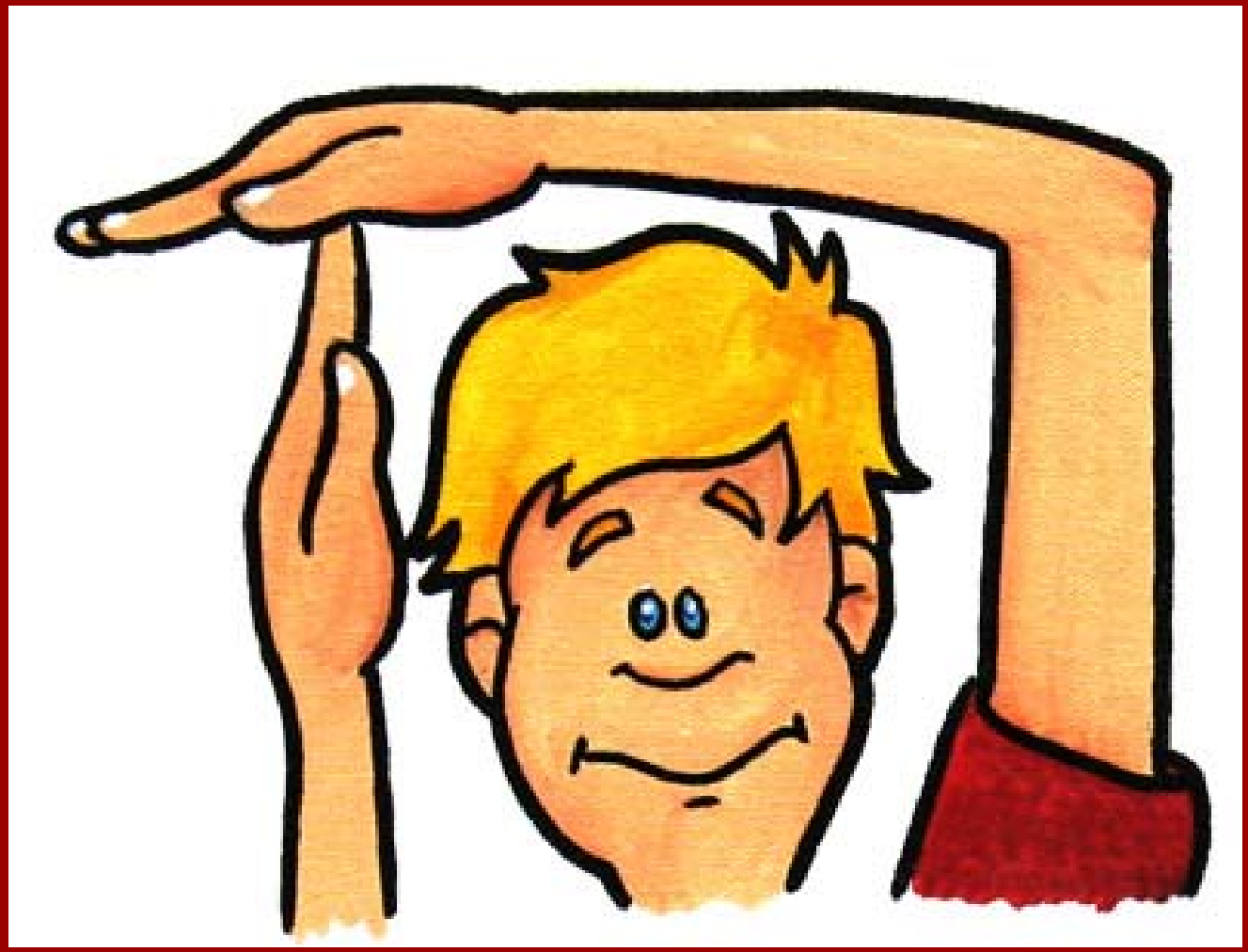
LS 2012 fig 2-18

4th Component: Microtrabecular Lattice?



