

Anatomy & Physiology Lab today!...  
Exam I next Thursday > 4<sup>th</sup> of July!!



## BI 121 Lecture 4

**I. Announcements** Nutrition Analysis Lab next Thursday!  
Please record your diet on p 3-7 LM & complete analysis by tomorrow using <https://www.supertracker.usda.gov/> Q?

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

**III. Cell Physiology, Mitochondria & Metabolism Connections**

LS 2012 fig 2-9 thru 2-12, 2-15 +...Mathews & Fox 1976

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

A. What's a gene? DNA? Why important? pp A-18 thru A-20 +

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

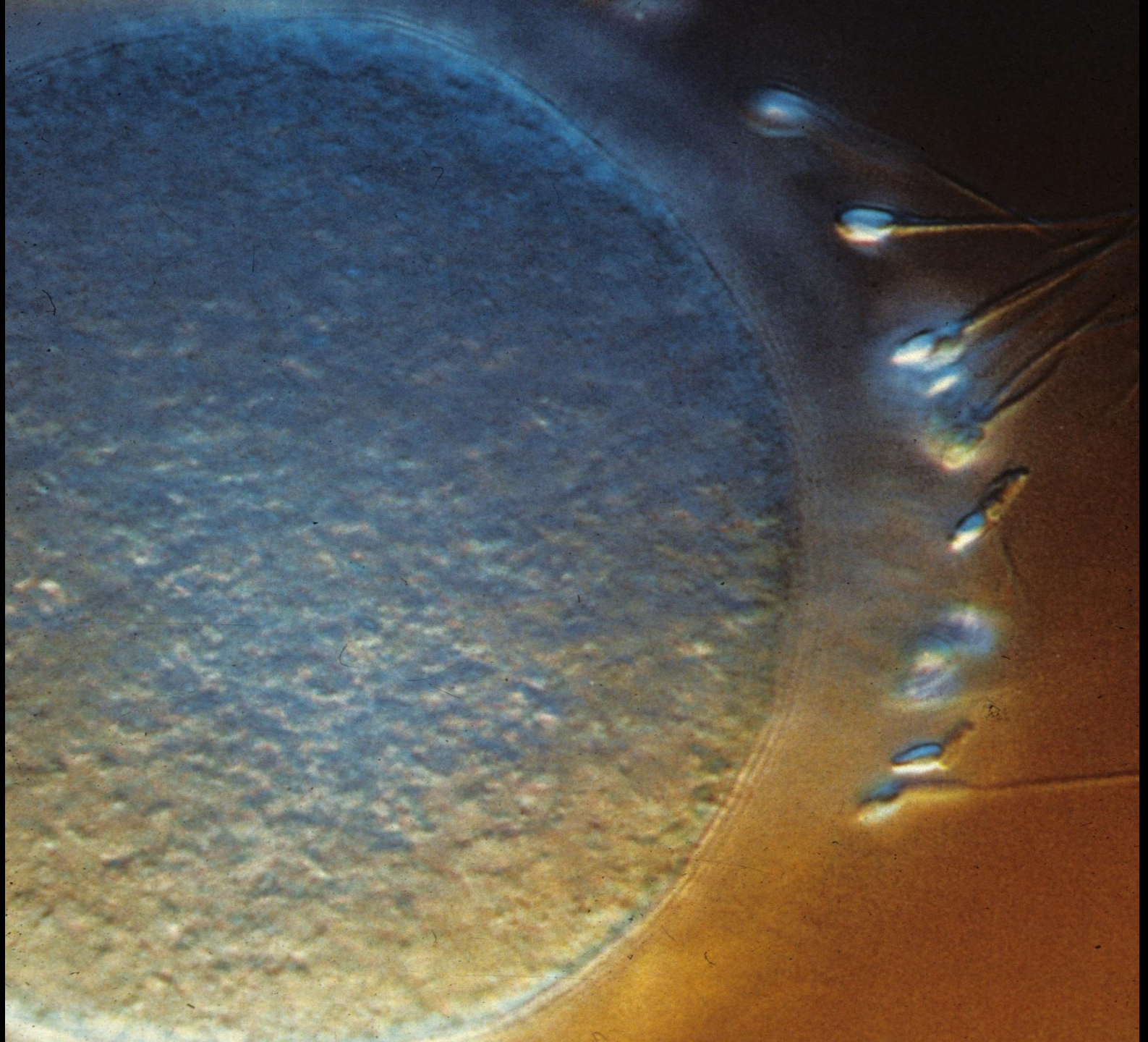
F. Class skit: Making proteins @ ribosomes!



**V. Nutrition Primer** DC Module 2,Sizer & Whitney(S&W) Sci Lib

A. Essential Nutrients: H<sub>2</sub>O, 1<sup>o</sup> Carbohydrates,  
2<sup>o</sup> Fats, 3<sup>o</sup> Proteins, Vitamins, Minerals; Macro- vs Micro-?

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





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# Mom's eggs execute Dad's mitochondria

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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.

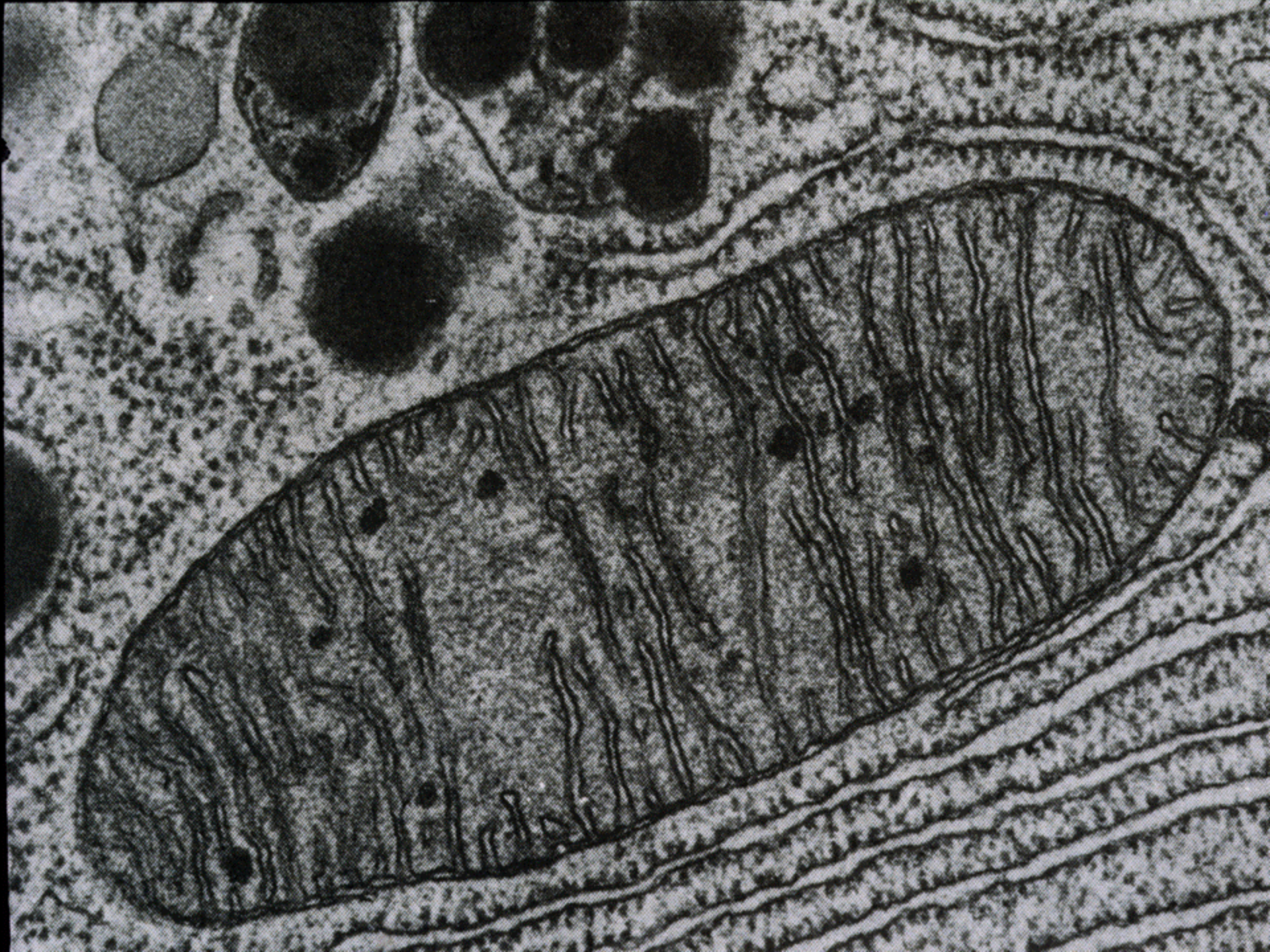
When paternal mitochondria escape destruction in normal mating, the resulting embryo may suffer. Schatten notes that a colleague has found sperm mitochondria in some defective embryos from infertility clinics.



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.







**AEROBIC**

w/O<sub>2</sub>

=

MITOCHONDRION

**ANAEROBIC**

without O<sub>2</sub>

= CYTOSOL



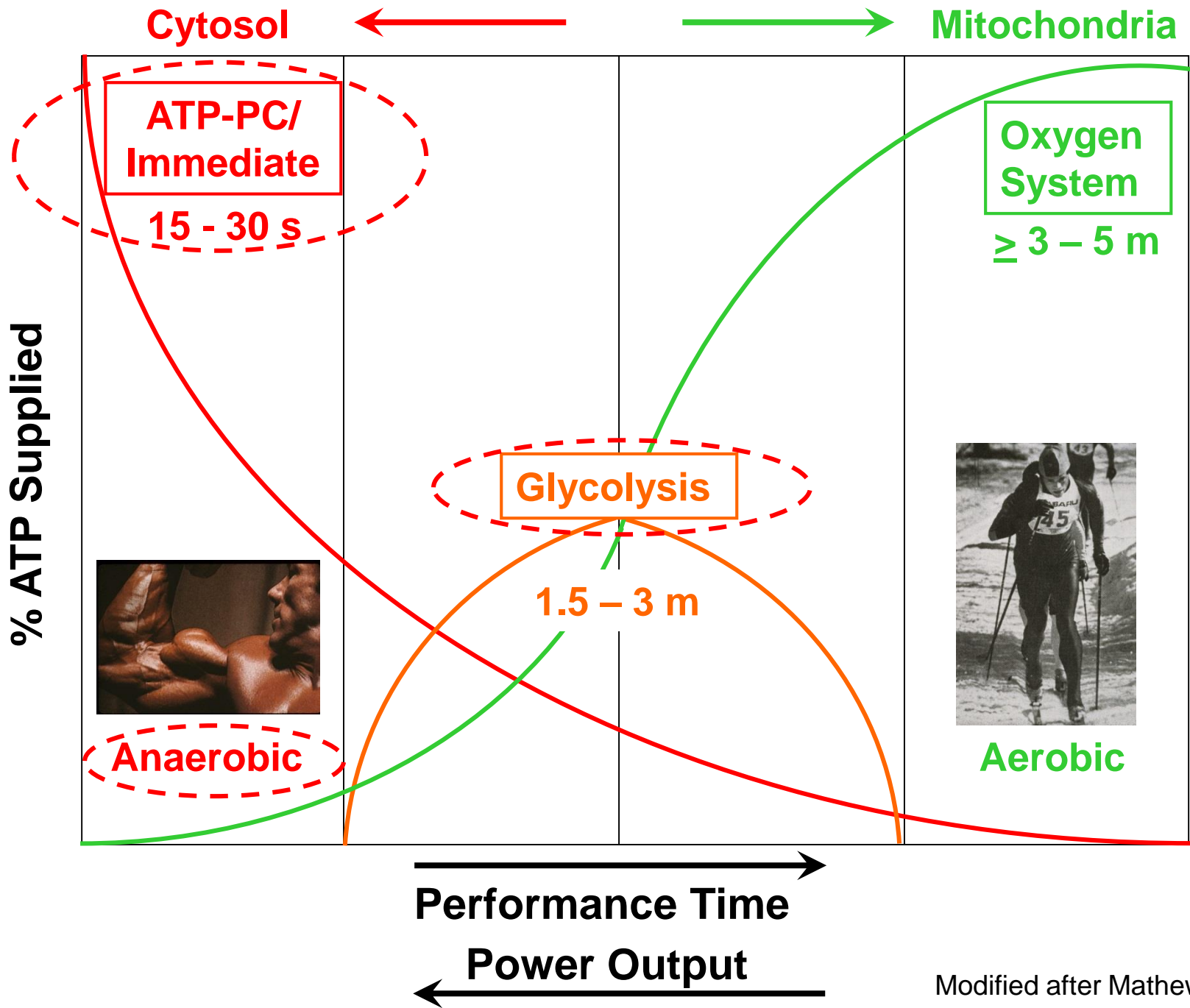
1. Immediate/ATP-PC
2. Glycolysis



WOW!

I'M CHAMP!

