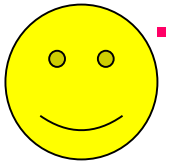
BI 121 Lecture 2



...Histology exploratory fun!!
Thanks for signing in!

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.* H_2O, T°C, BP Dr Evonuk + LS pp 8 - 10

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

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

B. Basic survival skills ch 1 p 3

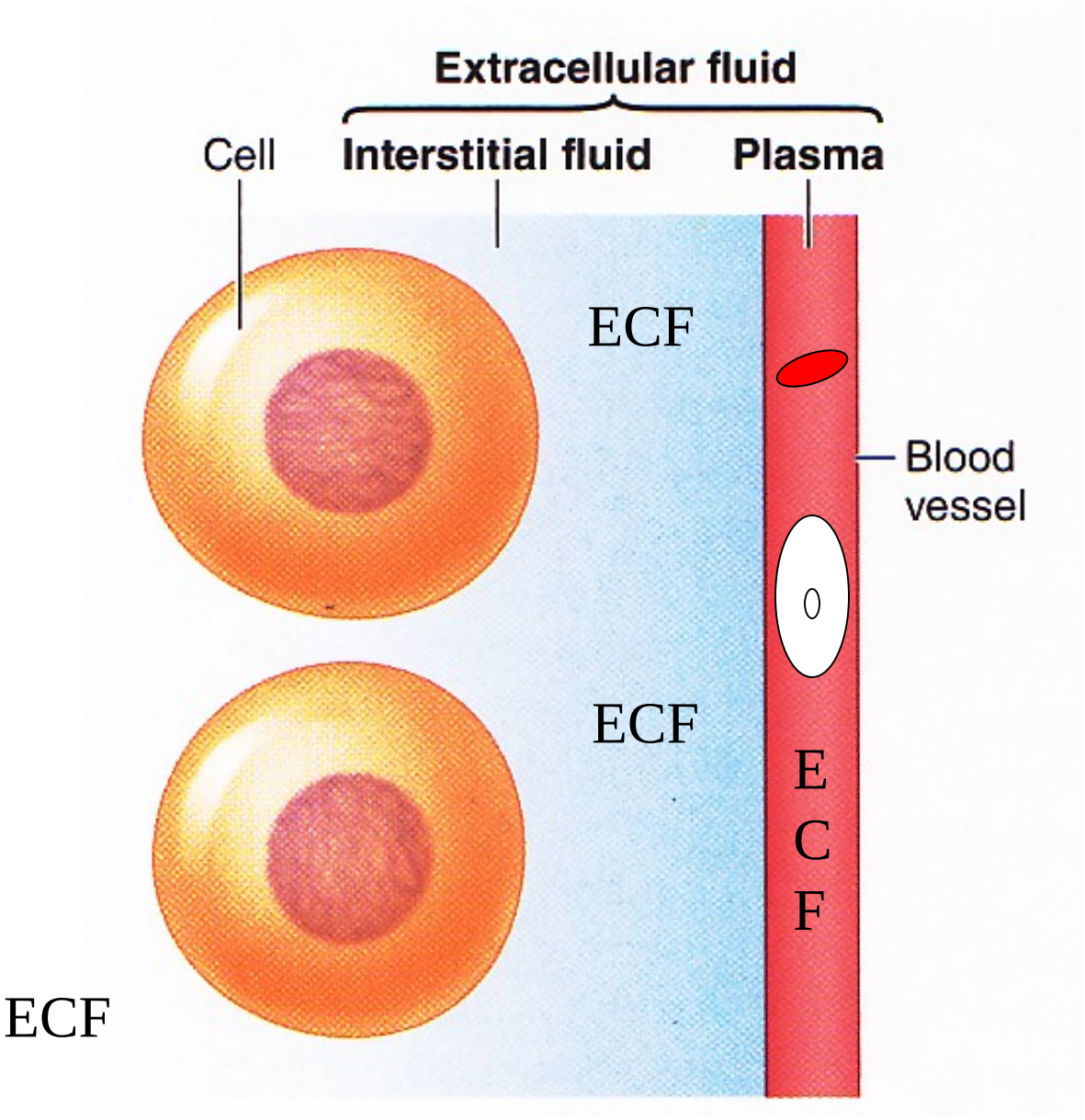
C. Organelles ≡ Membranous, cytoplasmic specialty shops!

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. ***Physiol News*** Moms eggs execute Dad's mitochondria?

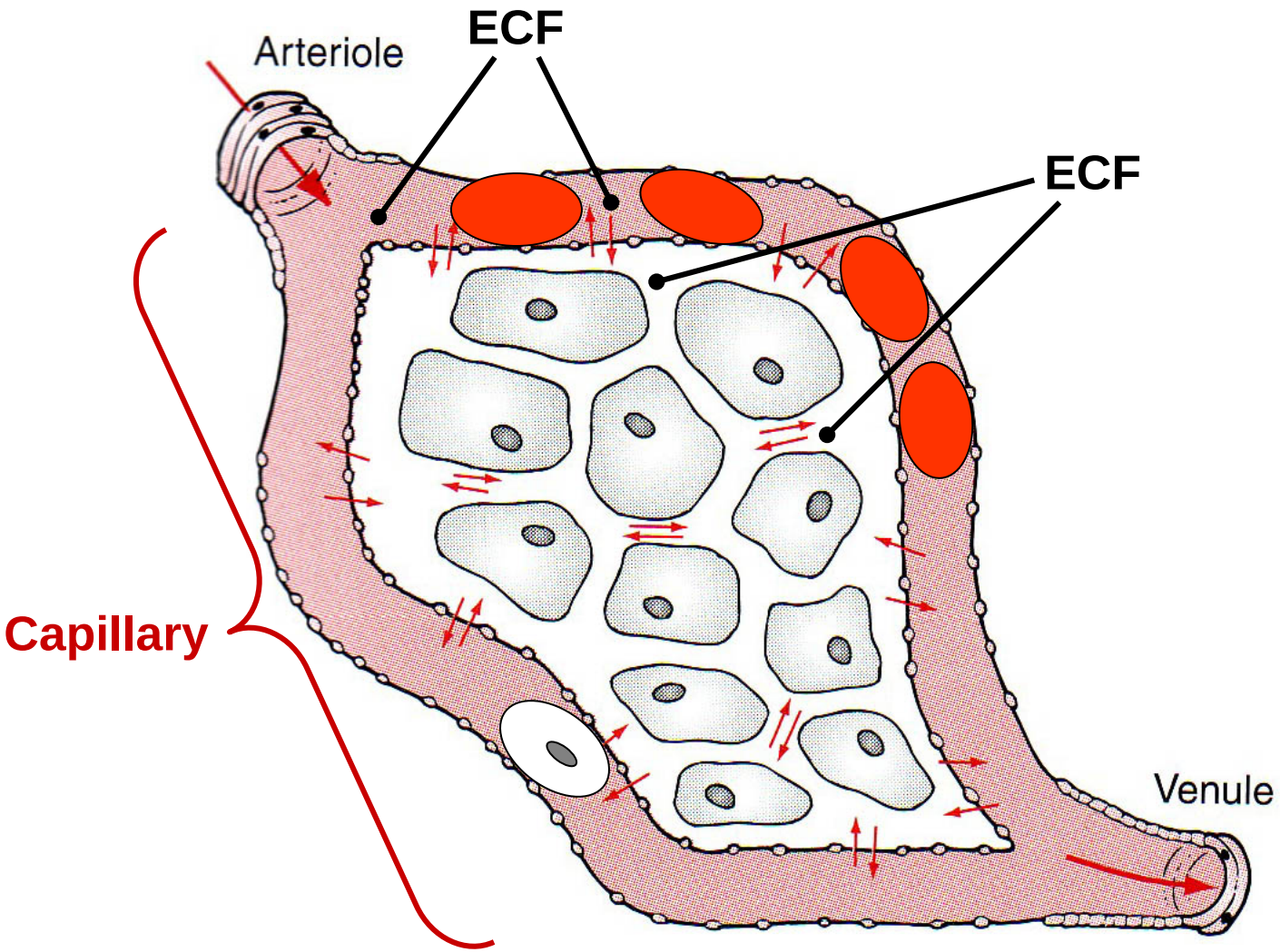
E. What about vaults? LS 2006, p 32 + *Science News*

Where is extracellular fluid?