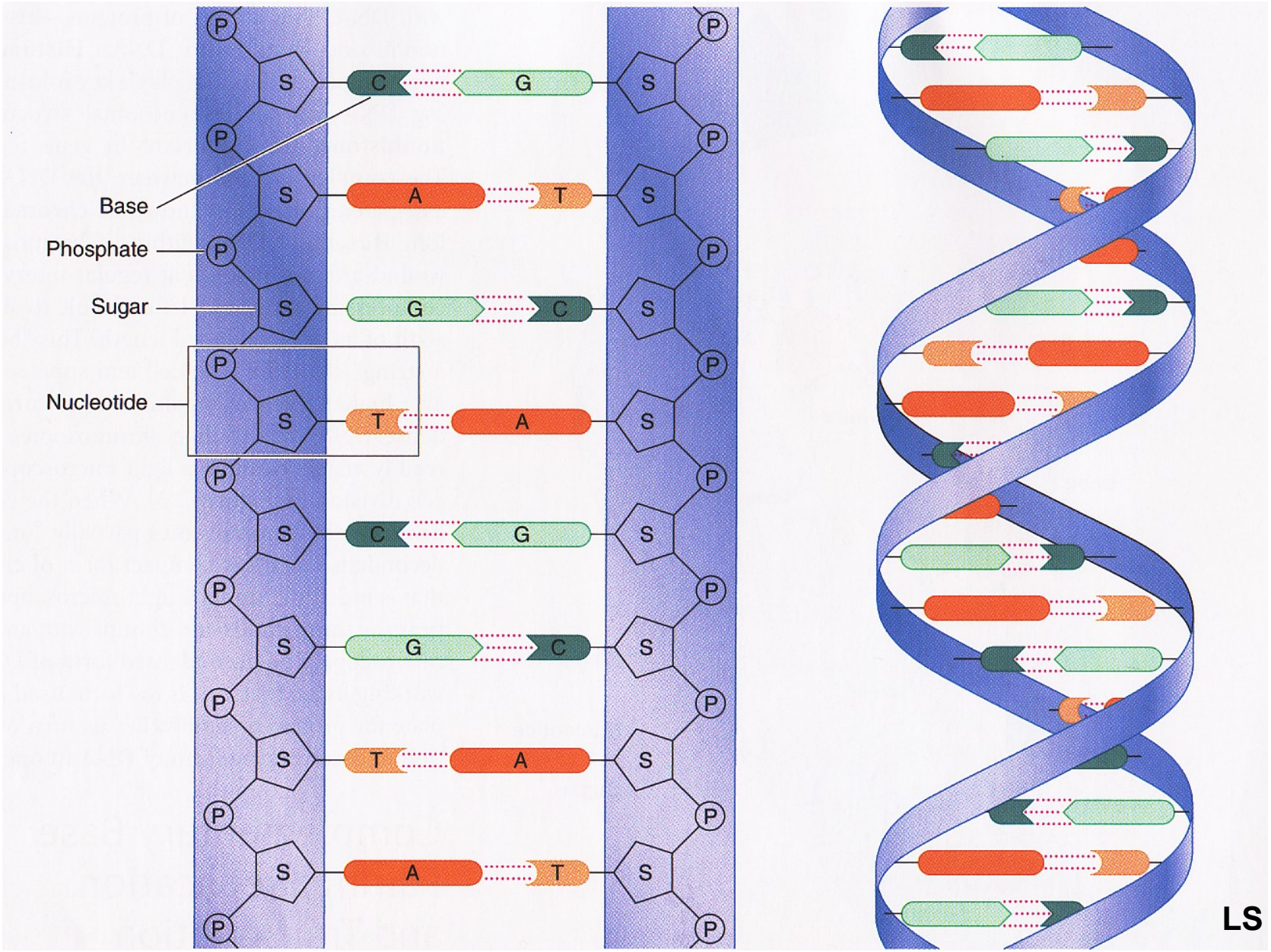
LS 2006 fig 2-20

Time-out for questions!



