Biological Frameworks for Engineers

ME 411/ ME 511

Biological Frameworks for Engineers

Class Organization

- Exam 1 due
- Hw 4 online
  - Due Wed Nov 7th

Biological Frameworks for Engineers

ME 411 / ME 511

Cell Energetics

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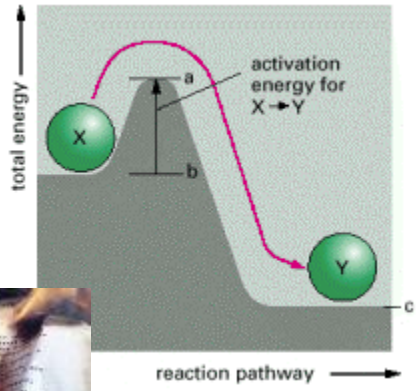
Energy Conversion

(energy from heat of fire)

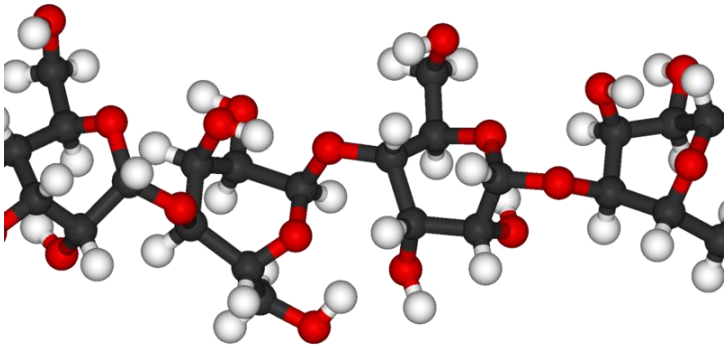
Paper + O_2



Smoke
+Ashes
+Heat
+CO_2
+H_2O

Energetically favorable

Cellulose



CO_2

H_2O

Covalent:

Nonpolar	Polar
C-C	C=O
C-H	H=O
O-O	

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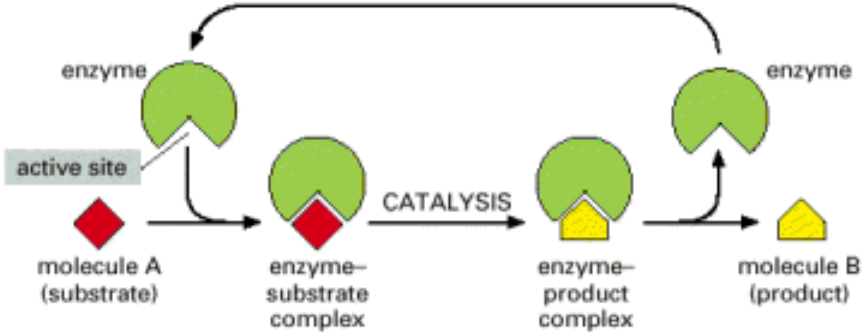
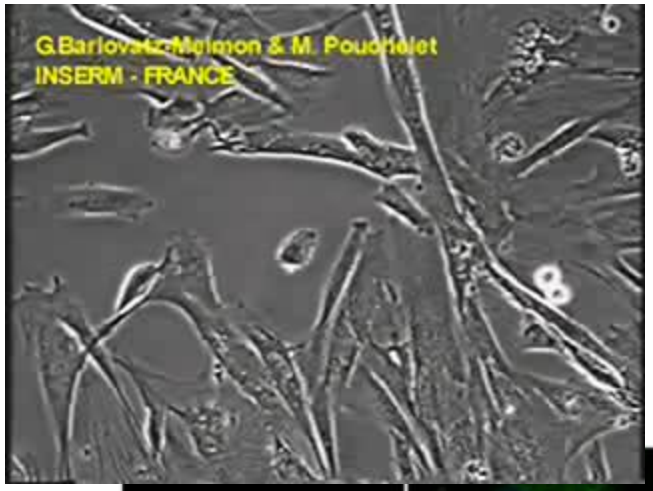
Energy Conversion

