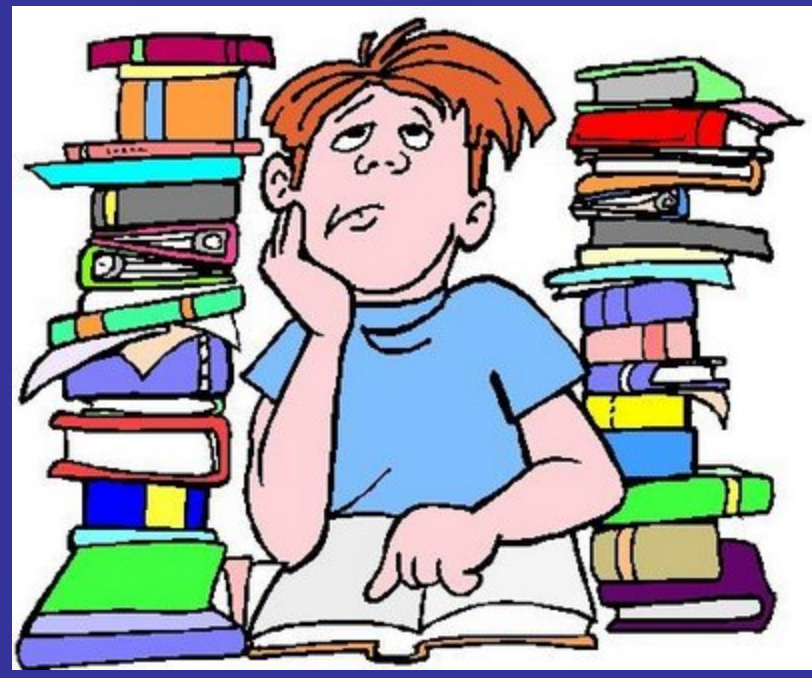
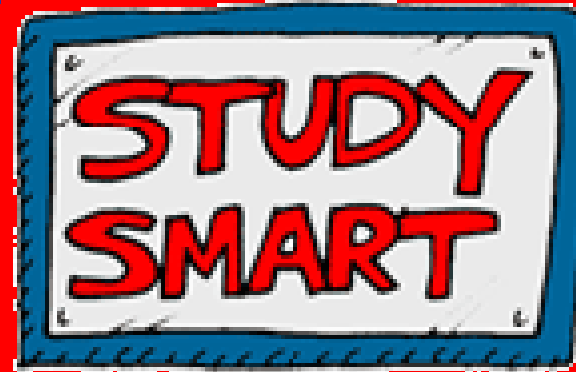
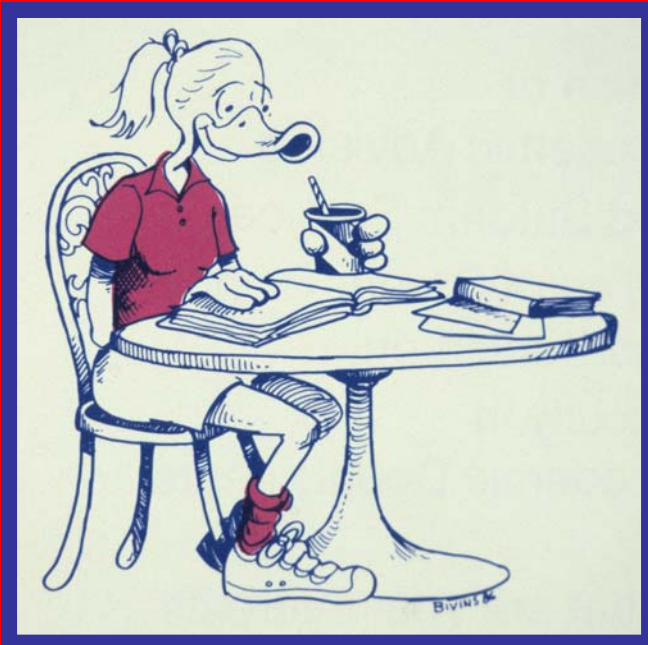


Midterm Review Slides



...Welcome to Human Physiology – what makes us tick!

BI 121 Lecture 1



G. Waples

I. Announcements: Please check & sign attendance roster.

Not on list? See Pat during a break or after class. *Lab 1 Histology* tomorrow in 130 HUE: 12 n & 1 pm sections.

II. Introduction: Staff, office hr, required sources, course overview, grading, expectations & success. Q?

III. Human Physiology LS ch 1, DC Module 1,

A. What? cf: Anatomy LS p 1

B. Where? Body Levels of Organization LS pp1-6, DC pp1-5

C. How? Different Study Approaches LS p 1

D. Why? Security+Decision-Making Power LS p xxi, DC p v

IV. Homeostasis LS ch 1, DC Module 1

A. What? Maintenance of ECF LS p 8

B. Where? ECF = Plasma + Interstitium LS fig 1-4 p 8

C. How? Simplified Homeostatic Model cf: LS fig 1-7 p 14
Balances LS p 9, DC pp 5-6

D. Why? Cell survival! LS fig 1-5 p 9, DC p 5

ANATOMY
STRUCTURE
WHAT?
WHERE?

VS

PHYSIOLOGY

VS

FUNCTION

VS

HOW?

VS

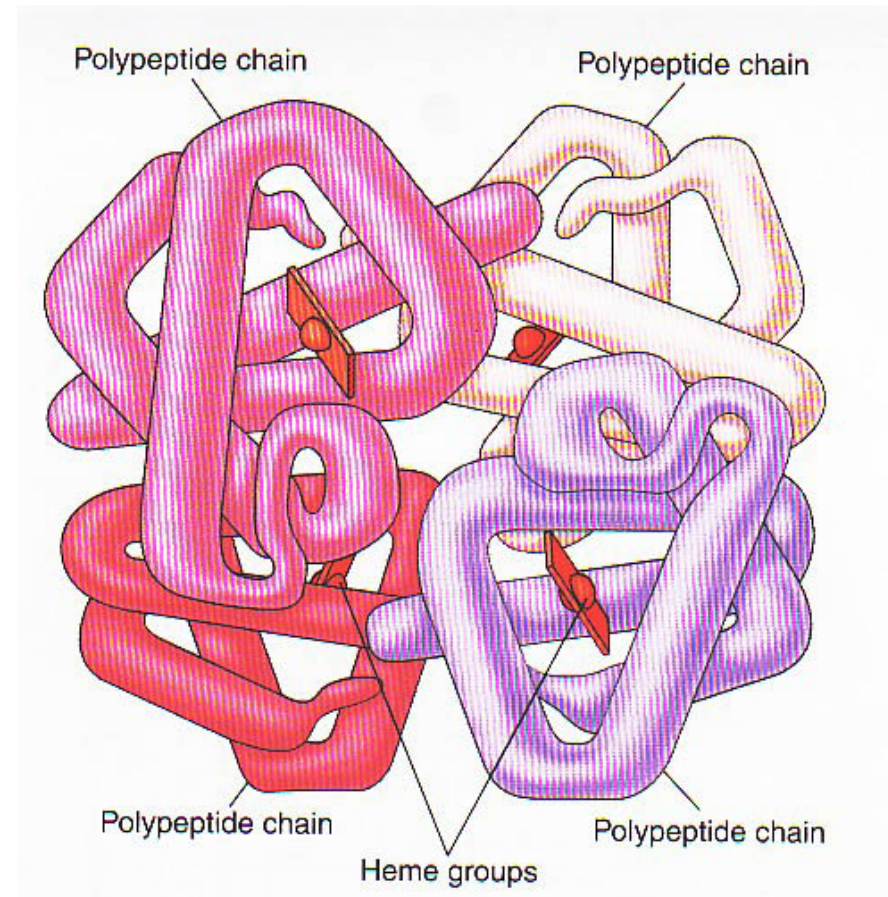
WHY?



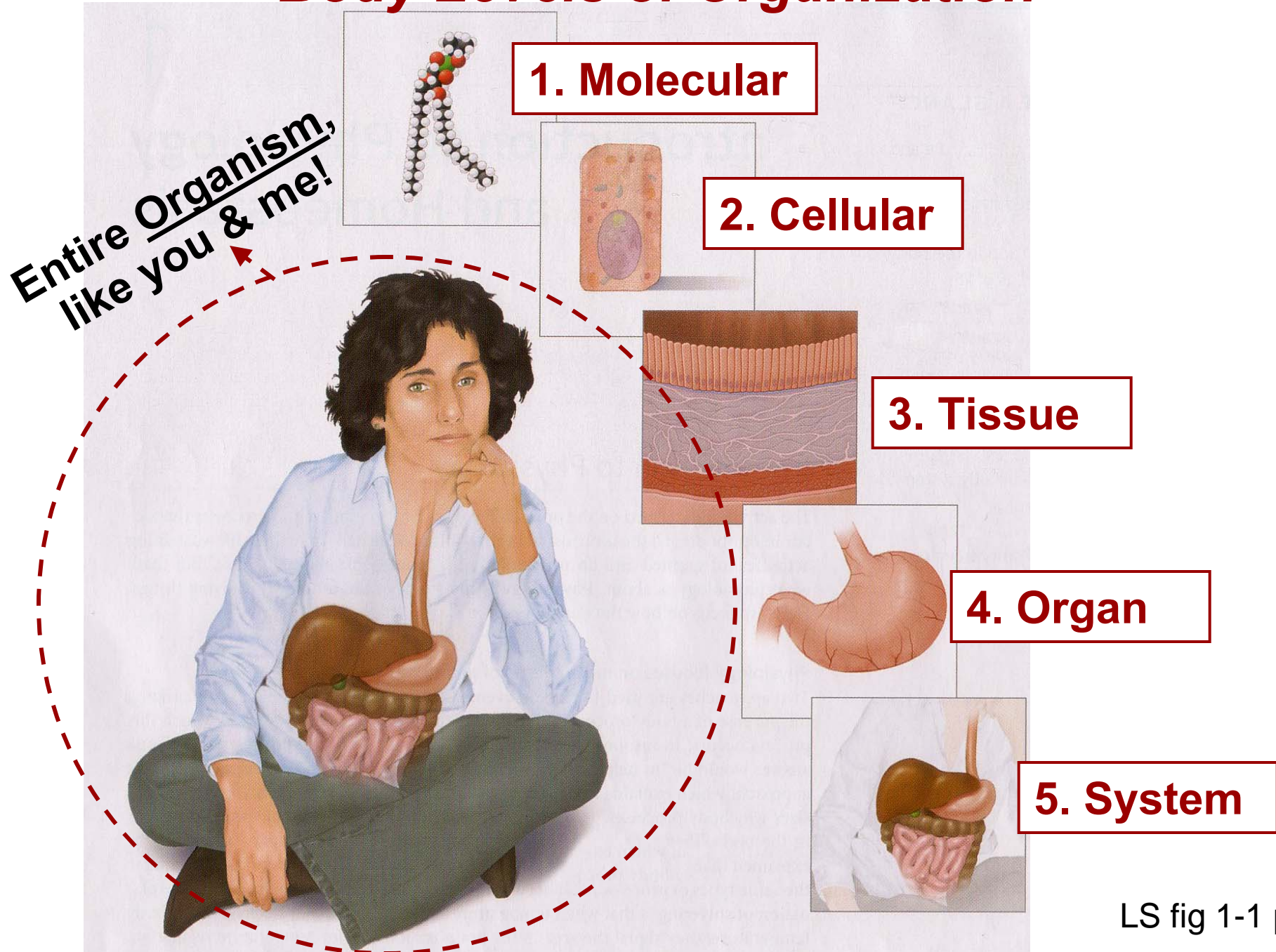
VS

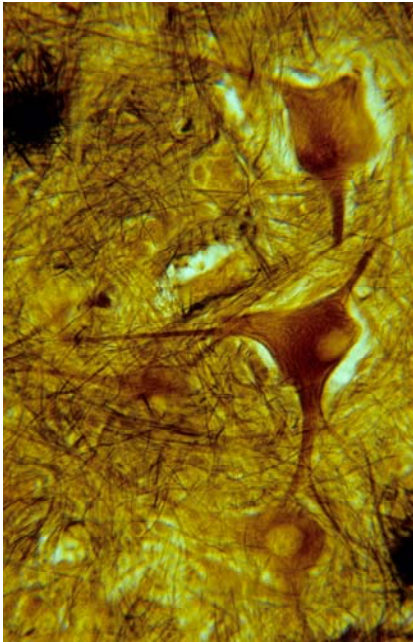


Structure begets function!
Structure gives rise to function!
Structure & function are inseparable!

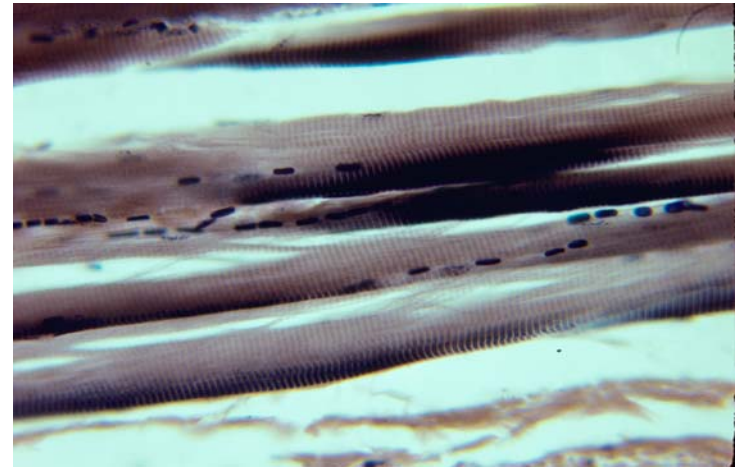


Body Levels of Organization

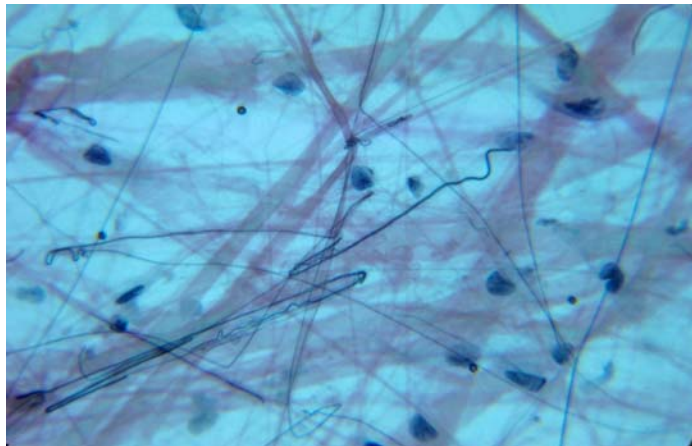




Nerve conducts



Muscle contracts

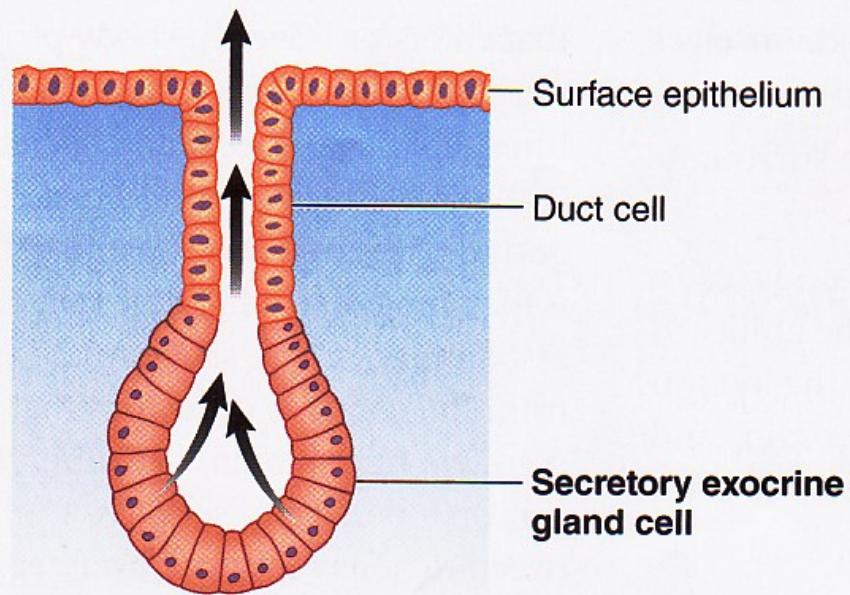


Connective connects!!