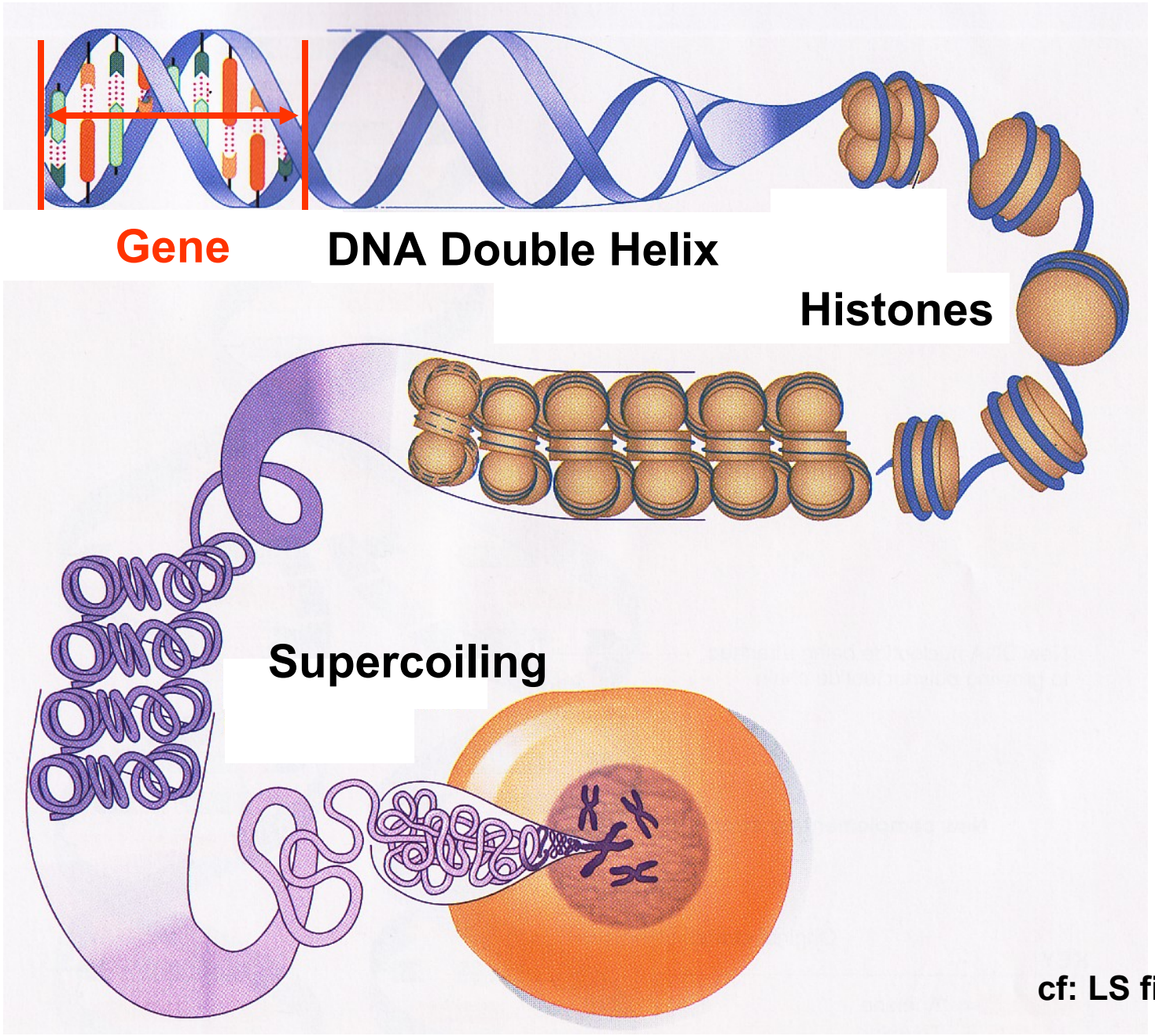
What are DNA's major functions?
Heredity + Day-to-Day Cell Function

What does DNA look like? Double-helix!!