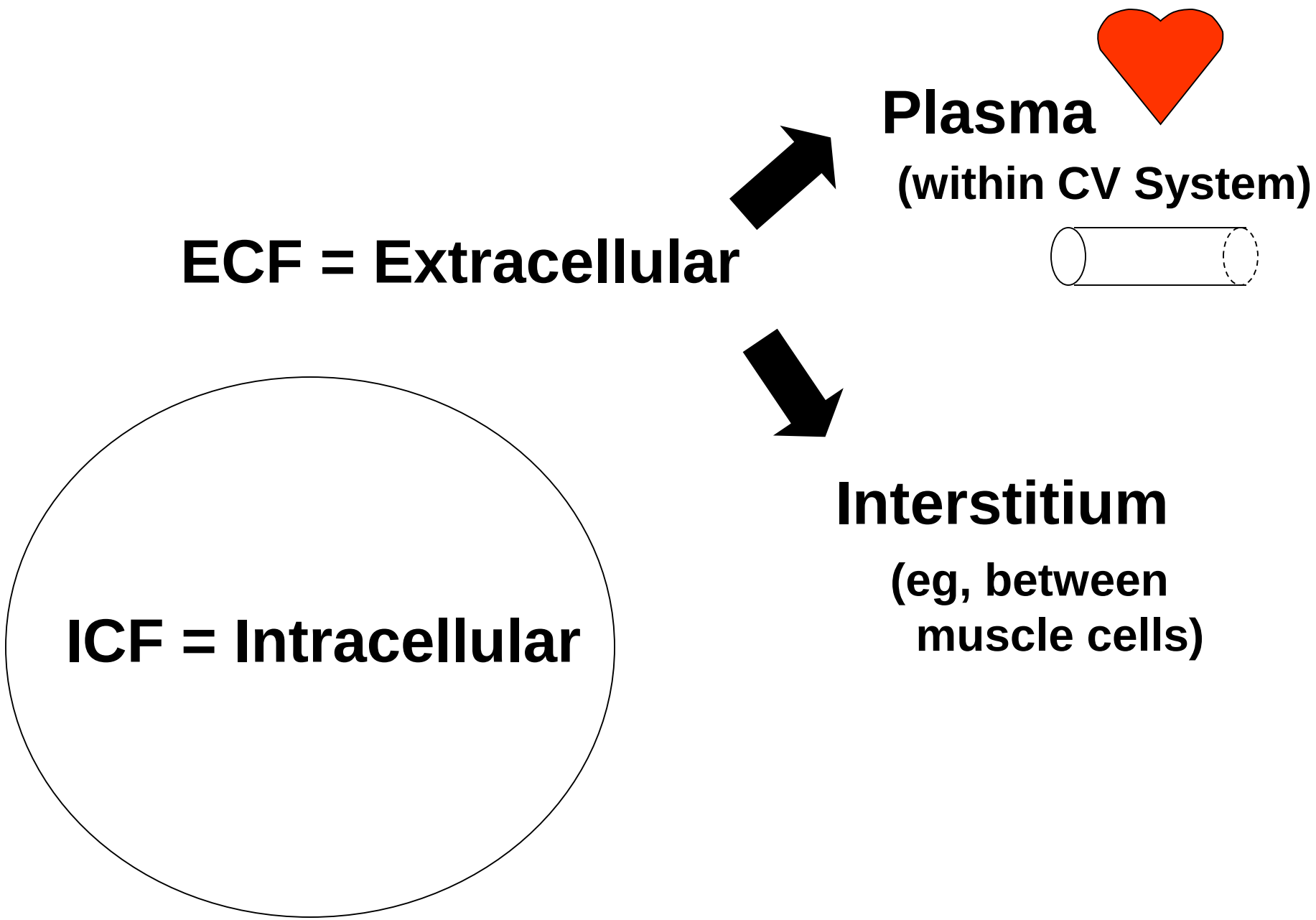
LS fig 1-5 p 7

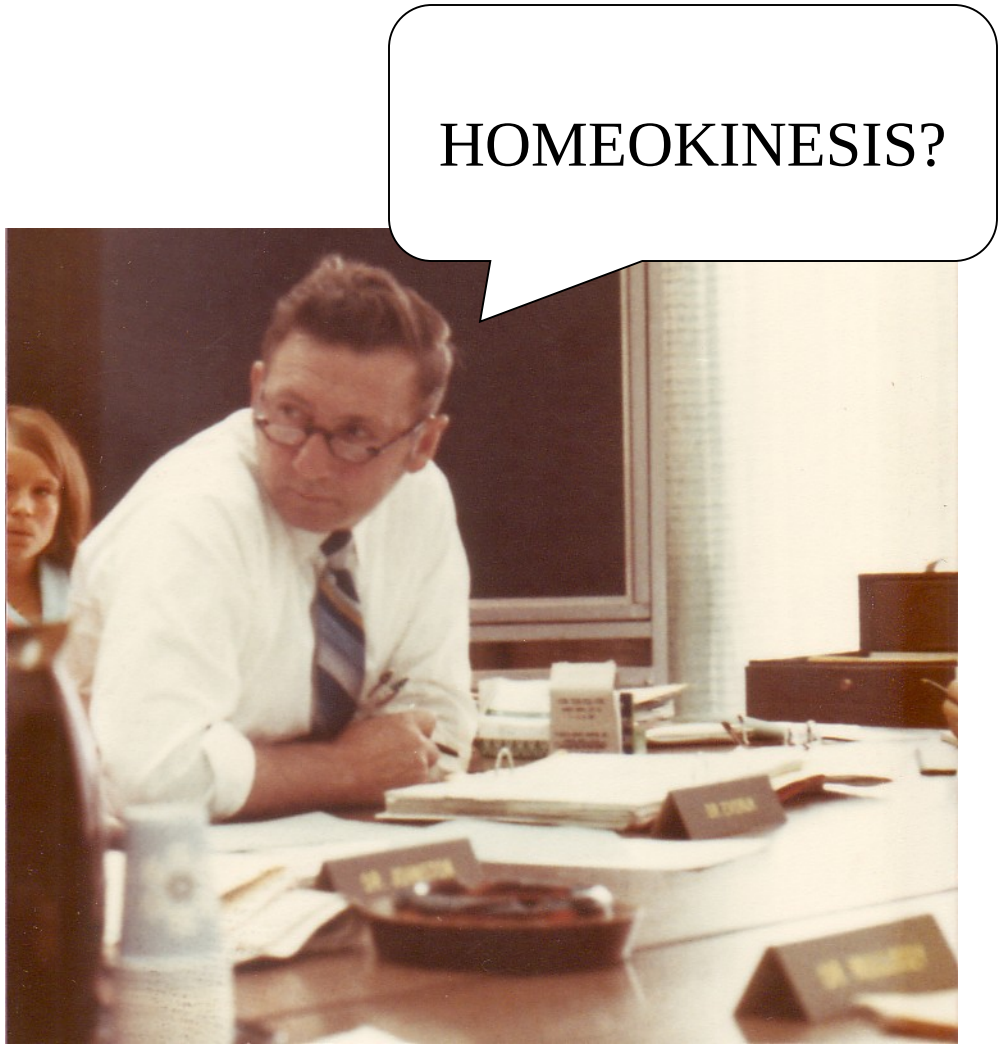
Where is extracellular fluid?



As long as <u>between/outside</u> cells, ECF everywhere?

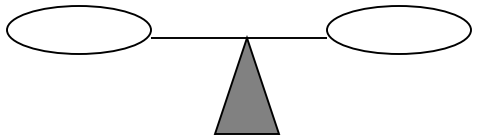
G&H 2011


Plasma
(within CV System)
ECF = Extracellular
Interstitium
(eg, between
muscle cells)
ICF = Intracellular


HOMEOKINESIS?

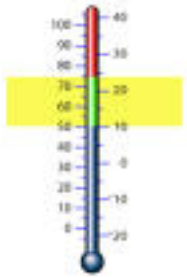
Metabolic

ANA- CATA-



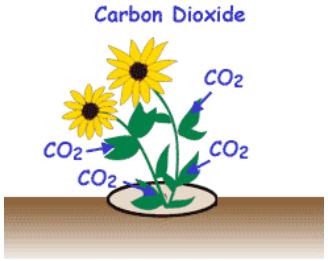
H_2O

T°C



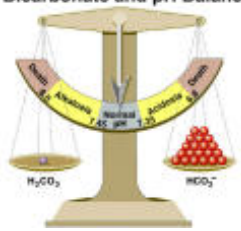
Dr. Evonuk's 6 Balances

O_2/CO_2



$Ion^{+/-}$

pH

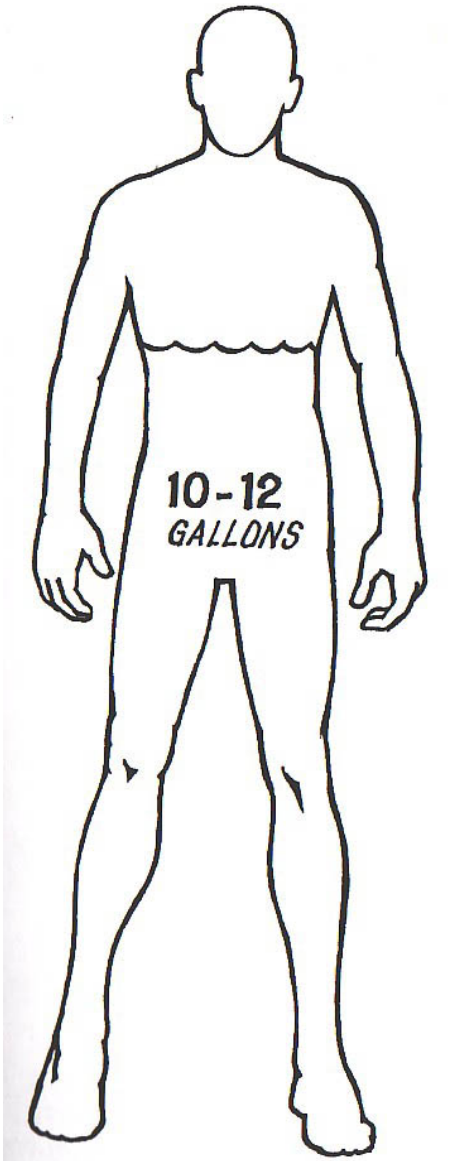


No, we're not watermelons, but H_2O is definitely critical!!

Drink about 1 L per 1000 calories energy expenditure!!

Human ~ 2/3 H_2O

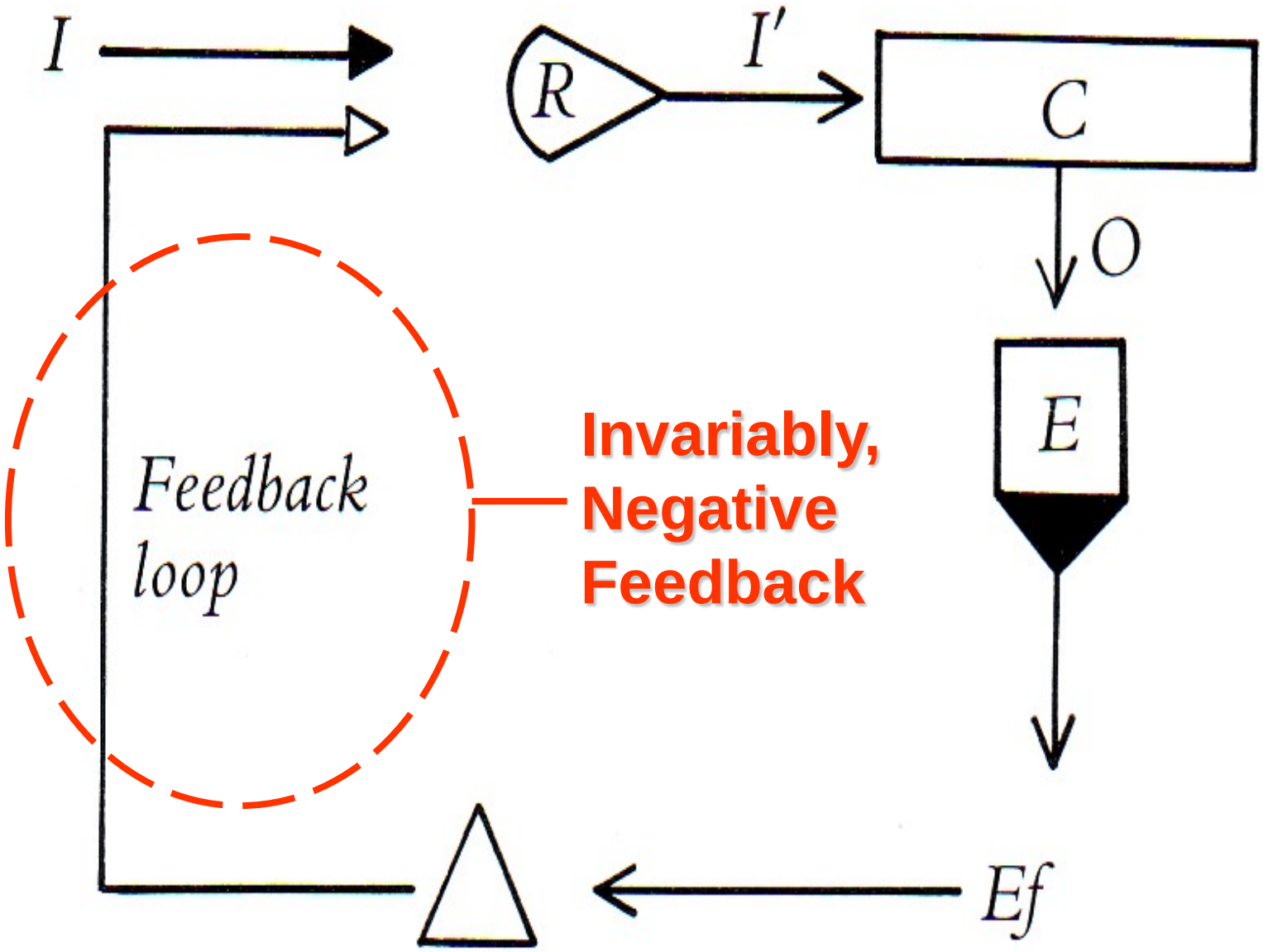
~ 60 – 70 %



150 lb /68 kg

***NB*: So 2000 kcal → drink 2000 mL ≡ 67.63 fl oz ≡ ~ 8 cups!**

= ~40 – 48 kg H_2O


I
R
I′
C
O
E
Feedback loop
Invariably, Negative Feedback
Ef

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

70% H_2O
= 49L

eg

ICF =
35L

+

ECF = 14L

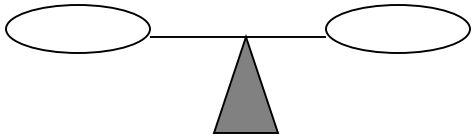
[Interstitium = 11L
Plasma = 3L]

H_2O

INPUT

Dietary Drink	1200 mL
Dietary Eat	400 mL
Oxidation	400 mL
Total =	2000 mL ✓

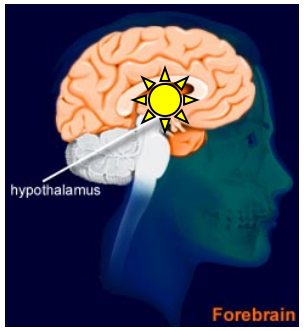
BALANCE!