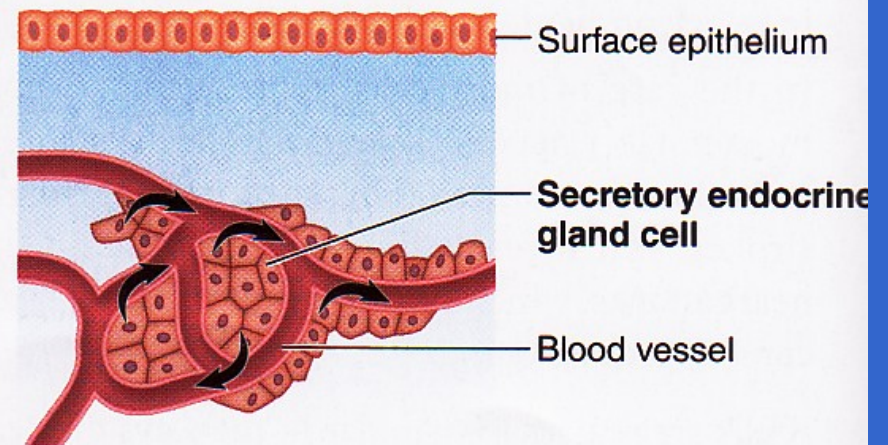


Epithelial covers

Epithelial tissue gives rise to glands: (a) exocrine & (b) endocrine

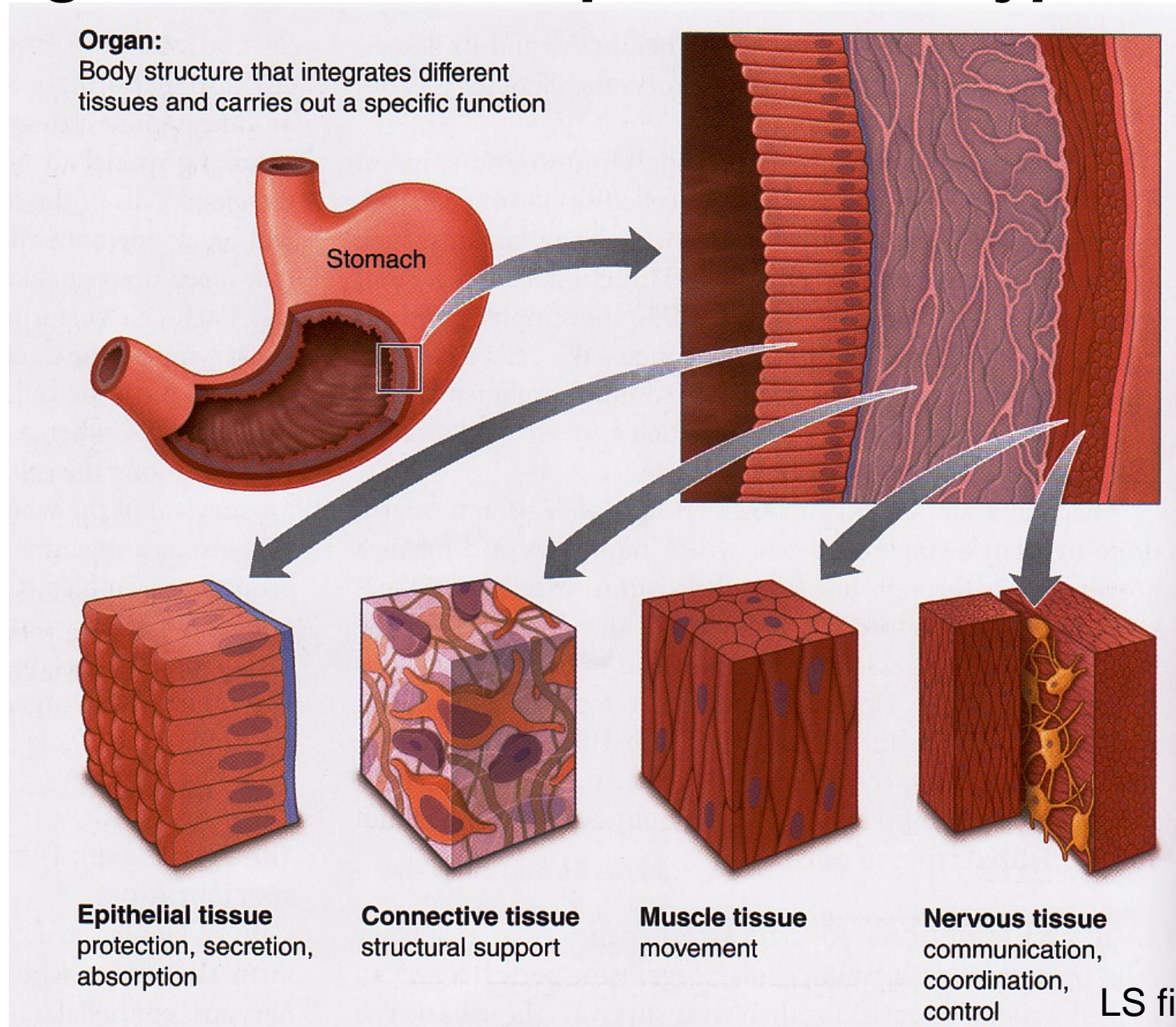


(a) Exocrine gland

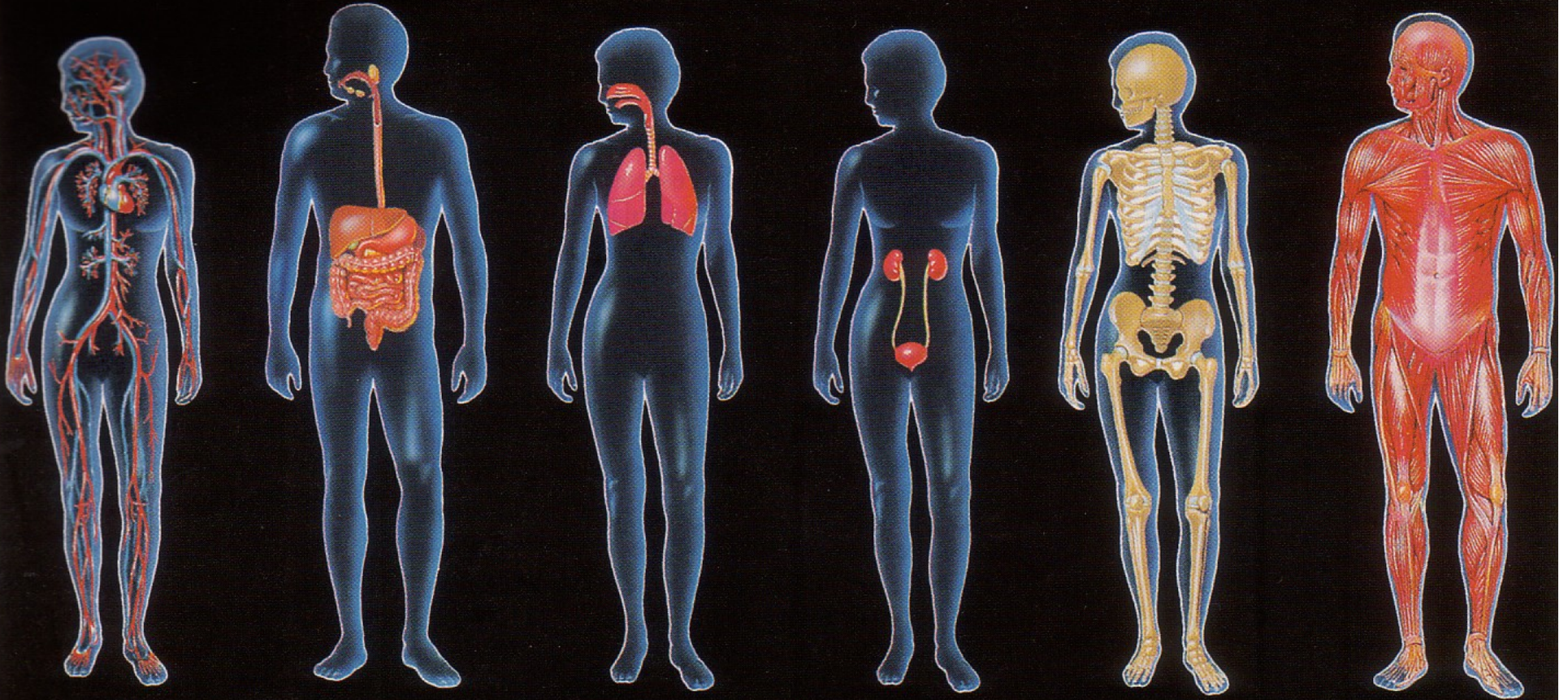


(b) Endocrine gland

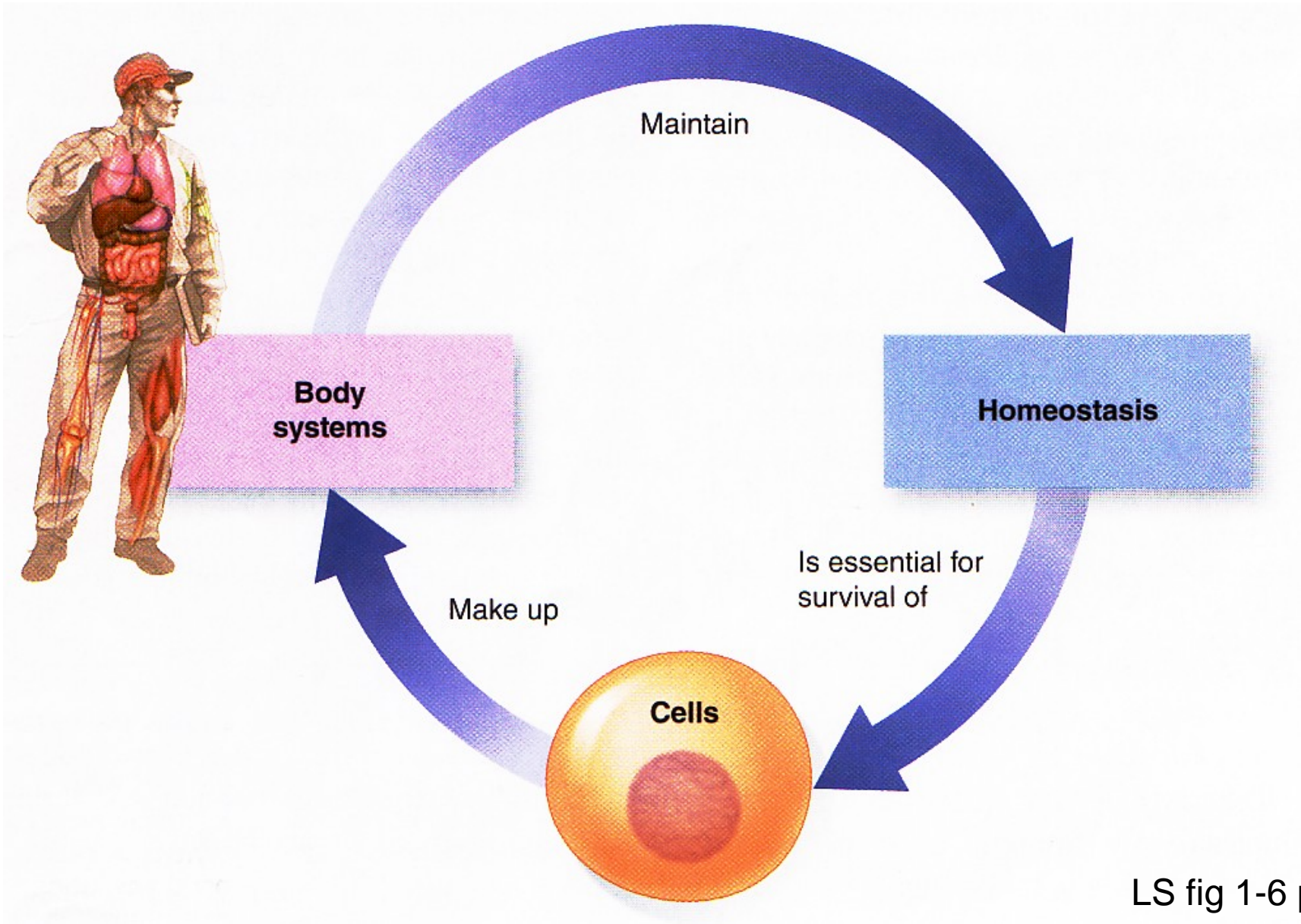
Organs are made up ≥ 2 tissue types



Which body systems?



Homeostasis is essential for cell survival!

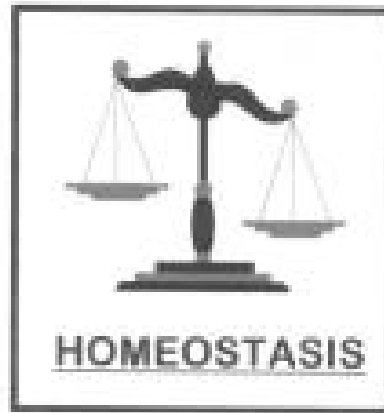


Maintenance of a relative constancy in the Internal environment = ECF = fluid outside of cells

**milieu
interieur?**



Claude Bernard

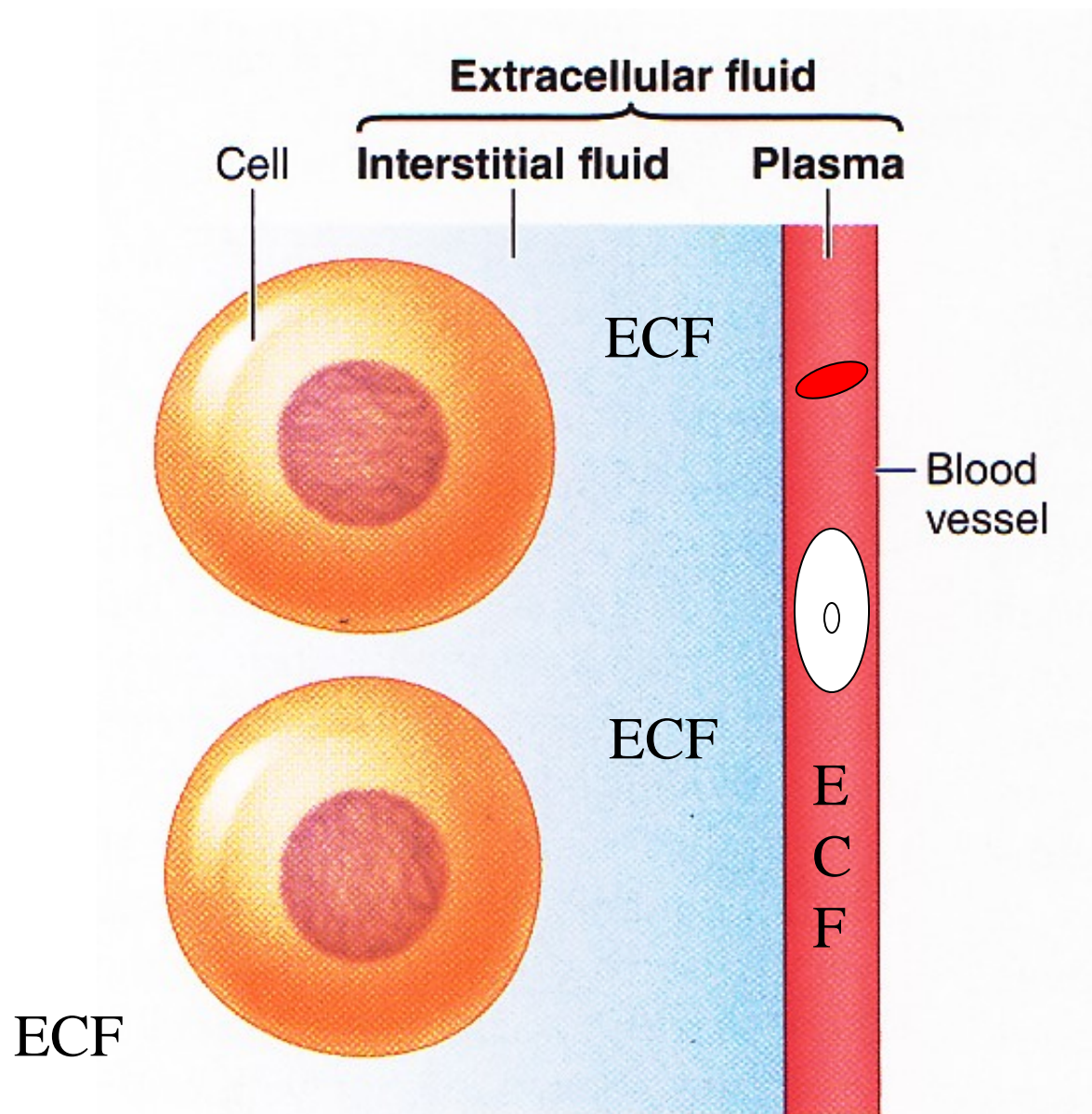


**100 trillion
cells working
intimately**



Walter B. Cannon

Where is extracellular fluid?



BI 121 Lecture 2



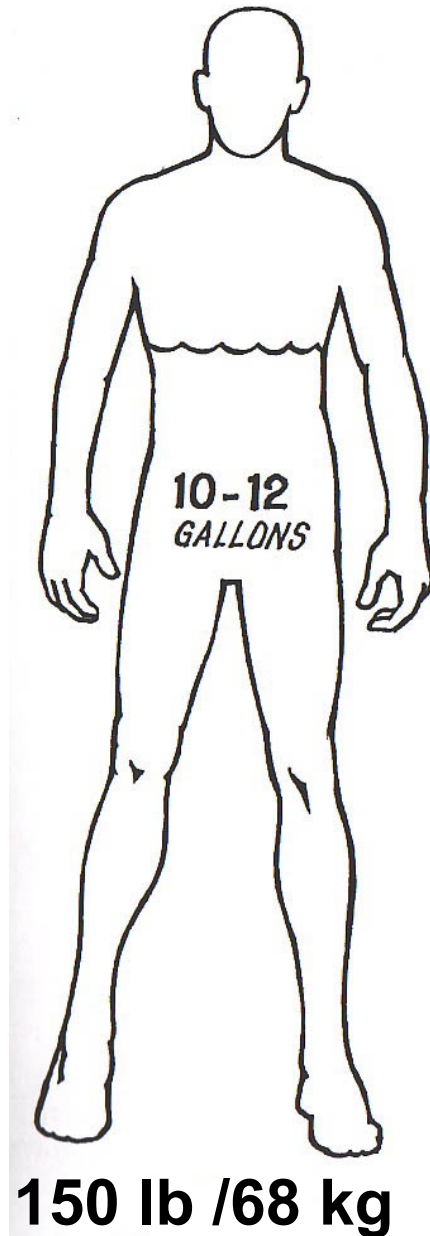
...Histology exploratory fun!!
Thanks for signing in!



- I. Announcements**: Lab today 12 n & 1 pm. Q? from last time?
- II. Physiology in the News** Are we like watermelons?
- III. Homeostasis Revisited** Dr Evonuk Balances LS pp 5 - 15
 - A. Simplified Model DO Norris *cf*: fig 1- 8 LS
 - B. Negative feedback? Positive feedback? LS pp 14 - 15
 - C. Balances & eg H₂O, T°C, BP Dr Evonuk + LS pp 8 - 10
- IV. 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*

Drink about 1 L per 1000 calories energy expenditure!!

Human ~ 2/3 H₂O
~ 60 – 70 %



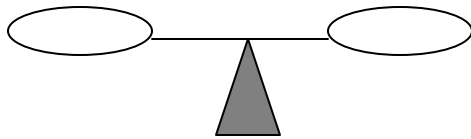
**NB: So 2000 kcal →
drink 2000 mL
≡ 67.63 fl oz
≡ ~ 8 cups!**

= ~40 – 48 kg H₂O

Metabolic

ANA-

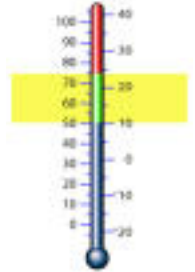
CATA-



H₂O

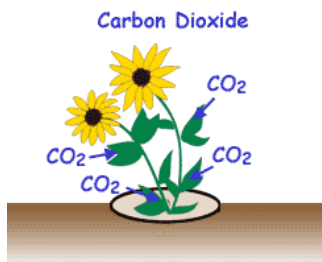


ToC



Dr. Evonuk's 6 Balances

O₂/CO₂

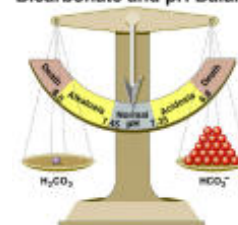


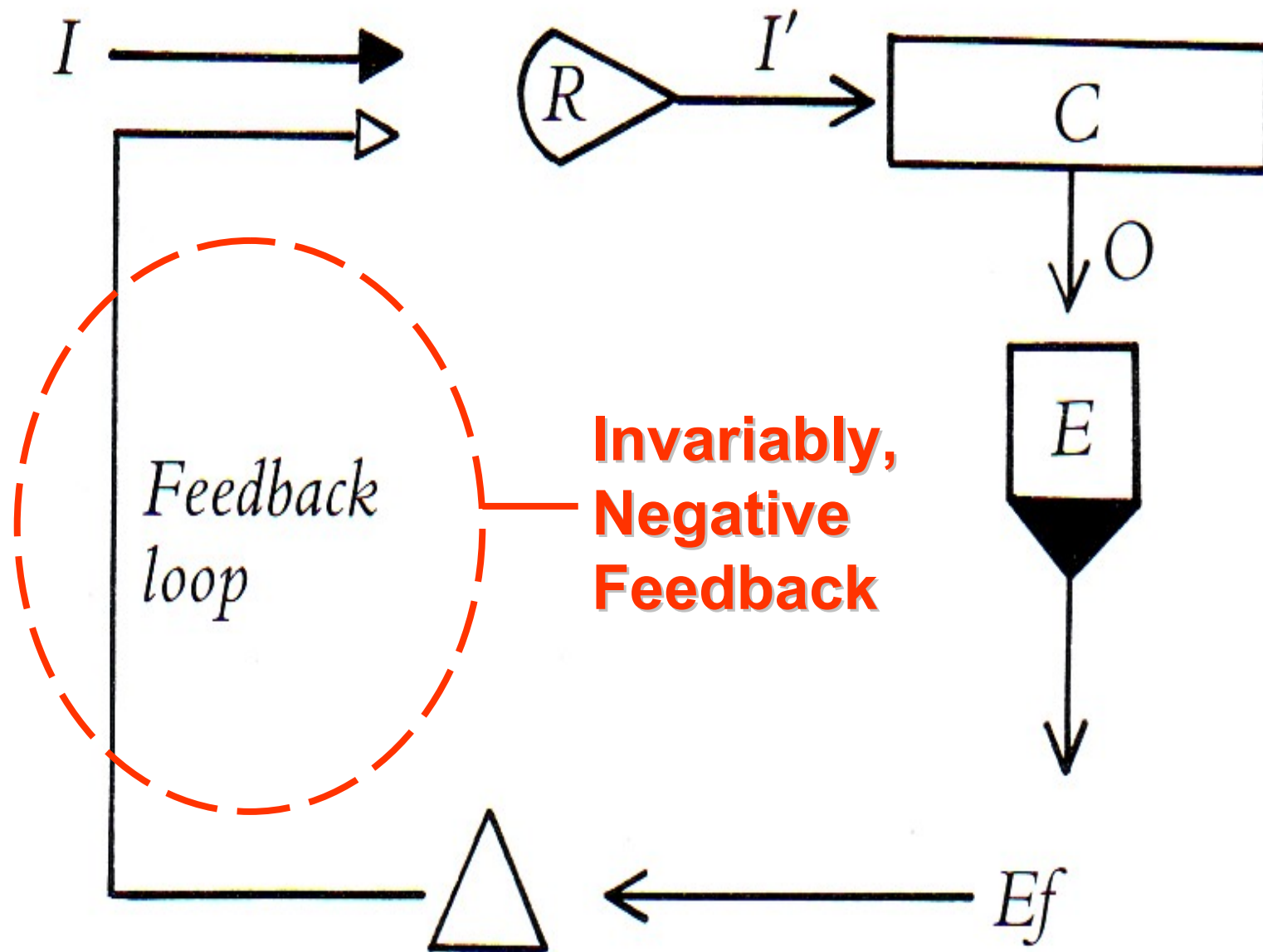
Ion^{+/-}

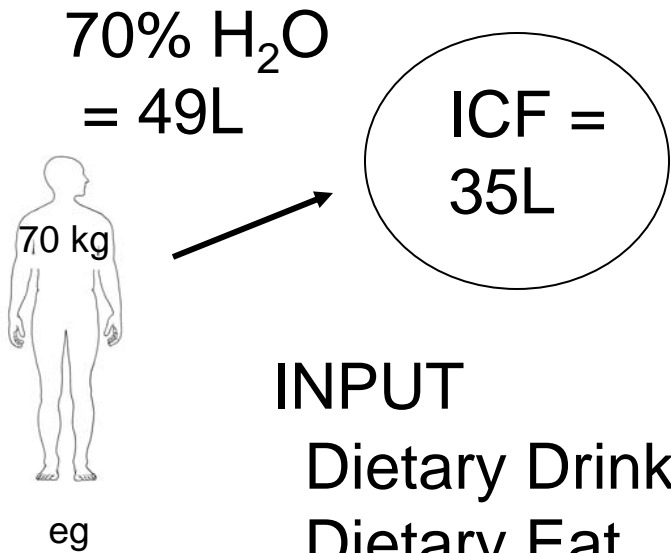


pH

Bicarbonate and pH Balance







+

ECF = 14L

[Interstitium = 11L
Plasma = 3L]

INPUT

Dietary Drink	1200 mL
Dietary Eat	400 mL
Oxidation	400 mL

Total = 2000 mL ✓

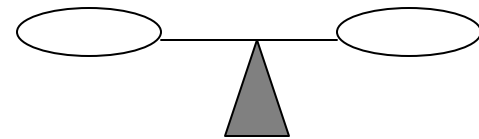
H₂O

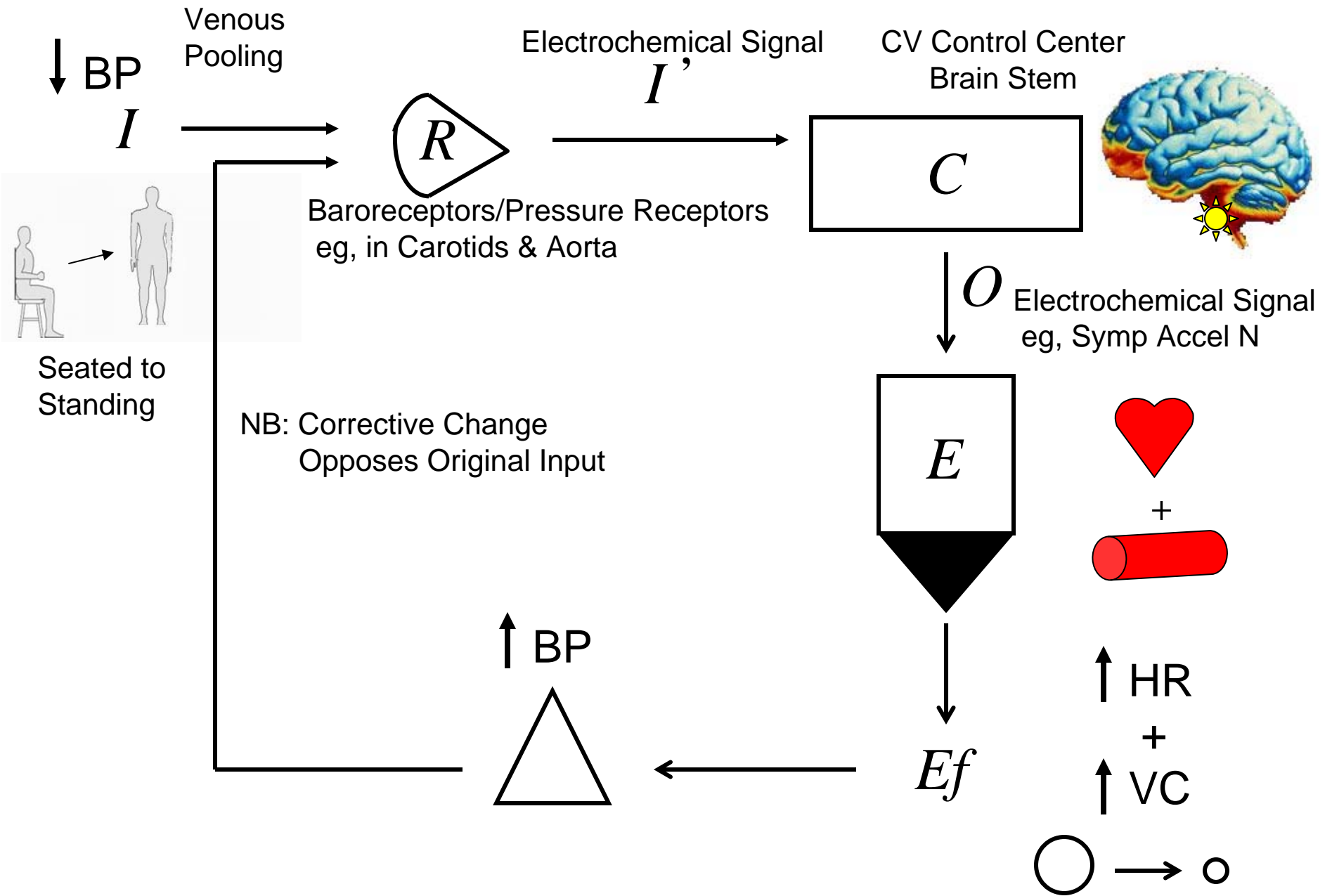
BALANCE!