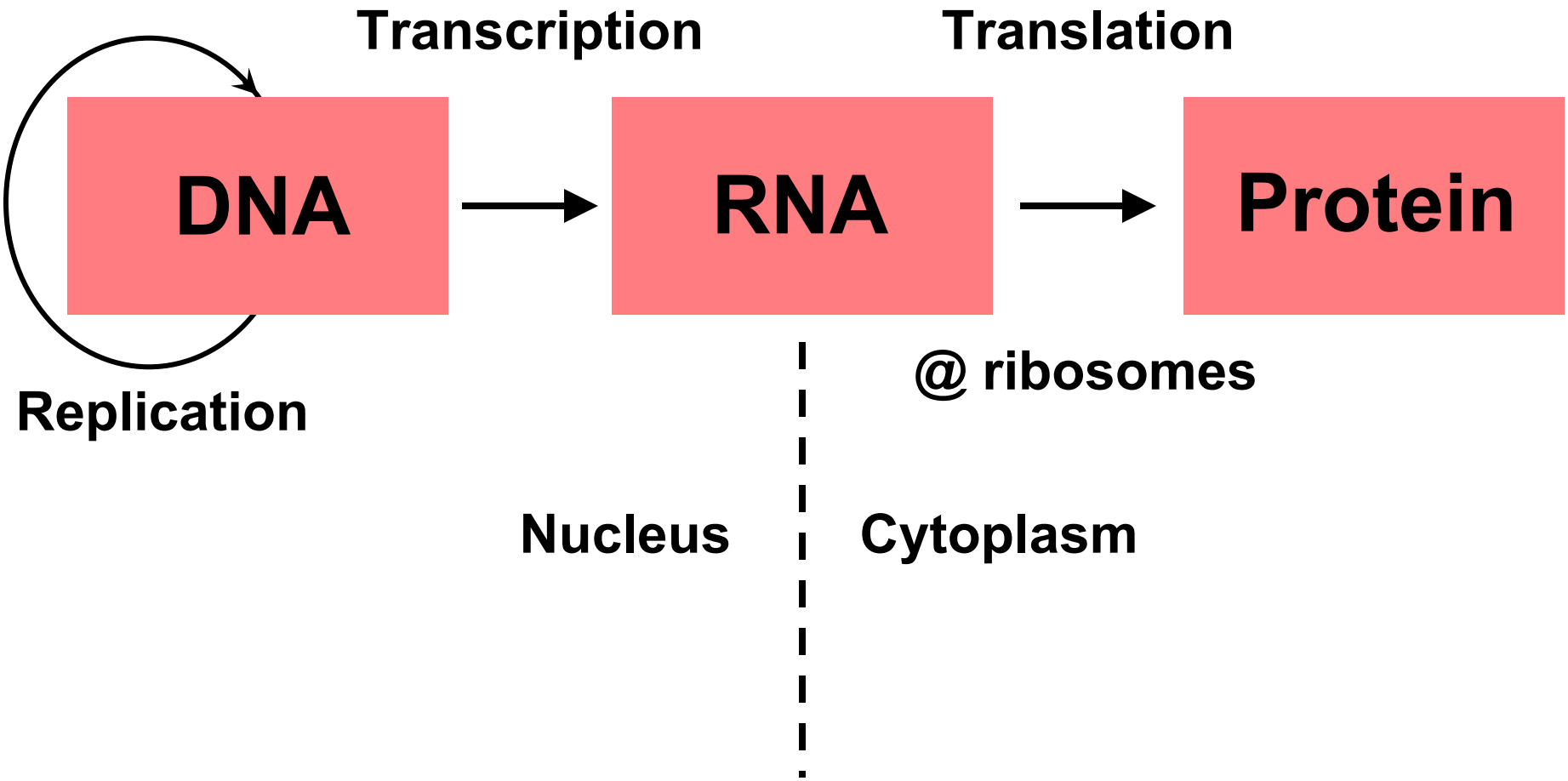
LS fig C-2

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