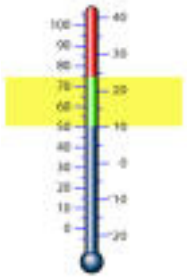
OUTPUT

Urine	1000 mL
Sweat + Insensible	900 mL
Feces	100 mL
Total =	2000 mL ✓

Controller = Hypothalamus with Set Point



T°C



T°C

Lethal

42°C

Protein Denaturation

True Diurnal Variation

110°F

Set Point

37°C

98.6°F

35°C

Mild Hypothermia

Profound Hypothermia

33°C

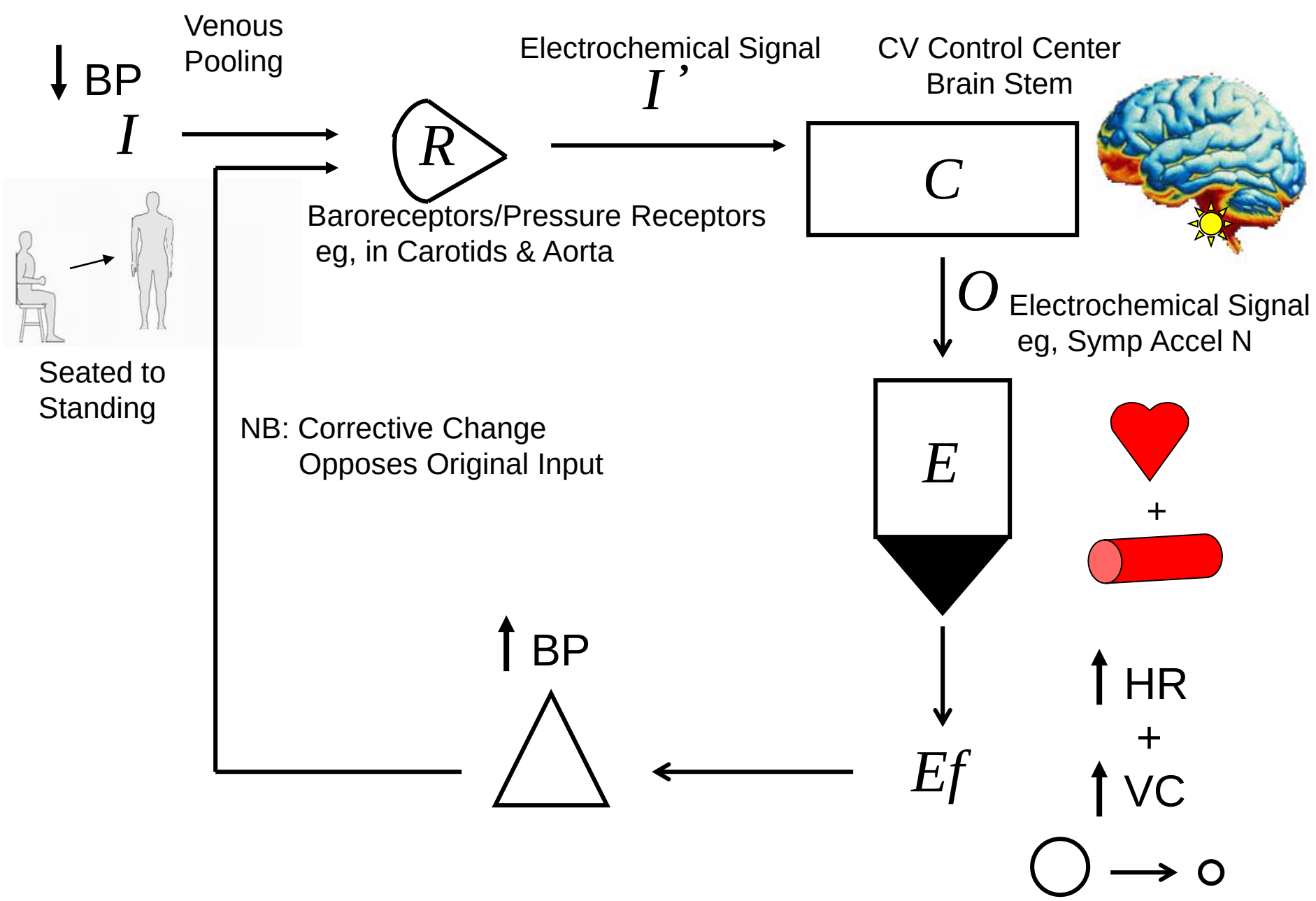
< 30°C

Lethal

29°C

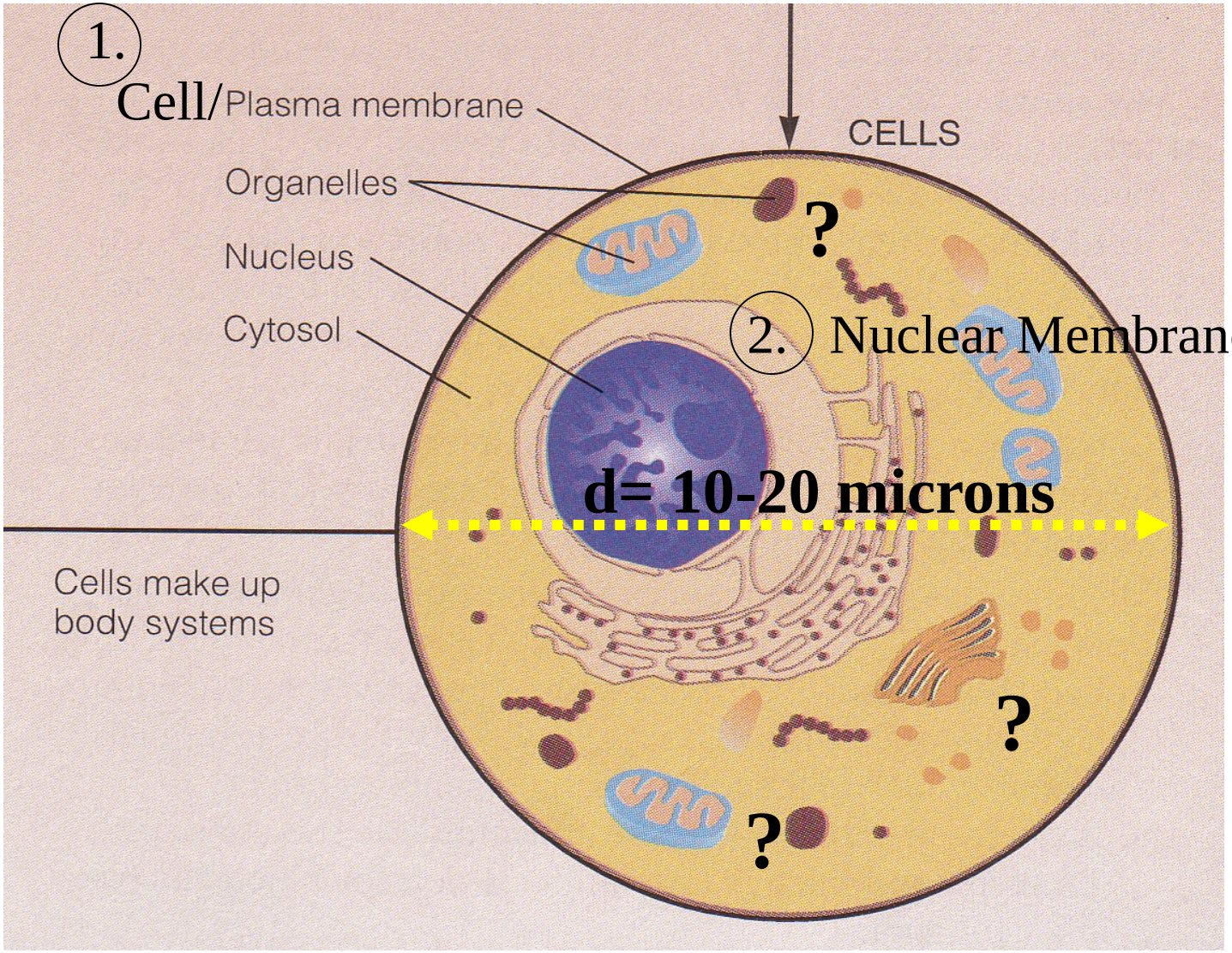
0600 1400 0600 1400

Time of Day


BP
I
Venous Pooling
R
Baroreceptors/Pressure Receptors
eg, in Carotids & Aorta
Electrochemical Signal
I'
CV Control Center
Brain Stem
C
O
Electrochemical Signal
eg, Symp Accel N
Seated to Standing
NB: Corrective Change
Opposes Original Input
E
+
BP
Ef
HR
+
VC

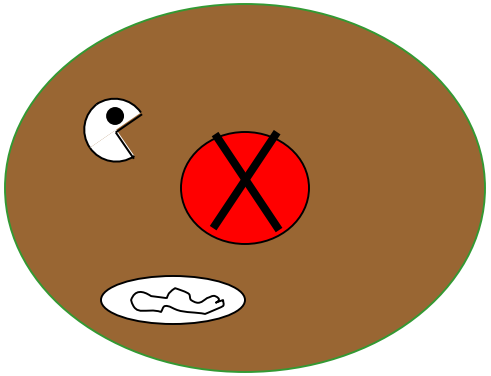
Group Discussion + Break!

HOW BIG? 100 CELLS LENGTHWISE = 1 mm!!



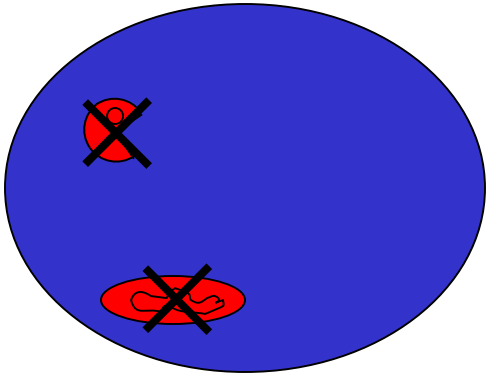
Cytoplasm = Cell - Nucleus

[Extract nucleus; includes organelles]



Cytosol = Cytoplasm - Organelles

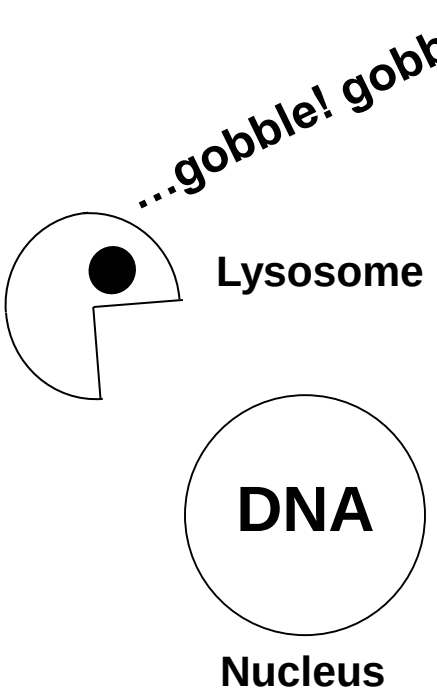
[Extract organelles; complex gel-liquid]



Why Compartments? Advantage?

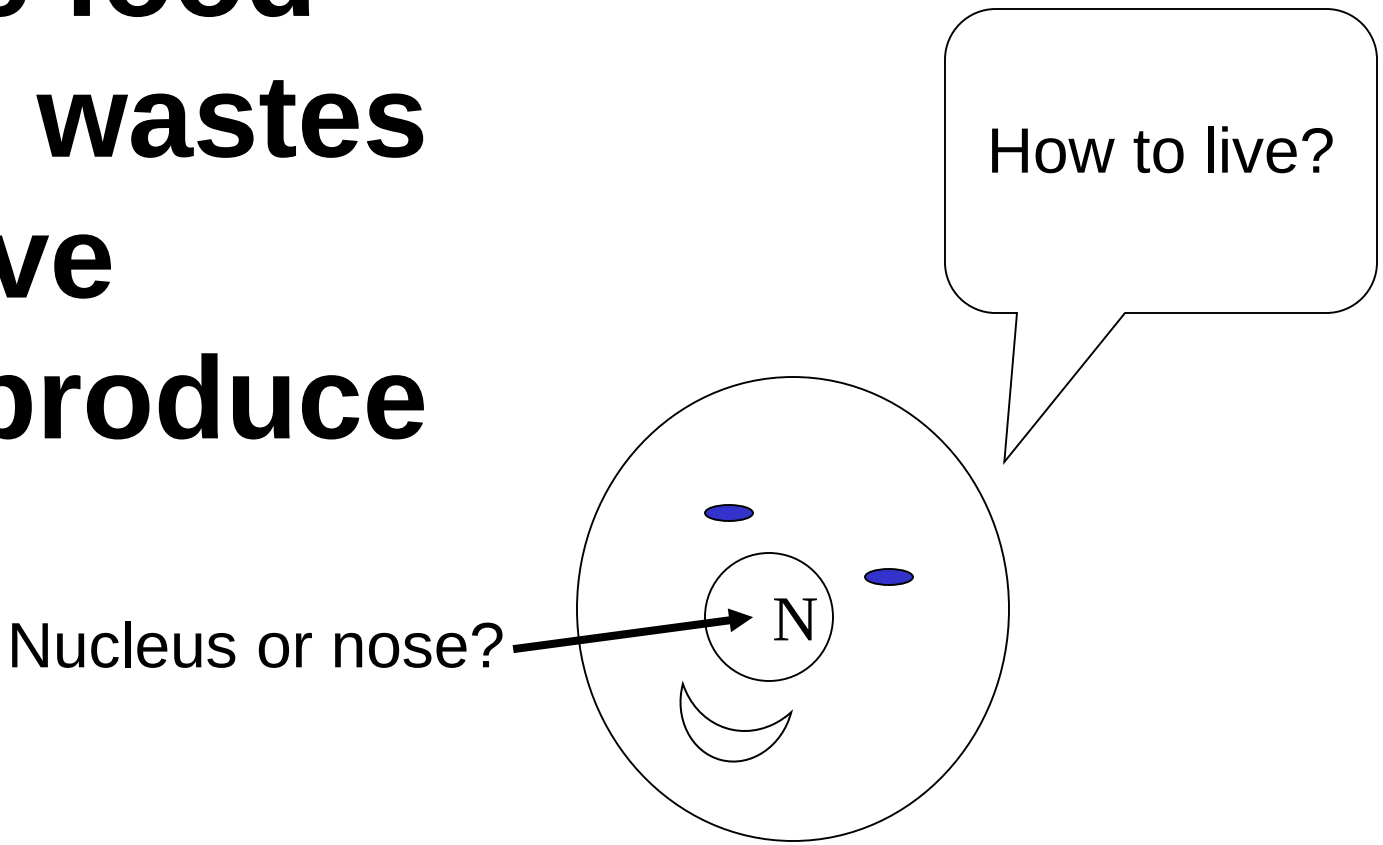
<u>*Incompatible*</u> reactions can take place

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



Basic Cell Survival Skills?