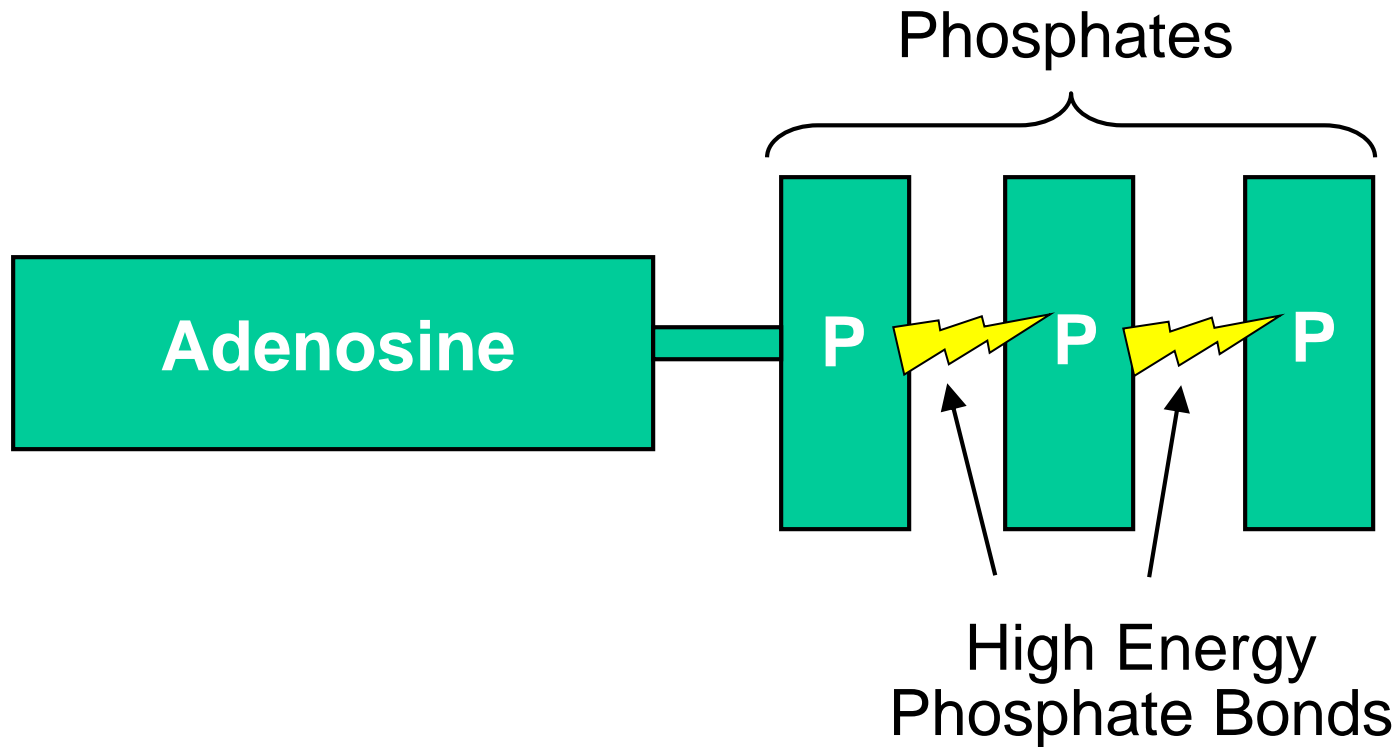




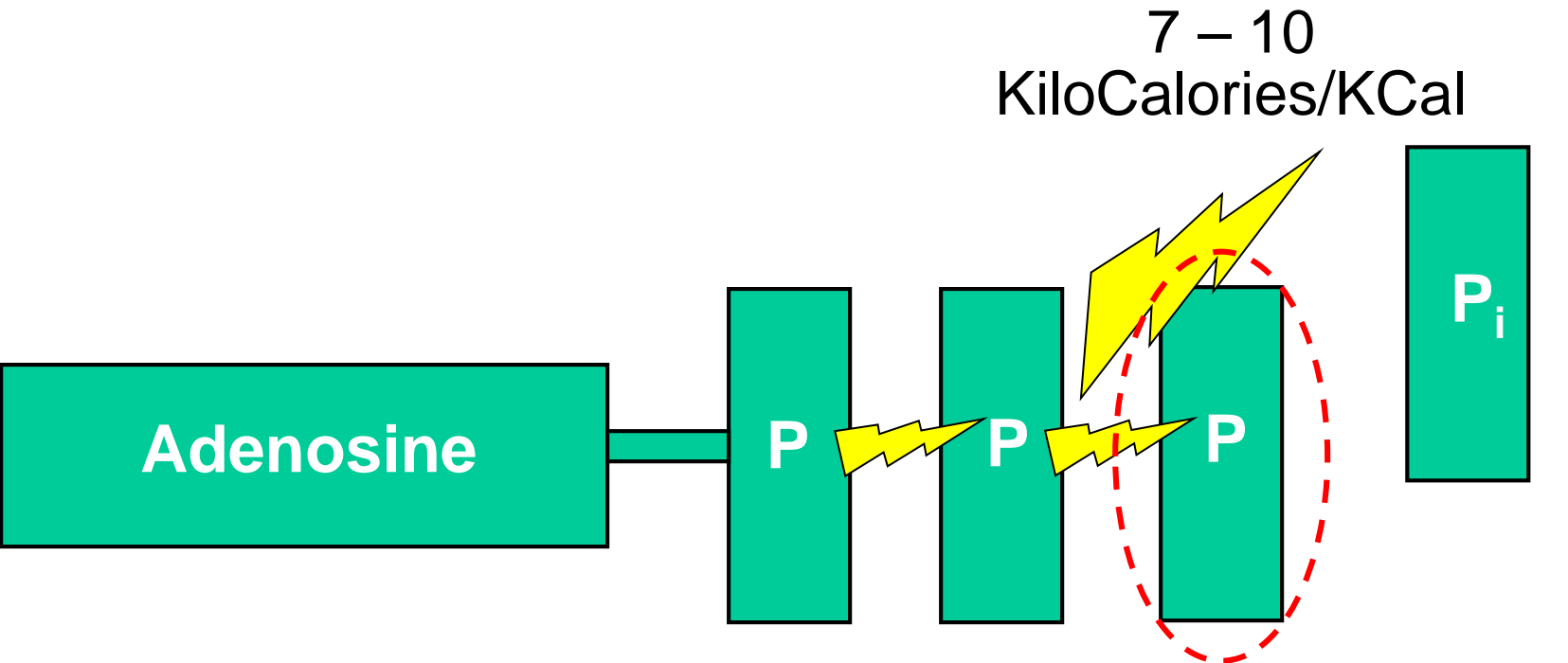
Modified after Mathews & Fox



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



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



① *Synthesis of Macromolecules*

Make big things from little things!

② *Membrane Transport*

Move things!  
Microscopic!

③ *Mechanical Work*

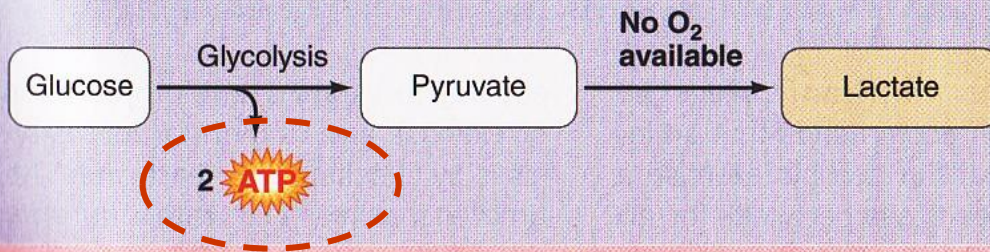
Move things!  
Macroscopic!





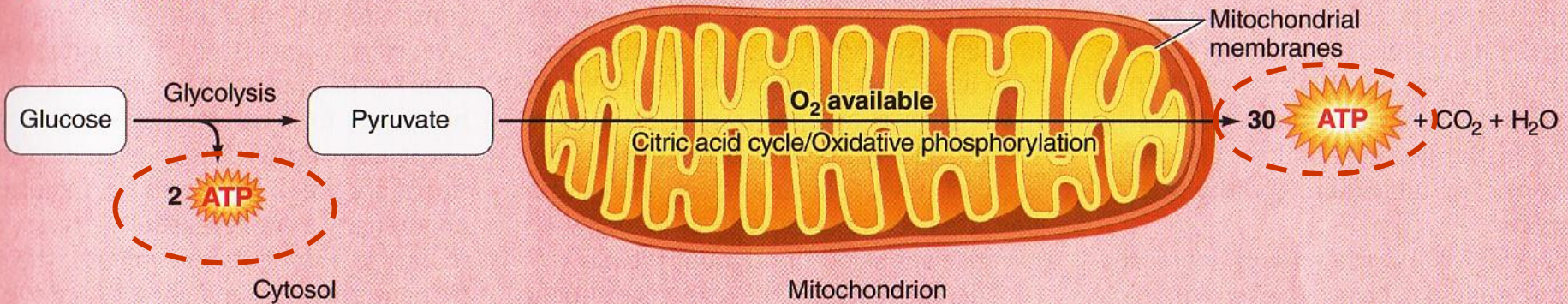
# Anaerobic vs. Aerobic Metabolism

## Anaerobic conditions



**Anaerobic Glycolysis**  
"sugar dissolving"  
**without O<sub>2</sub>. Net of 2 ATP**  
**per molecule of glucose**

## Aerobic conditions



**Aerobic Metabolism**  
**+mitochondrial processing of**  
**glucose with O<sub>2</sub>. Net of 32 ATP**  
**per molecule of glucose**



**AEROBIC**

w/O<sub>2</sub>

PRIMARY FUEL

FAT,  
CARBOHYDRATE  
& PROTEIN  
(Small Amounts)

CARBOHYDRATE  
(Glucose & Glycogen)

ATP, ADP &  
Creatine  
Phosphate (CP)

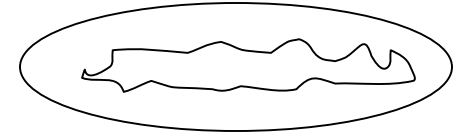
% AEROBIC  
(Oxidative  
Energy System)

% ANAEROBIC  
(Immediate & Non-Oxidative  
Energy Systems)

ACTIVITY

TIME (Min:Sec)

| ACTIVITY                     | % AEROBIC (Oxidative Energy System) | % ANAEROBIC (Immediate & Non-Oxidative Energy Systems) | TIME (Min:Sec) |
|------------------------------|-------------------------------------|--|----------------|
| Marathon                     | 100                                 | 0  | 135:00         |
| Cross-Country Skiing         | 90                                  | 10   | 29:00          |
| 10-K Run                     | 80                                  | 20   | 14:00          |
| 3-Mile Run                   | 70                                  | 30   | 9:00           |
| 2-Mile Run                   | 60                                  | 40   | 3:45           |
| 800-Meter Swim               | 50                                  | 50   | 3:45           |
| 1-Mile Run                   | 40                                  | 60   | 1:30           |
| Boxing                       | 30                                  | 70   | 1:30           |
| 200-Meter Swim               | 20                                  | 80   | 0:50           |
| Circuit Weight Training      | 10                                  | 90   | 0:20           |
| Soccer                       | 0                                   | 100  | 0:10           |
| Lacrosse                     |                                     |  |                |
| Tennis                       |                                     |  |                |
| Basketball                   |                                     |  |                |
| Volleyball                   |                                     |  |                |
| 200-Meter Dash               |                                     |  |                |
| Football                     |                                     |  |                |
| Conventional Weight Training |                                     |  |                |