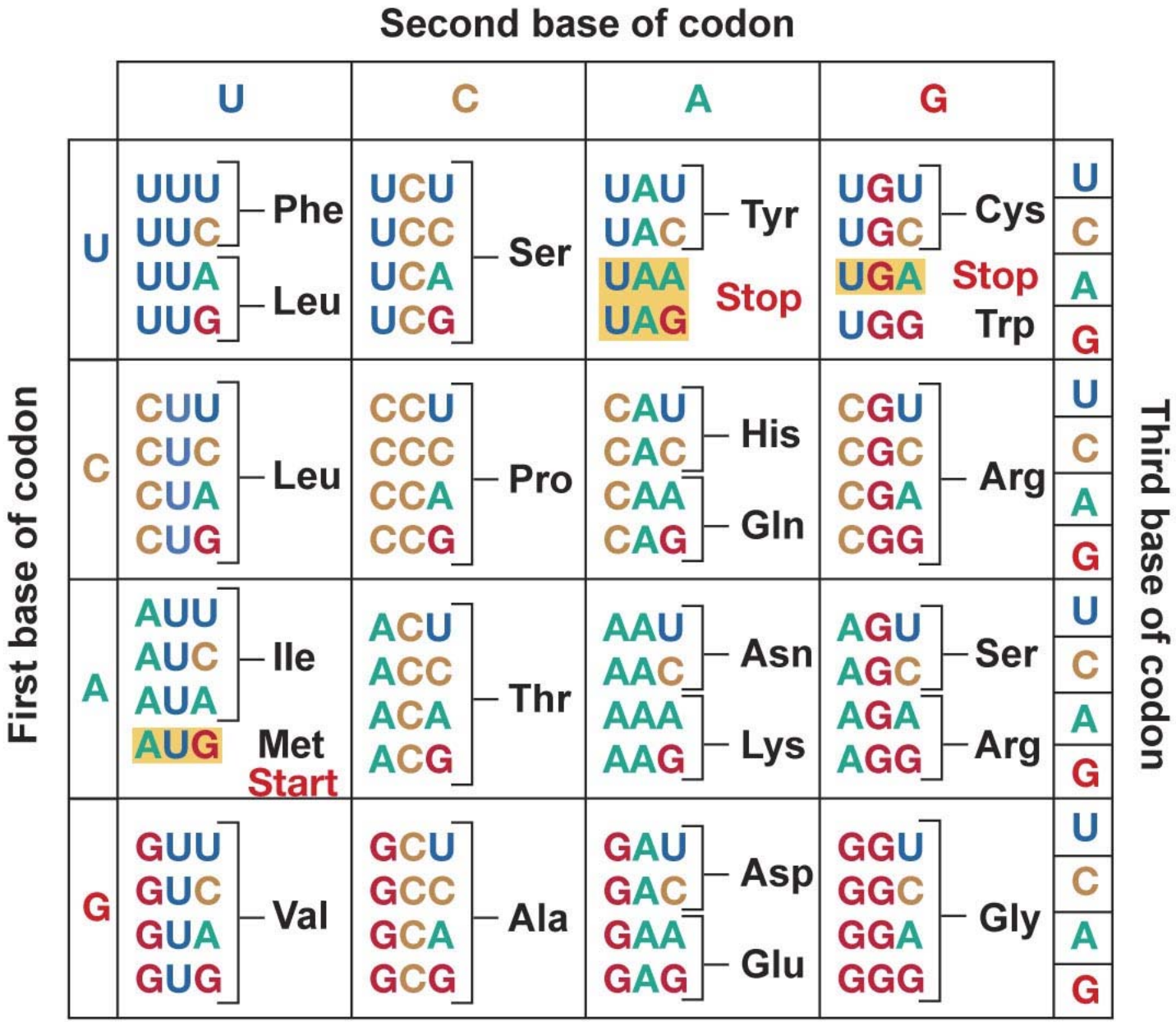
DNA vs *RNA*?