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



1 e.g. Cell of 100 Trillion!

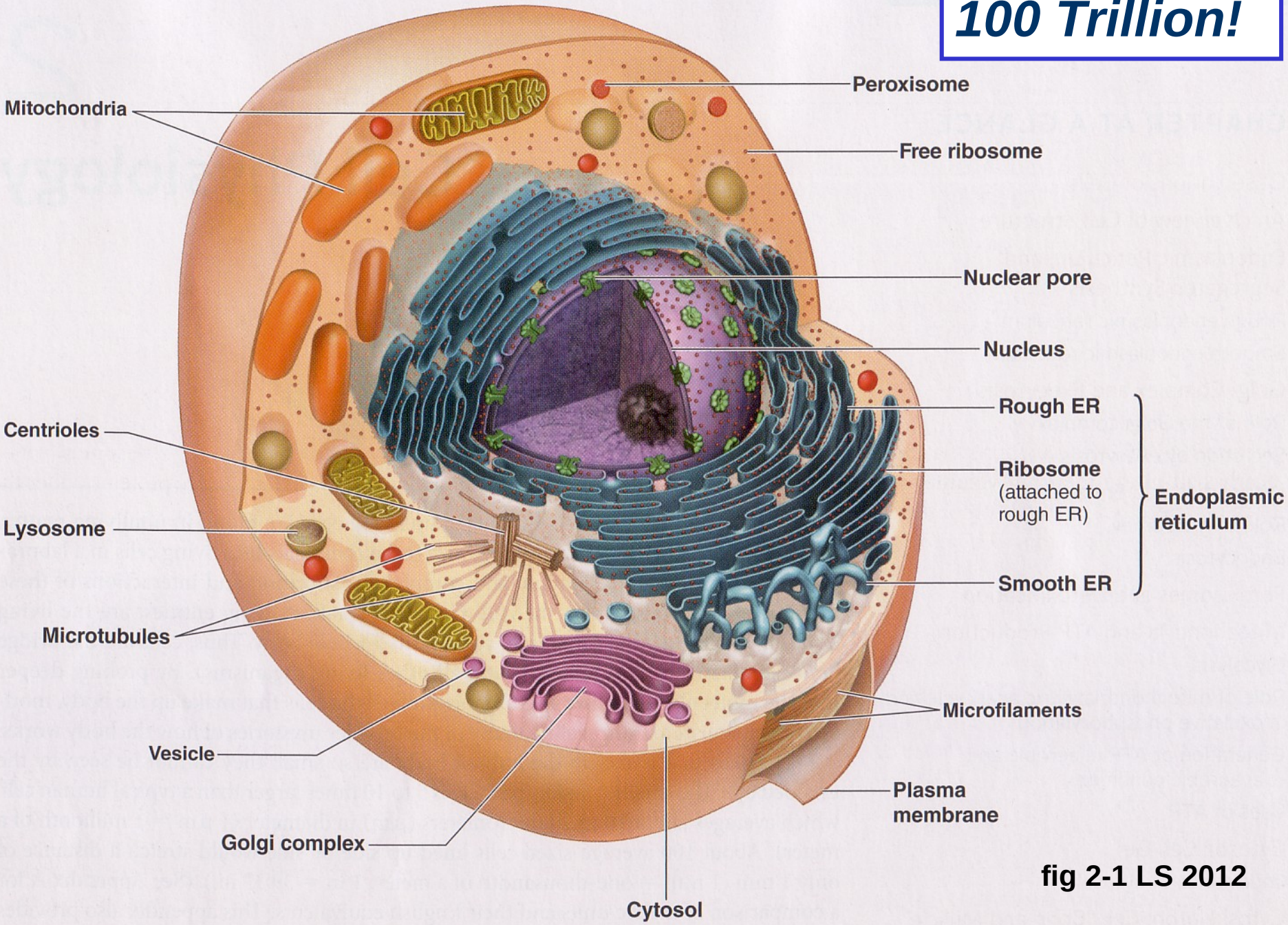
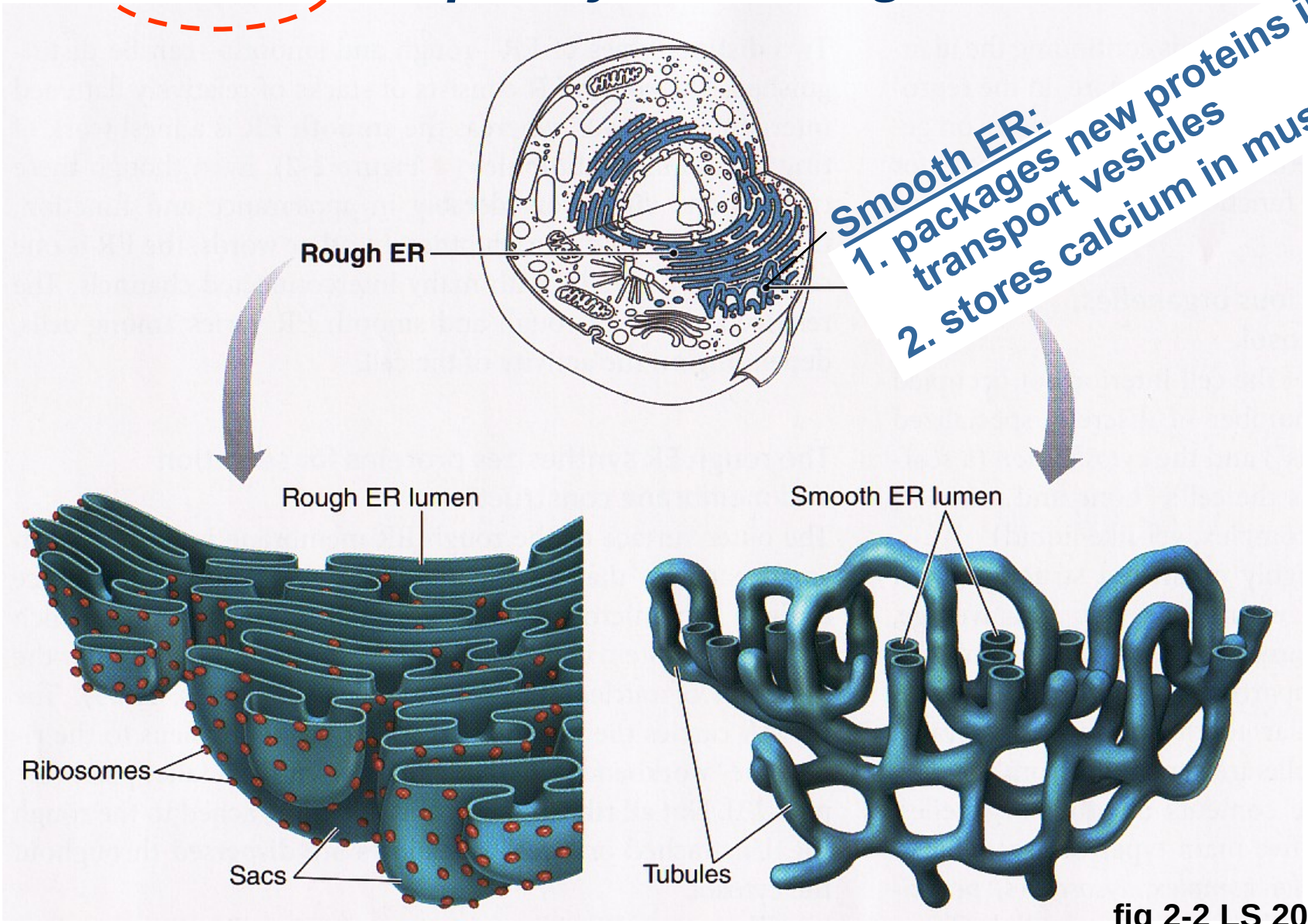