**MITOCHONDRIA**

**CYTOSOL**

Glycolysis



**Immediate/ATP-PC**



**ANAEROBIC**



# Stages of Cellular Metabolism/Respiration

**Anaerobic  
Glycolysis  
Cytosol**

**Aerobic  
Metabolism  
Mitochondria**

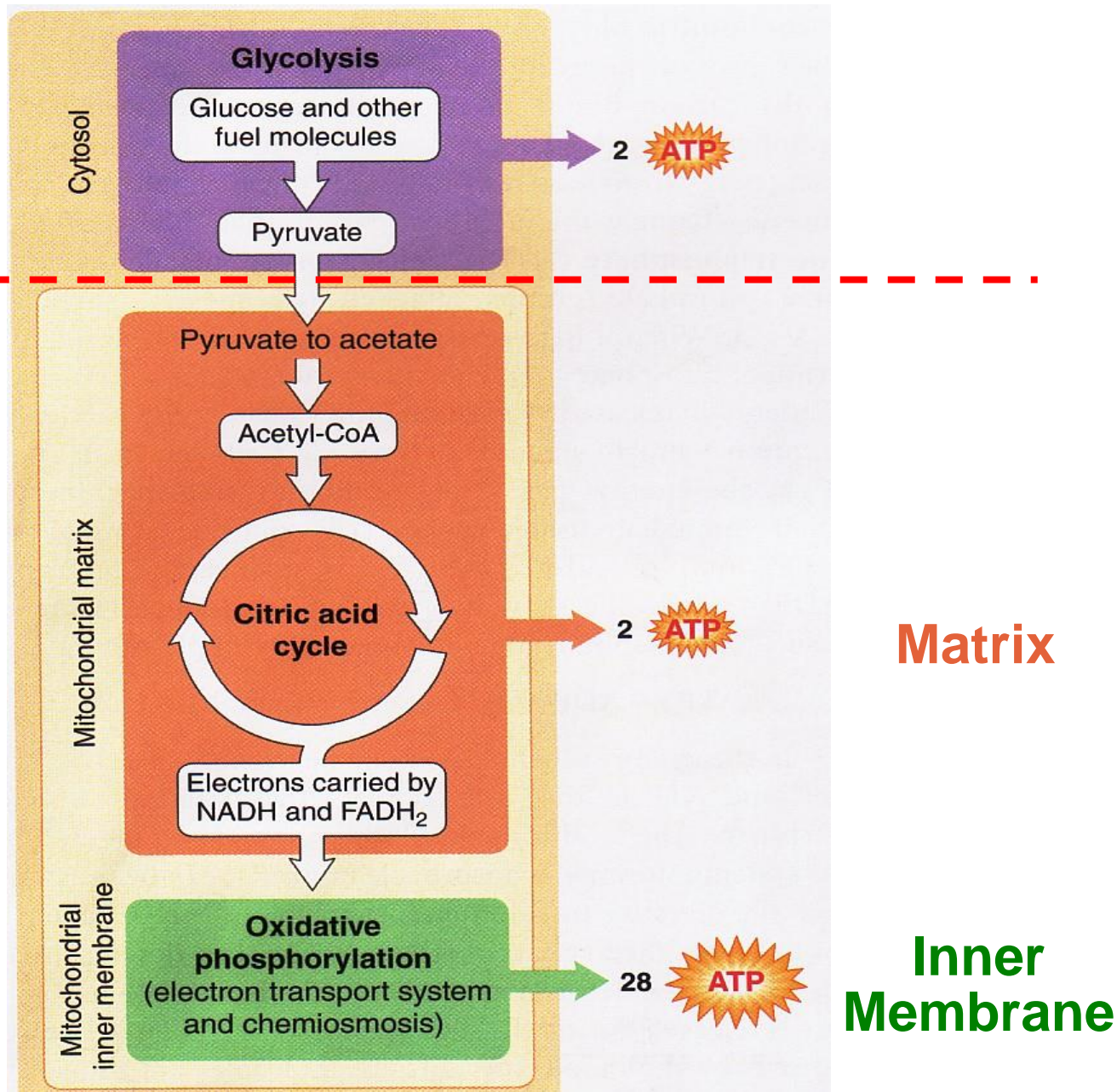


fig 2-9 LS 2012

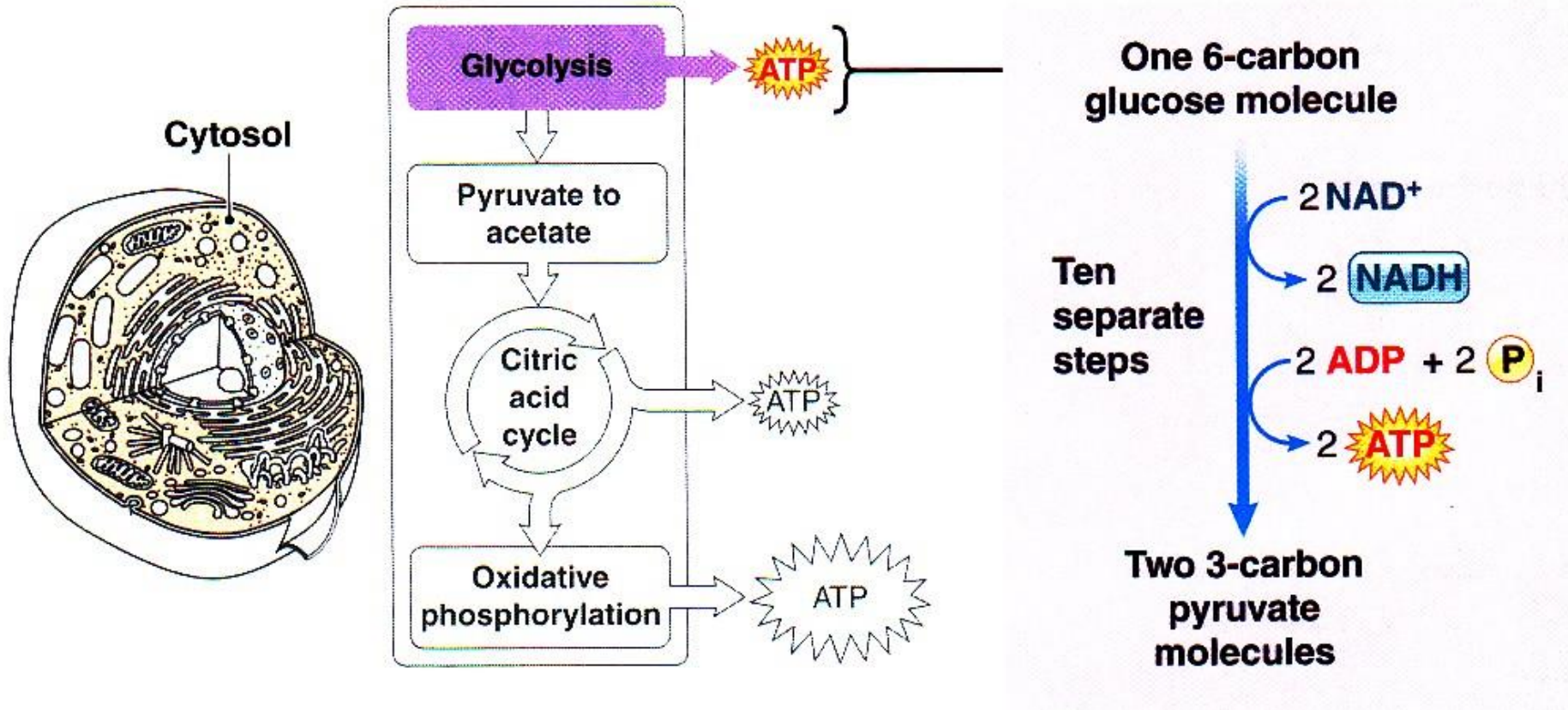


fig 2-10 LS 2012



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

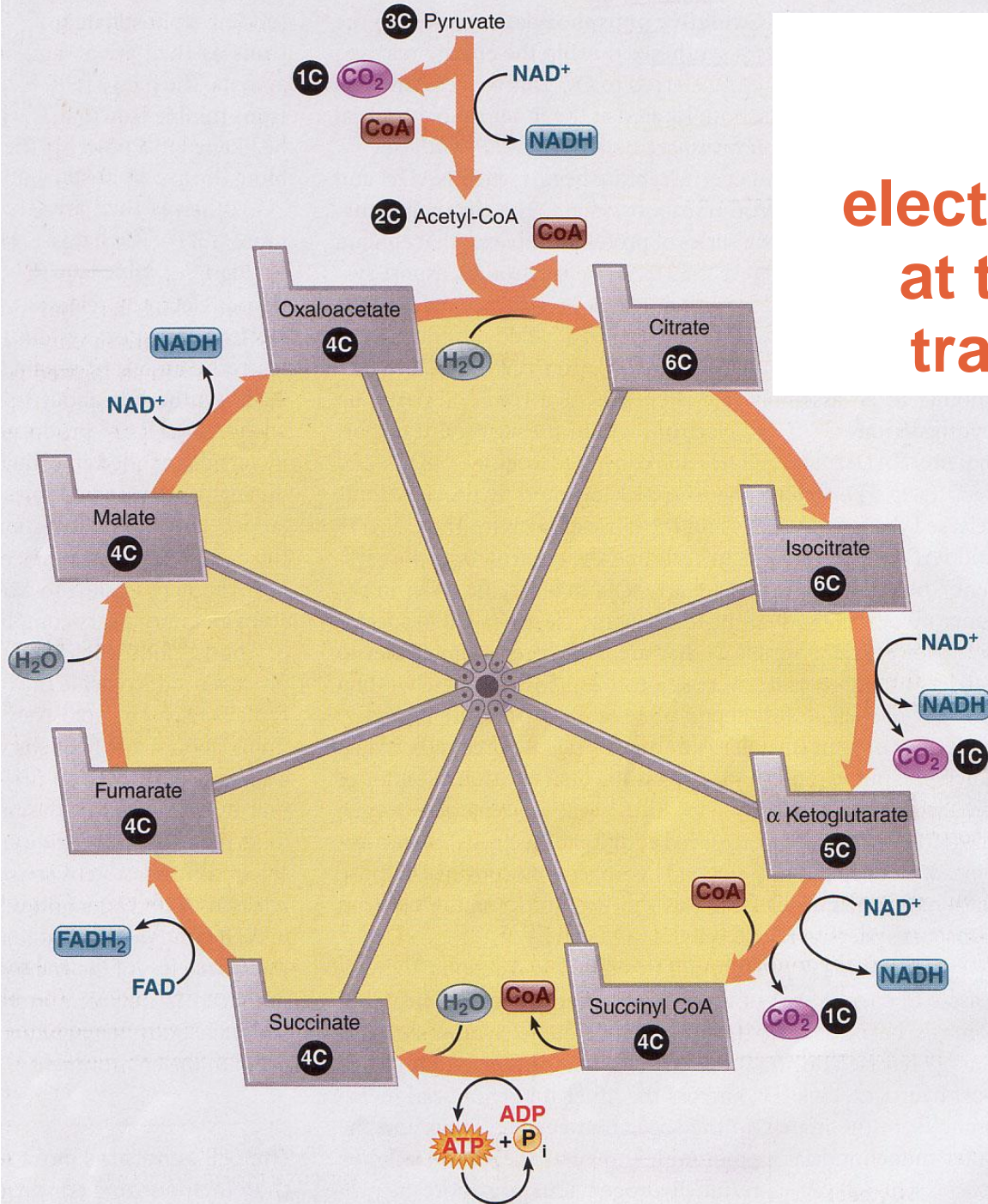


fig 2-11 LS 2012  
+ David Oganessian  
<http://pixdaus.com>



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

Cytosol

Outer mitochondrial membrane

MitoSciences®

Rod Capaldi  
U of O Biology



Inner  
...