OUTPUT

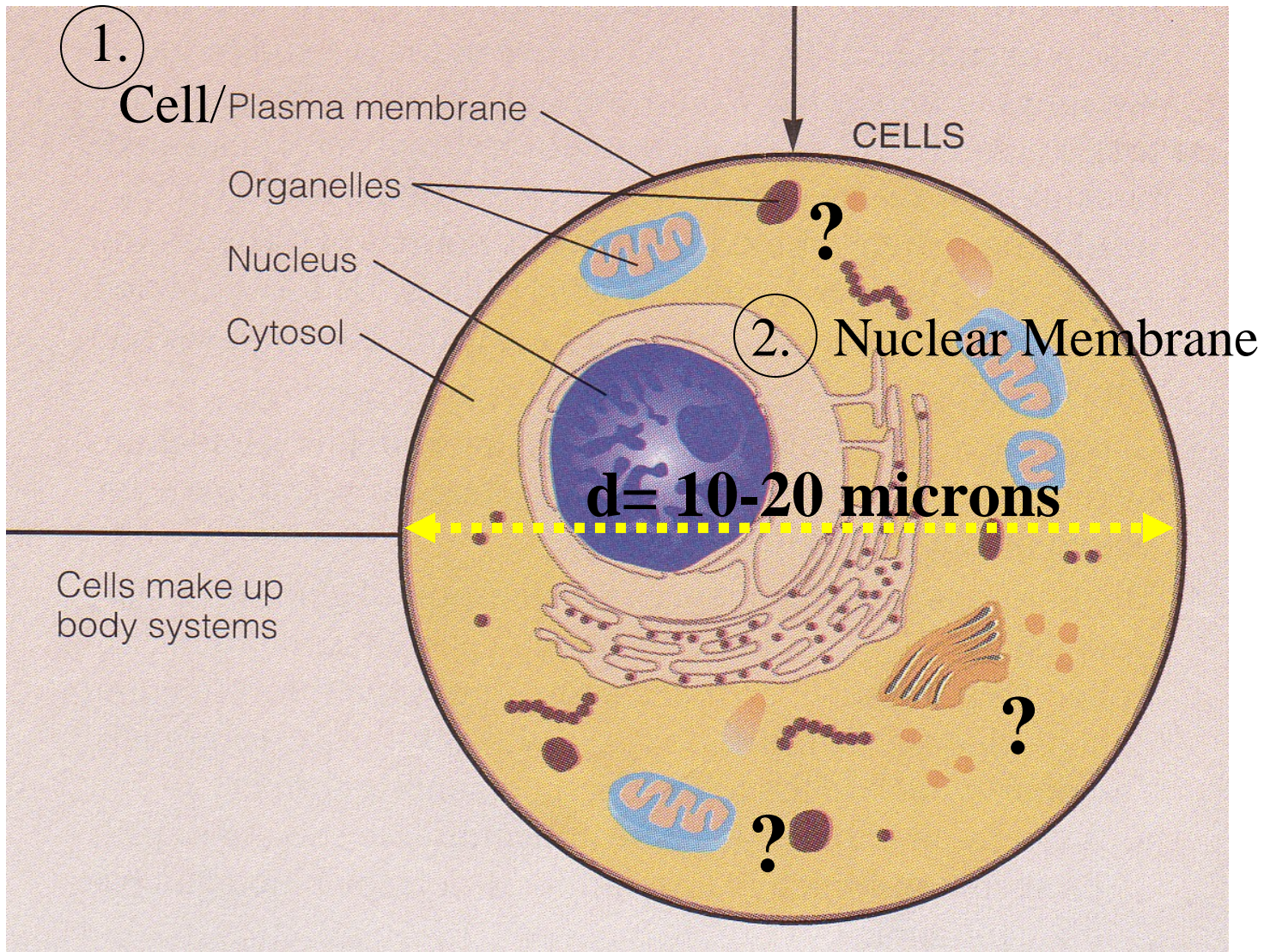
Urine	1000 mL
Sweat + Insensible	900 mL
Feces	100 mL

Total = 2000 mL ✓



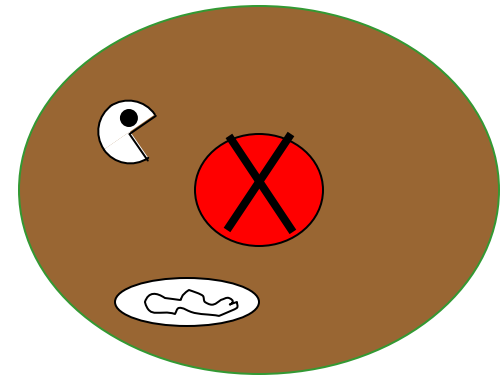


HOW BIG? 100 CELLS LENGTHWISE = 1 mm!!



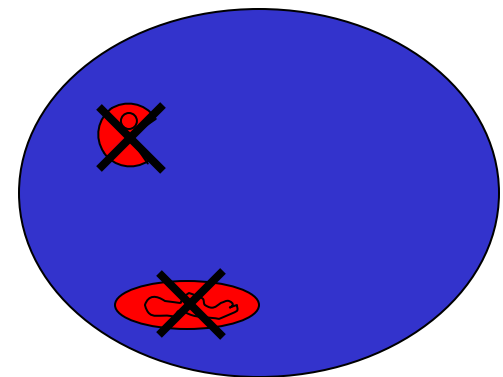
Cytoplasm = Cell - Nucleus

[Extract nucleus; includes organelles]



Cytosol = Cytoplasm - Organelles

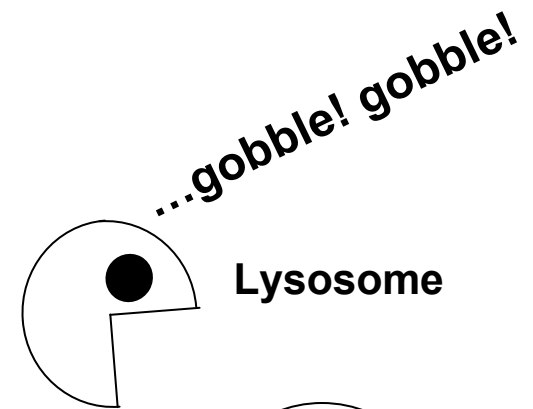
[Extract organelles; complex gel-liquid]



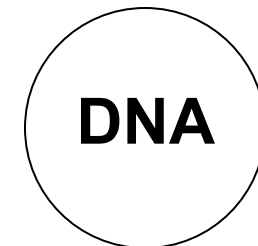
Why Compartments? Advantage?

**Incompatible reactions can
take place**

Simultaneously!!



Lysosome

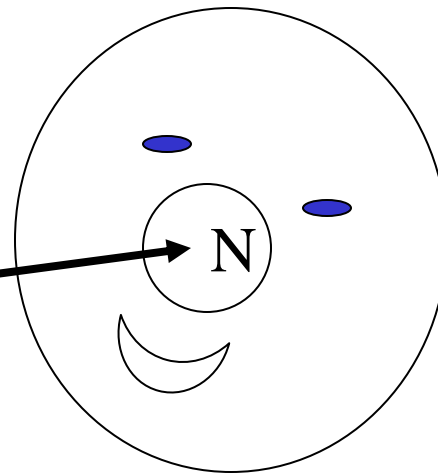


Nucleus

Basic Cell Survival Skills?

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

Nucleus or nose?



How to live?

**1 e.g. Cell of
100 Trillion!**

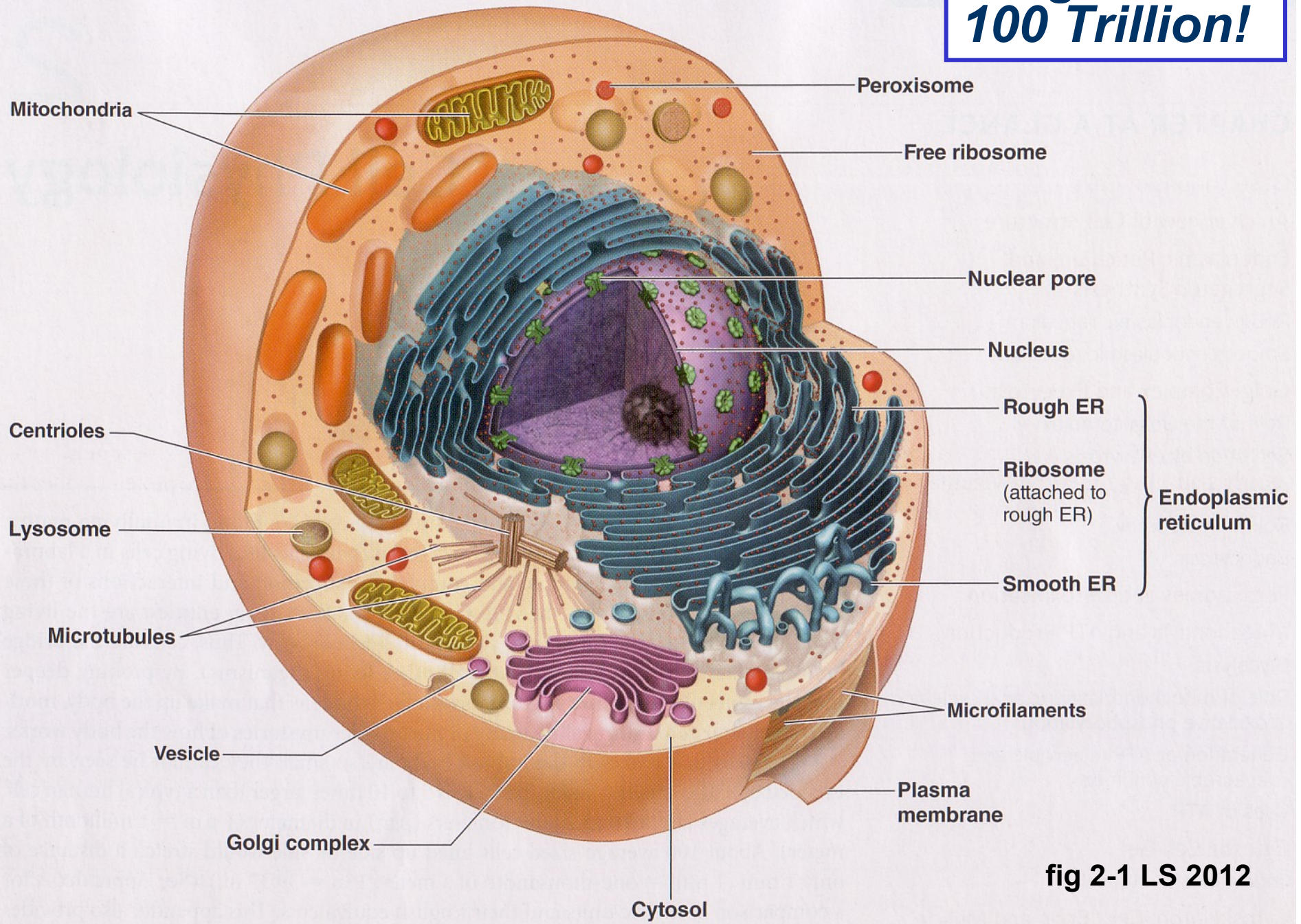


fig 2-1 LS 2012

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

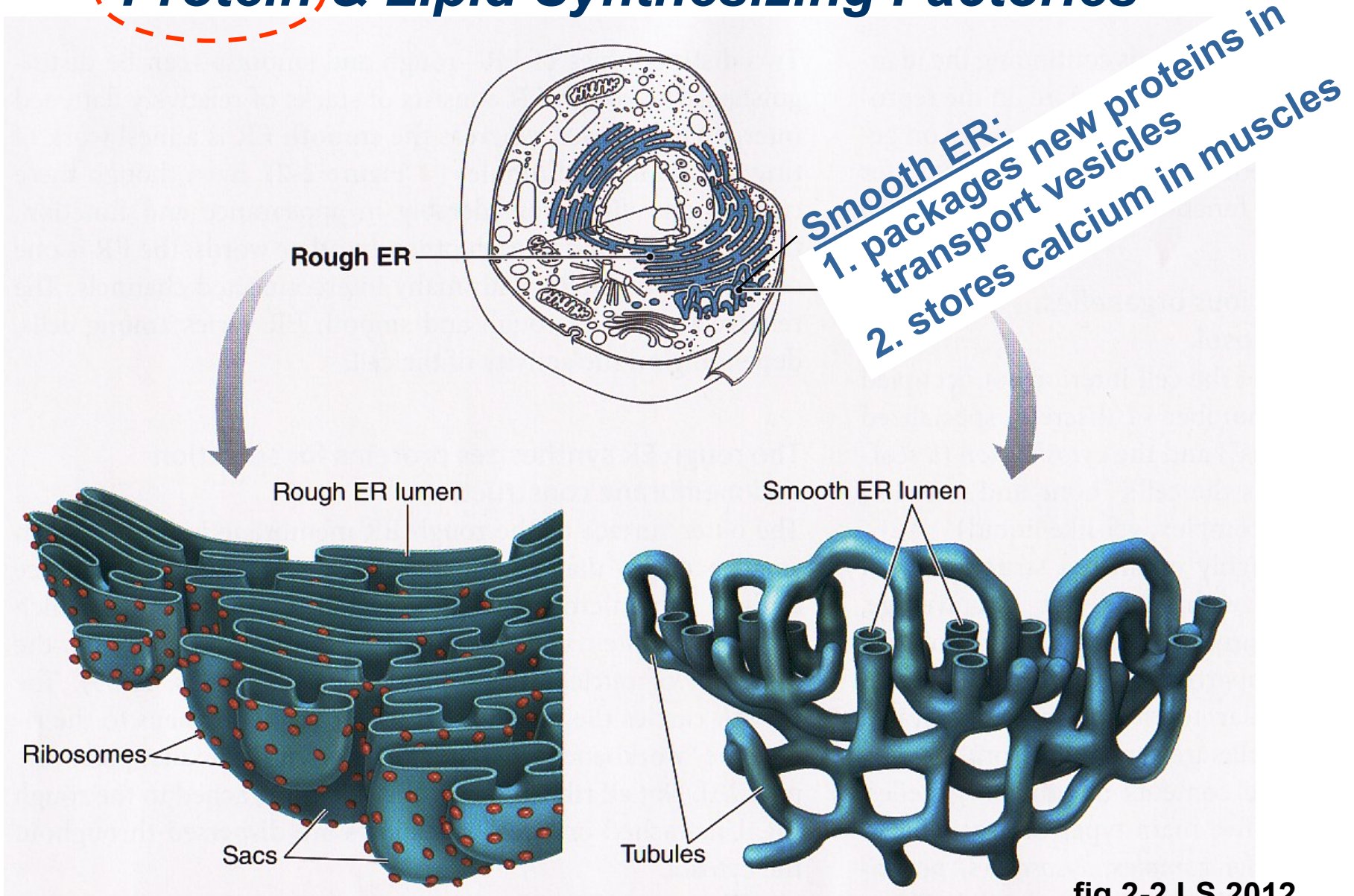


fig 2-2 LS 2012

Secretion of Proteins Produced by ER

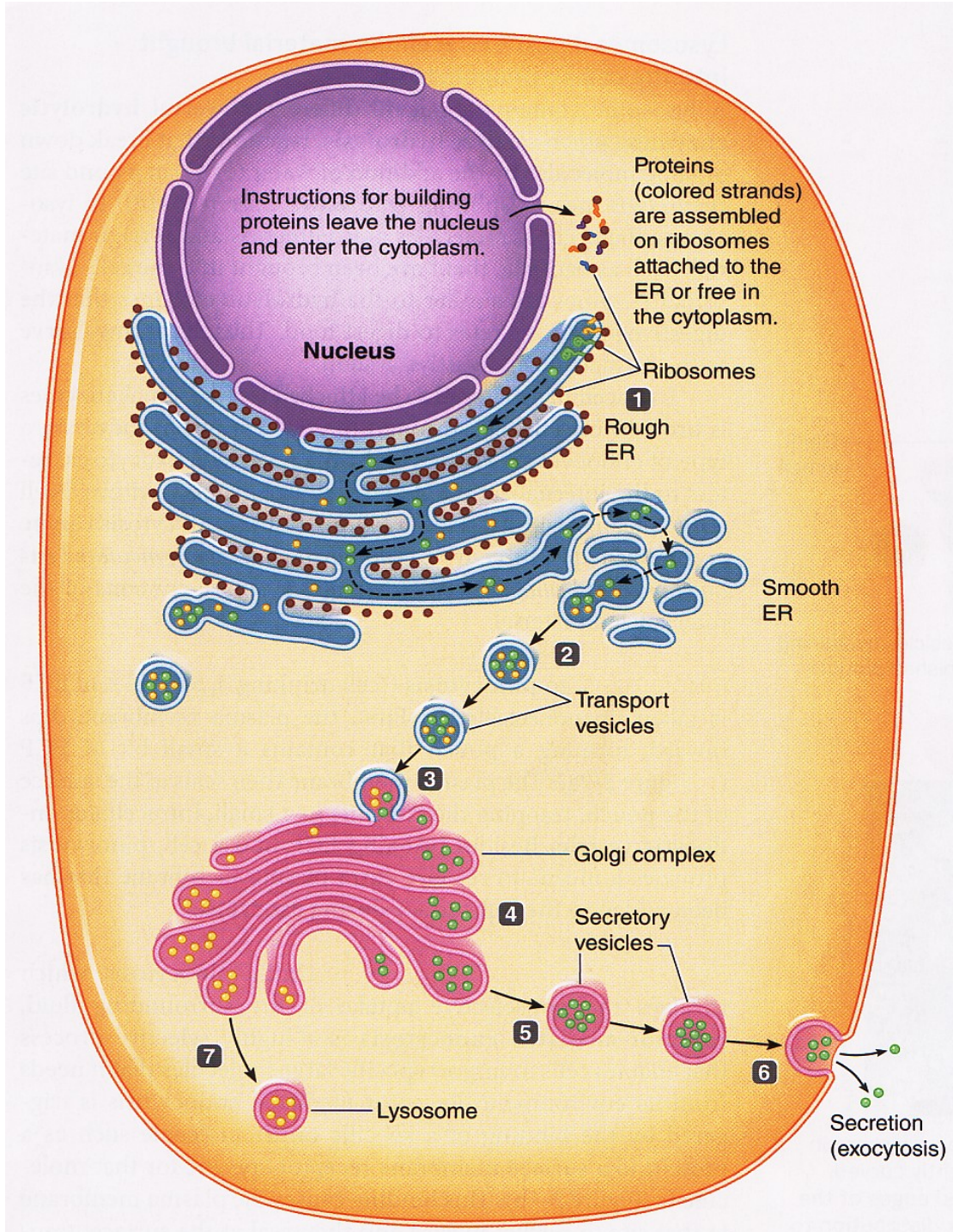


fig 2-3 LS 2012

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



I. Announcements Q from yesterday lecture or lab?

II. Cell Physiology (continued) LS 2012 ch 2

A. Organelles \equiv Membranous, cytoplasmic specialty shops!
...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

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

C. 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

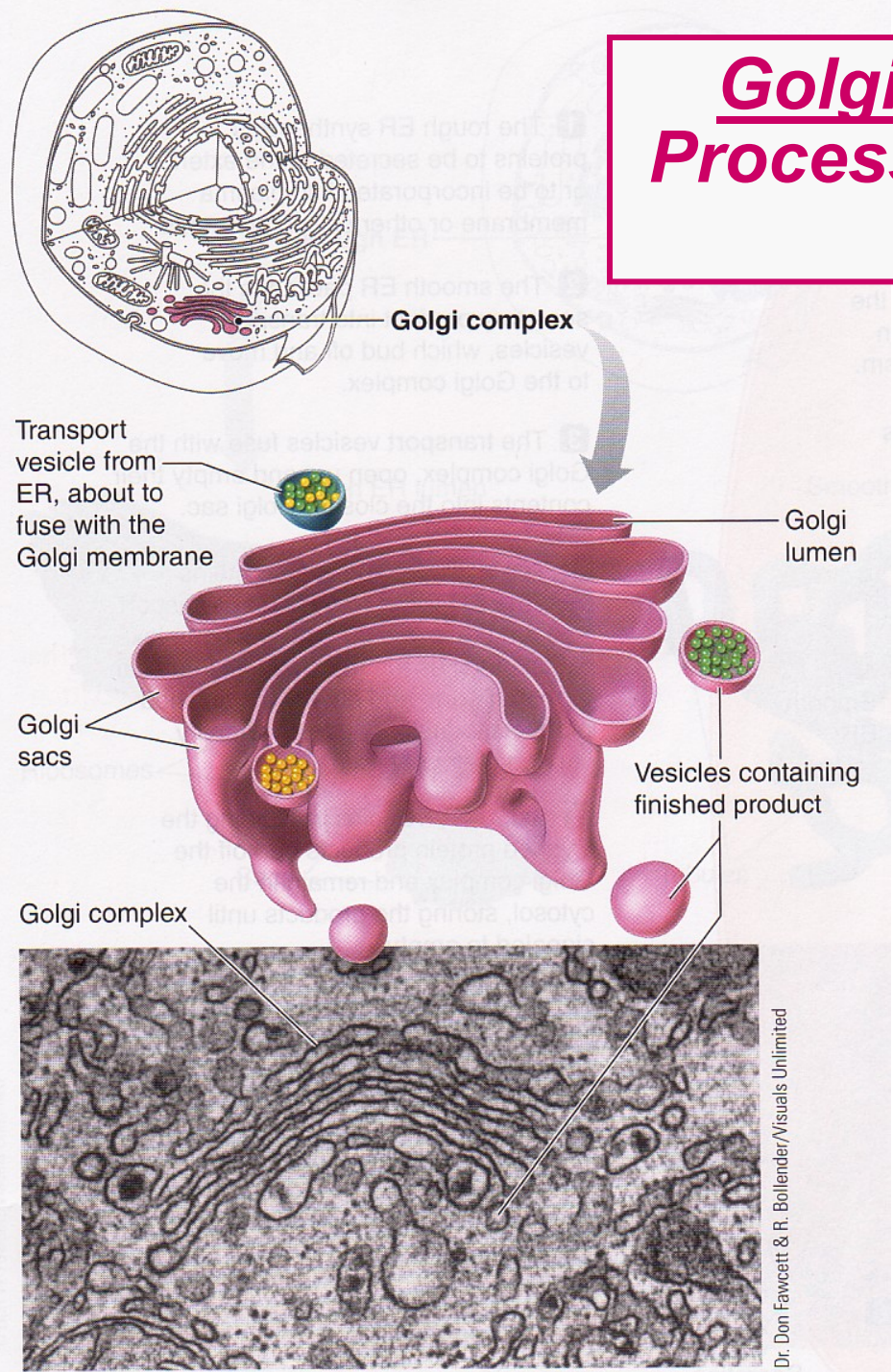
D. How does information flow in the cell? fig C-6