fig 2-1 LS 2012

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

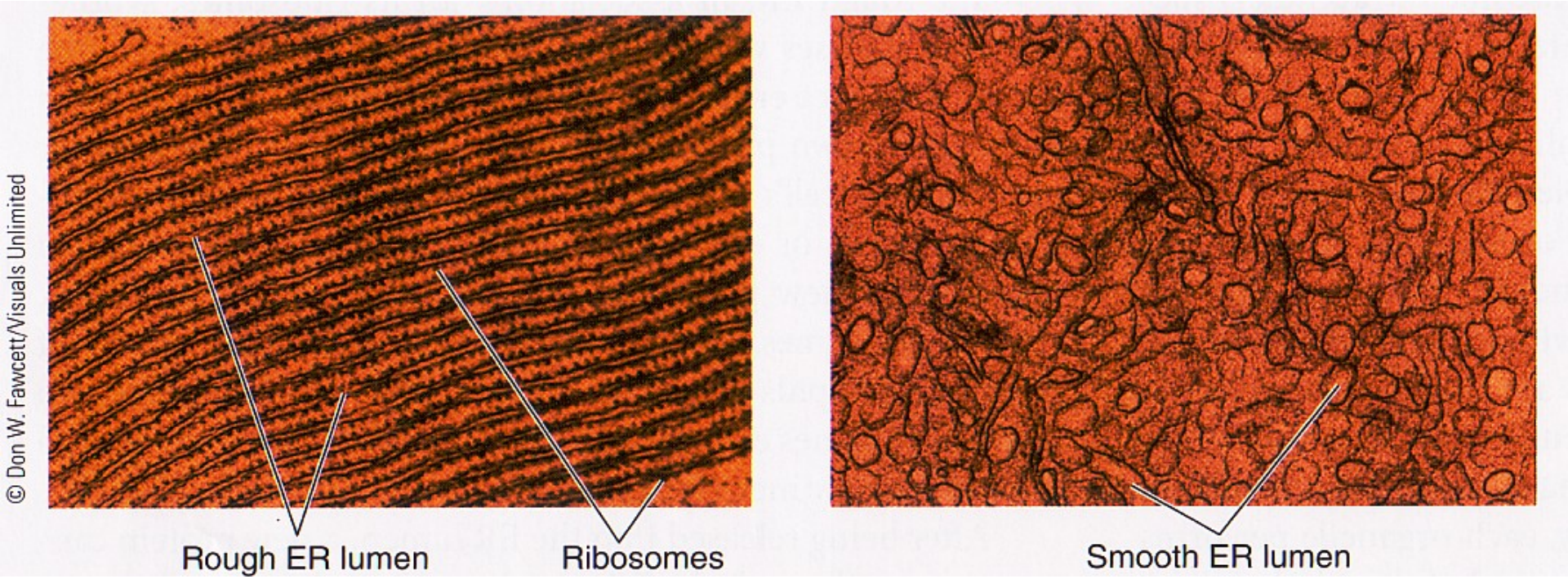


fig 2-2 LS 2012

Secretion of Proteins Produced by ER

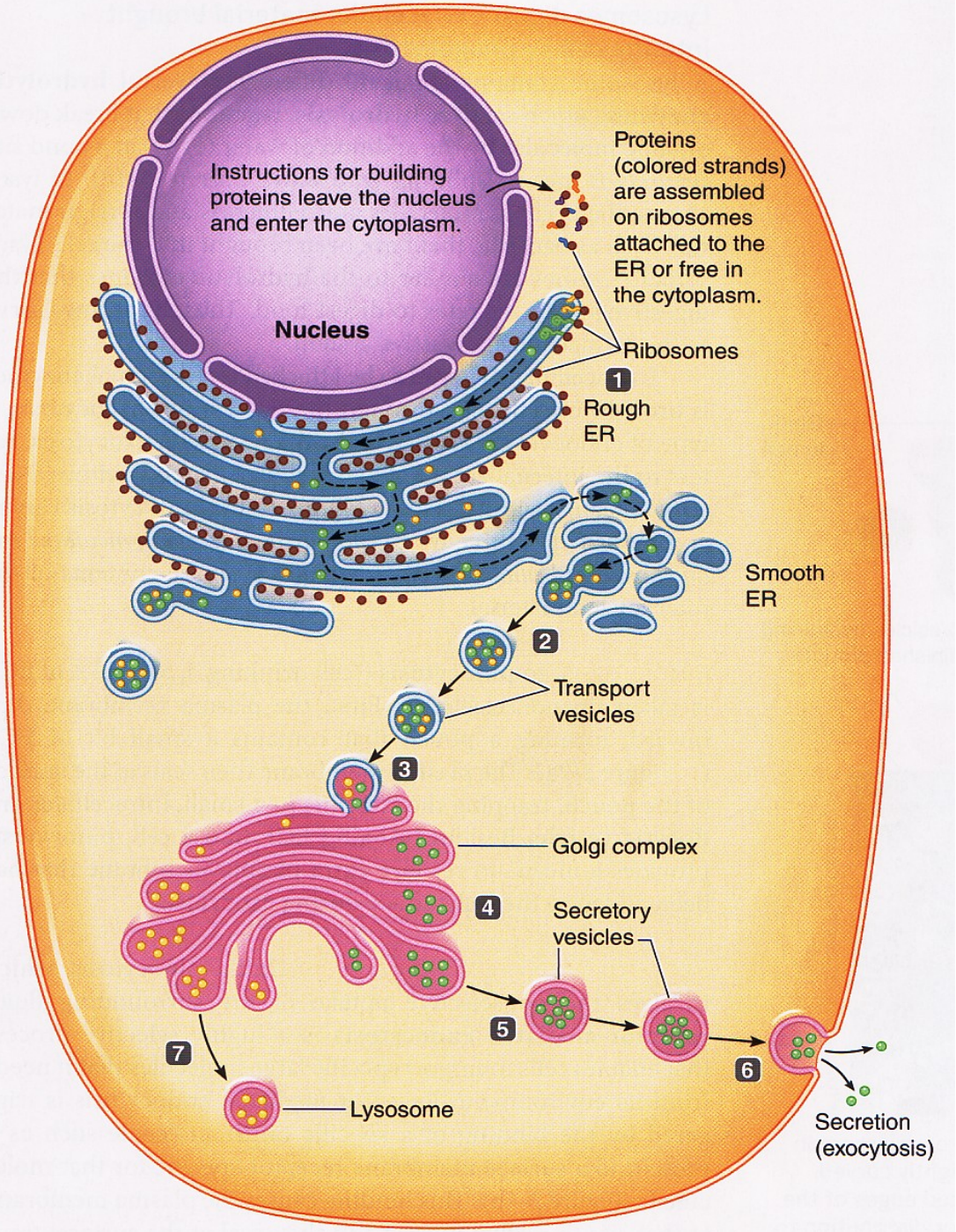


fig 2-3 LS 2012

Golgi Complex: Final Processing, Packaging & Distribution

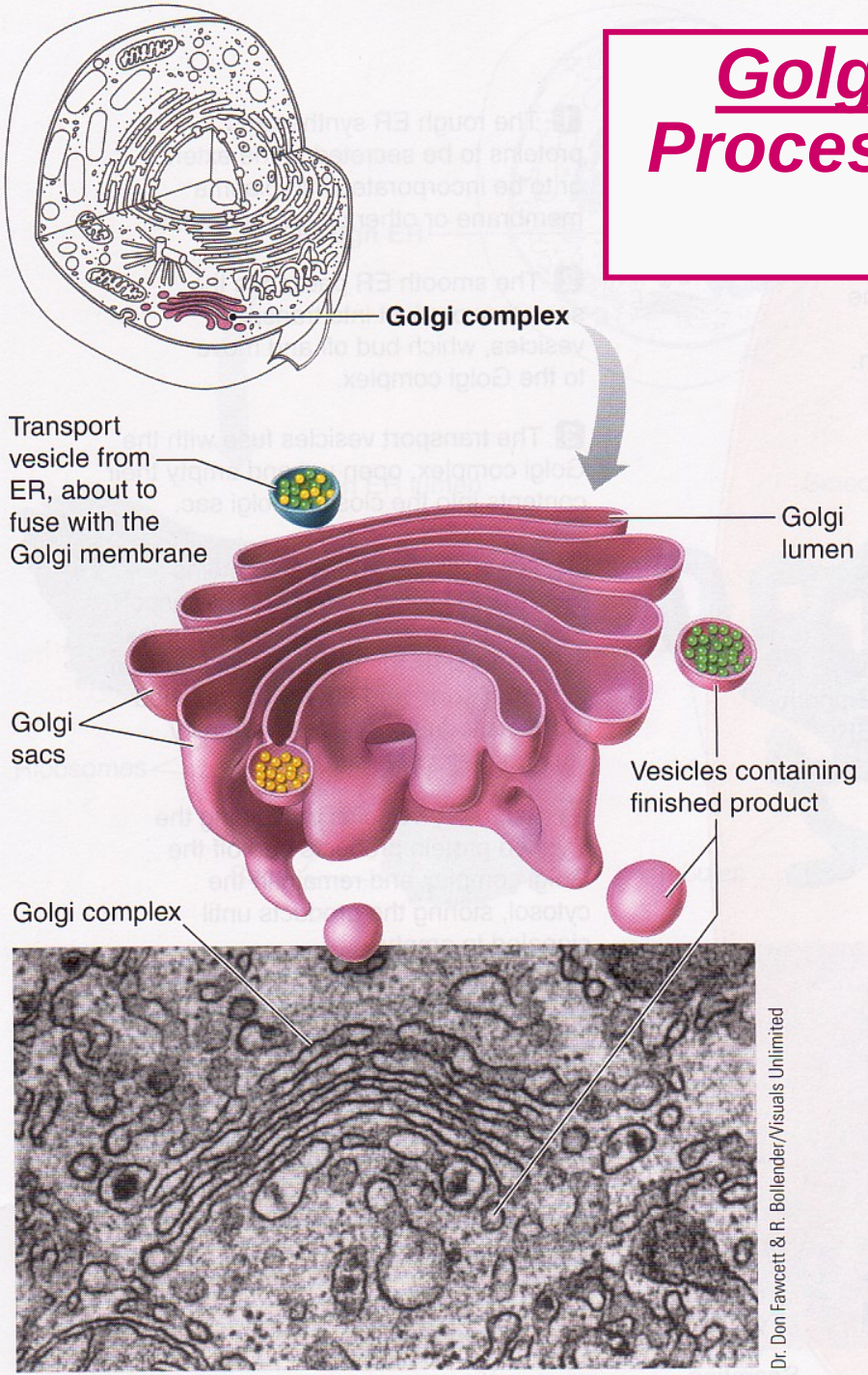
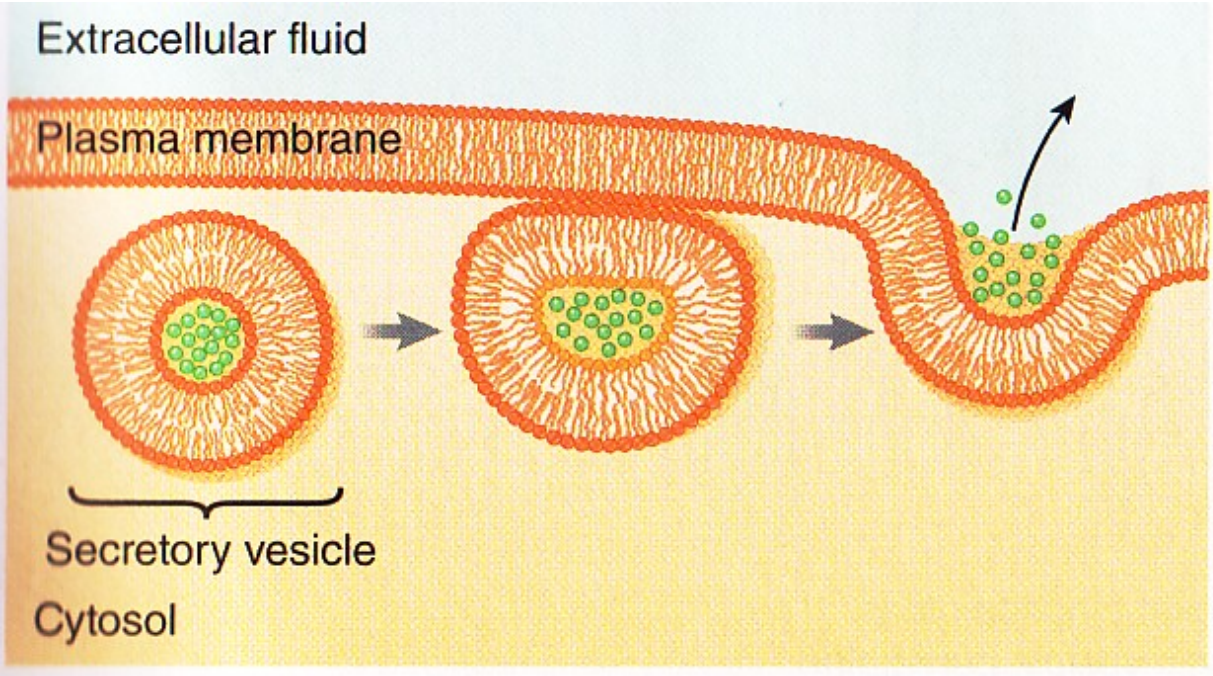


fig 2-4 LS 2012

Exocytosis: Primary Means of Secretion



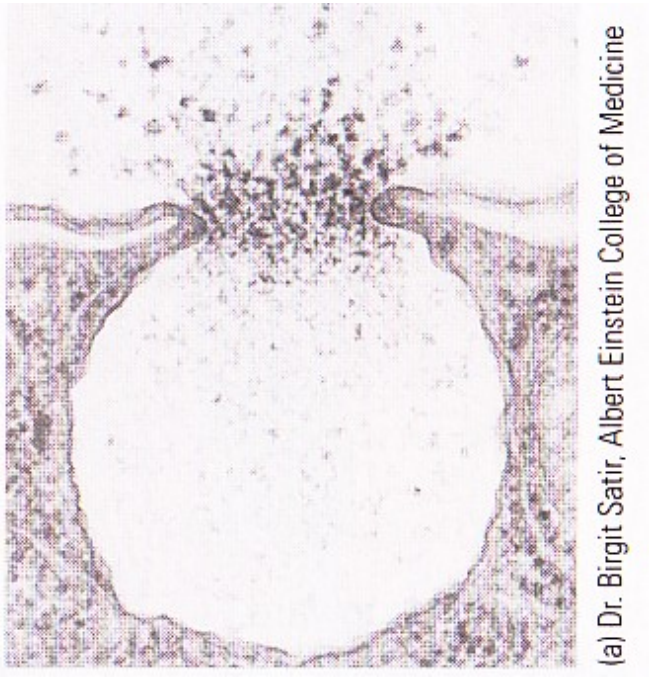
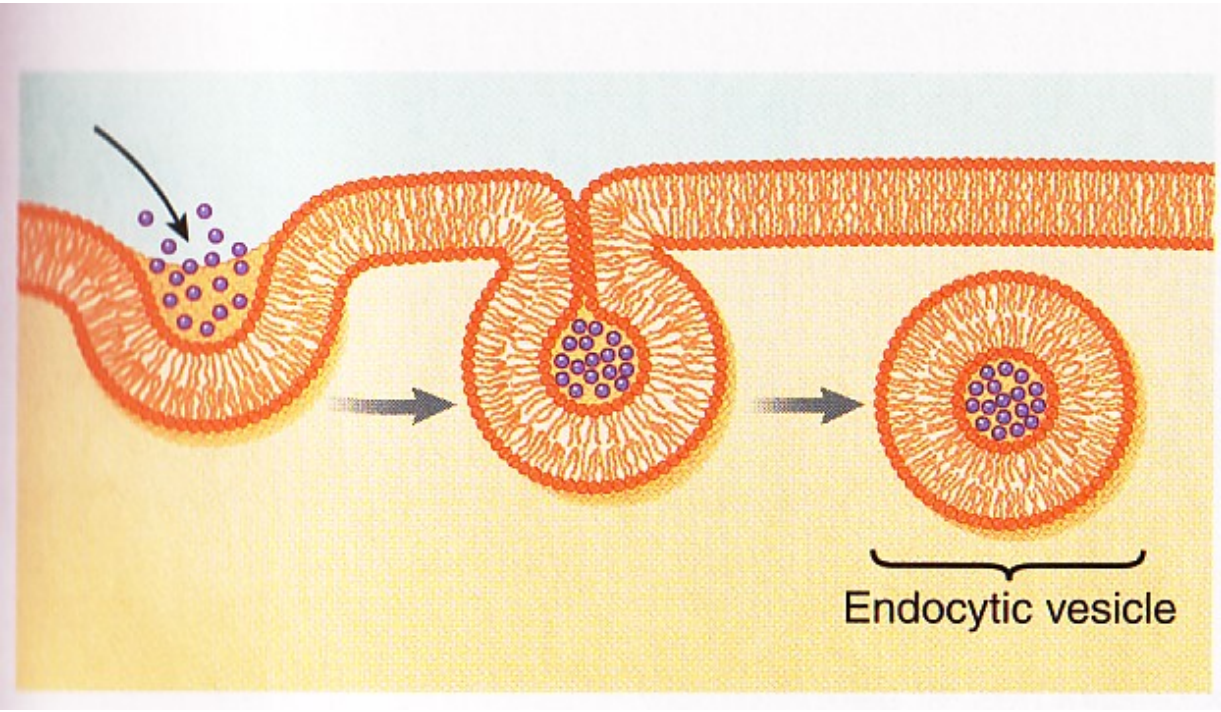