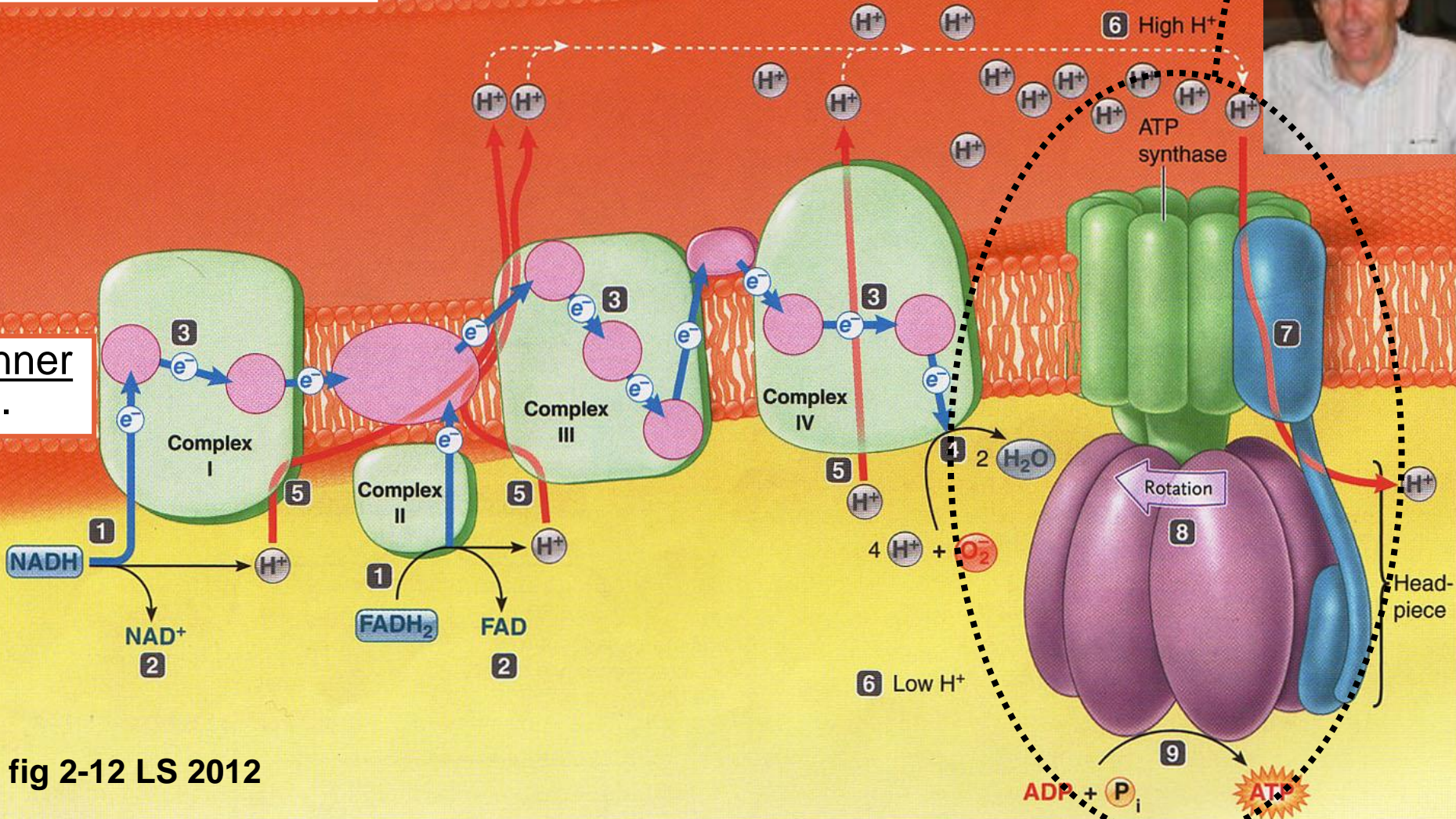


fig 2-12 LS 2012

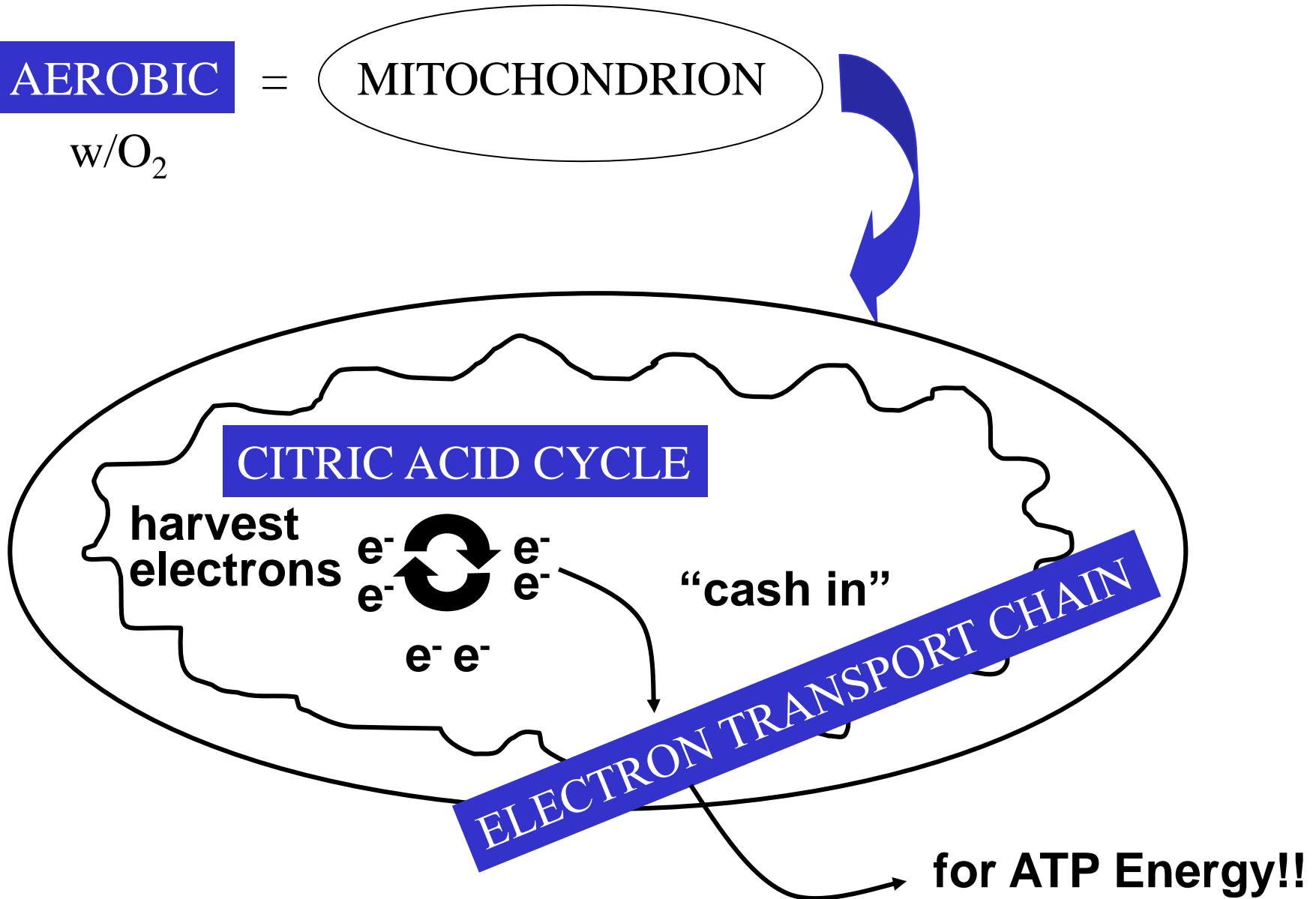
# Goals of Aerobic Metabolism

**AEROBIC**

=

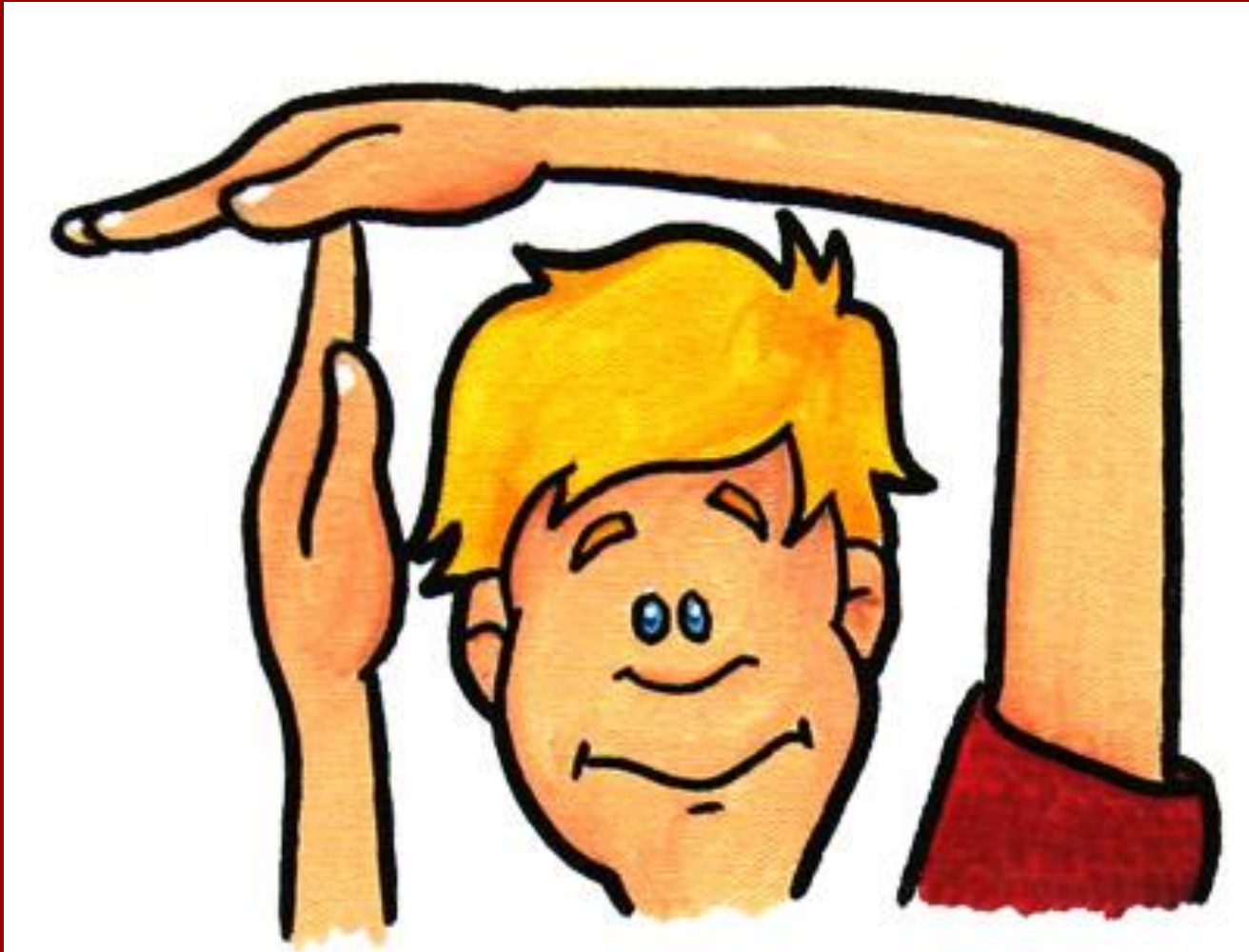
MITOCHONDRION

w/O<sub>2</sub>





***Time-out for questions!***

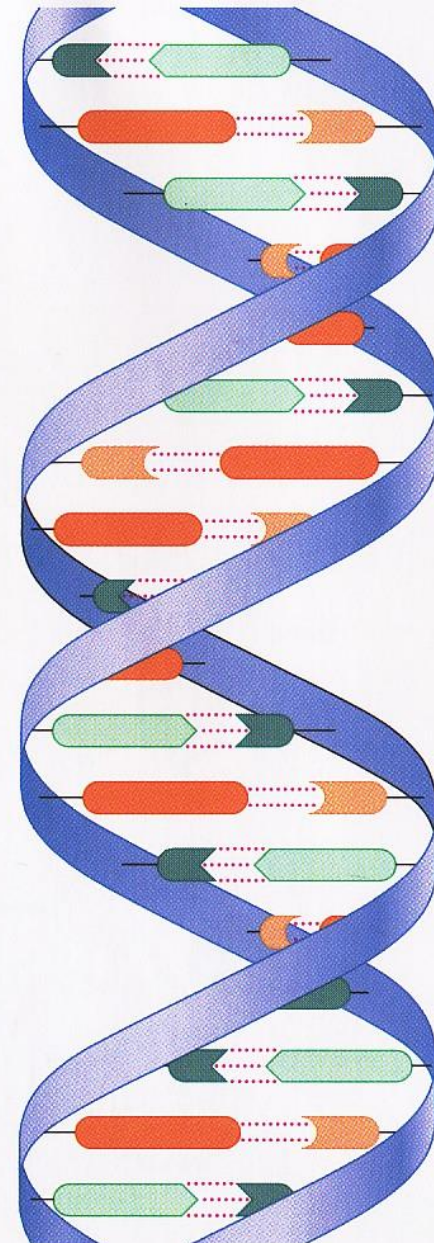
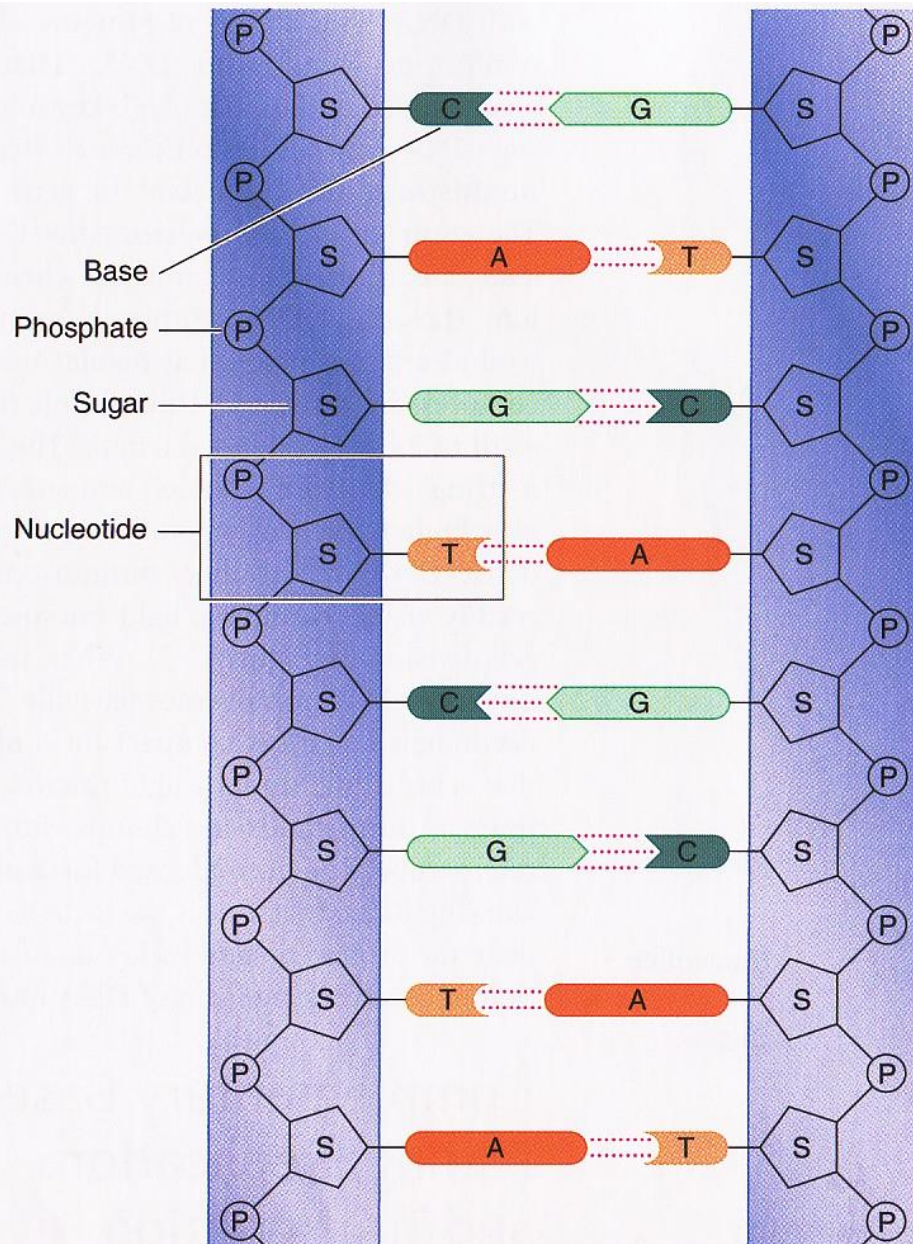