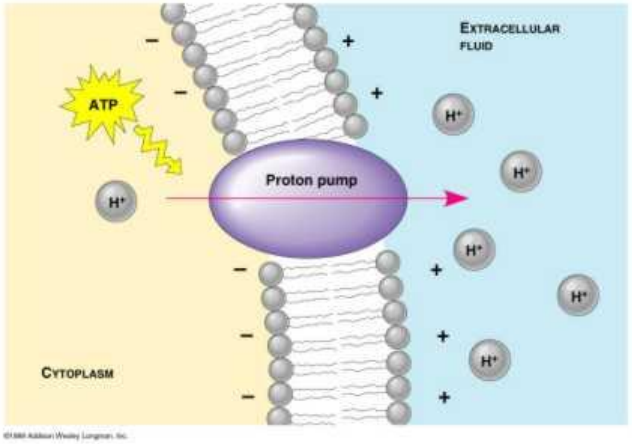


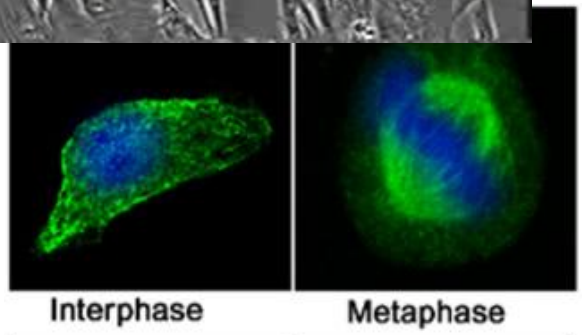
Enzymes bind one or two molecules (substrates) in such a way that activation energy is greatly reduced (catalyst)

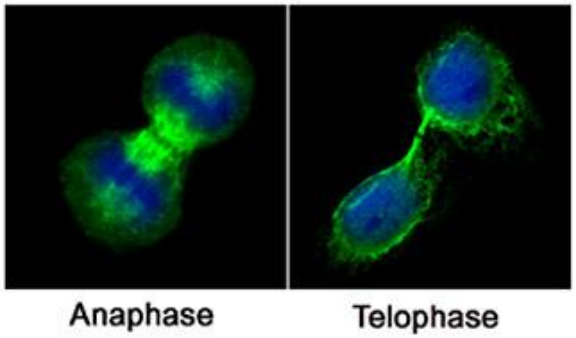
But we will need active carriers of energy to temporarily store it

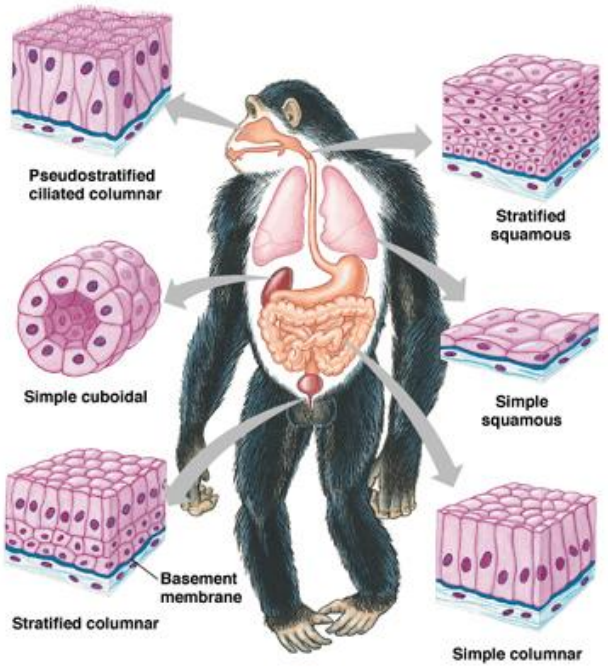
Why do we need Energy?