fig 2-5a LS 2012

Endocytosis: Primary Means of Ingestion



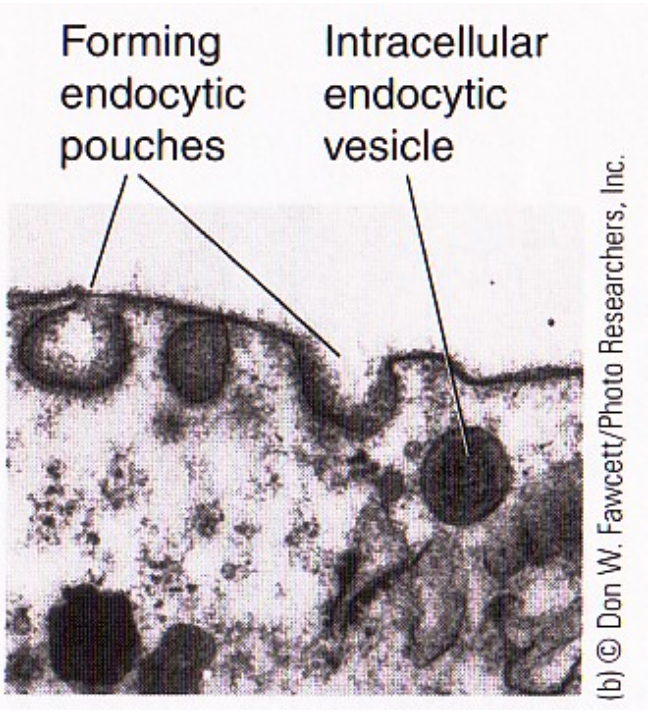


fig 2-5b LS 2012

Lysosomes vs. *Peroxisomes*

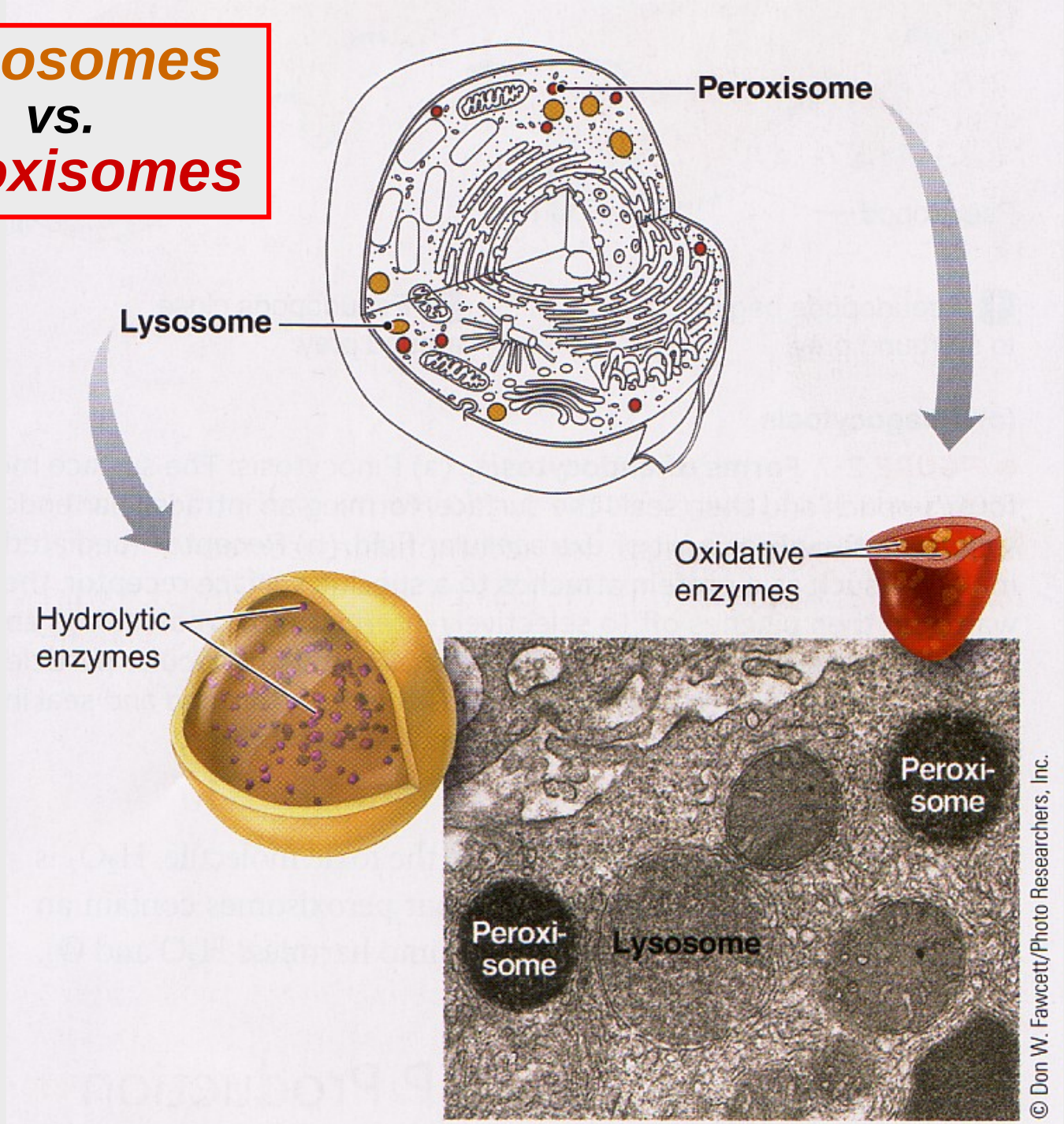


fig 2-6 LS 2012

Phagocytosis: Cell Eating!

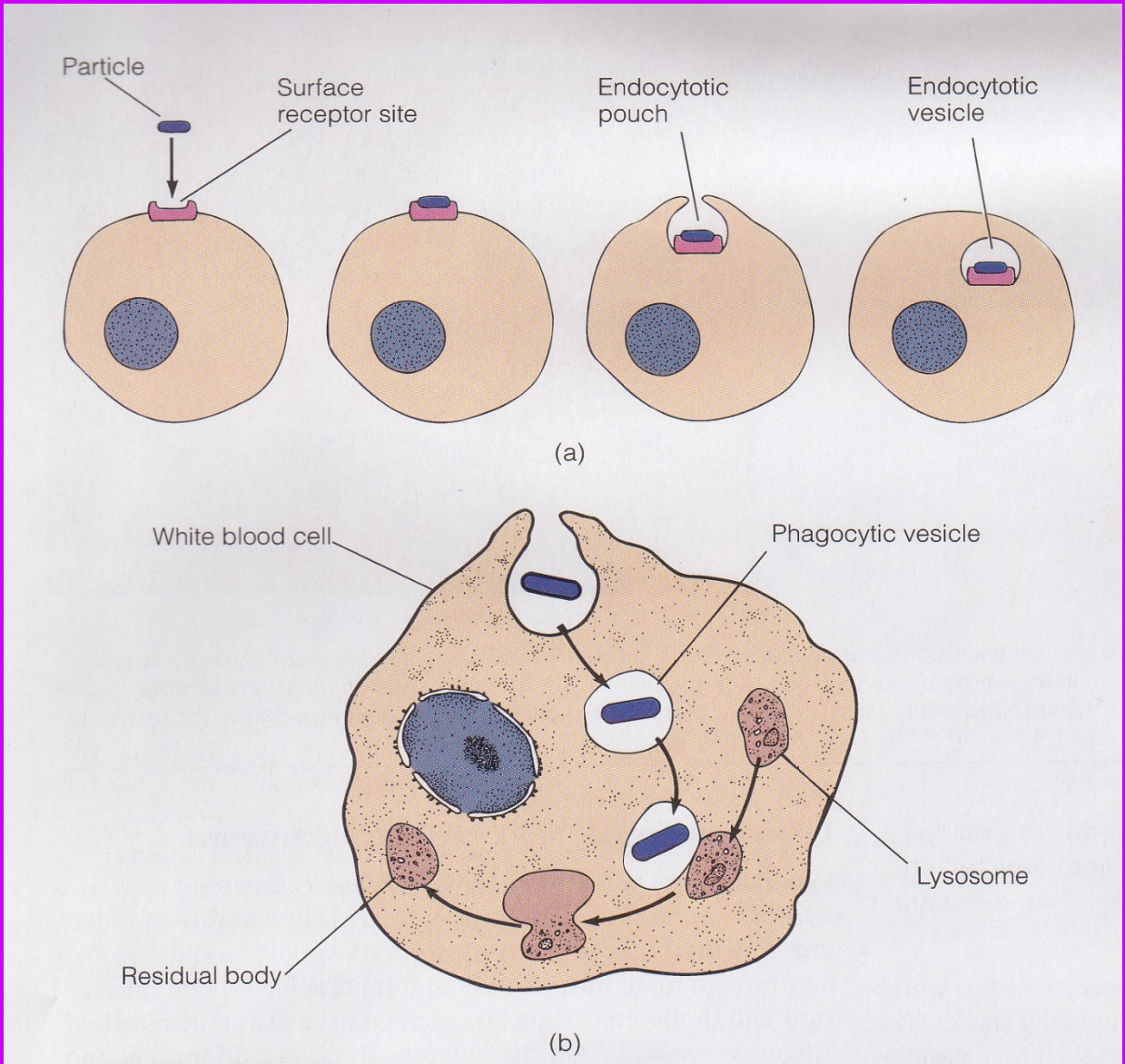
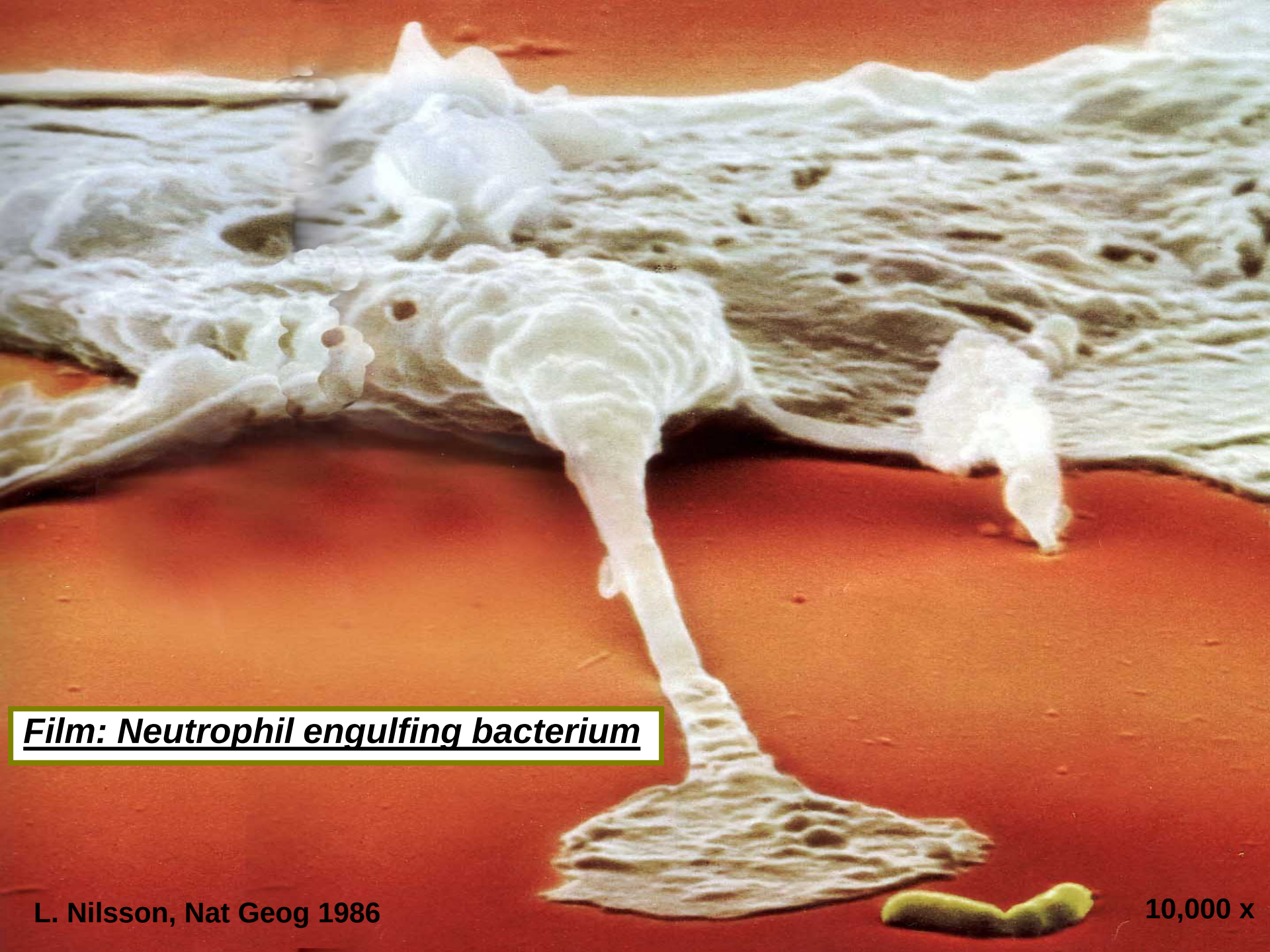
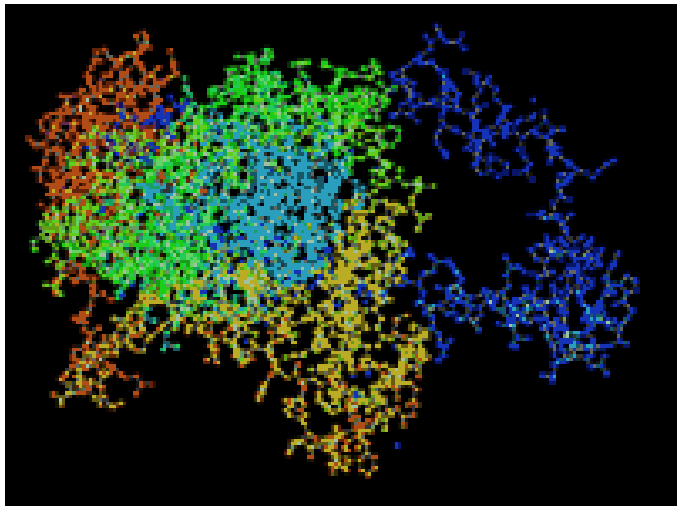