# *What are DNA's major functions? Heredity + Day-to-Day Cell Function*



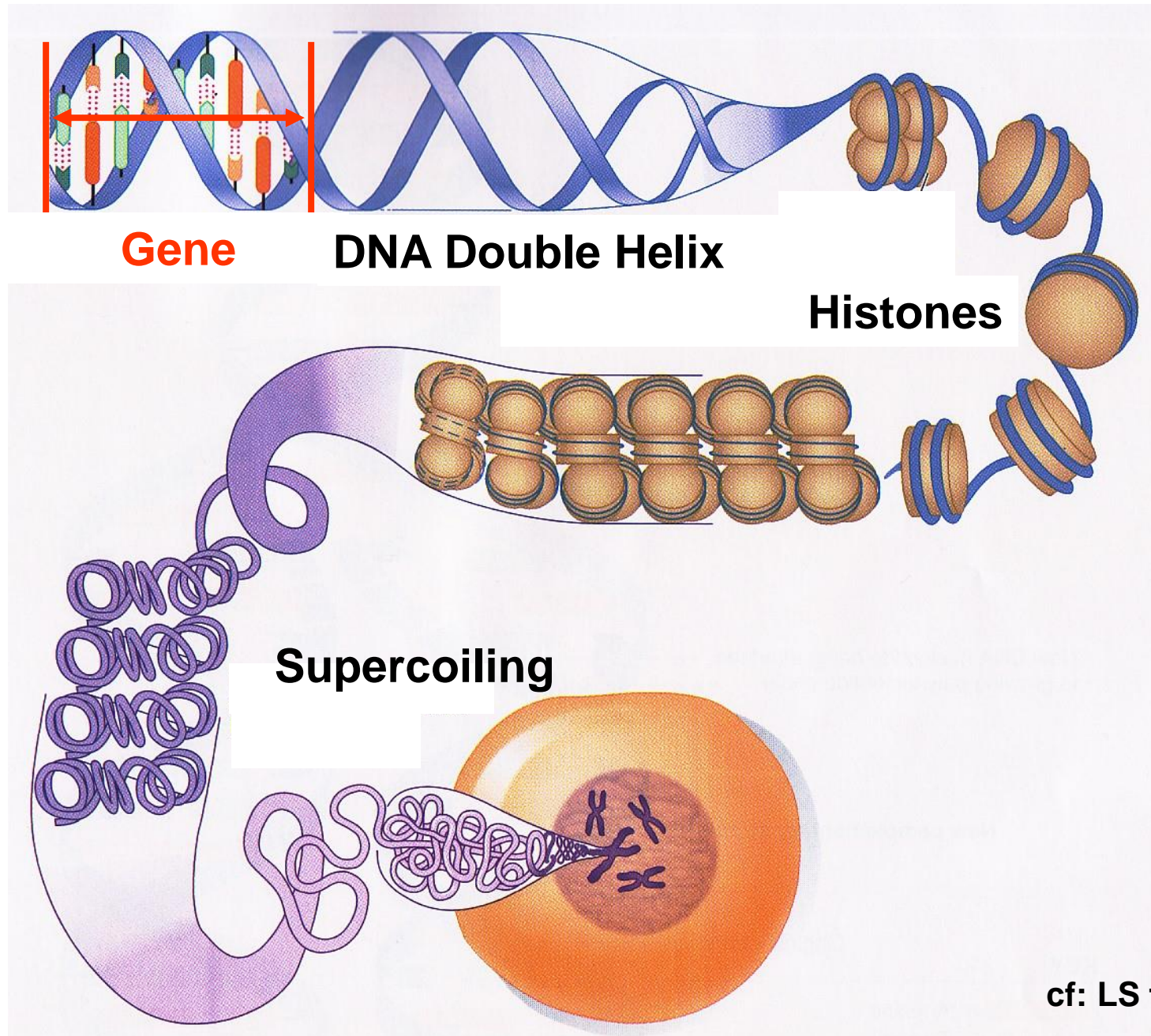


# What does DNA look like? Double-helix!!



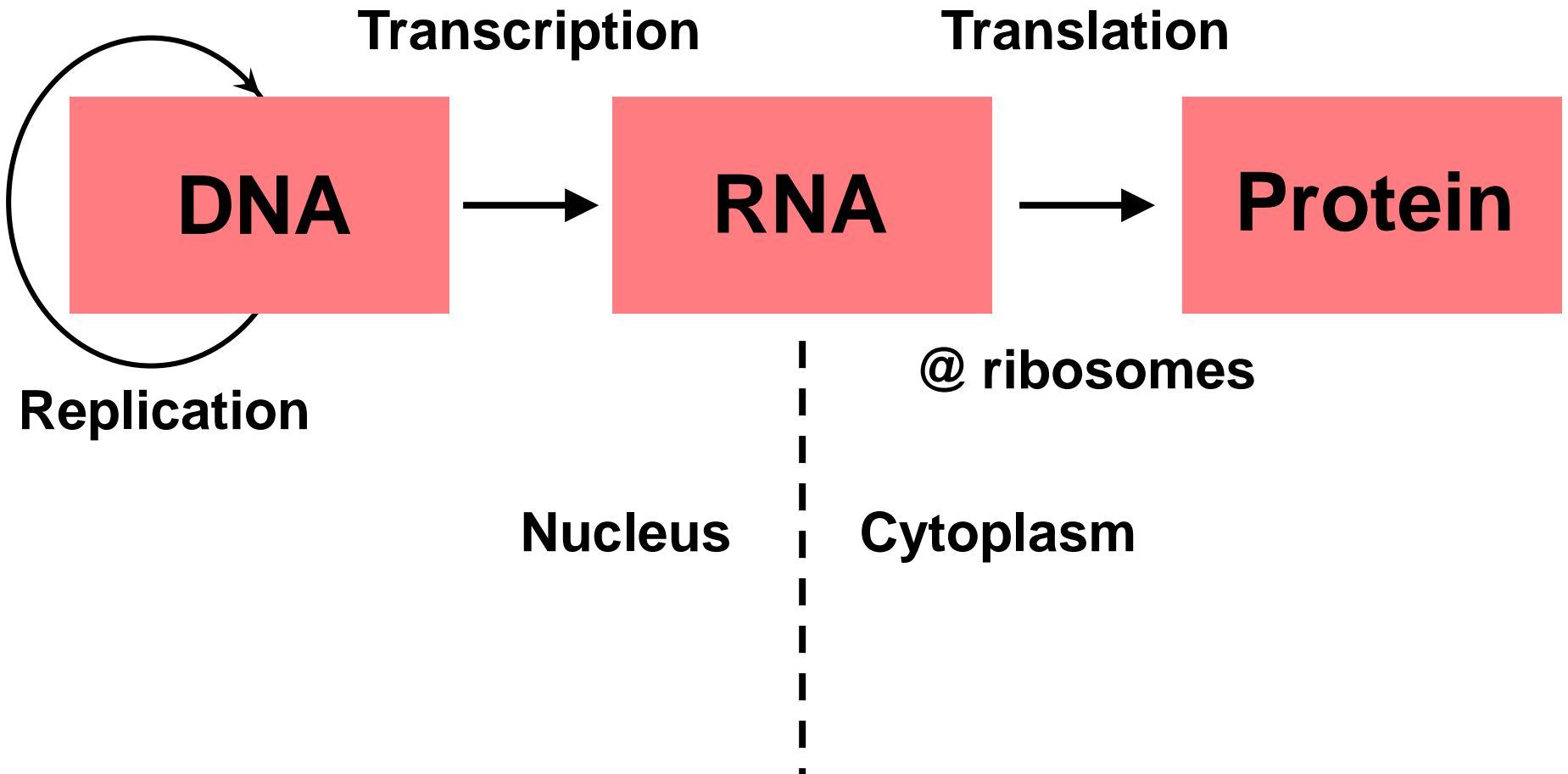


**Gene** = *Stretch of DNA that codes for a protein*





# *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<sup>o</sup> 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**