E. How does DNA differ from RNA? pp A-20 thru A-22

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

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

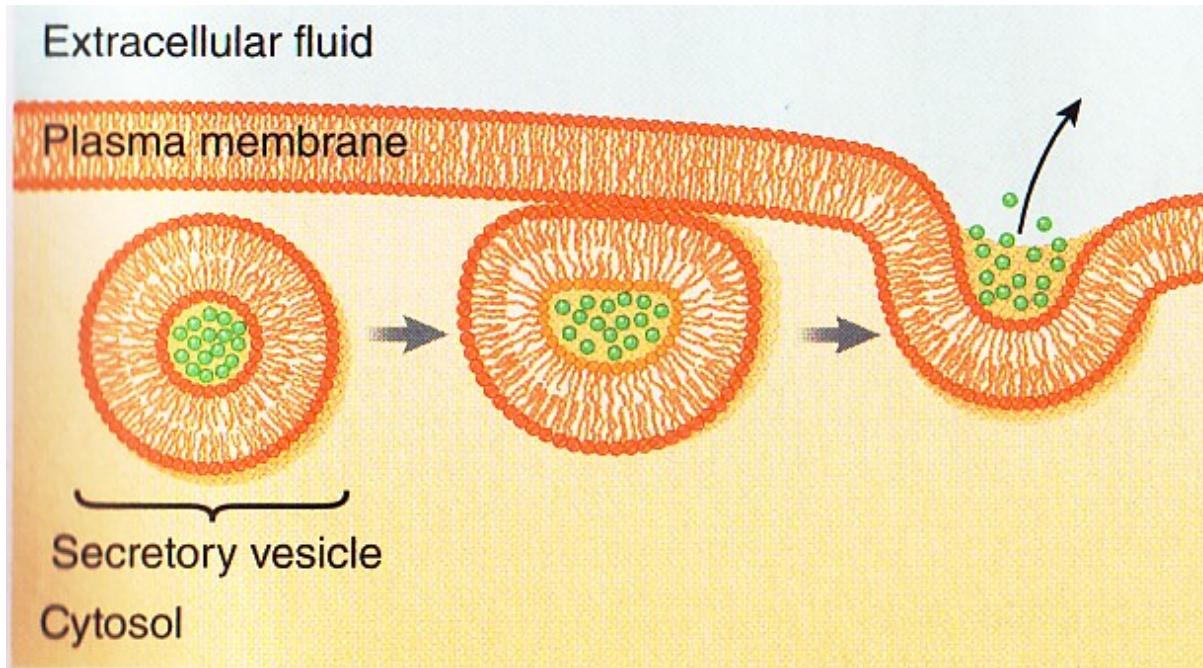
Golgi Complex: Final Processing, Packaging & Distribution



Dr. Don Fawcett & R. Bollender/Visuals Unlimited

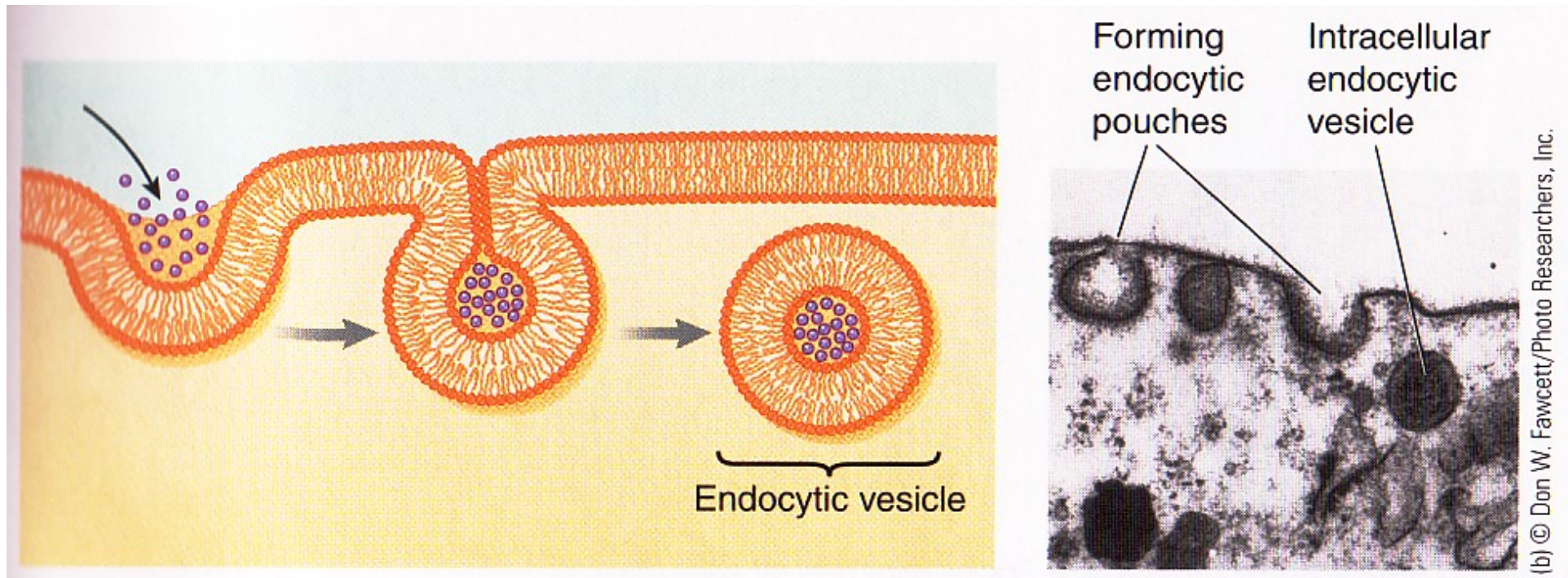
fig 2-4 LS 2012

Exocytosis: Primary Means of Secretion



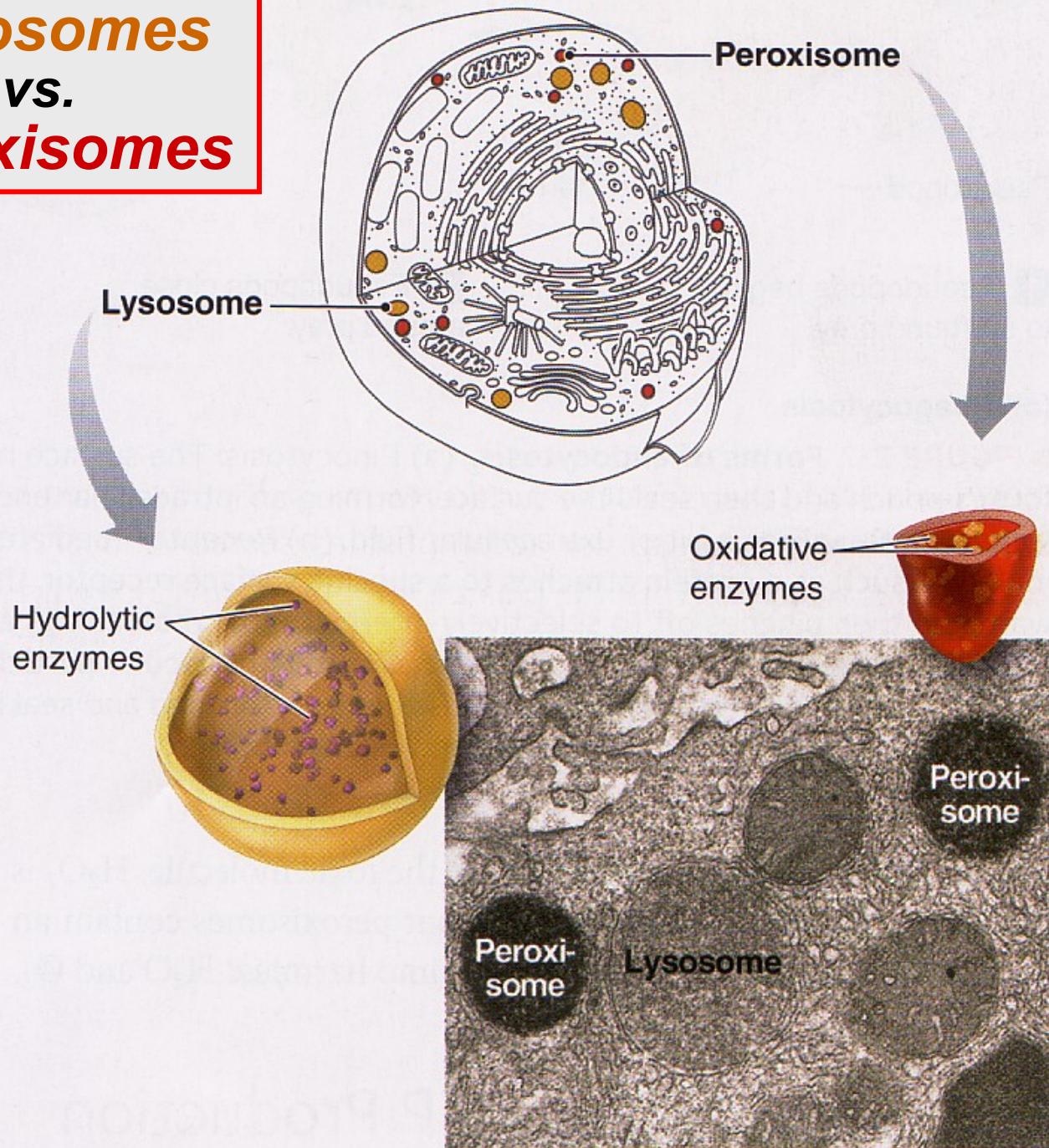
(a) Dr. Birgit Satir, Albert Einstein College of Medicine

Endocytosis: Primary Means of Ingestion



Viruses like HIV & Flu Exploit this Mechanism!

Lysosomes vs. Peroxisomes



© Don W. Fawcett/Photo Researchers, Inc.

fig 2-6 LS 2012

Phagocytosis: Cell Eating!

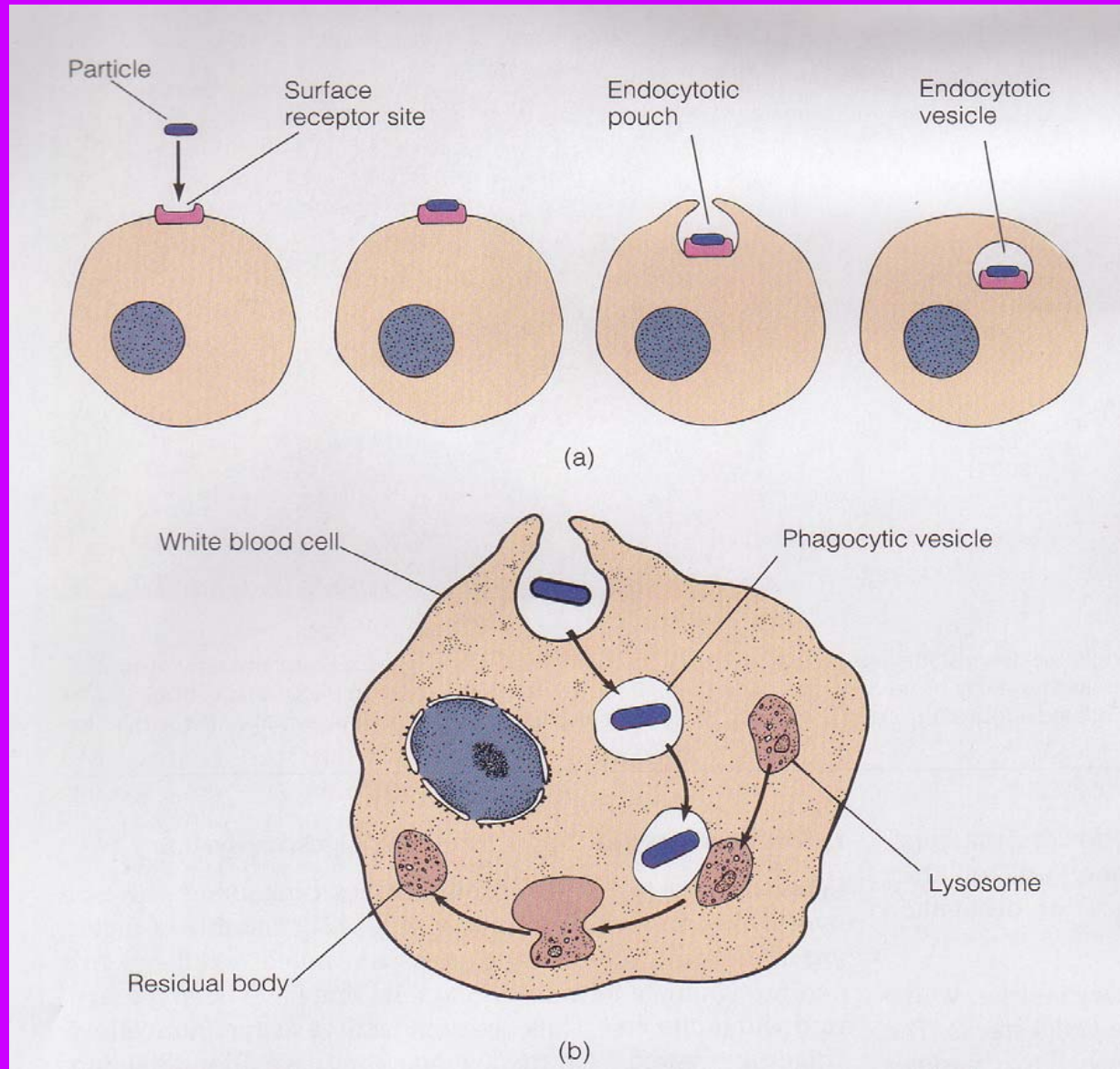
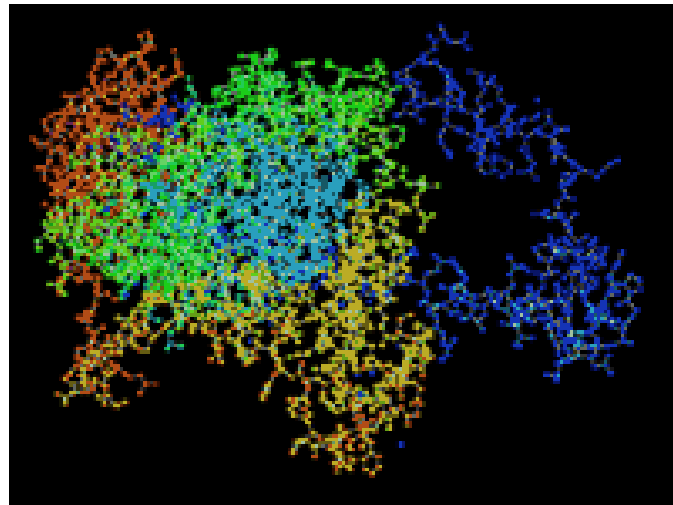
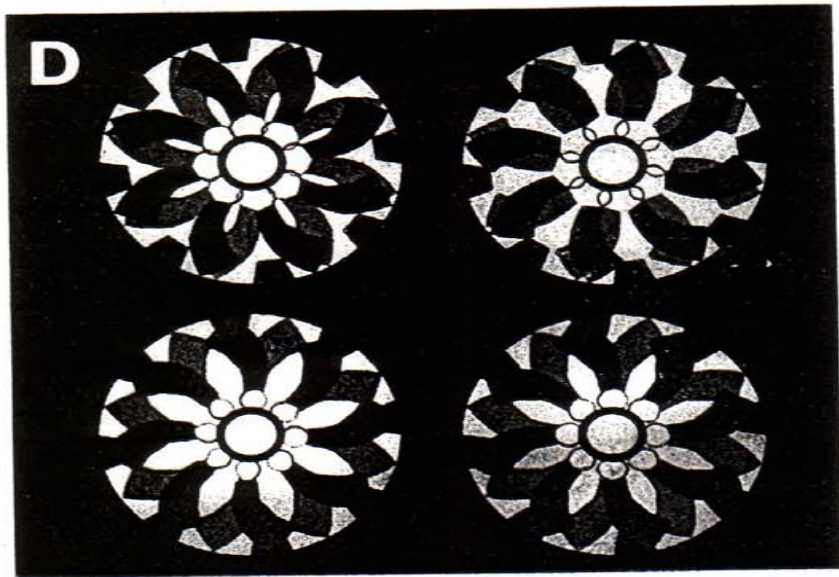
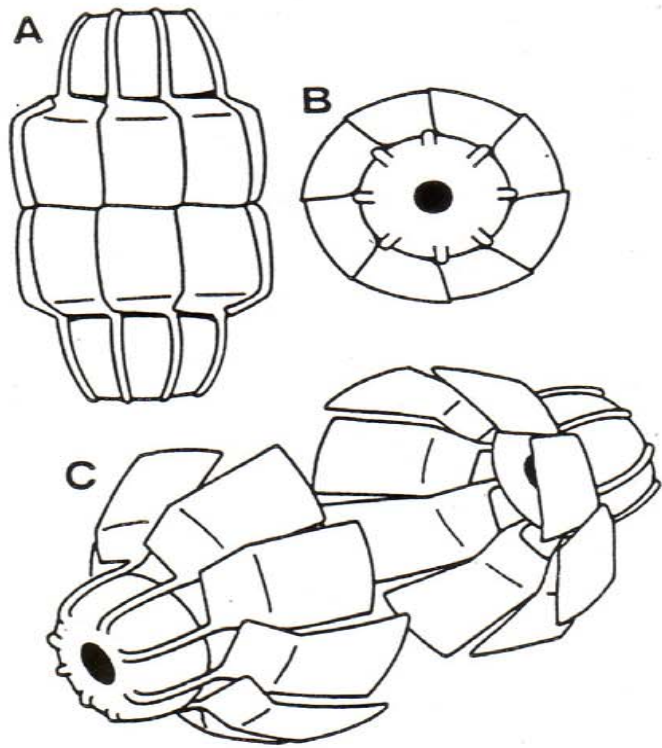


fig 2-7 LS 2006

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





AEROBIC

w/O₂

=

MITOCHONDRION

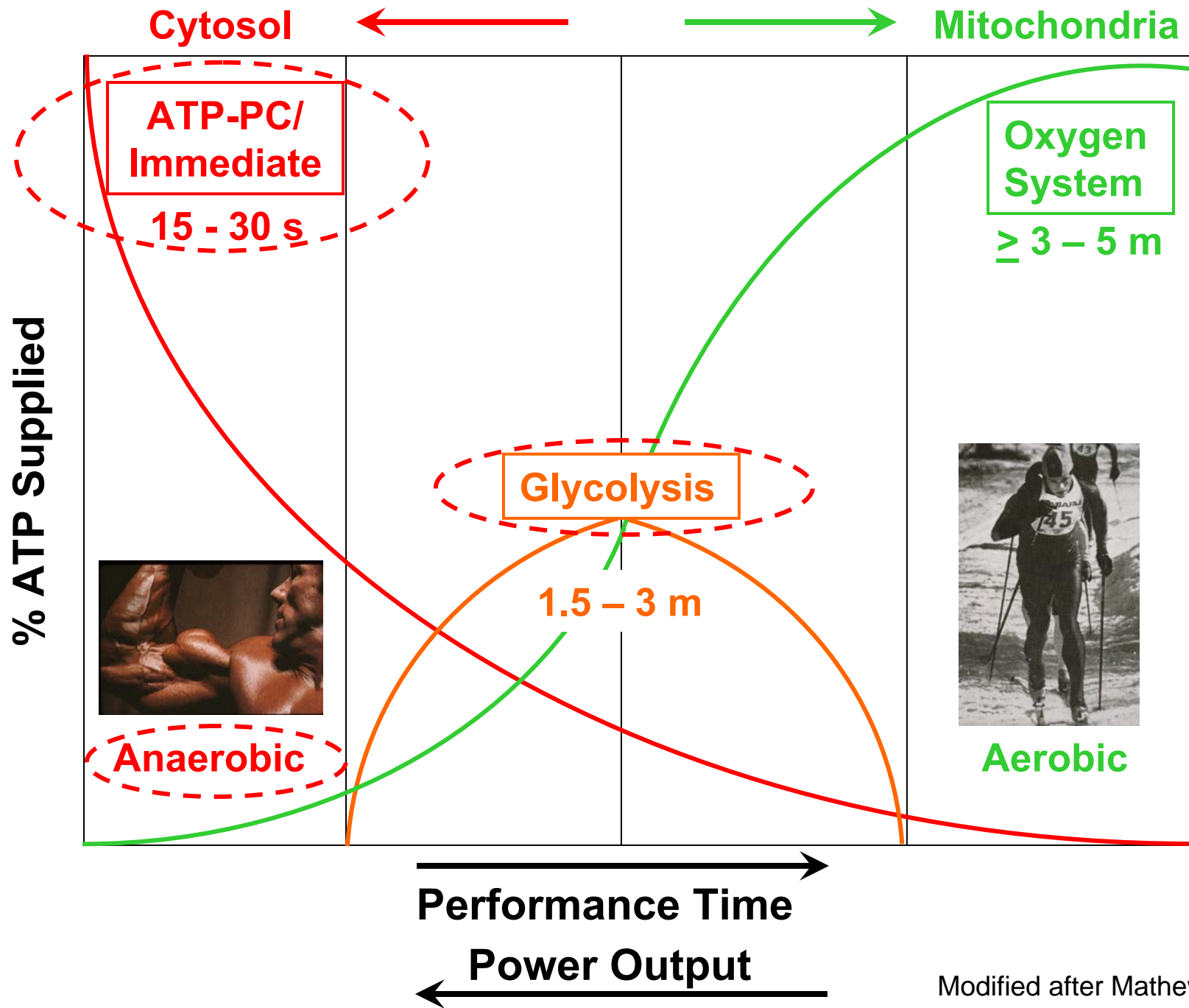
ANAEROBIC

without O₂

= CYTOSOL



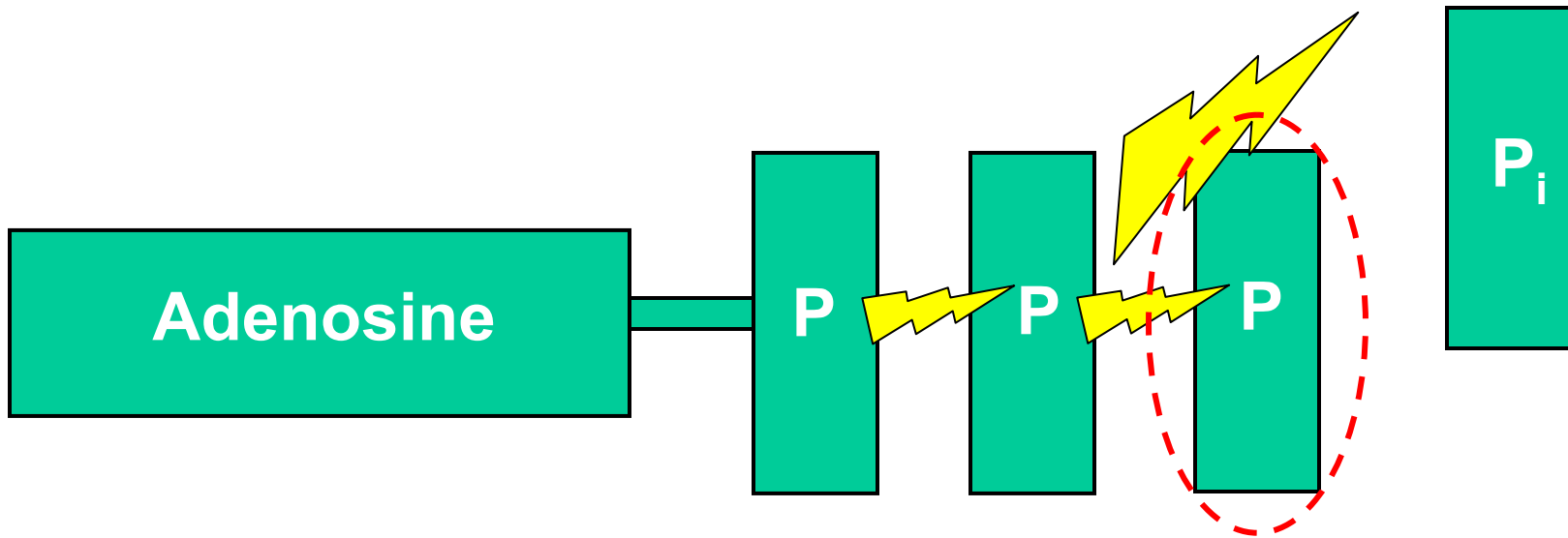
1. Immediate/ATP-PC
2. Glycolysis



Modified after Mathews & Fox

Cleave One High Energy Phosphate Bond To Do Work!!