fig 2-7 LS 2006


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

Catalase Enzyme Reaction in Peroxisomes Neutralize Toxin at Production Site!



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

Mitochondria: Energy Organelles

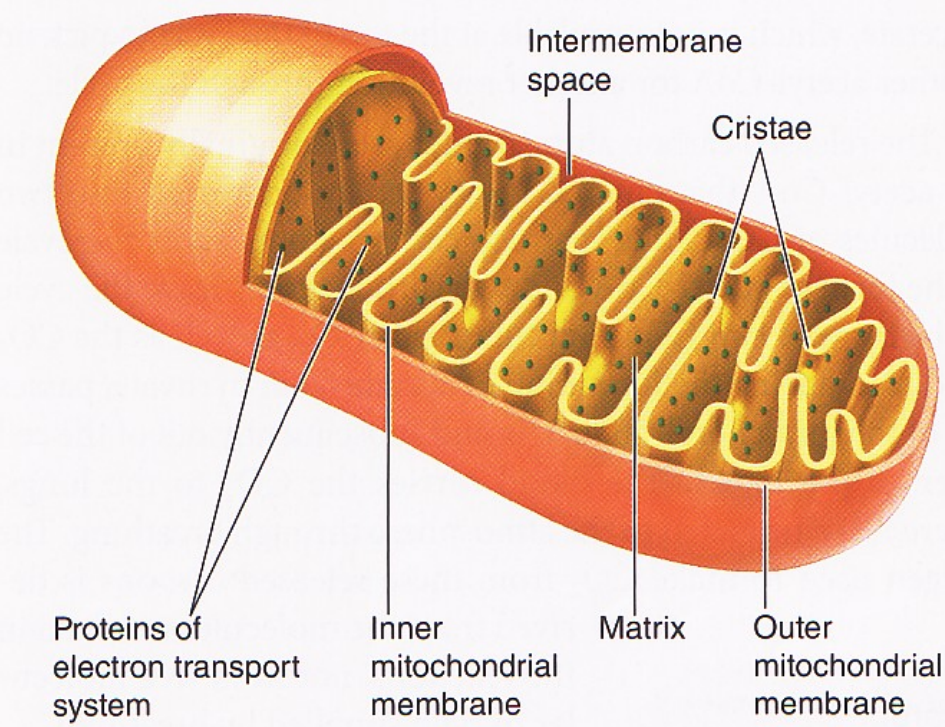
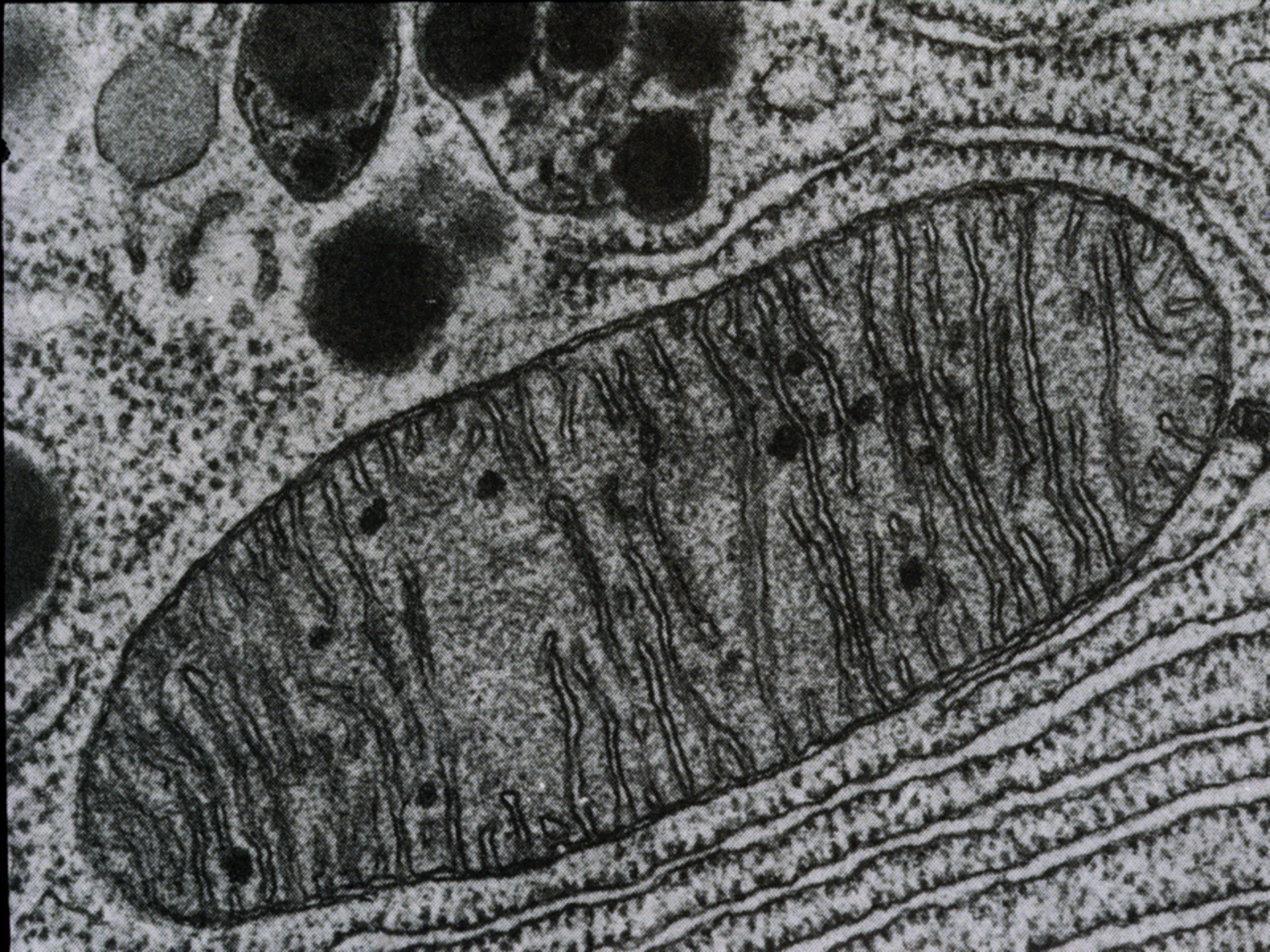
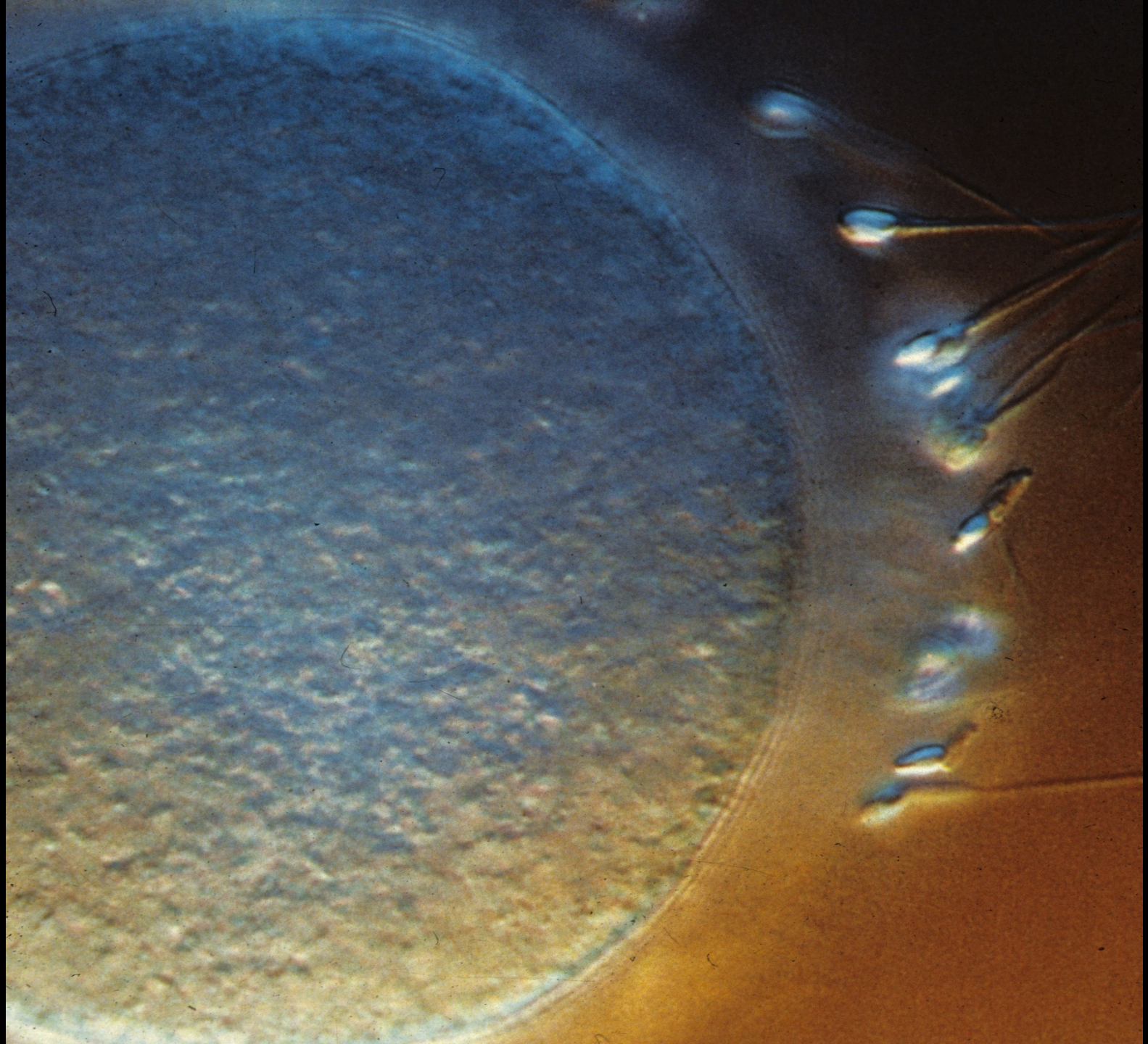