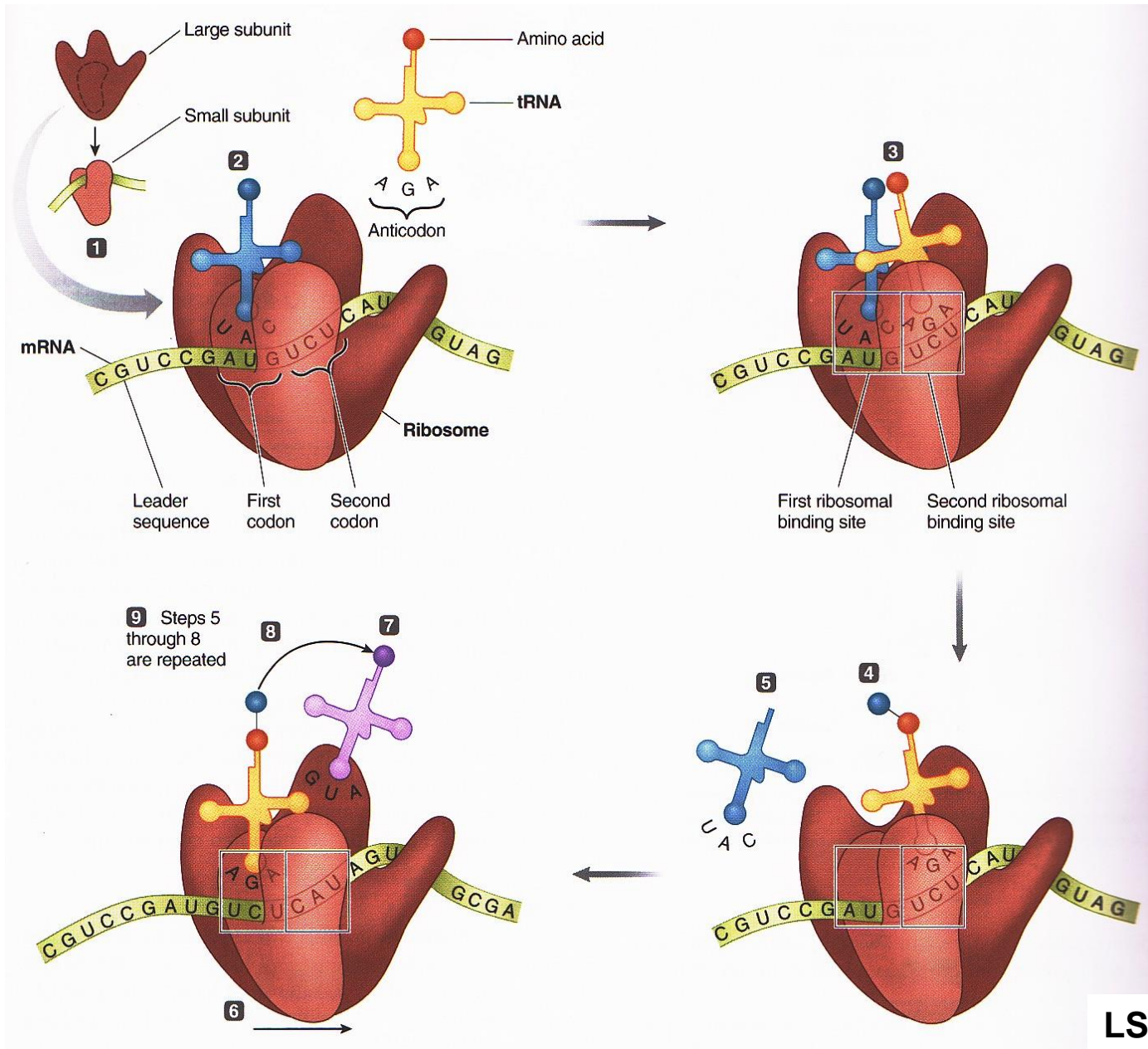
**AUG**

**UAC**

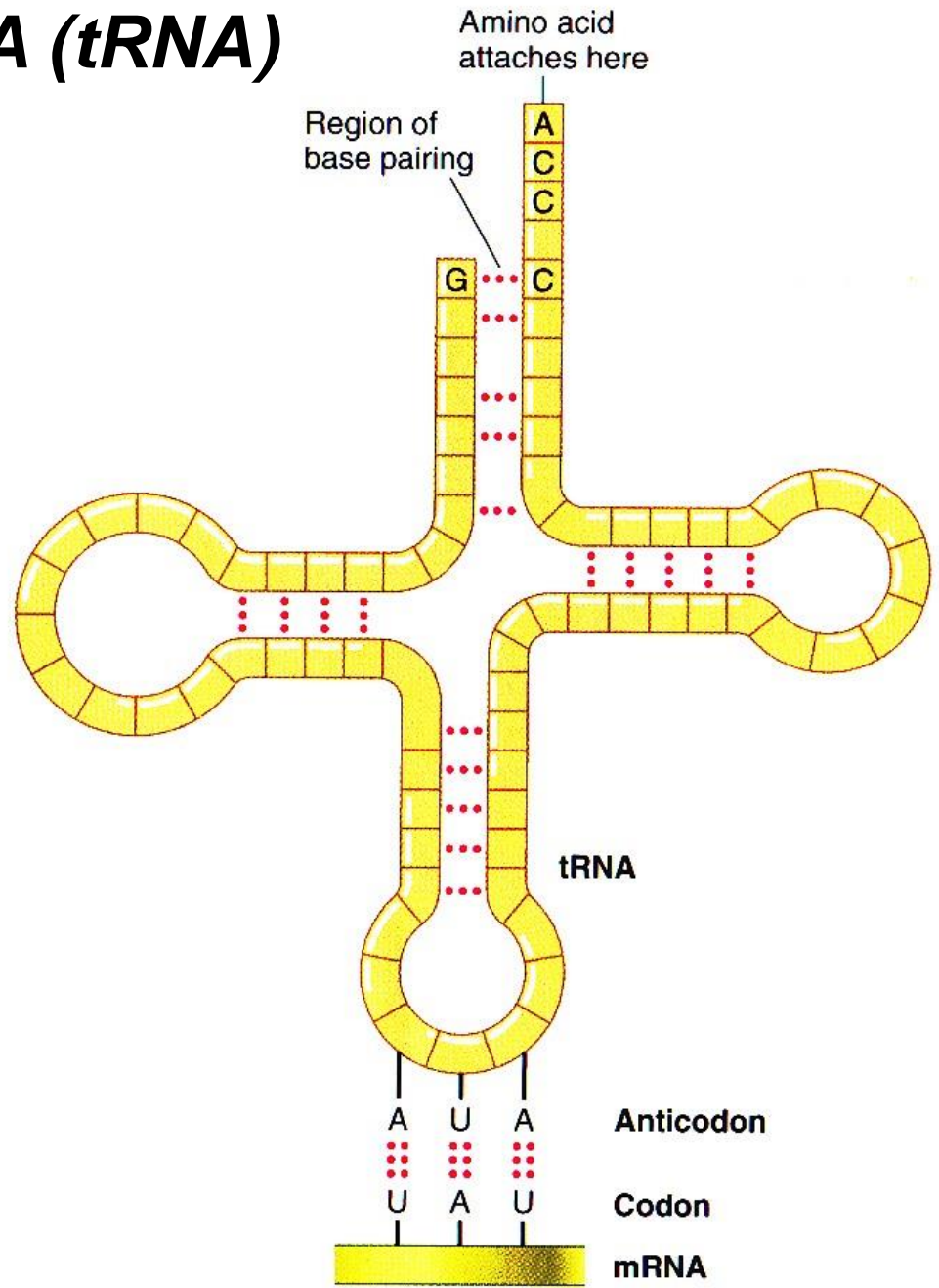
|                     |   | Second base of codon                           |                                      |  |   |                     |
|---------------------|---|--|--------------------------------------|--|---|---------------------|
|                     |   | U  | C                                    | A  | G   |                     |
| First base of codon | U | UUU ] Phe<br>UUC ]<br>UUA ] Leu<br>UUG ]       | UCU ] Ser<br>UCC ]<br>UCA ]<br>UCG ] | UAU ] Tyr<br>UAC ]<br>UAA ] Stop<br>UAG ] Stop | UGU ] Cys<br>UGC ]<br>UGA ] Stop<br>UGG ] Trp | U                   |
|                     | C | CUU ] Leu<br>CUC ]<br>CUA ]<br>CUG ]           | CCU ] Pro<br>CCC ]<br>CCA ]<br>CCG ] | CAU ] His<br>CAC ]<br>CAA ] Gln<br>CAG ]       | CGU ] Arg<br>CGC ]<br>CGA ]<br>CGG ]          | C                   |
|                     | A | AUU ] Ile<br>AUC ]<br>AUA ]<br>AUG ] Met Start | ACU ] Thr<br>ACC ]<br>ACA ]<br>ACG ] | AAU ] Asn<br>AAC ]<br>AAA ] Lys<br>AAG ]       | AGU ] Ser<br>AGC ]<br>AGA ] Arg<br>AGG ]      | A                   |
|                     | G | GUU ] Val<br>GUC ]<br>GUA ]<br>GUG ]           | GCU ] Ala<br>GCC ]<br>GCA ]<br>GCG ] | GAU ] Asp<br>GAC ]<br>GAA ] Glu<br>GAG ]       | GGU ] Gly<br>GGC ]<br>GGA ]<br>GGG ]          | G                   |
|                     |   |  |                                      |  |   | Third base of codon |
|                     |   |  |                                      |  |   | U                   |
|                     |   |  |                                      |  |   | C                   |
|                     |   |  |                                      |  |   | A                   |
|                     |   |  |                                      |  |   | G                   |



# Translation? Ribosomes Make Proteins



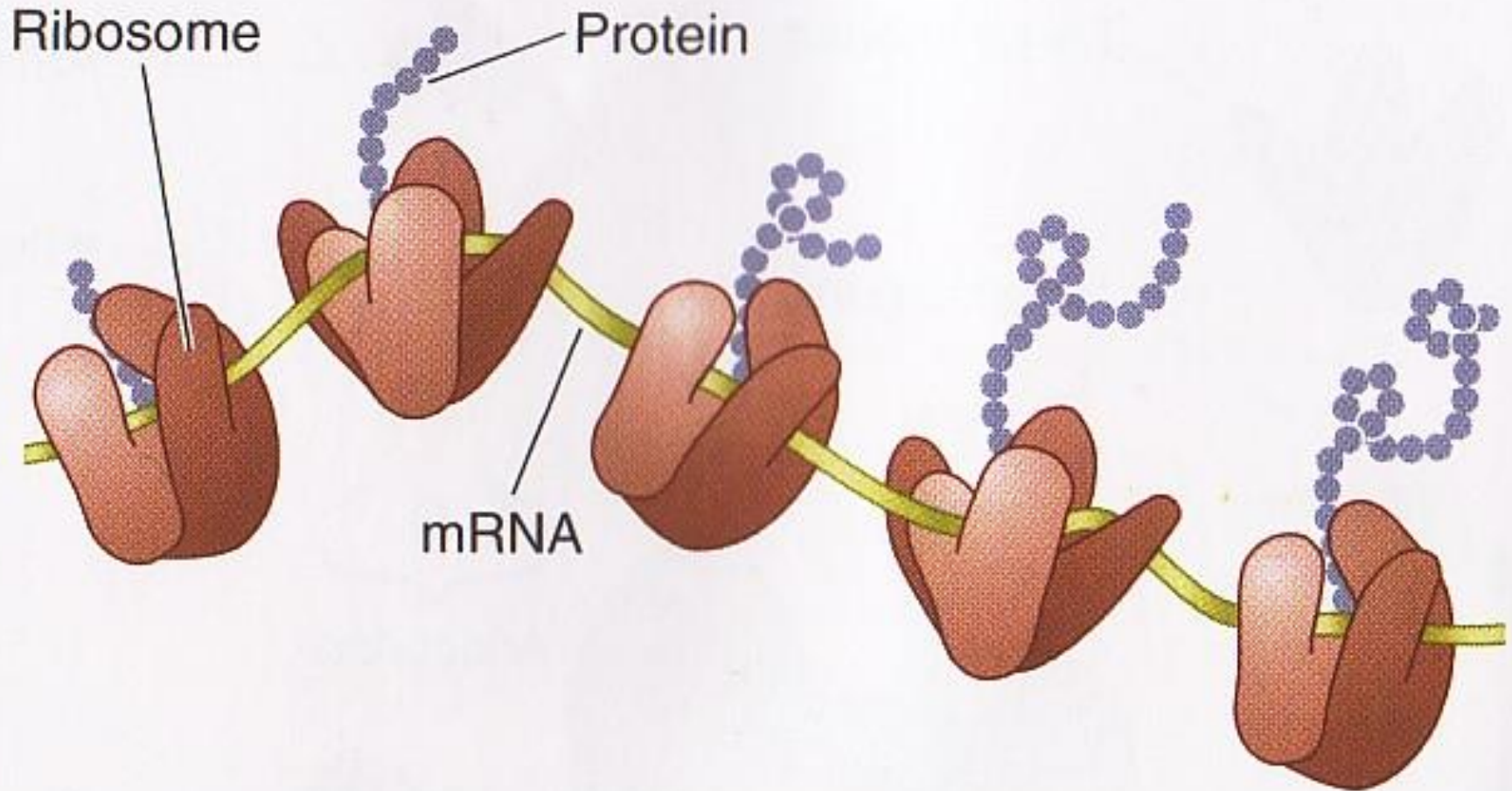
# Transfer RNA (tRNA)



LS fig C-8



# *A Polyribosome. Which Way is Synthesis?*



# Class Skit, Questions & Discussion!



A *protein* synthesizing factory, where *translation* takes place!

What's a ribosome?

You rock, baby!







**TIME  
OUT**

**BREAK!**

# Macronutrients & Micronutrients Essential for Life

## Macronutrients

H<sub>2</sub>O/Water

✓ 1<sup>o</sup> Carbohydrates

✓ 2<sup>o</sup> Fats/Triglycerides/Lipids

✓ 3<sup>o</sup> Proteins

## Micronutrients

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

Minerals (K<sup>+</sup>, Na<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>,  
Fe<sup>2+</sup>, Zn<sup>2+</sup>,...)