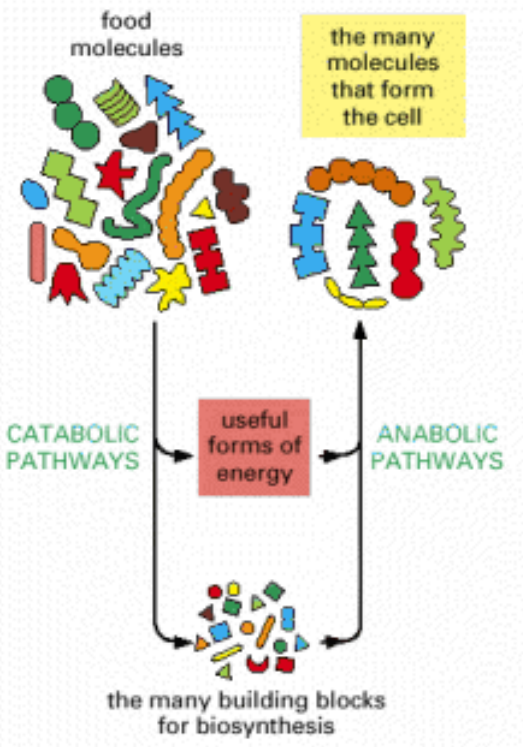








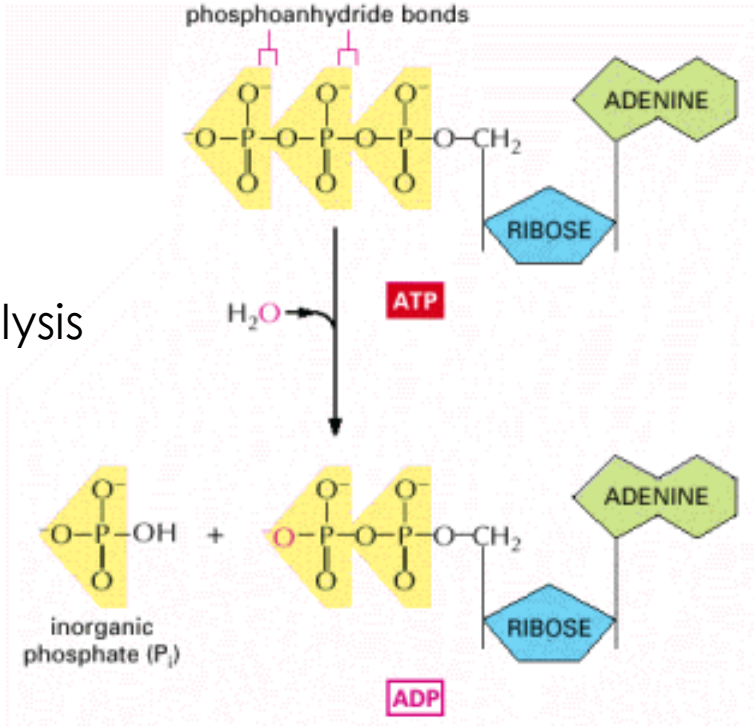
Metabolism


food molecules
the many molecules that form the cell
CATABOLIC PATHWAYS
useful forms of energy
ANABOLIC PATHWAYS
the many building blocks for biosynthesis