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

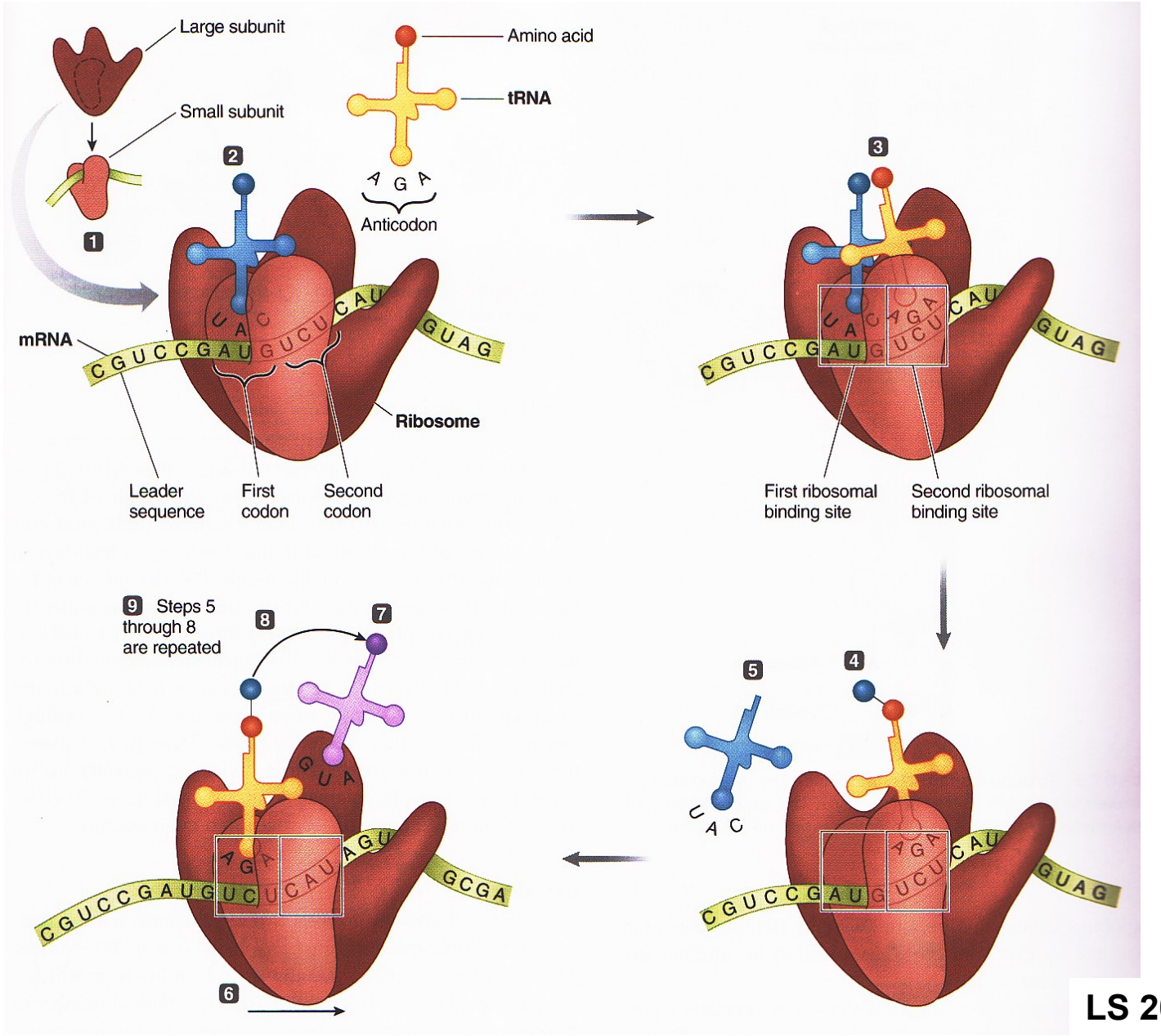
Triplets of bases code for amino acids, the building blocks of proteins