7 – 10
KiloCalories/KCal



① *Synthesis of
Macromolecules*

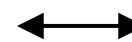
Make big things
from little things!

② *Membrane
Transport*

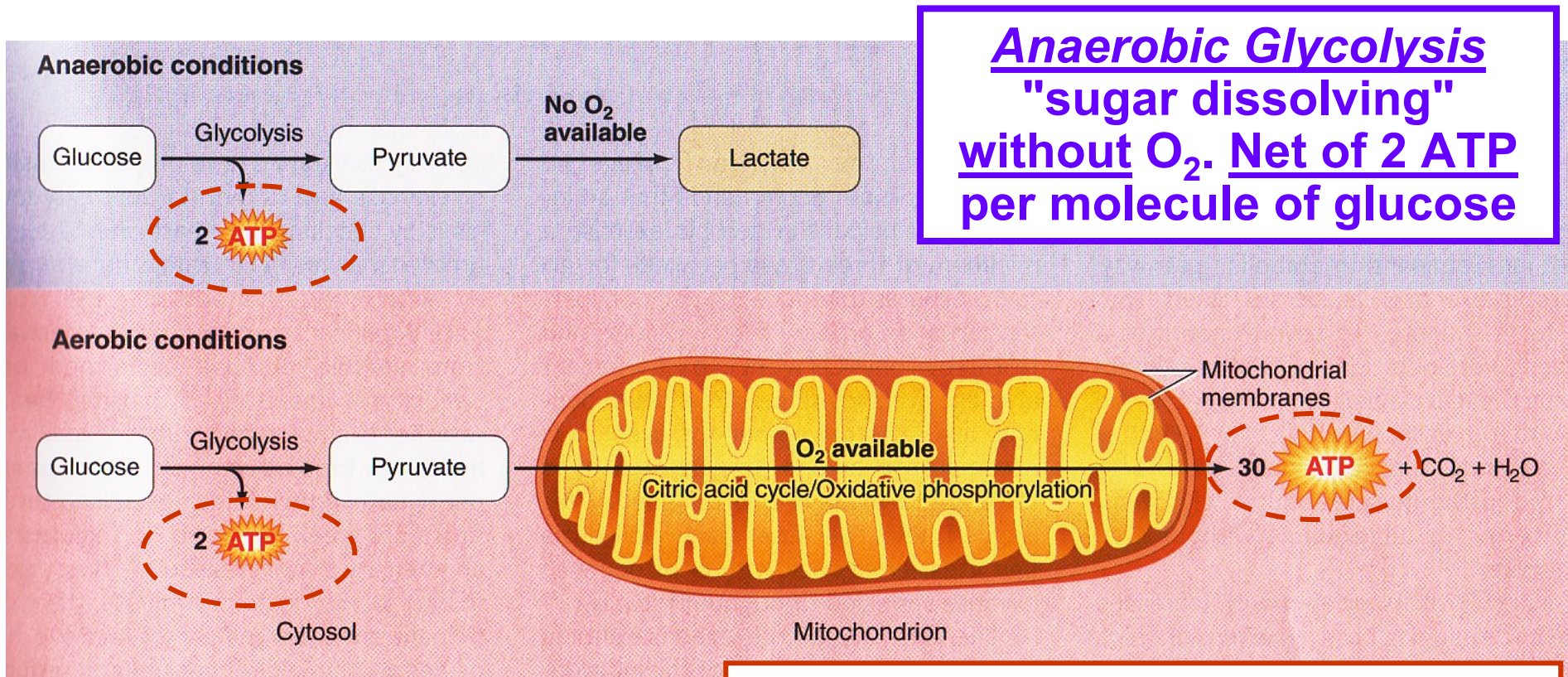
Move things!
Microscopic!

③ *Mechanical
Work*

Move things!
Macroscopic!



Anaerobic vs. Aerobic Metabolism



Anaerobic Glycolysis
"sugar dissolving"
without O₂. Net of 2 ATP
per molecule of glucose

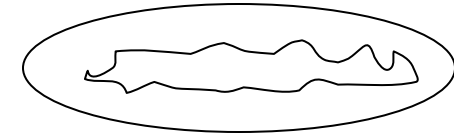
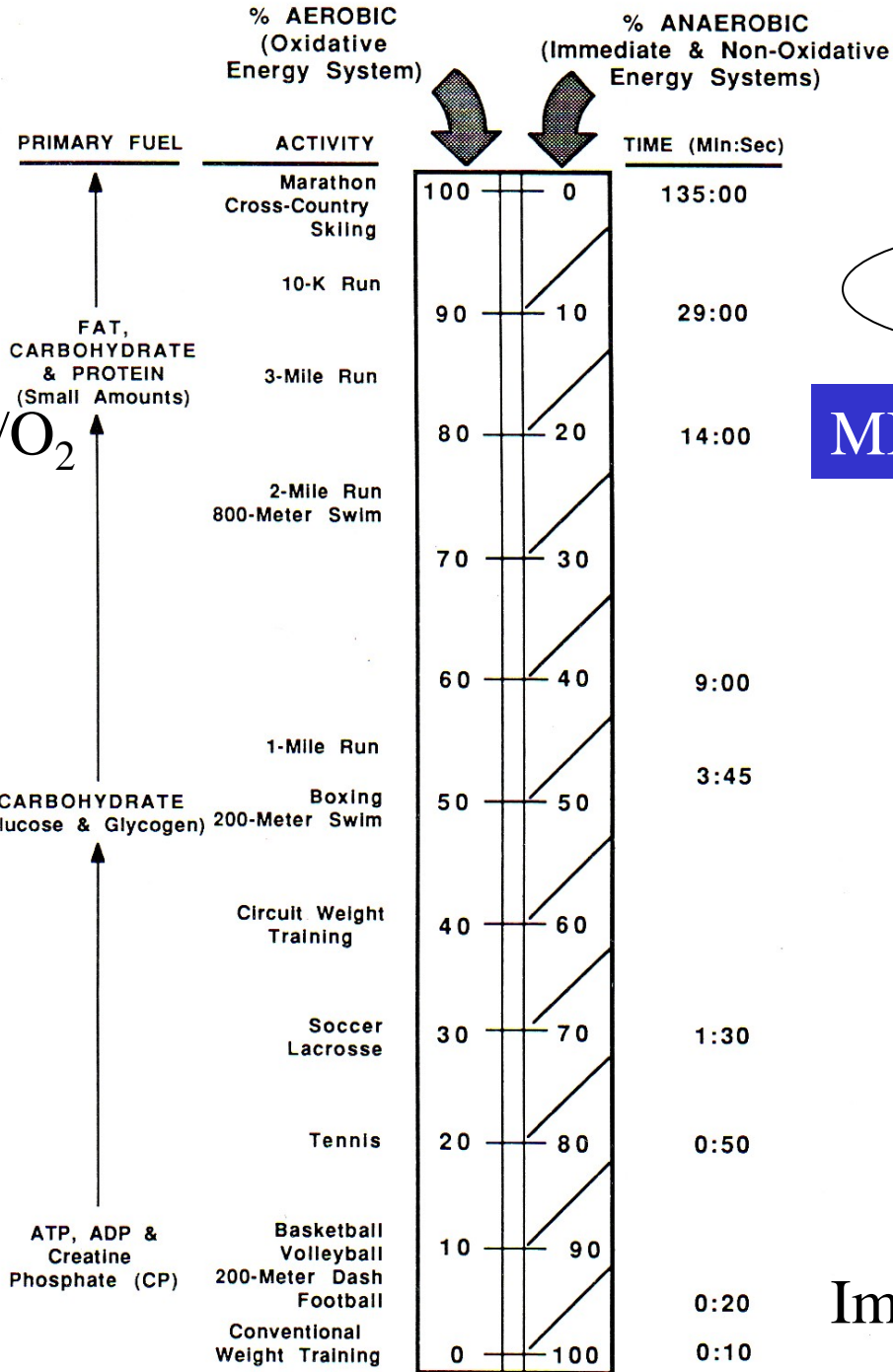
Aerobic Metabolism
+mitochondrial processing of
glucose with O₂. Net of 32 ATP
per molecule of glucose