## Sample Food Sources

Water, other drinks, fruits  
& vegetables

Grains, vegetables, fruits,  
dairy products

Meats, full-fat dairy  
products, oils

Meats, legumes, dairy  
vegetables

**NB: Need only minute quantities!**

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

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

✓ **Energy nutrients = yield ATP**





# USDA Food Pyramid 1992

Fats, oils, and sweets  
**Use Sparingly**

Milk, yogurt, and  
cheese group  
**2-3 Servings**

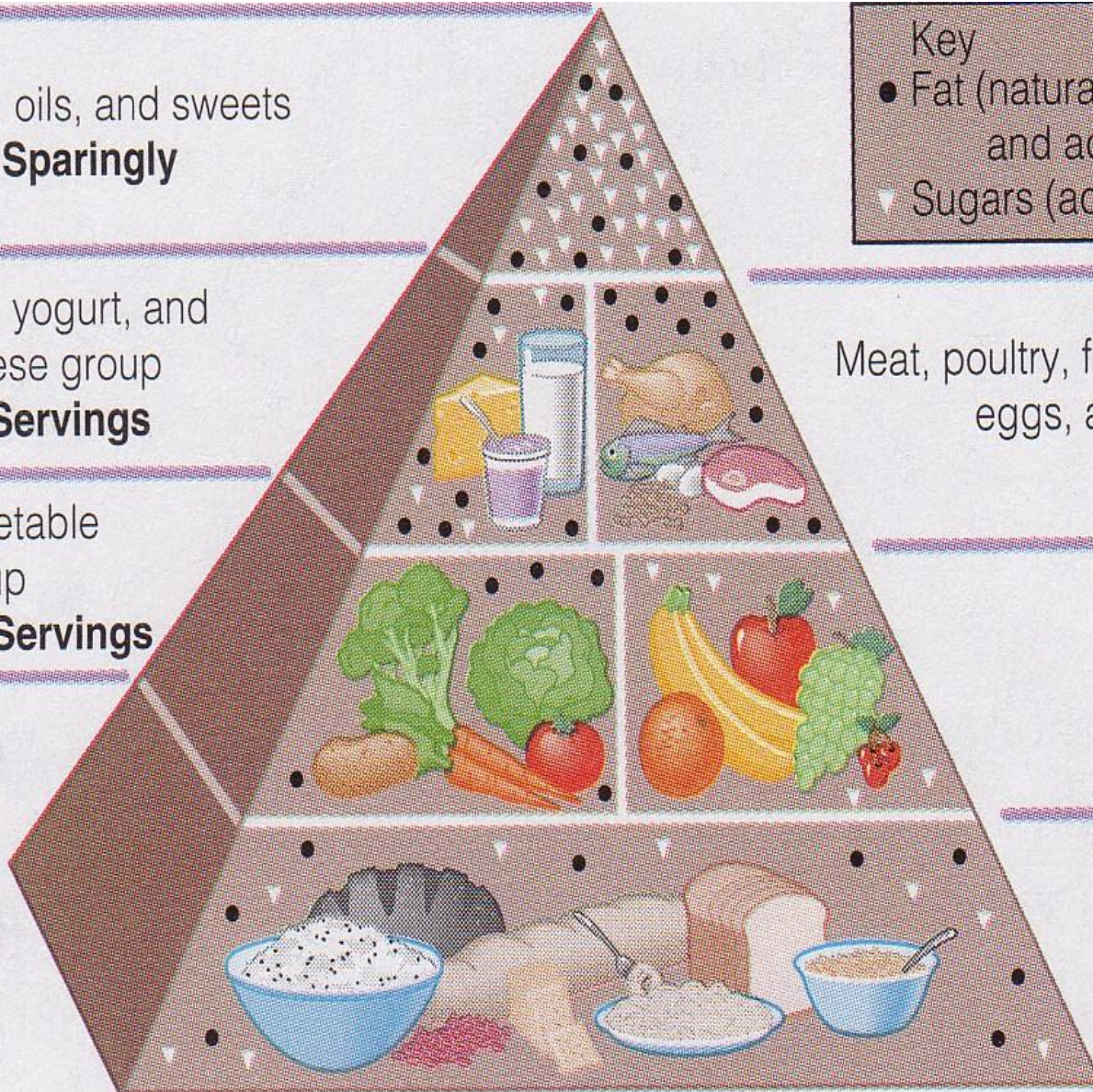
Vegetable  
group  
**3-5 Servings**

Bread, cereal,  
rice, and  
pasta group  
**6-11 Servings**

Meat, poultry, fish, dry beans,  
eggs, and nuts group  
**2-3 Servings**

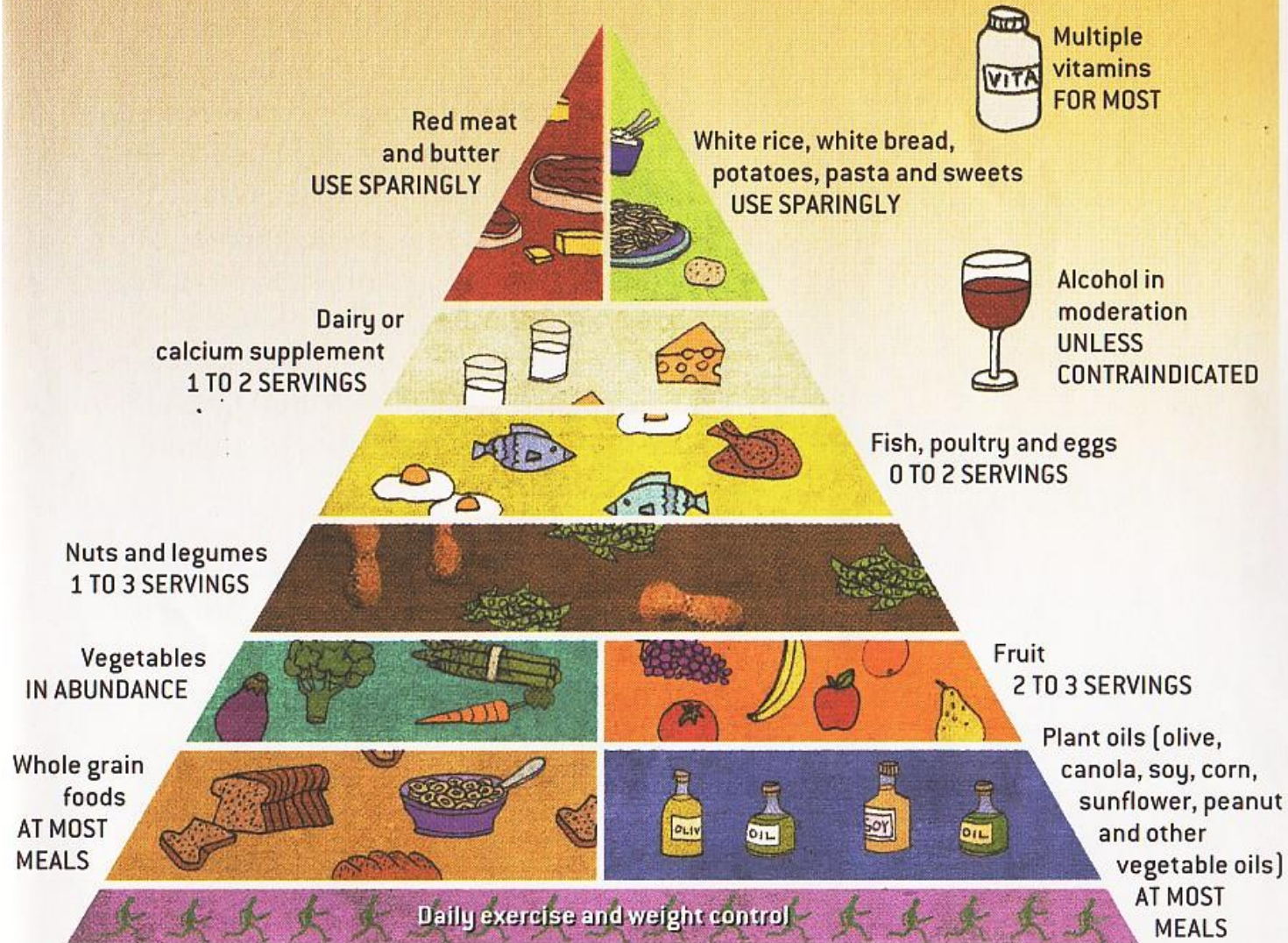
Fruit group  
**2-4 Servings**

Key  
● Fat (naturally occurring  
and added)  
▼ Sugars (added)





# Willett & Stampfer Suggestions 2003



## NEW FOOD PYRAMID



# US Modifications to 1992 Food Pyramid 2005

Fats, oils, and sweets

Use sparingly

↑ "good" fats!

↓ saturated & trans fats!

KEY

● Fat (naturally occurring and added)

▼ Sugars (added)

Milk, yogurt,  
and cheese  
group  
2-3 servings

3 or more!

Vegetable  
group  
3-5  
servings

5 or more!

Meat, poultry, fish,  
dry beans, eggs,  
and nuts group  
2-3 servings

eg, fish, nuts

Fruit group  
2-4 servings

4 or more!

Bread,  
rice, and pasta  
group  
6-11  
servings

1/2 whole grain

Regular Physical Activity: Exercise! Exercise!!

# *Dietary Guidelines for Americans 2005*

## *Food Guidance System*

Hooray!



1. ↑ emphasis on ↓ kcal + ↑ exercise.
2. 9-A-Day! 4 fruit + 5 vegetable servings.
3.  $\geq 3$  of 6 whole grains  $\longrightarrow$   $\frac{1}{2}$  whole grains!
4. 3 servings of dairy, eg 3 c fat-free milk.
5. ↓ saturated + trans fats + ↑ unsaturated/  
“good” fats, eg  $\Omega$ -3 fish, walnuts.
6. Drink in moderation if at all.
7. Practice food safety.

# *MyPlate launched 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,...



## *Diet & Health Guidelines for Cancer Prevention*

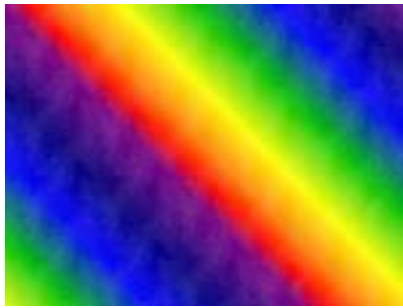
- 1. Choose a diet rich in variety of plant-based foods.**
- 2. Eat plenty of vegetables & fruits.**
- 3. Maintain a healthy weight & be physically active.**
- 4. Drink alcohol only in moderation, if at all.**
- 5. Select foods low in fat & salt.**
- 6. Prepare & store food safely.**

And always, remember...

**Do not smoke or use tobacco in any form.**



*American Institute for Cancer Research (AICR)*



# *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.

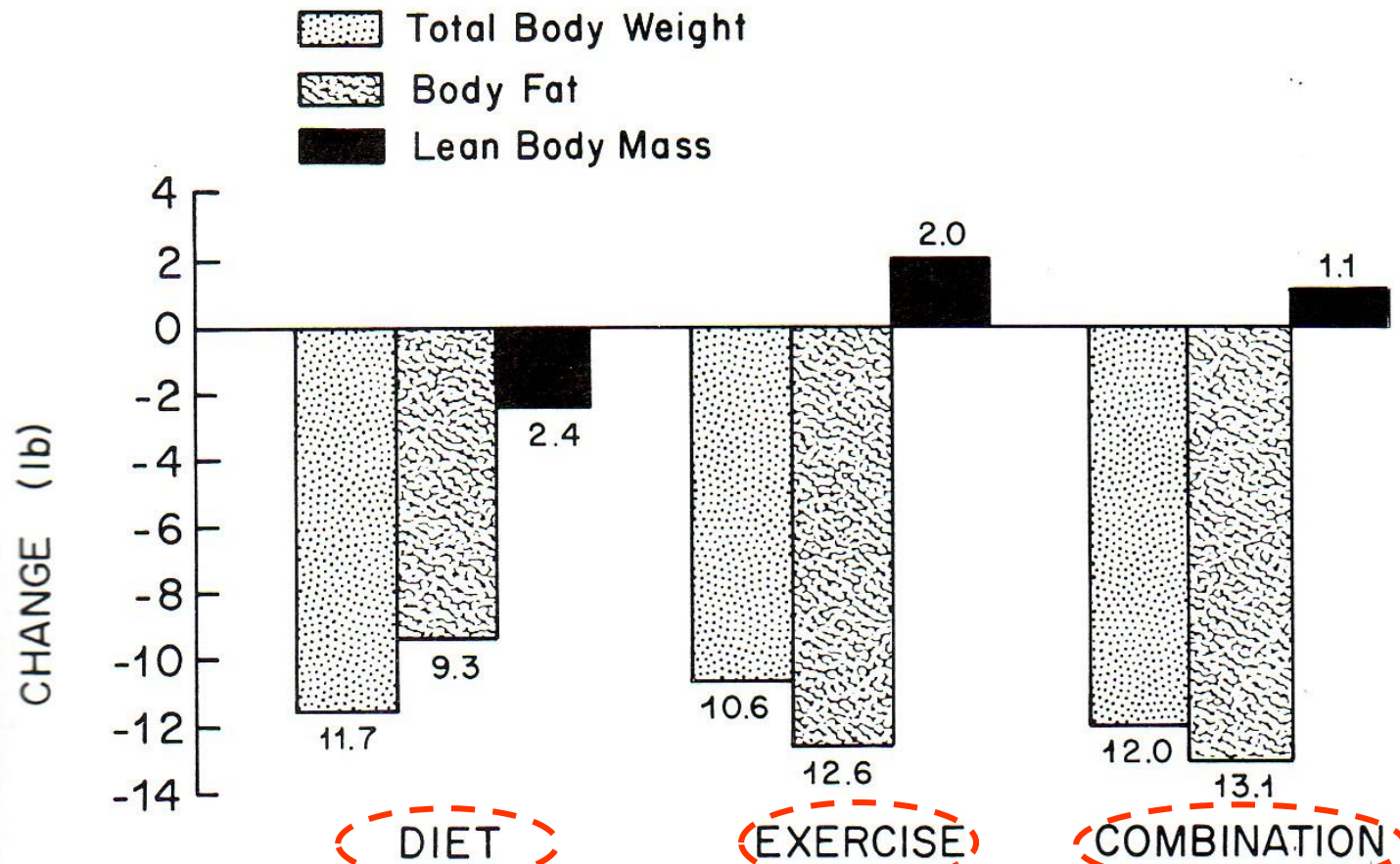
A surprising number of people get 1/5 of their calories from sodas or other liquids.

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.





**Figure 4-9.** Changes in body weight, body fat, and lean body weight for diet, exercise, and combination groups. (From Zuti W. B., and Golding, L. A.: Comparing diet and exercise as weight reduction tools. *Phys. Sportsmed.* 4:49-53, 1976.)

**NB: Each group 500 kcal deficit/day, 16 weeks**





***Exercise is better than dieting in lowering body fat & preserving muscles!***



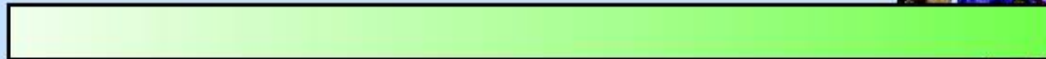
# Dietary Composition & Physical Endurance

eg, Atkins!

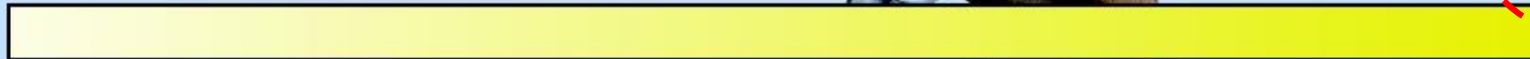
High-fat diet



Normal mixed diet



High-carbohydrate diet



~ 1/3 endurance!