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



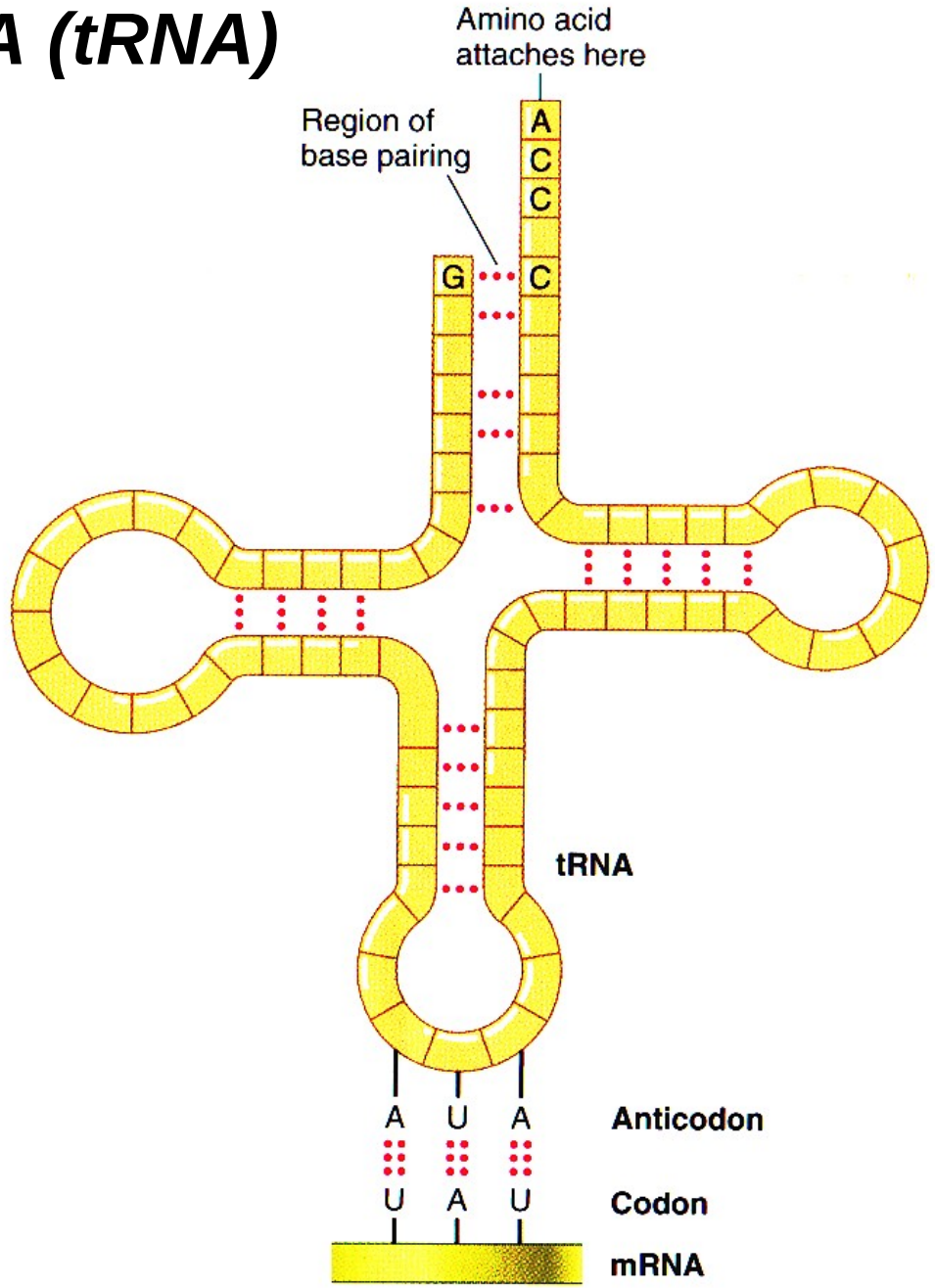
D. Silverthorn, *Physiology: An Integrated Approach.* San Francisco: Pearson Education, 2010.