fig 2-15 LS 2012



AEROBIC

w/O₂



MITOCHONDRIA

CYTOSOL

Glycolysis

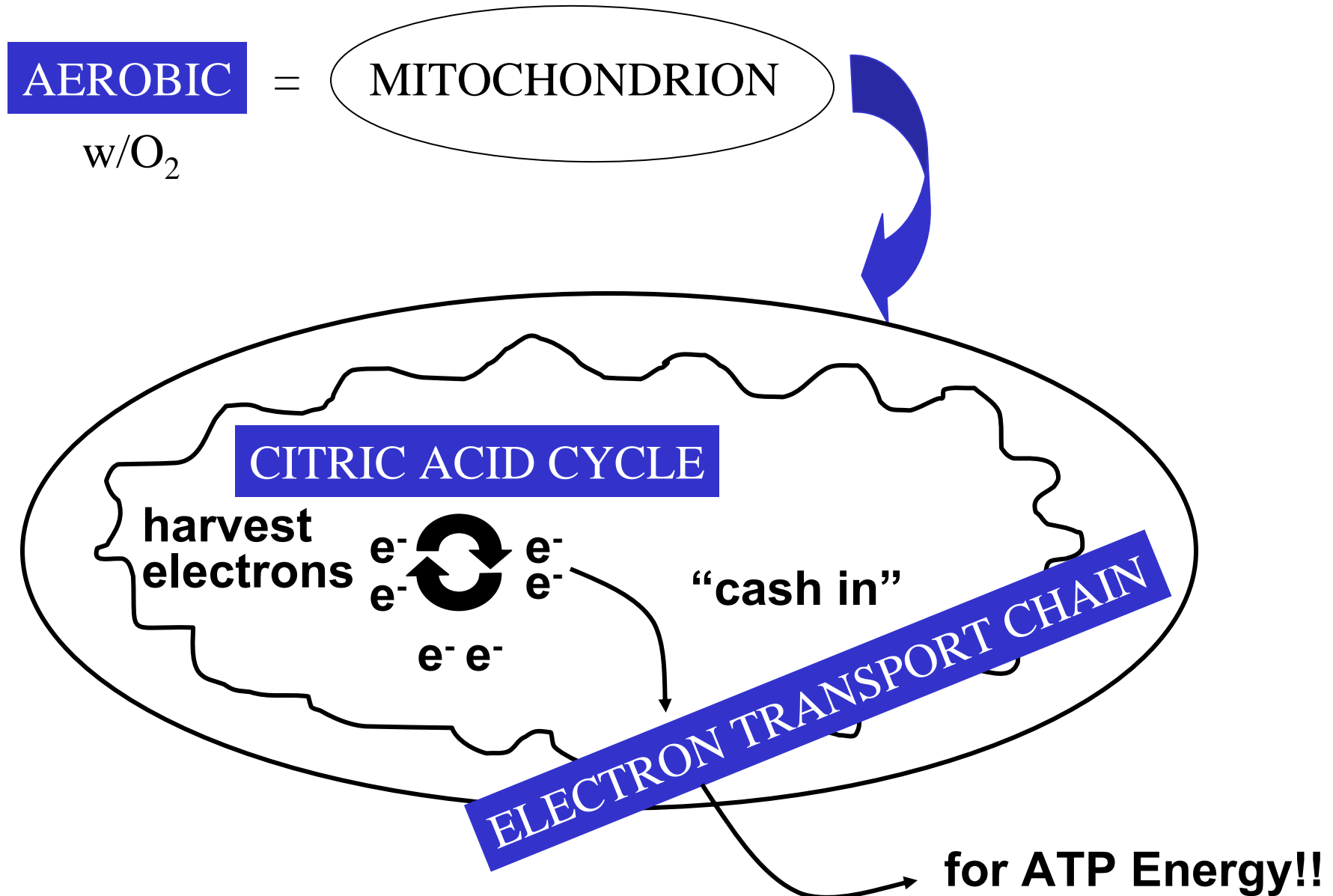


Immediate/ATP-PC

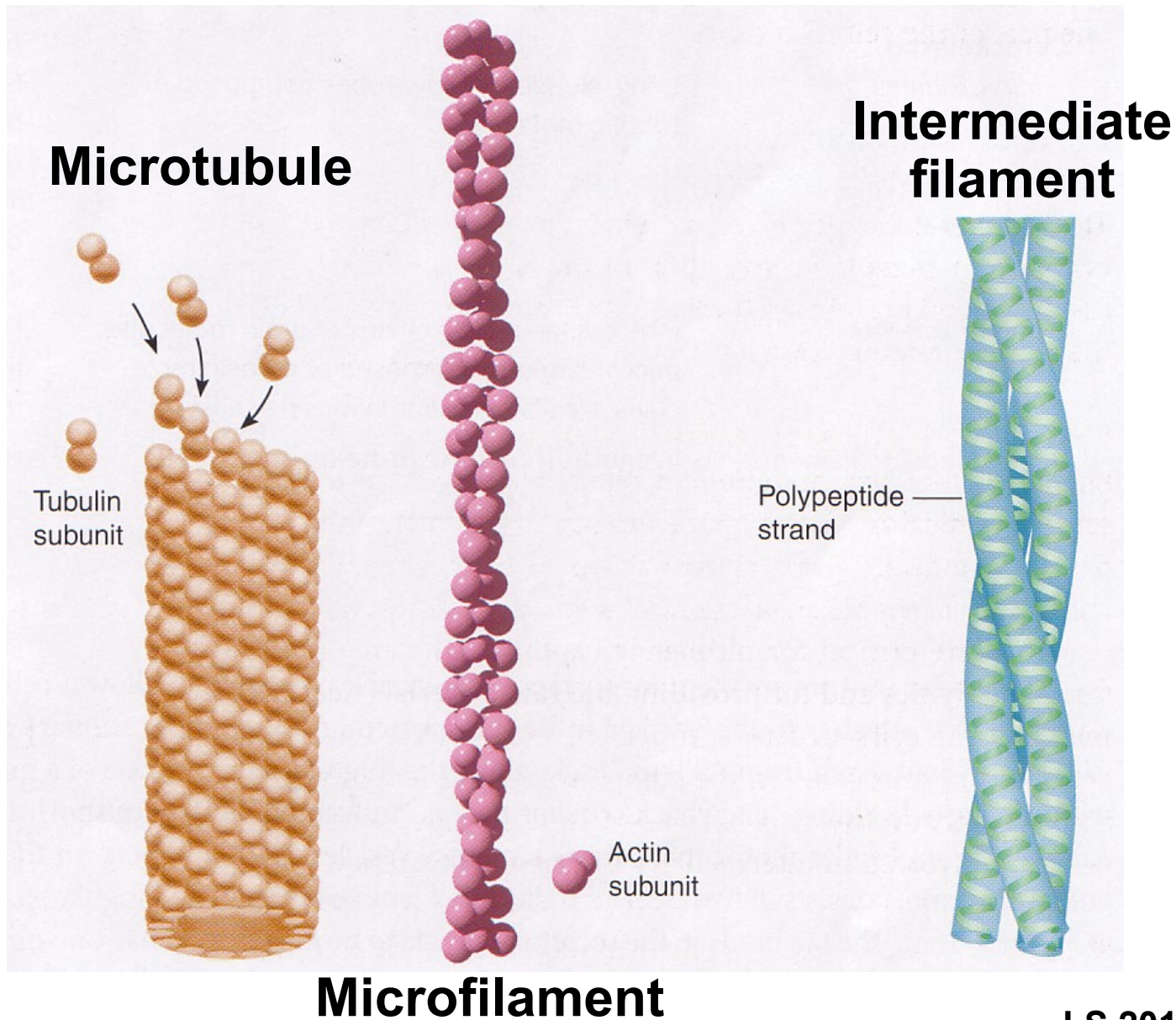


ANAEROBIC

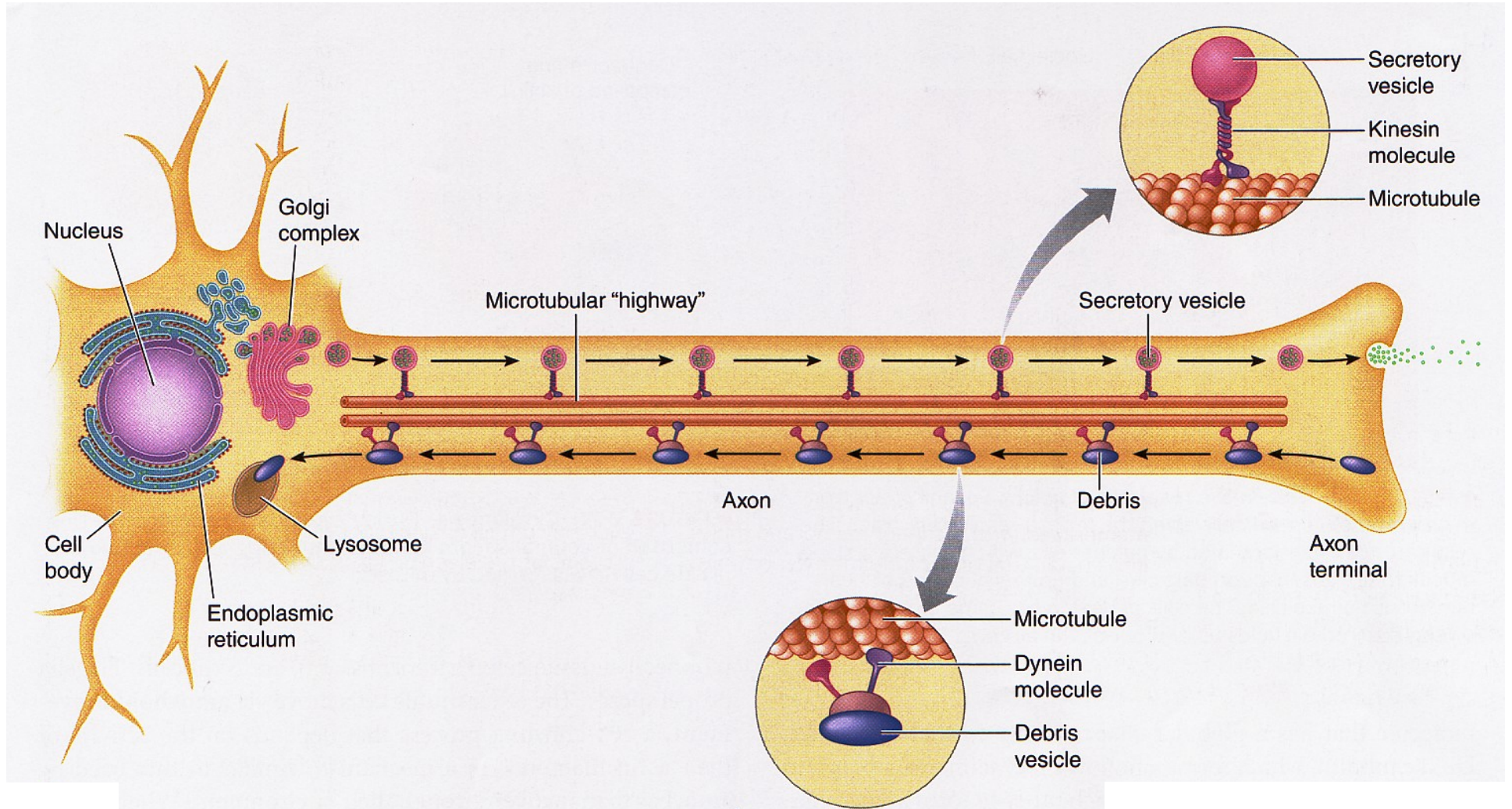
Goals of Aerobic Metabolism



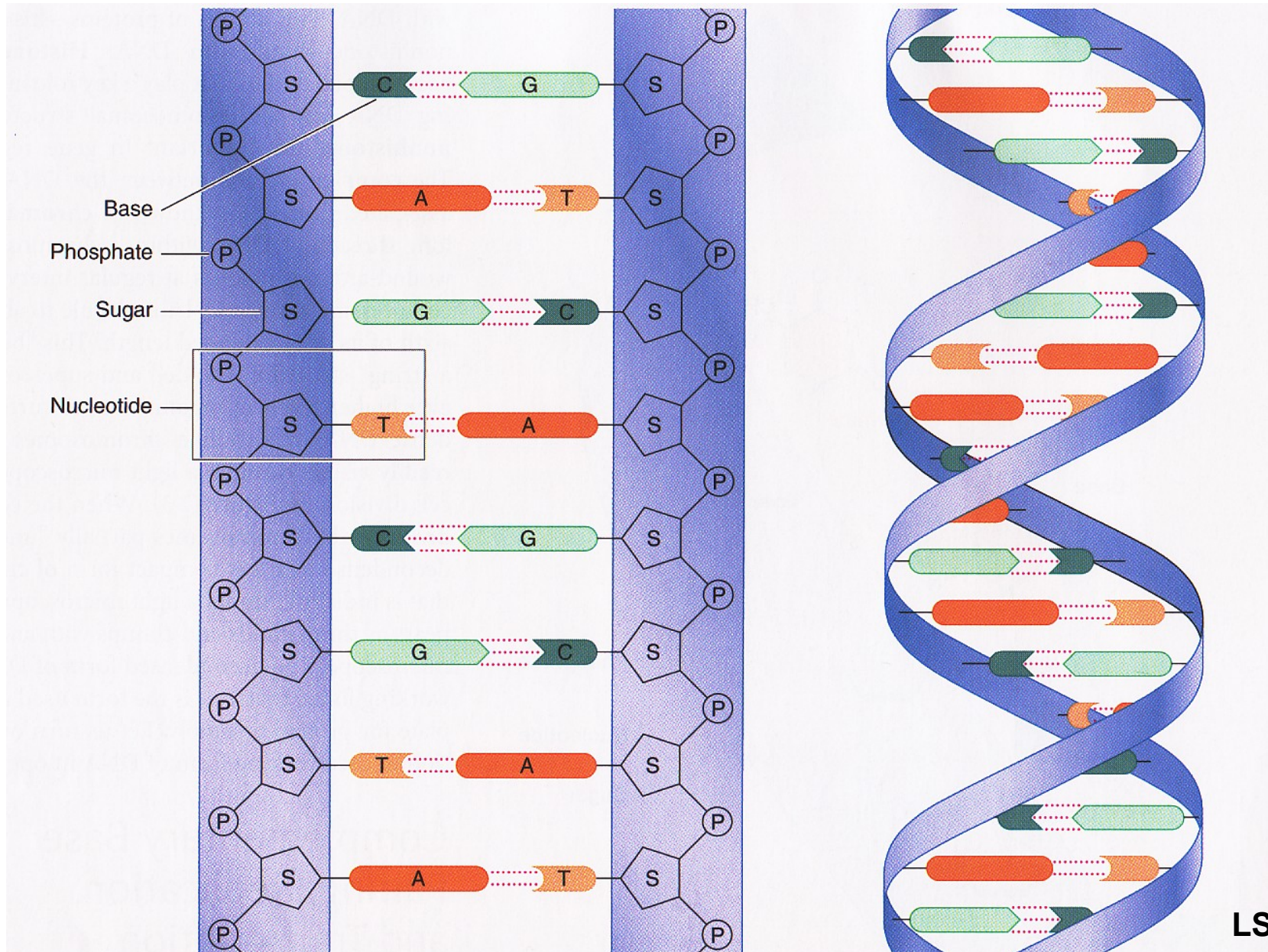
Cytoskeleton: Cell "Bone & Muscle"



Microtubular Highway!!



What does DNA look like? Double-helix!!



LS fig C-2

BI 121 Lecture 4

Anatomy & Physiology Lab today!...



I. Announcements Nutrition Analysis Lab next Tuesday!
Please record diet on p 3-7 LM & begin analysis using
<https://www.supertracker.usda.gov/> Estimating quantities.

Q?

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

A. What's a gene? Where located? Why important?

p A-18, fig C-2, C-3

B. How does information flow in the cell? fig C-6

C. How does DNA differ from RNA? pp A-20 thru A-22

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

E. How & where are proteins made? fig C-7, C-9

F. Class skit: Making proteins @ ribosomes!

III. Nutrition PrimerSizer & Whitney (S&W) Sci Lib



A. Essential Nutrients: H₂O, 1^o Carbohydrates,
2^o Fats, 3^o Proteins, Vitamins, Minerals; Macro- vs Micro-?

B. Dietary Guidelines: USDA, AICR, Eat Like the **Rainbow!**

C. Diet or exercise? Diet composition & endurance? Fasting?
Zuti & Golding 1976; Sacks **AHA NPAM Council** 2009;
AMDR? Adjusted Macronutrient Distribution Range!

D. ***Beware of Nutrition Quackery*** S. Kleiner & Monaco 1990

Deck of Cards

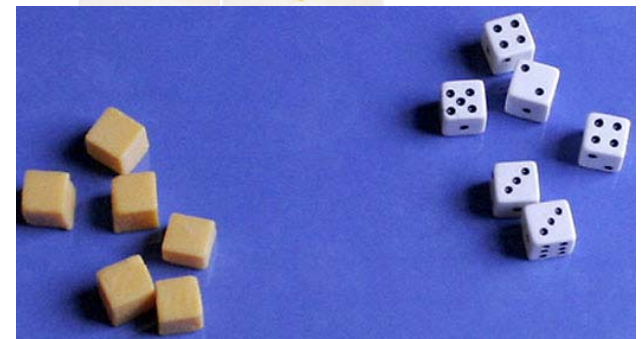
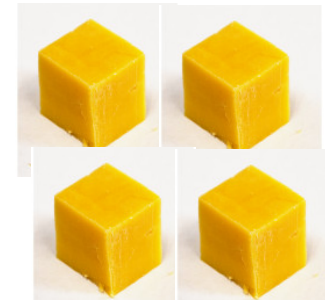


≡

4 oz → 3 oz



raw → cooked



≡ 1 oz

≡ 1.5 oz



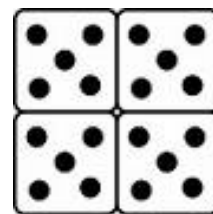
or



≡ 1 c



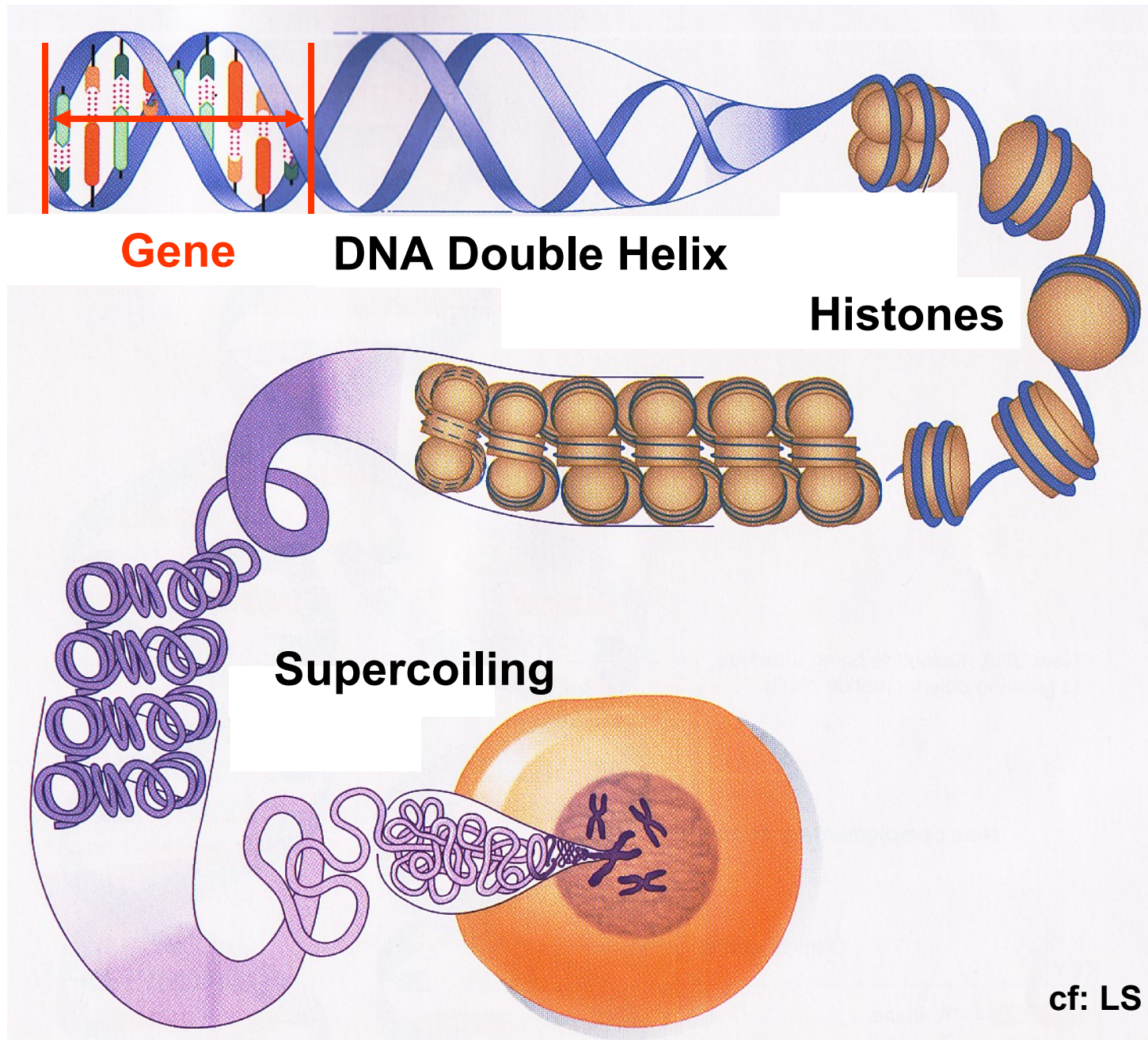
≡ 1/3 c



≡ 1/4 c

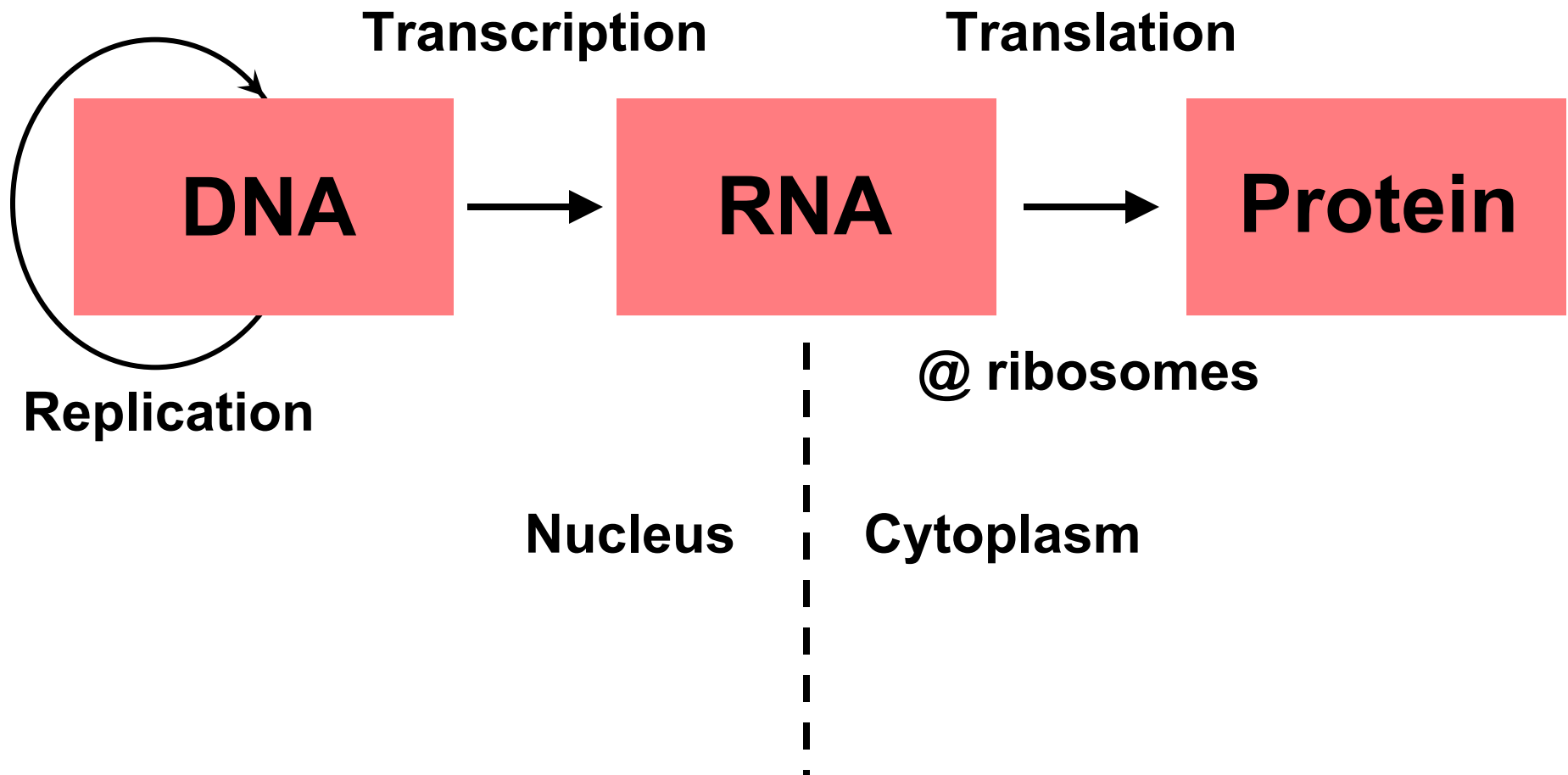


Gene = *Stretch of DNA that codes for a protein*



cf: LS fig C-3

What does DNA do, day-to-day?



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^o Cytoplasm
(but Nucleus origin)

6. mRNA, rRNA, tRNA

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

DNA

code word

TAT

ACG

TTT

TAC

mRNA

codon

AUA

UGC

AAA

AUG

tRNA

anti-codon

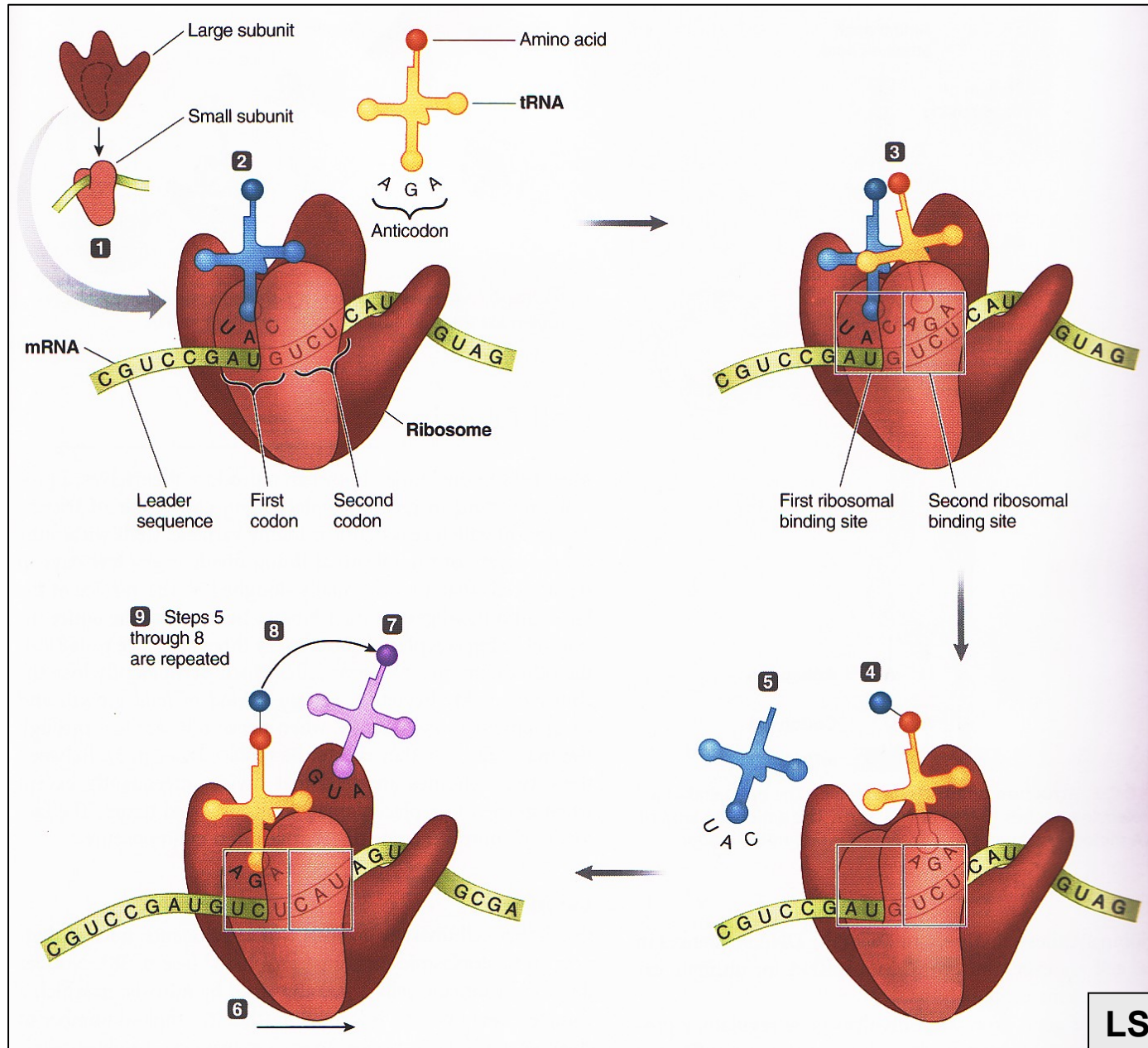
UAU

ACG

UUU

UAC

Translation? Ribosomes Make Proteins



Macronutrients & Micronutrients Essential for Life

Macronutrients

H₂O/Water

✓ 1^o Carbohydrates

✓ 2^o Fats/Triglycerides/Lipids

✓ 3^o Proteins

Micronutrients

Vitamins (A, D, E, K; C + B)

Minerals (K⁺, Na⁺, Ca²⁺, Mg²⁺,
Fe²⁺, Zn²⁺,...)

Sample Food Sources

Water, other drinks, fruits
& vegetables

Grains, vegetables, fruits,
dairy products

Meats, full-fat dairy
products, oils

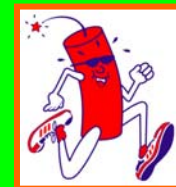
Meats, vegetables,
legumes

NB: Need only minute quantities!

Vegetables, vegetable oils,
fruits, dairy, citrus, grains

Fruits, processed foods,
dairy, nuts, vegetables,
grains, meats

✓ **Energy nutrients = yield ATP**



MyPlate launches June 2, 2011!

2. Focus on fruits.
Whole fruit preferable to juice, but any fruit counts!
Fill $\frac{1}{2}$ your plate with fruits & vegetables!

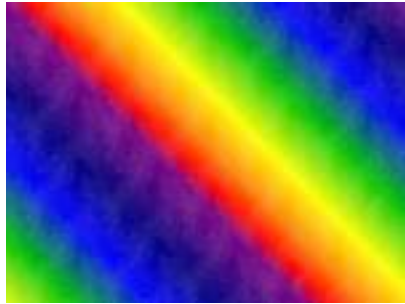


3. Make at least $\frac{1}{2}$ of your grains whole grains!

5. Get your calcium-rich foods. Buy skim or 1% milk. Go easy on cheese!

1. Vary your veggies.
Fill $\frac{1}{2}$ your plate with fruits & vegetables!

4. Go lean with protein. Keep protein to $< \frac{1}{4}$ plate! Nuts, beans, peas, seeds, poultry, lean meat, seafood,...



Eating the Rainbow Hawaiian Style!!



Your plate should be the size of a Frisbee, not a manhole cover.

When it comes to colorful foods, Fruit Loops don't count.

A surprising number of people get 1/5 of their calories from sodas or other liquids.

If you look at the label & need a chemistry degree to read it, put the item back on the shelf!



SOURCE: P. Rath, *Honolulu Advertiser*, Sept 11, 2008 citing D. Chong & N. Kerr.



Yes, more fun!...



BI 121 Lecture 5

I. Announcements Lab 3 tomorrow Nutritional Analyses.

Thanks for recording dietary data on LM p 3-7 & exploring <https://www.supertracker.usda.gov/>. Sample MT Questions.

II. Nutritional Physiology in the News

UCB Wellness Letter, June 2011, Salt–beyond hypertension

III. Nutrition Primer (continued) DC Module 2, S&W +...

A. Fasting? Dr. Sacks **AHA NPAM Council** 2009; AMDR?

B. *Beware of Nutrition Quackery* S. Kleiner & Monaco 1990

IV. Digestion LS 2012 ch 15, pp 437-9, DC Module 3 pp 17-23

A. Steps of digestion Dr. Evonuk + LS pp 437- 9; DC p 23

B. Hydrolysis: the central linking theme! LS p 438, Fox 2009

C. What's missing? LS fig 15-1 p 438

D. GI-Donut analogy? Dr. Lorraine Brilla WWU

E. Gut secretions: What? Where? Why? LS p 438, 440-1

F. Organ-by-organ review LS tab 15-1 pp 440-1 + DC fig 3-1

G. Histology & control of the gut LS fig 15-2, 15-3 p 442-3

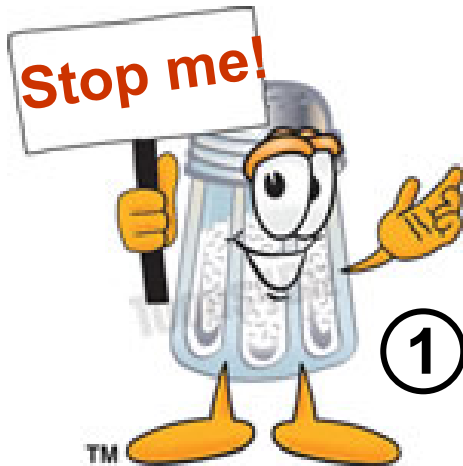
H. Stomach protein digestion + zymogens? LS fig 15-7, 15-9

I. Pancreas & liver accessory organs; Recycling! LS pp 457-63

J. Small intestine? Ulcers? LS fig 15-20,15-22 pp 467- 8

<http://www.cdc.gov/ulcer> LS Beyond the Basics p 456

More Reasons to Shake the Salt Habit



① ↓ blood vessel vasodilation w/in 30 min by ingesting 1500 mg Na+!