Maximum endurance time:

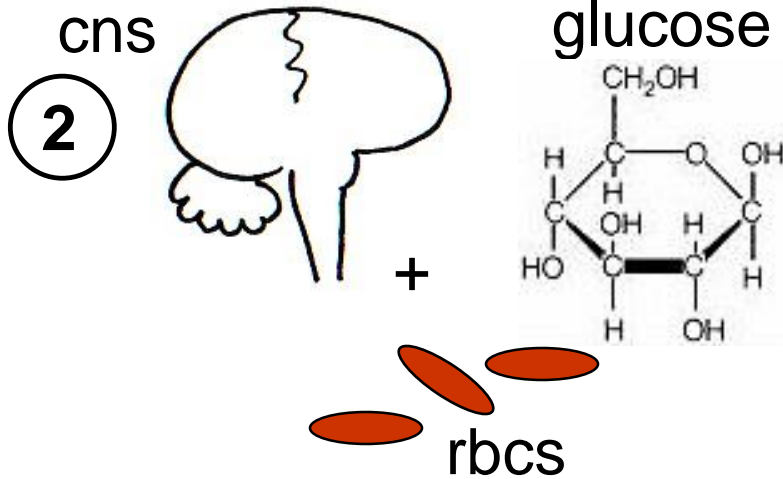
57 min

114 min

167 min







# Negative Effects of Low Carbohydrate

1



- ① ↑ fatigue/exhaustion central & peripheral!
- ② ↓ glucose – brain+spinal cord, rbcs thrive upon.
- ③ ↓ variety which reduces intake of phytochemicals, vitamins, minerals & fiber.
- ④ ↑ risk of respiratory infections.

4



+ gall stones,  
↓ thermoregulation...

# ***We're better at storing fat vs carbohydrate!***

**Dietary Fat**



**3 % Kcal**

**Body Fat**



**23 % Kcal**

**Dietary  
Carbohydrate**





To Help Lower Body Wt & %Fat  
**EXERCISE!! +*Minimize* These!!**



**FAT 9 Kcal/g**

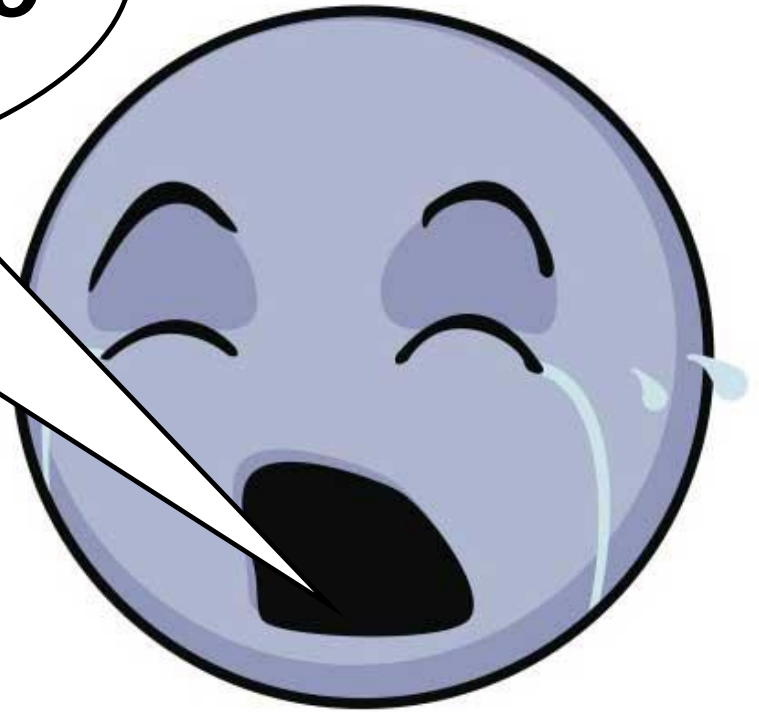
**ETOH 7 Kcal/g**

**CARB 4 Kcal/g**

**PRO 4 Kcal/g**

**NB: *Minimize* not *Eliminate!*  
*Moderation* not *Abstinence!!***

***I'm not sure I believe you!  
Why can't I just starve to  
lose weight?***



**TOTAL FAST =**  
**No Energy Nutrients**  
**(No Carbohydrates, Fats  
or Proteins)**

**ONLY**

- 1. Water**
- 2. Vitamins**
- 3. Minerals**



# 60-day Fast???

Lost 60 lb!! Wow!!

Yet

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

Fat < 1/4 total wt loss!

***You can lose weight by  
starving – but it's mostly  
water & muscle! Also, there  
can be complications!***



# **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.**



# Council on Nutrition, Physical Activity and Metabolism (NPAM) Spring 2009



## Dietary Carbohydrate, Fat and Protein in Weight-Loss Diets: A Report and Insider's Reflections on the Pounds Lost Trial

Frank M. Sacks, MD

**W**ell-controlled studies of energy-reduced diets conducted in controlled environments showed that the macronutrient composition of the diet did not affect weight loss (1). Nonetheless, theories persisted that specific macronutrients would be superior for weight loss. For example, the traditional paradigm for low-fat, high-carbohydrate diets was based on the lower energy density of carbohydrate compared to fat, and the metabolic efficiency of converting dietary fat to body fat (2). Indeed strict vegetarians sustain lower body weight for

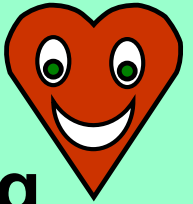
that Mediterranean diets were superior to low-fat diets for weight loss (5,6). Others claimed that a radically different approach that used low-carbohydrate, high-fat, and high-protein foods could produce weight loss without attention to reducing intake because of the satiety of protein-rich foods. Low-carbohydrate diets succeeded in the first few months with more rapid weight loss than low-fat diets but by one year, none of the trials found that weight loss on low-carbohydrate

*Continued on page 26*



years on low-fat diets (3). However, meaningful differences in body weight usually were not achieved in population-based trials of conventional low-fat diets (4). Thus, higher-fat, Mediterranean-style diets were proposed to be better for long-term weight loss because of their variety and satisfaction. Two trials found

## ***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.**

***US Dietary Recommended Intakes (DRI)  
Committee Acceptable Macronutrient  
Distribution Ranges (AMDR)!***

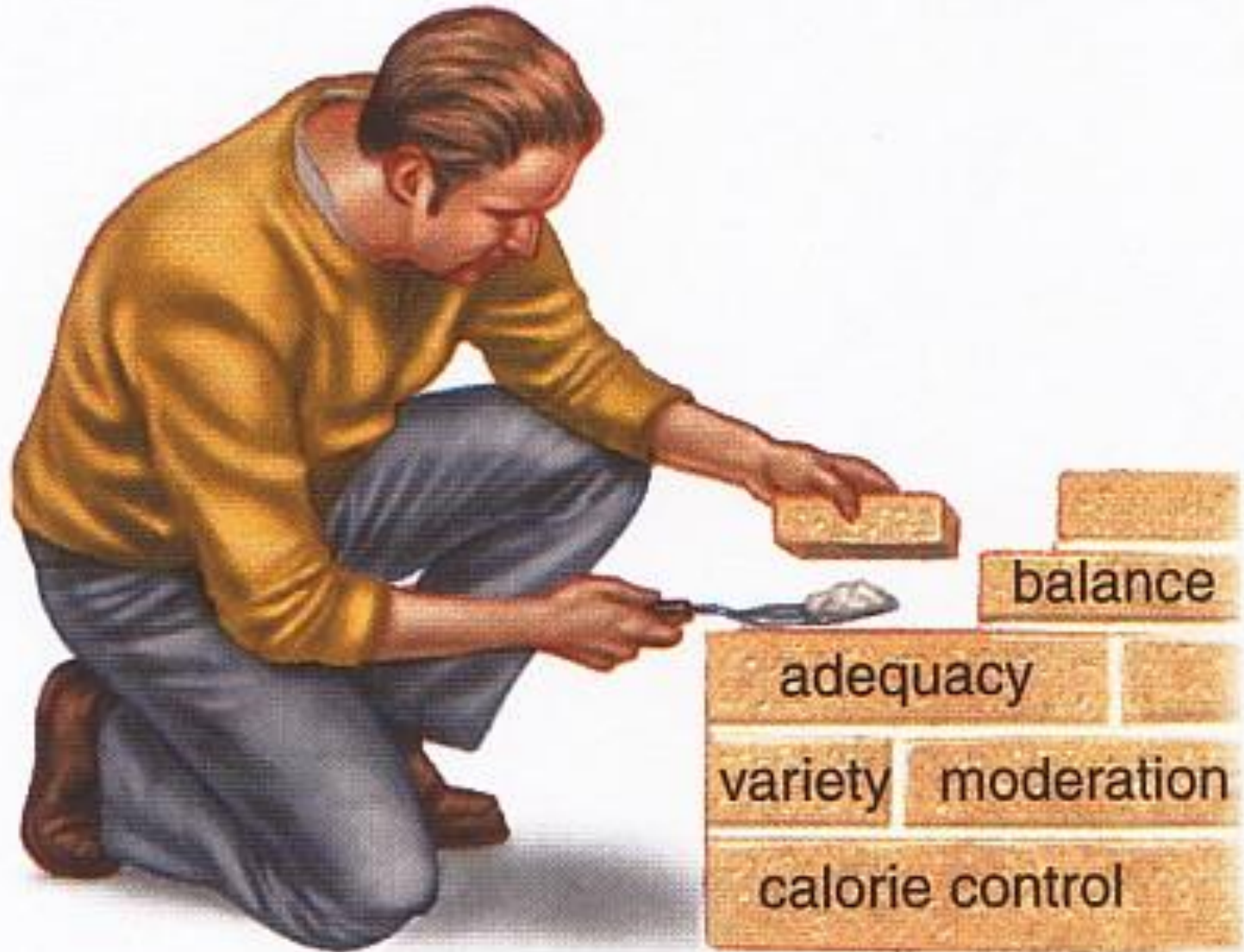
| <b><u>Energy Nutrient</u></b> | <b><u>% Total Calories</u></b> |
|-------------------------------|--------------------------------|
| <b>Carbohydrate</b>           | <b>45-65%</b>                  |
| <b>Fat</b>                    | <b>20-35%</b>                  |
| <b>Protein</b>                | <b>10-35%</b>                  |



# Emphasize ABCs + Variety & Moderation!



*All of these factors help to build  
a nutritious diet.*



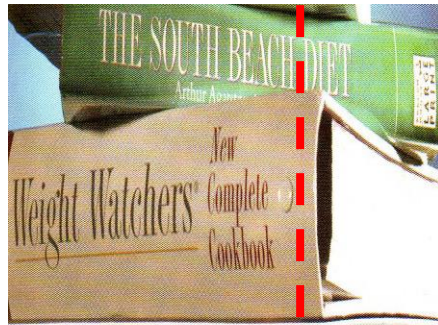
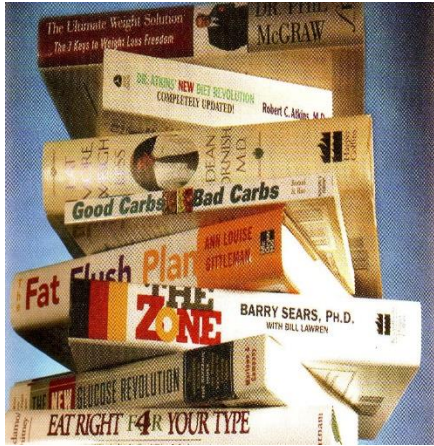


# ***Kleiner's & Monaco's Top 10 Hit List for Nutrition Quackery***

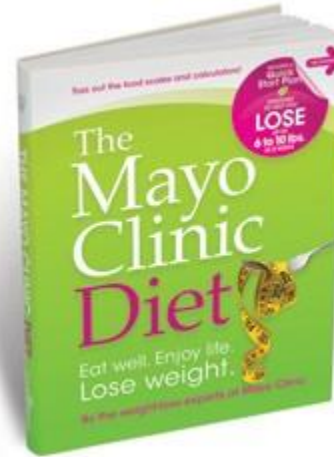
1. Treatment based on unproven theory calling for non-toxic, painless therapy.
2. Author's/purveyor's credentials aren't recognized in scientific community.
3. No reports in scientific, peer-reviewed literature but rather mass media used for marketing.
4. Purveyors claim medical establishment is against 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**

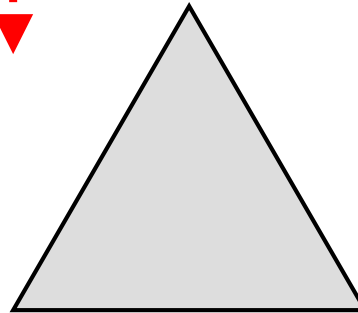


**AHA + DASH +  
MAYO CLINIC**



**LOWER  
CARBOHYDRATE**

**ELIMINATE CALORIES  
or FOOD GROUPS  
ENCOURAGE FASTING**



**LOWER  
FAT**



**ADEQUACY  
BALANCE  
CONSISTENCY  
& MODERATION**