Translation? Ribosomes Make Proteins



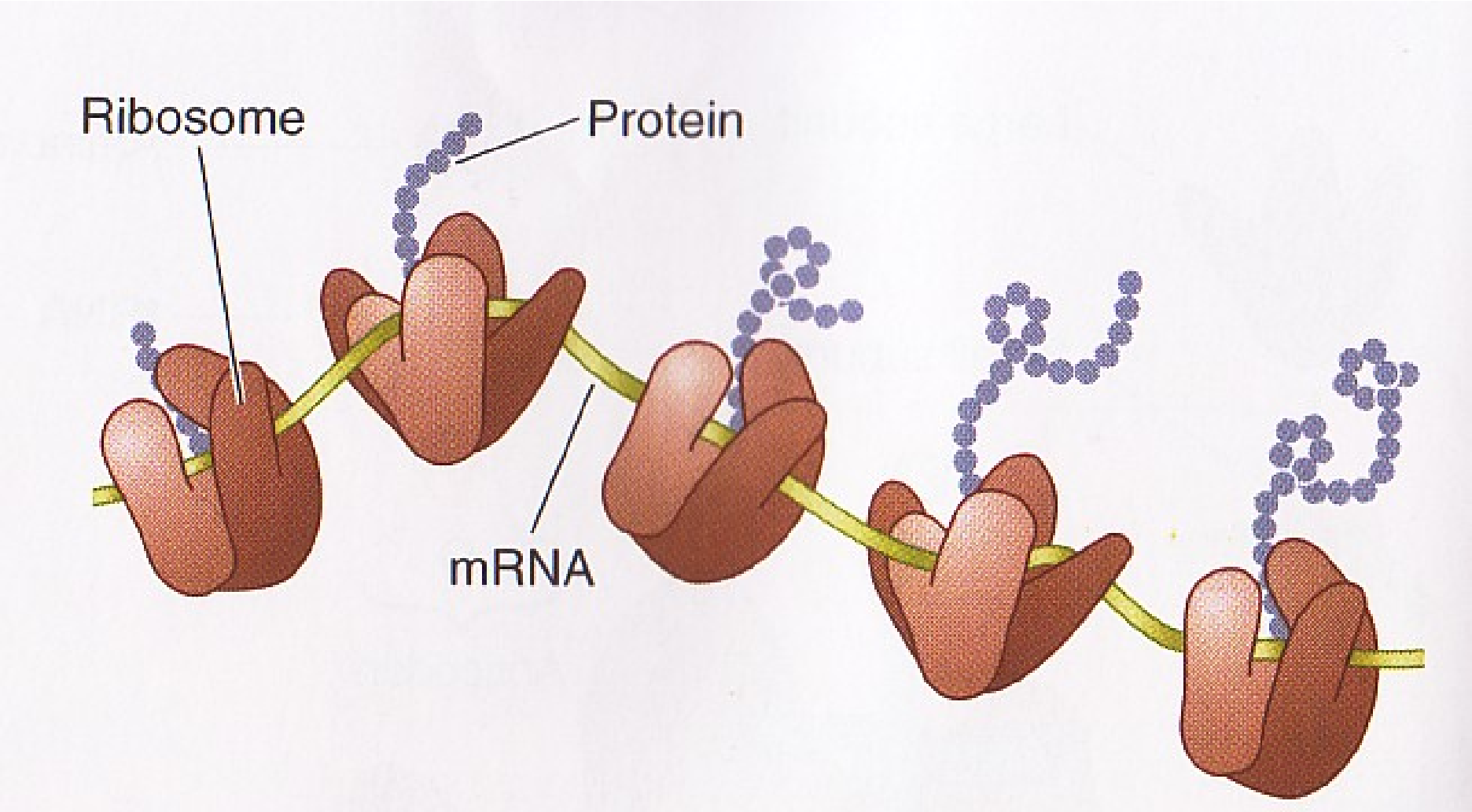
LS 2012 fig C-7

Transfer RNA (tRNA)



LS fig C-8

A Polyribosome. Which Way is Synthesis?



LS fig C-9