② ↑ Ca²⁺ excretion ↑ bone loss, risk of osteoporosis & fractures.

③ May directly impair kidney function & ↑ risk of kidney stones.

④ GI cancer risk, inflammation?



I'm outta here!!



60-day Fast???

Lost 60 lb!! Wow!!

Yet

76.7% {
26 lb Water
20 lb Lean Body Mass
14 lb Fat

Fat < $\frac{1}{4}$ total wt loss!

Potential Complications of Total Fasting

**Nausea, diarrhea, persistent vomiting,
postural hypotension, nutritional
deficiencies, menstrual irregularities,
and...sudden death.**

Positive Aspect??

**General loss of appetite within
first 2 days, maintained
throughout fasting period.**



Dr. Sacks' Conclusions:

We conclude that healthful diets with varying emphases on carbohydrate, fat & protein levels can all achieve clinically meaningful weight loss & maintenance of weight loss over a 2-yr period. The results give people who need to lose weight the flexibility to choose a diet that they can stick with, as long as it's heart healthy. Such diets can also be tailored for individuals based on their personal & cultural preferences & in this regard may have the best chance for long-term success.

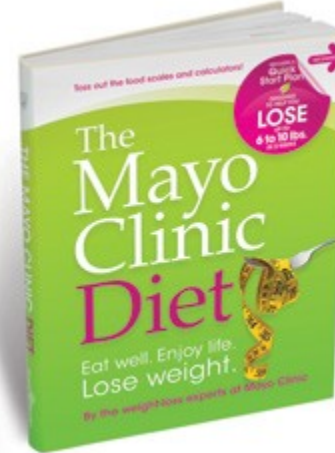
Kleiner's & Monaco's Top 10 Hit List for Nutrition Quackery

1. Treatment based on unproven theory calling for non-toxic, painless therapy.
2. Author's/purveyor's credentials aren't recognized in scientific community.
3. No reports in scientific, peer-reviewed literature but rather mass media used for marketing.
4. Purveyors claim medical establishment is against them & play on public's paranoia about phantom greed of medical establishment.
5. Treatments, potions, drugs manufactured according to secret formula.
6. Excessive claims promising miraculous cures, disease prevention or life extension.
7. Emotional images rather than facts used to support claims.
8. Treatments require special nutritional support including health food products, vitamins and/or minerals.
9. Clients are cautioned about discussing program to avoid negative.
10. Programs based on drugs or treatments not labeled for such use.

NOT PEER-REVIEWED = TRADE BOOKS



PEER-REVIEWED = TEXTS → RESEARCH



AHA + DASH + MAYO CLINIC 



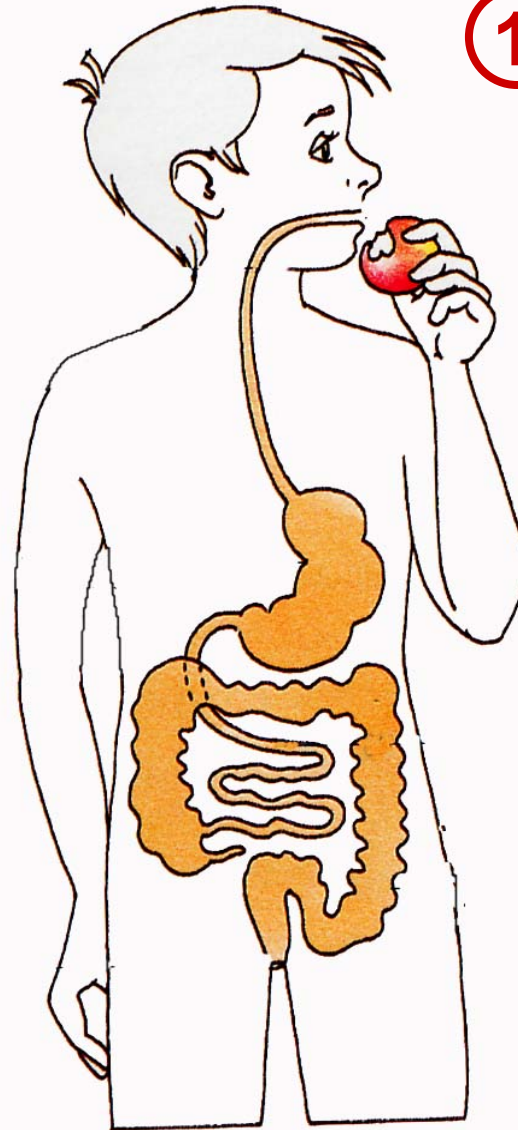
 **LOWER CARBOHYDRATE**

LOWER FAT 

**ELIMINATE CALORIES or FOOD GROUPS
ENCOURAGE FASTING**

**ADEQUACY
BALANCE
CONSISTENCY
& MODERATION**

Digestion Steps



① Ingestion

② Mechanical Digestion

③ Chemical Digestion

④ Peristalsis

⑤ Absorption

⑥ Storage

⑦ Defecation

SOURCE: Dr. Eugene Evonuk, 1989. cf. L Sherwood, 2012 pp 437-8.

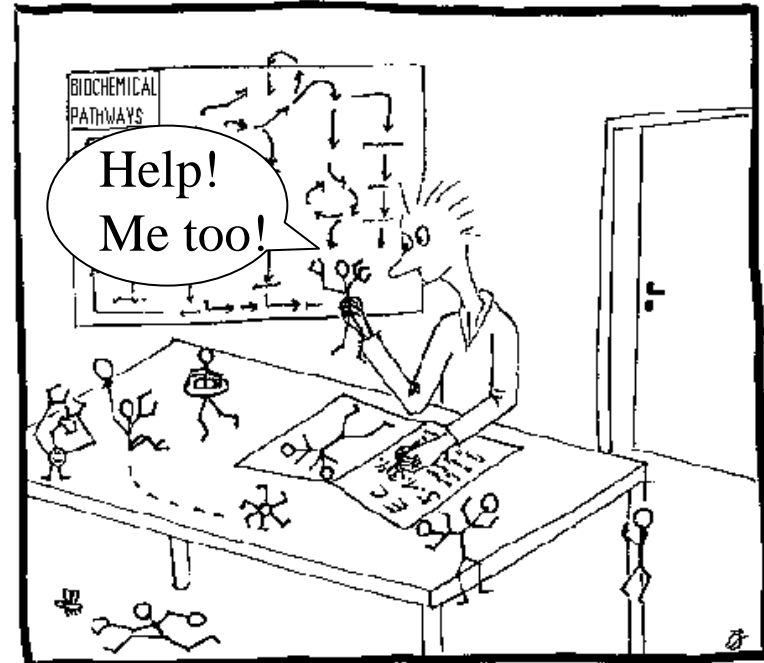
Hydrolysis of Energy Nutrients

Hi gang!!
You need me
for digestion!!



+

The ENZYME data bank



H₂O

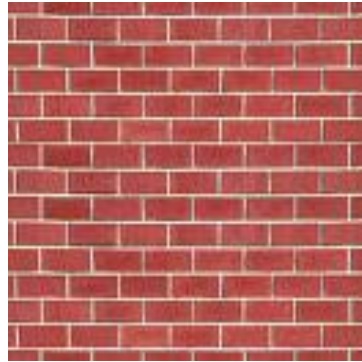
+

Enzyme

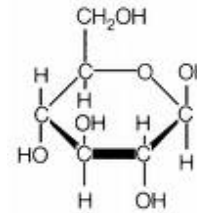
Polymer to Monomer (Many to One)



...Central-linking theme!!

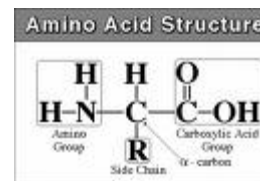


Carbohydrate

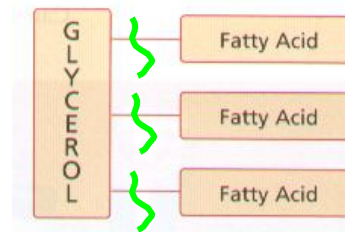


Glucose

Protein
+
Fat

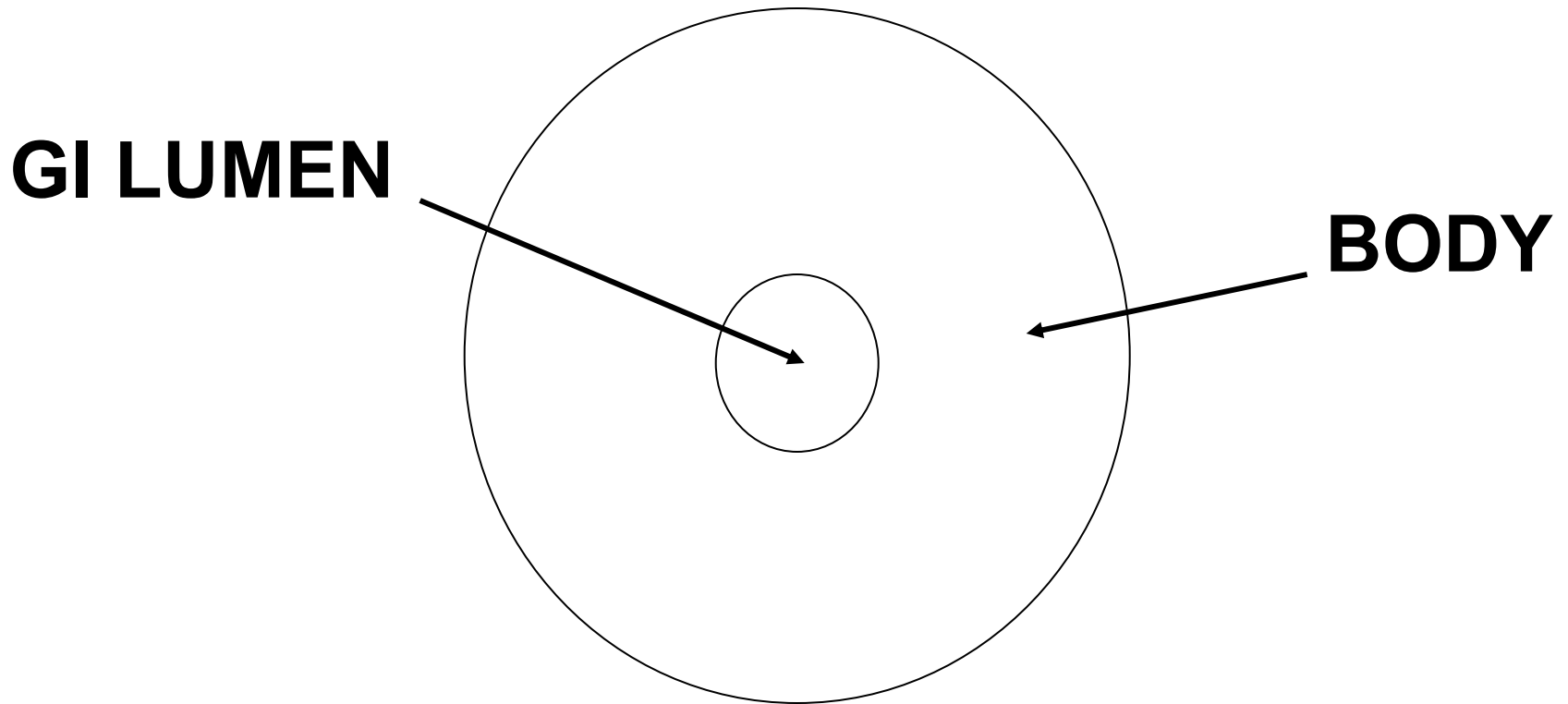


Amino Acids



Fatty Acids
+
Glycerol

GI-DONUT ANALOGY



Gut Secretions

Secretion

Release Site

1. Mucus

into GI Lumen

2. Enzymes

into GI Lumen

3. H₂O, acids, bases+

into GI Lumen

4. Hormones

into Blood

1. Mouth

Ingestion entry way
salivary gland secretion
mucus + enzymes
enzymatic digestion: carbohydrate
mastication = chewing
deglutition = swallowing

4. Liver-Gall Bladder

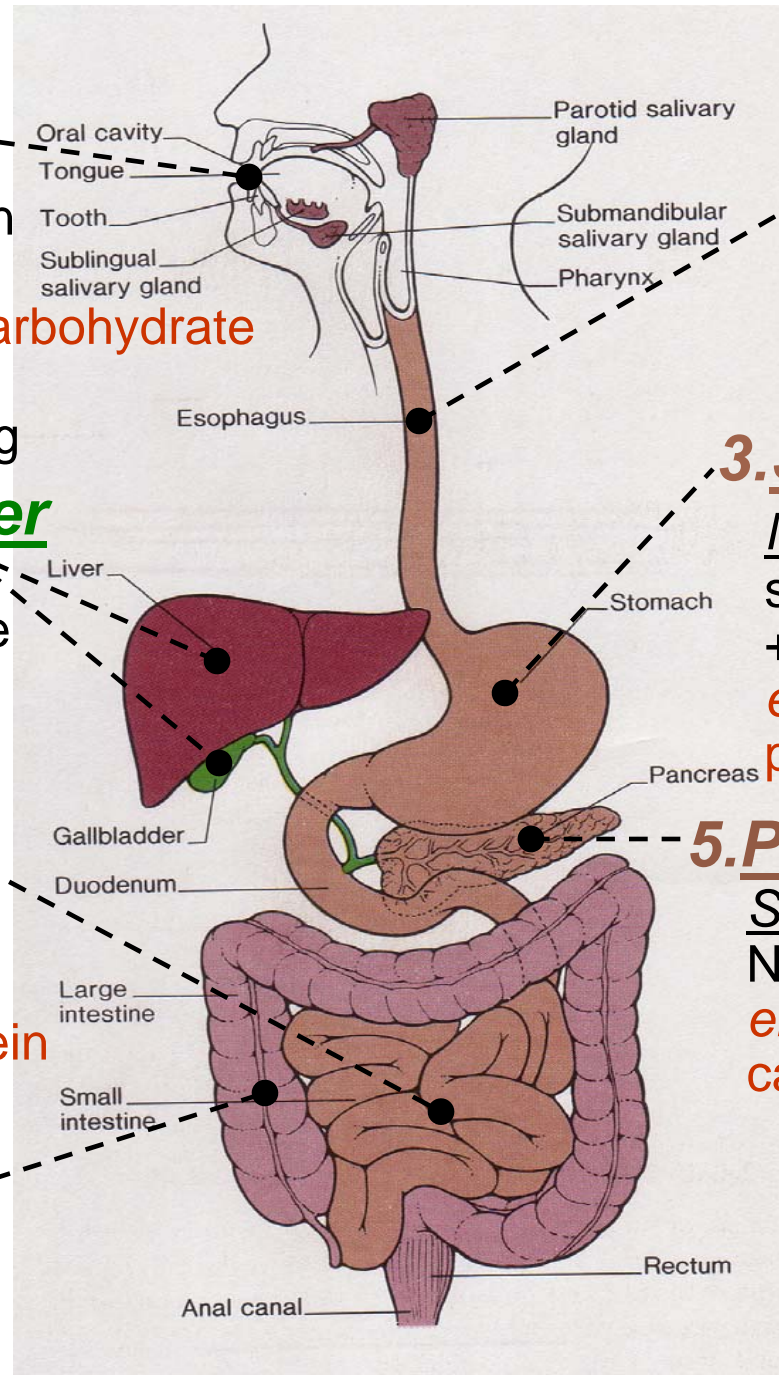
Emulsification =
detergent action of bile
+ secretion

6. Small Intestine

Absorption
Secretion mucus
+ enzymes
enzymatic digestion:
carbohydrate, fat, protein
Peristalsis

7. Large Intestine

Dehydration
secretion + absorption
storage + peristalsis



2. Esophagus

Rapid transit
peristalsis
secretion mucus

3. Stomach

Mixing peristalsis
secretion mucus + HCl
+ enzymes
enzymatic digestion:
protein + butter fat!

5. Pancreas

Secretion mucus +
NaHCO₃ + enzymes
enzymatic digestion:
carbohydrate, fat, protein

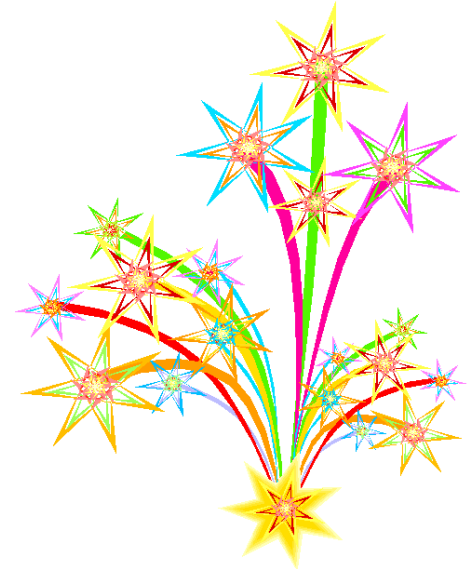
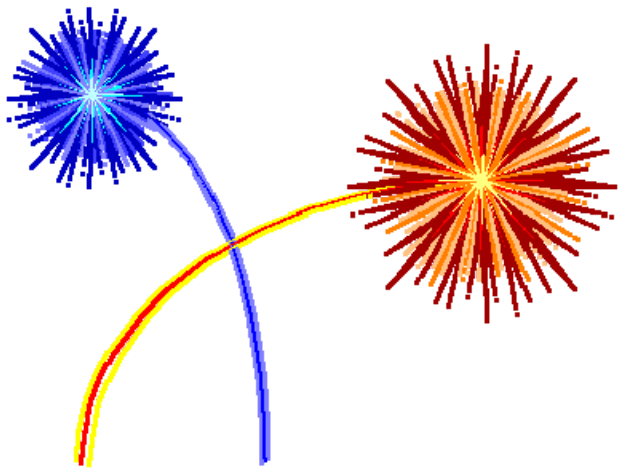
*Hey – I'll be ready
because I book it!!*



BI 121 Lecture 6 + Q + ½ Midterm Review

- I. Announcements Next session Q? ~½ review, then Midterm.**
Fun Lab 3 Nutrition today! Sample Suisse Calculation? Q?
- II. Nutrition in the News Be a whiz at healthy grilling!**
American Institute for Cancer Research, Grilling Quiz!
- III. Digestion Connections LS ch 15, DC Module pp 17-23**
 - A. Histology & control of the gut LS fig 15-2, 15-3 p 442-3
 - B. Stomach protein digestion + zymogens? LS fig 15-7, 15-9
 - C. Accessory organs: Pancreas & Liver + Recycling!
LS pp 457-63
 - D. Small intestine? Ulcers? LS fig 15-20, 15-22 pp 467-8
<http://www.cdc.gov/ulcer> Beyond the Basics LS p 456
 - E. Summary of chemical digestion LS tab 15-5 p 466
 - F. Large intestine? LS fig 15-24 pp 472-4
- IV. Midterm Review Discussion + Q?**

Stay focused now!
Later, have fun &
be safe!!



How Do I Calculate the % of Total Calories from Carbohydrate, Fat & Protein?