fig 2-8 LS 2012





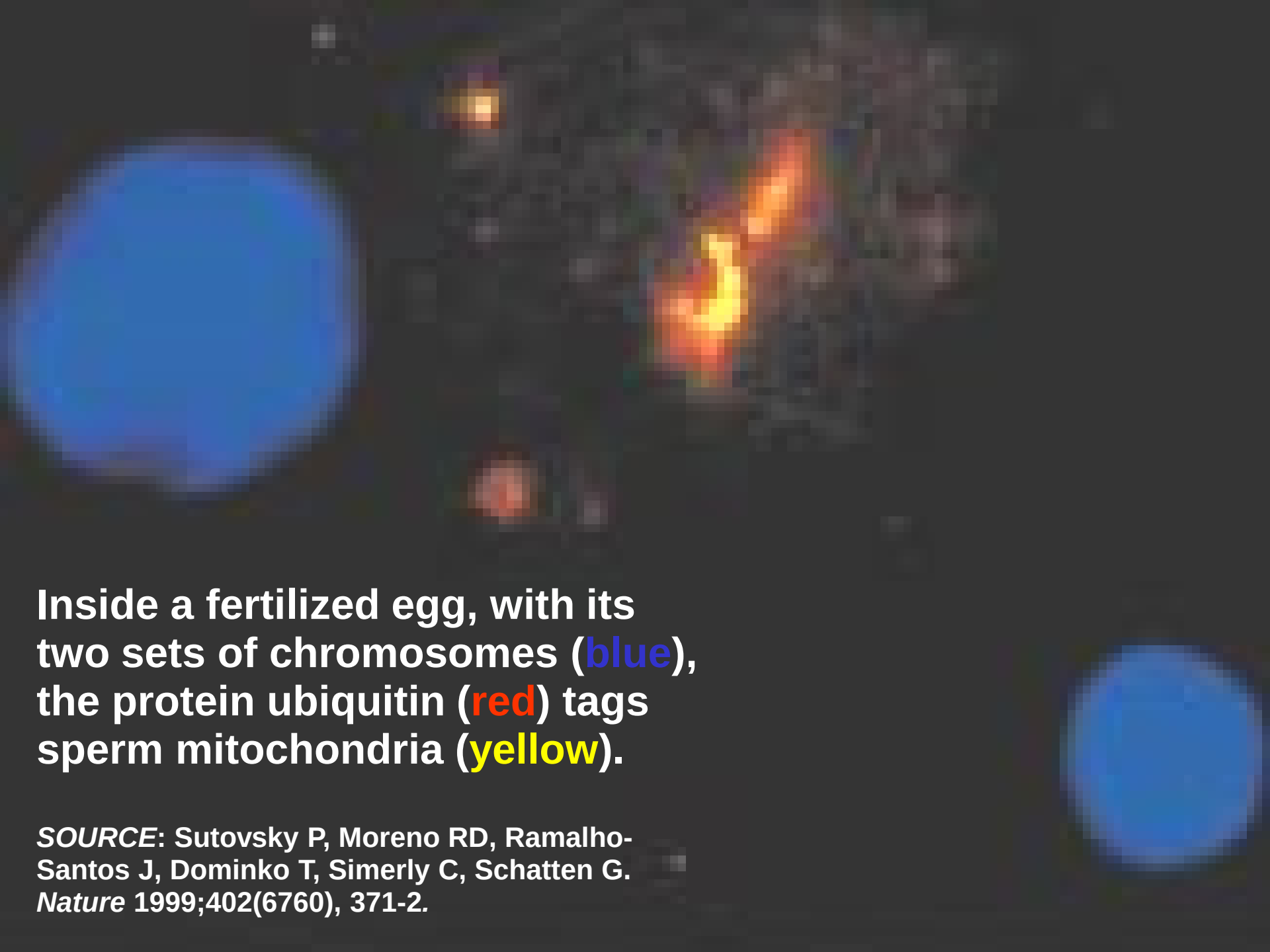
Mom's eggs execute Dad's mitochondria

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-

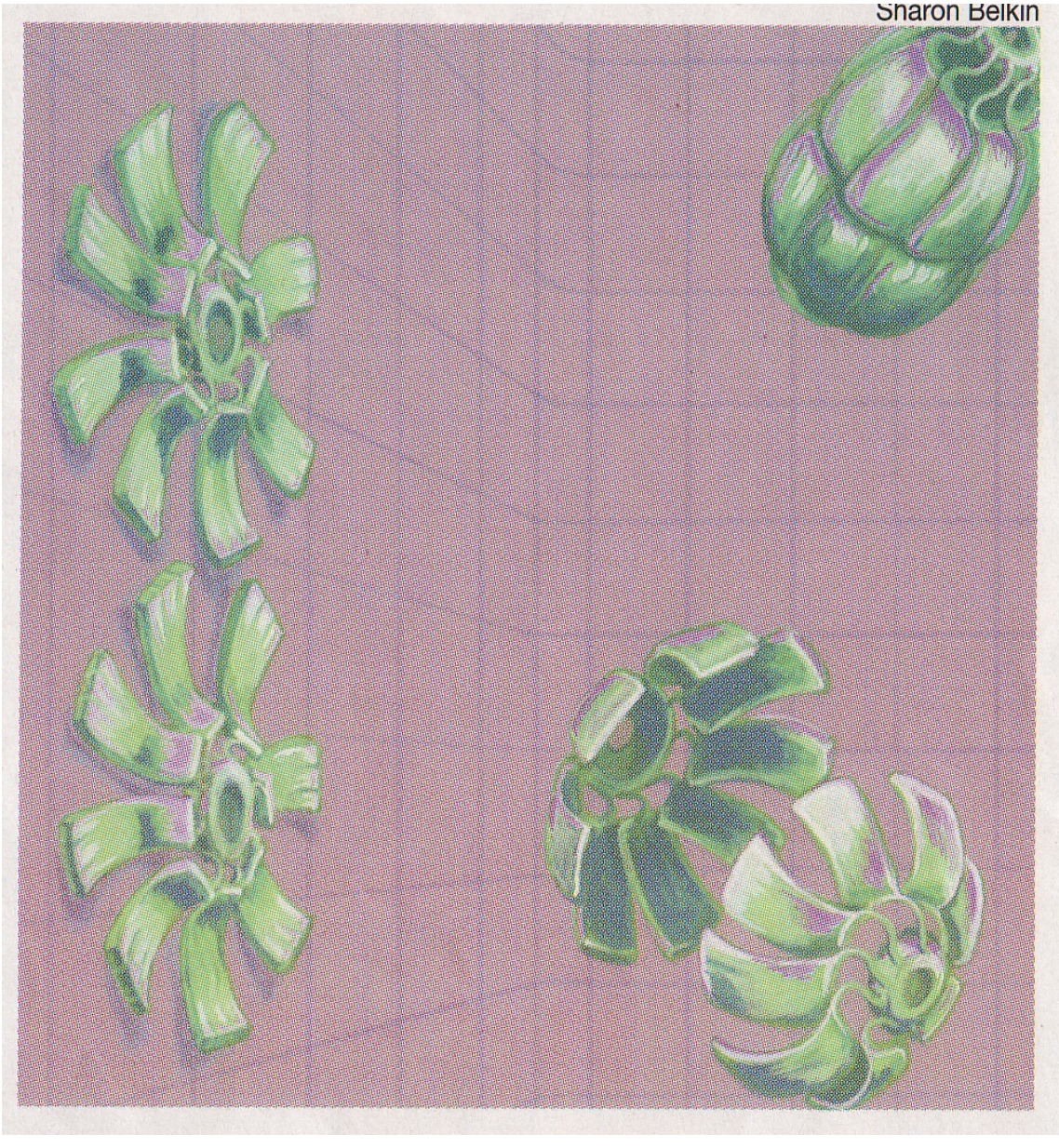
through a microscope. But if it were contaminated with objects that shrug off the stain, that sea would be dotted with white islands. Rome likens the strategy to finding an invisible person by looking for an unexplained shadow in the beam of a spotlight.

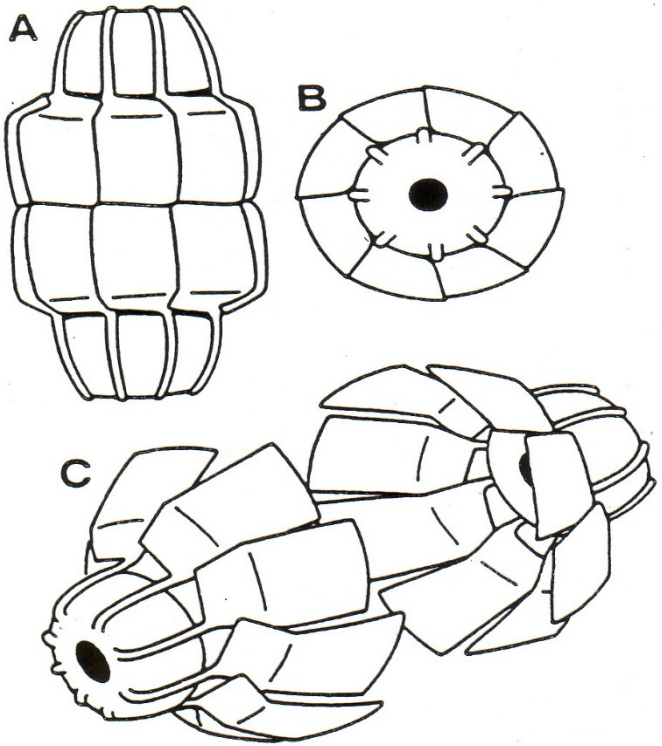
To Kedersha's surprise, unstained ovoid objects appeared among her coated vesicles. Since some of the stain settled into furrows on top of the unexpected shapes, the negative staining revealed fine details of the exterior of these mysterious interlopers, including arches that reminded Rome and Kedersha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

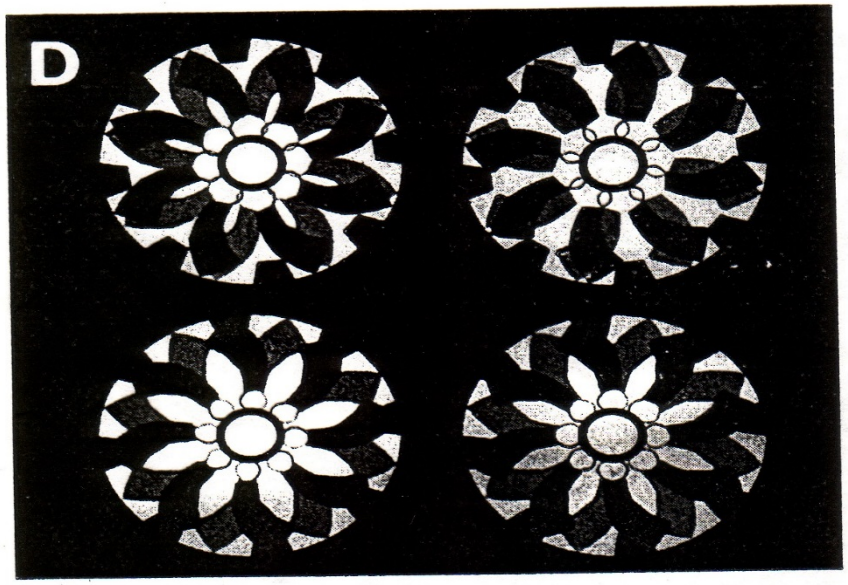
us something by this incredible structure. And the one thing we might surmise from the structure [of vaults] is that they might contain something," says Rome.

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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