Carbohydrate 46 g x 4 kcal/g = 184 kcal

% Carbohydrate = $184/567 = 0.326 \equiv \sim 33\%$

Fat 39 g x 9 kcal/g = 351 kcal

% Fat = $351/567 = 0.619 \equiv \sim 62\%$

Protein 8 g x 4 kcal/g = 32 kcal

% Protein = $32/567 = 0.056 \equiv \sim 6\%$

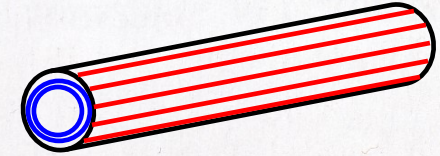
$\Sigma = 567$ kcal

American Institute for Cancer Research (AICR) Healthy Grilling Quiz Summary

- 1. Marinade, marinade, marinade! By doing so, you can decrease carcinogens formed during grilling by $\leq 96\%$!**
- 2. Cover the grill with aluminum foil, turn gas down or wait for low-burning embers, cook to the side.**
- 3. Best choices for grilling include vegetables and fruits (no HCAs + enzymes to inactivate HCAs!), and lean meats (eg, fish & skinless chicken ↓ PAHs).**
- 4. Flip meat every minute to reduce charring & remove charred portions prior to eating.**
- 5. To limit cancer risk, eat no more than 3 oz grilled red meat. Cook small portions/kebabs.**

LS 2012 fig 15-2 p 442

Longitudinal → Shortens L



Circular → ↓d or Width

Body wall

Serosa

Submucosa

Duct of large accessory digestive gland (i.e., liver or pancreas) emptying into digestive-tract lumen

Outer longitudinal muscle

Inner circular muscle

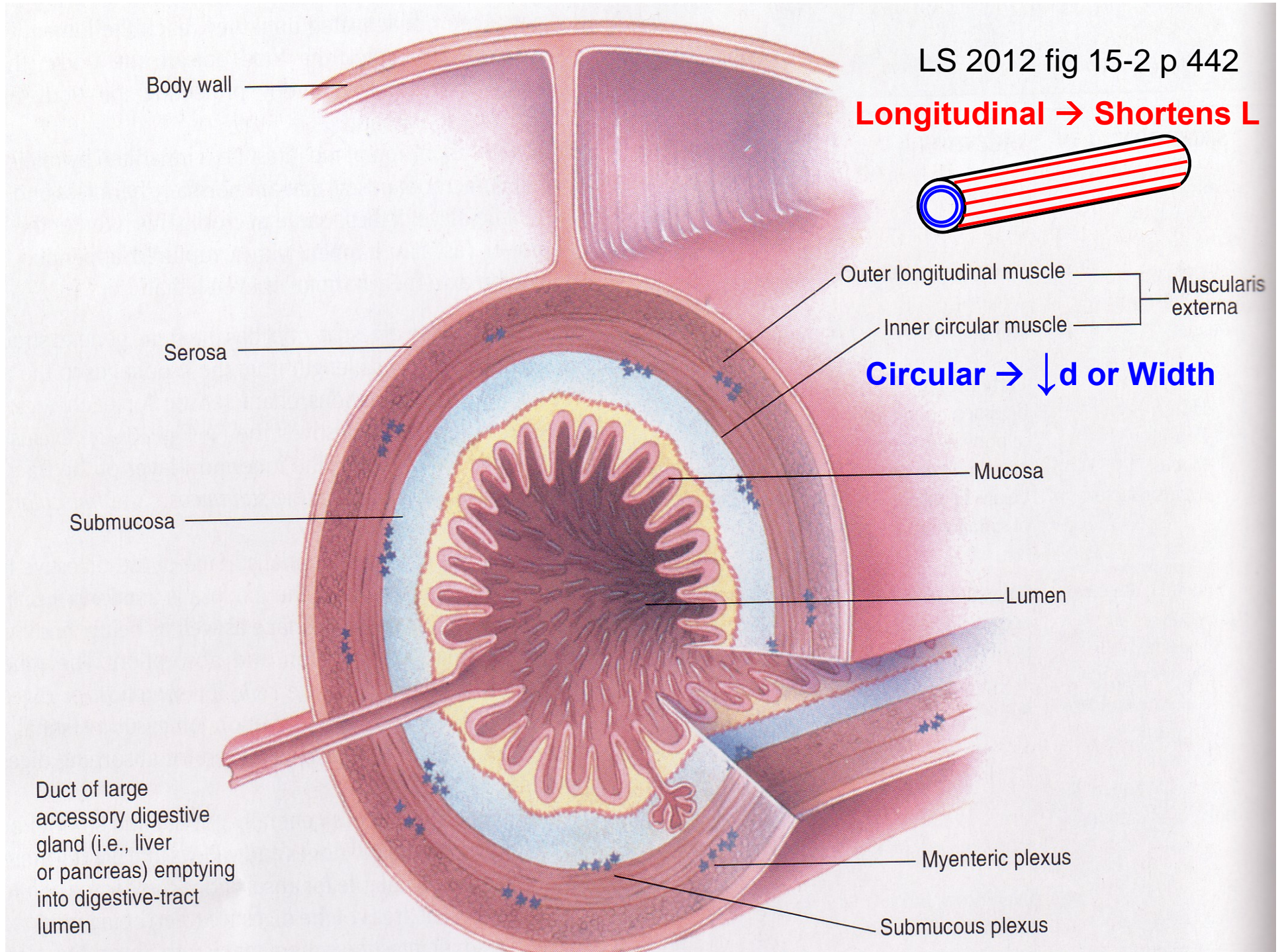
Muscularis externa

Mucosa

Lumen

Myenteric plexus

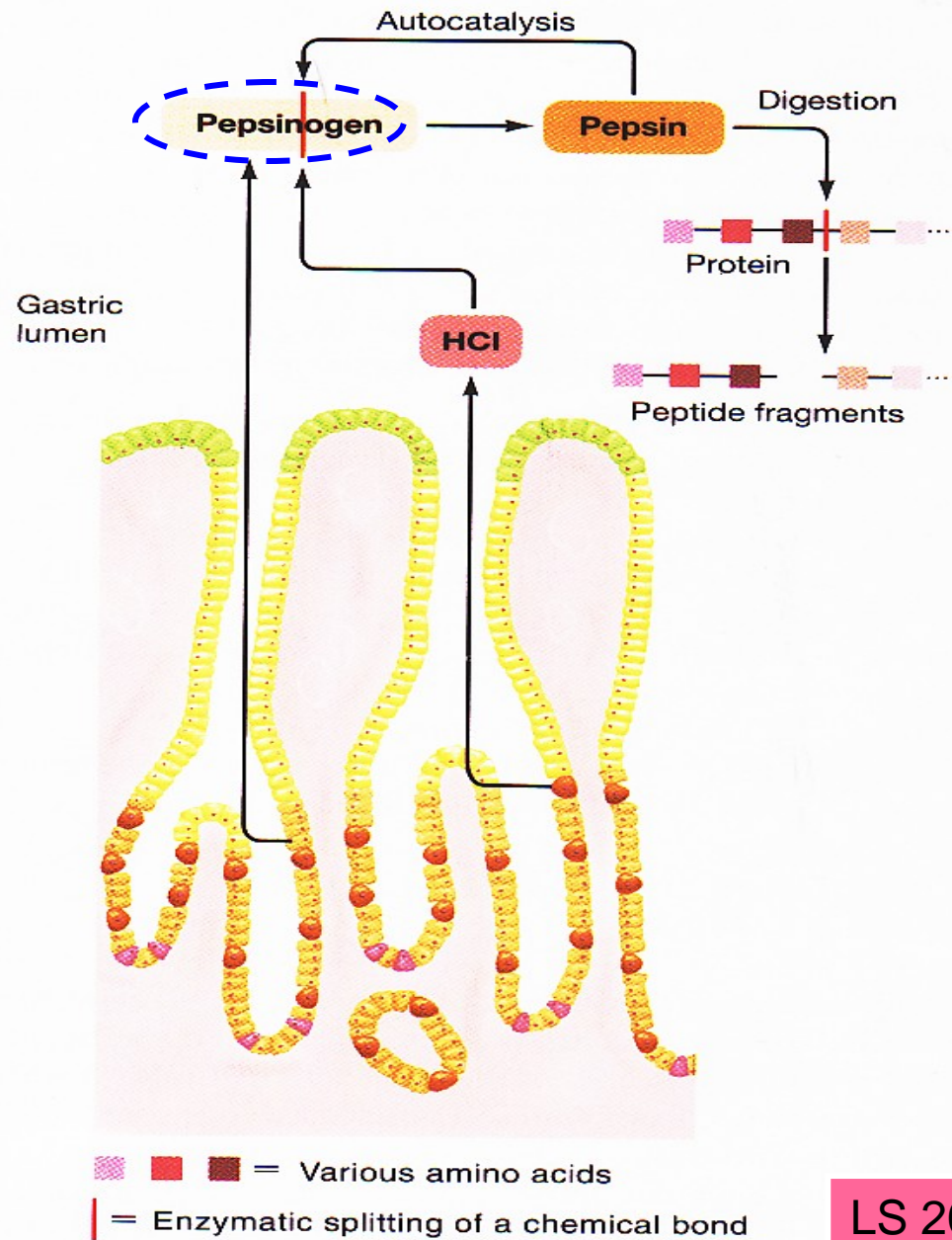
Submucous plexus



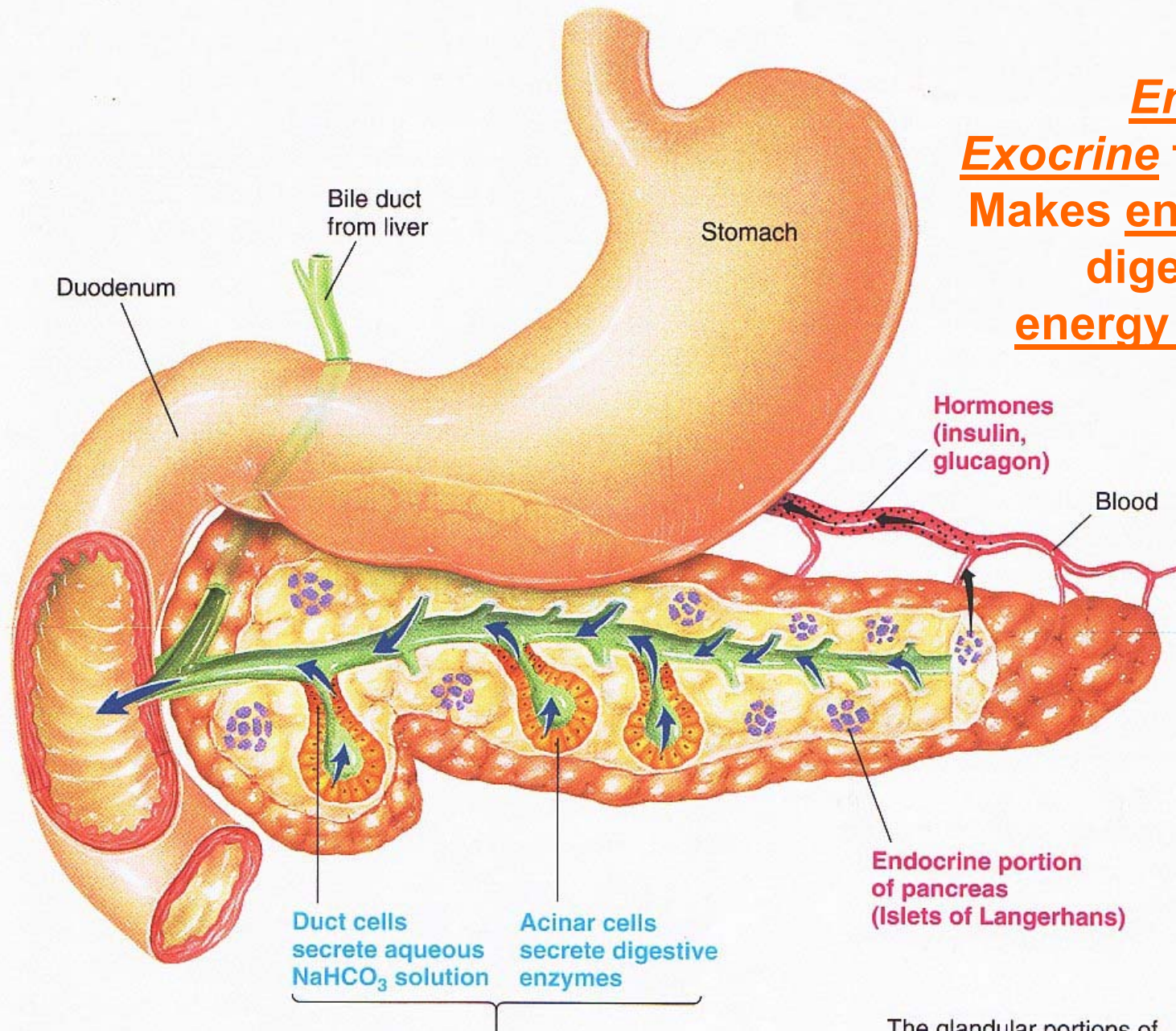
Common Control Mechanisms

- 1. Local (autoregulation)**
- 2. Nervous (rapidly-acting)**
- 3. Hormonal (slower-acting/
reinforcing)**

**Zymogen =
an inactive
precursor**



**Endocrine + Exocrine functions;
Makes enzymes for
digesting all 3
energy nutrients!**

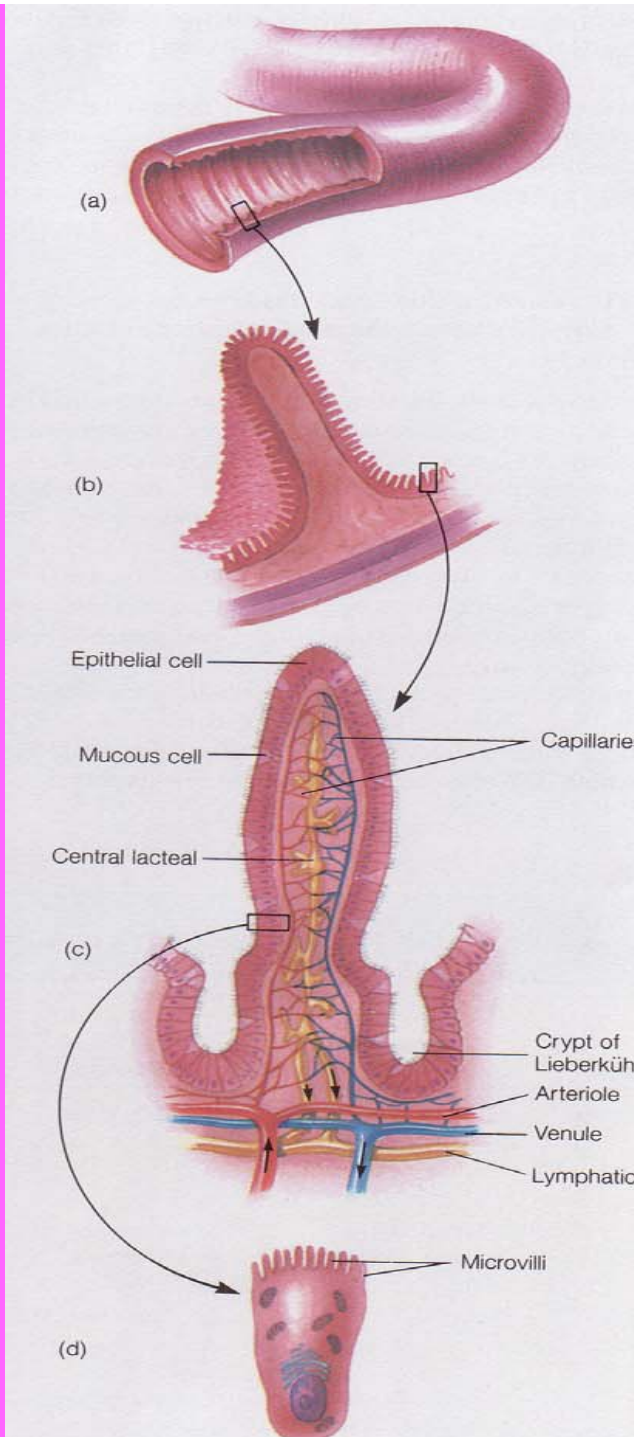


Endocrine portion of pancreas (Islets of Langerhans)

Duct cells secrete aqueous NaHCO_3 solution
Acinar cells secrete digestive enzymes

Exocrine portion of pancreas (Acinar and duct cells)

The glandular portions of the pancreas are grossly exaggerated.



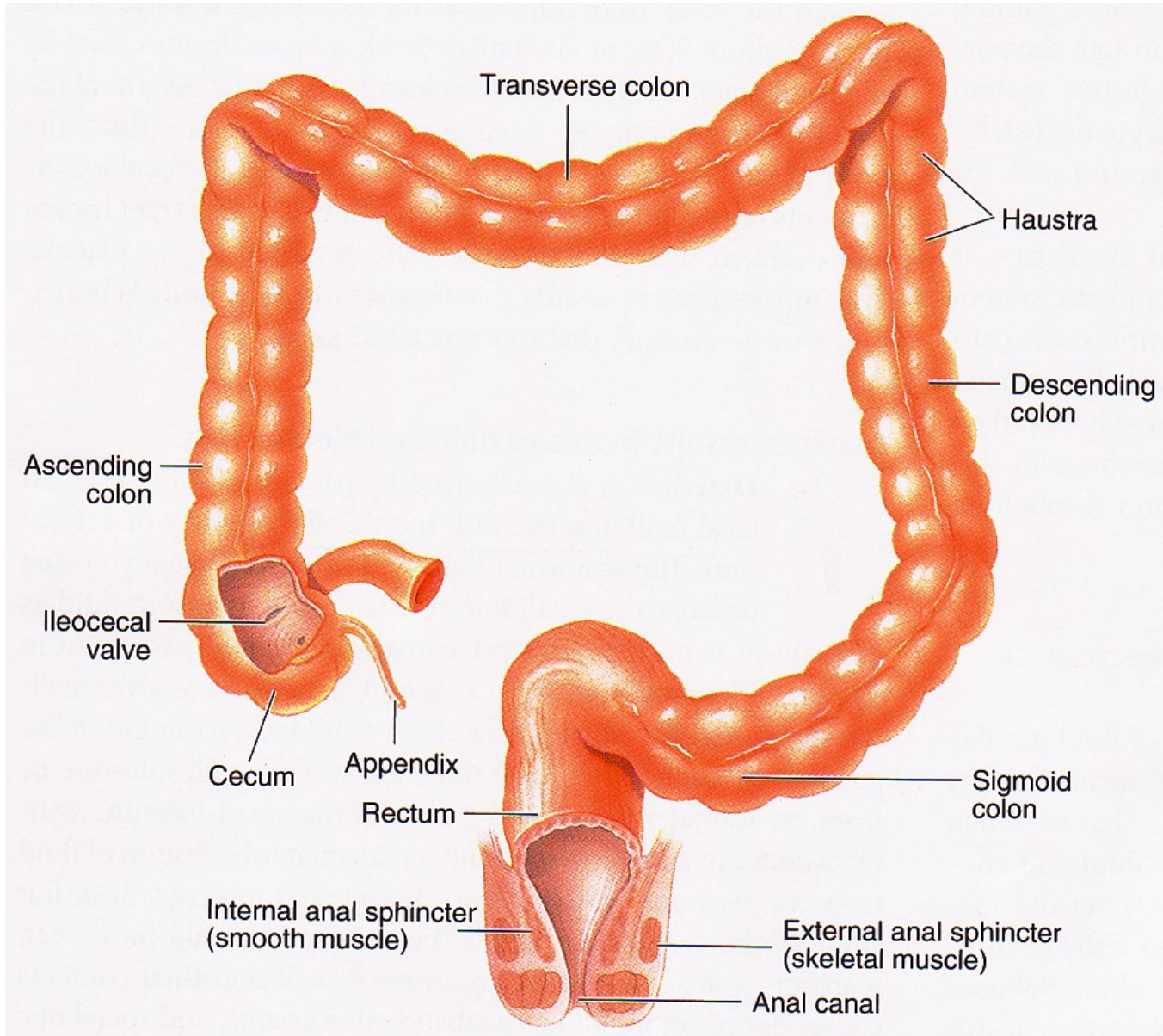
Ulcer Facts

- Most ulcers are caused by an infection, not spicy food, acid or stress.
- The most common ulcer symptom is burning pain in the stomach.
- Your doctor can test you for *H. pylori* infection.
- Antibiotics are the new cure for ulcers.
- Eliminating *H. pylori* infections with antibiotics means that your ulcer can be cured for good.

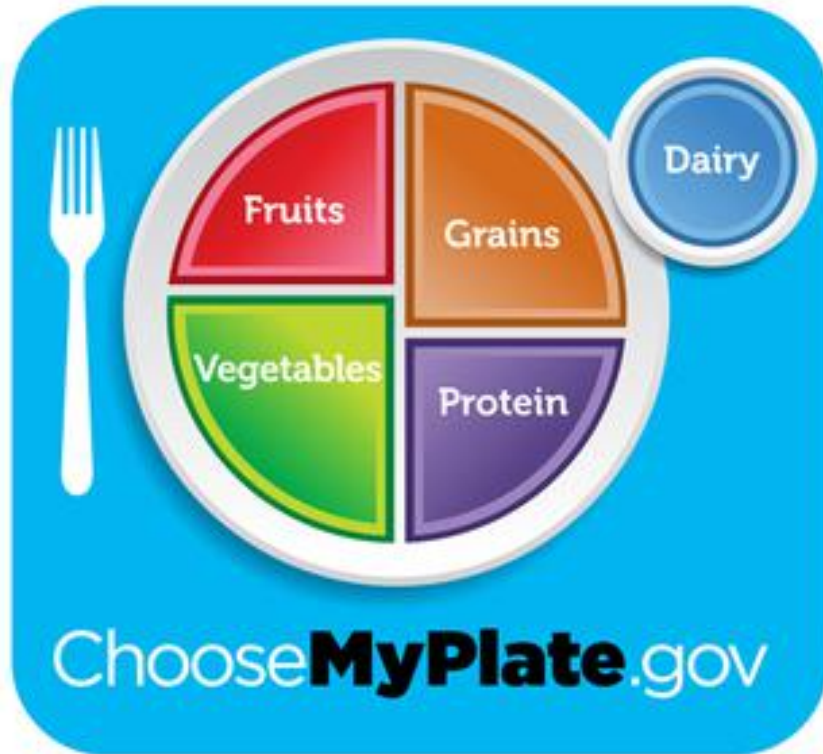
▲ **Table 15-5 Digestive Processes for the Three Major Categories of Nutrients**

Nutrients	Enzymes for Digesting the Nutrients	Source of Enzymes	Site of Action of Enzymes	Action of Enzymes	Absorbable Units of the Nutrients
Carbohydrates	Amylase	Salivary glands	Mouth and (mostly) body of stomach	Hydrolyzes polysaccharides to disaccharides (maltose)	
		Exocrine pancreas	Small-intestine lumen		
	Disaccharidases (maltase, sucrase, lactase)	Small-intestine epithelial cells	Small-intestine brush border	Hydrolyze disaccharides to monosaccharides	Monosaccharides, especially glucose
Proteins	Pepsin	Stomach chief cells	Stomach antrum	Hydrolyzes protein to peptide fragments	
	Trypsin, chymotrypsin, carboxypeptidase	Exocrine pancreas	Small-intestine lumen	Attack different peptide fragments	
	Aminopeptidases	Small-intestine epithelial cells	Small-intestine brush border	Hydrolyze peptide fragments to amino acids	Amino acids
Fats	Lipase	Exocrine pancreas	Small-intestine lumen	Hydrolyzes triglycerides to fatty acids and monoglycerides	Fatty acids and monoglycerides
	Bile salts (not an enzyme)	Liver	Small-intestine lumen	Emulsify large fat globules for attack by pancreatic lipase	

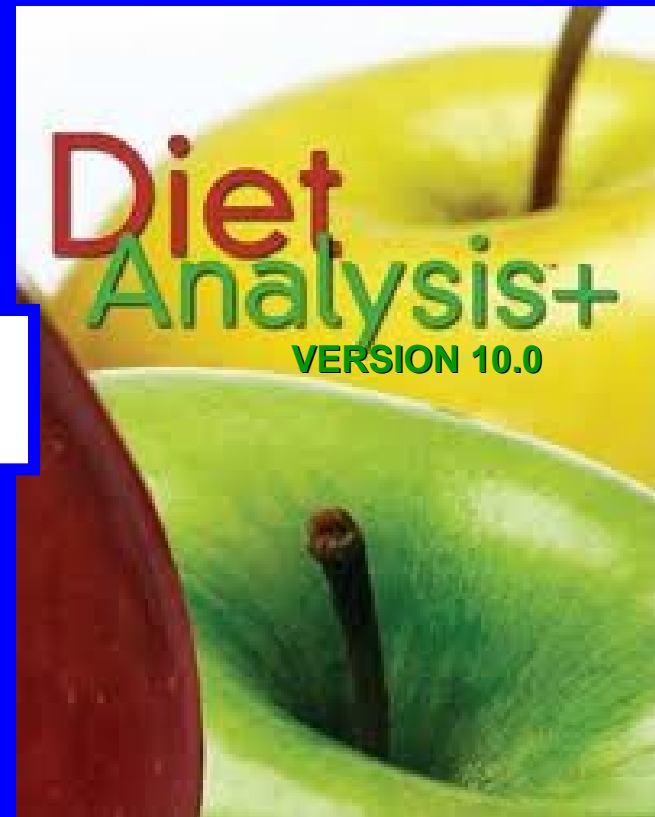
Large Intestine Structure & Function



Lab 3: Nutritional Analyses via 2 Programs



+



<https://www.supertracker.usda.gov/>