ATP

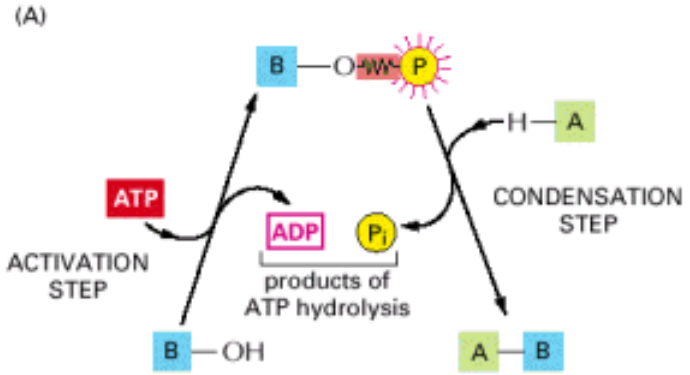
Structure: High Energy Storage

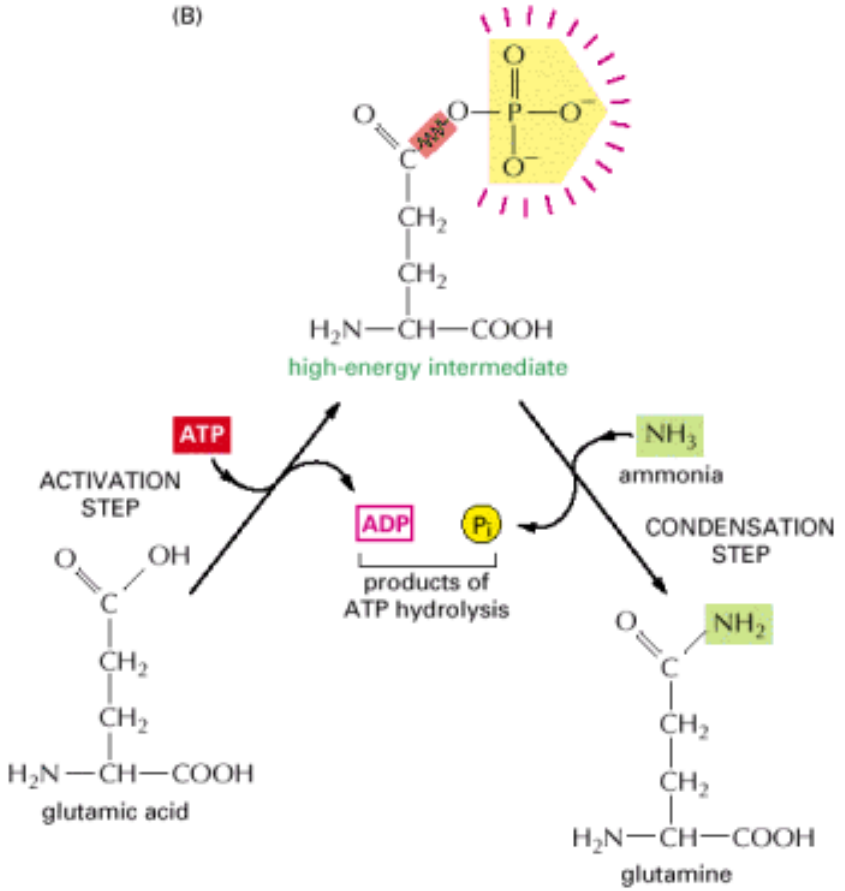
Reaction: Hydrolysis



ΔG = -11 to -13 kcal/mole of usable energy

Harnessing ATP





Energetically UNfavorable

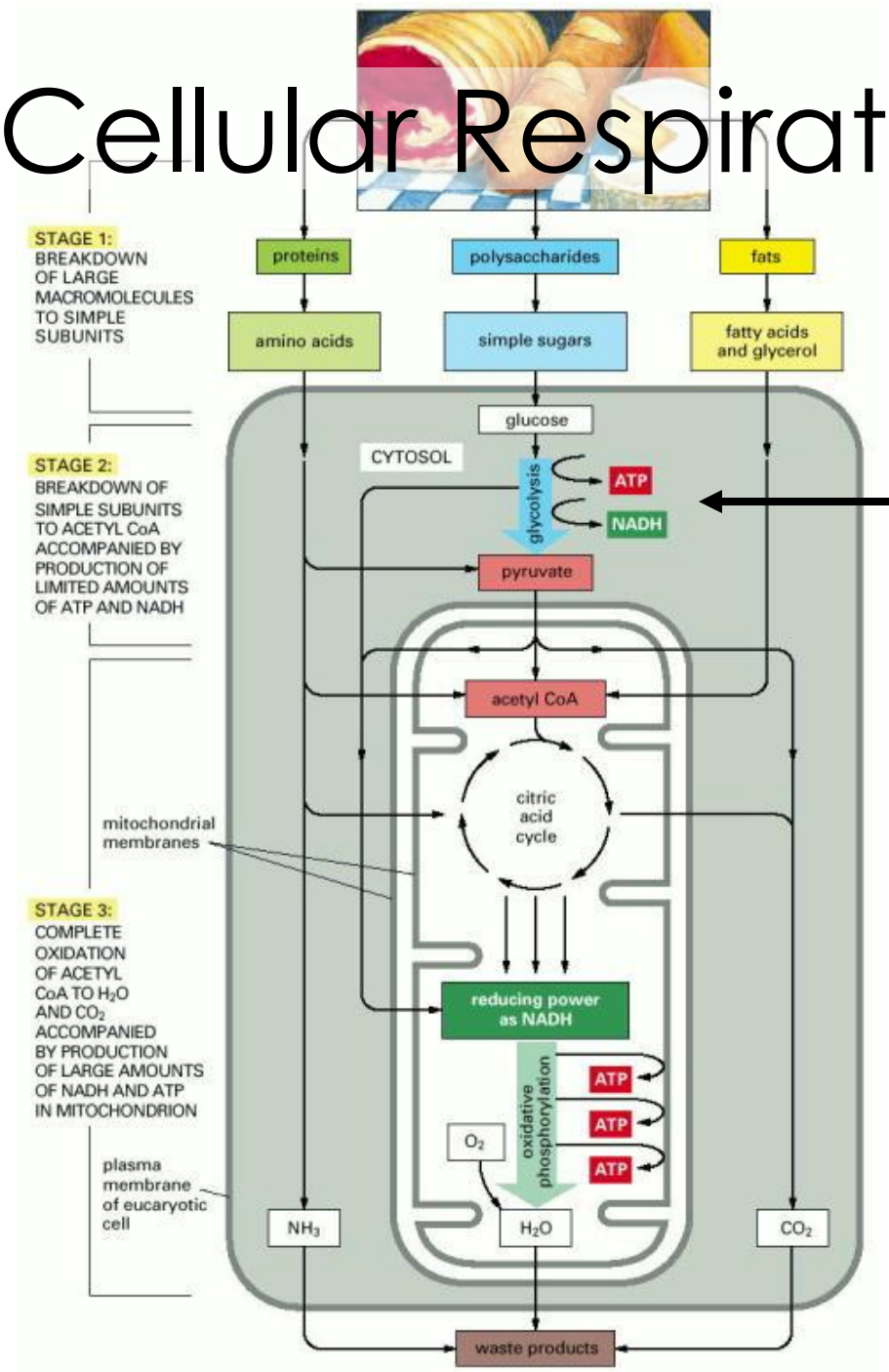
$$A\text{–}H + B\text{–}OH \rightarrow A\text{–}B + H_2O$$

Energetically favorable

1. $B\text{–}OH + ATP \rightarrow B\text{–}O\text{–}PO_3 + ADP$
2. $A\text{–}H + B\text{–}O\text{–}PO_3 \rightarrow A\text{–}B + P_i$

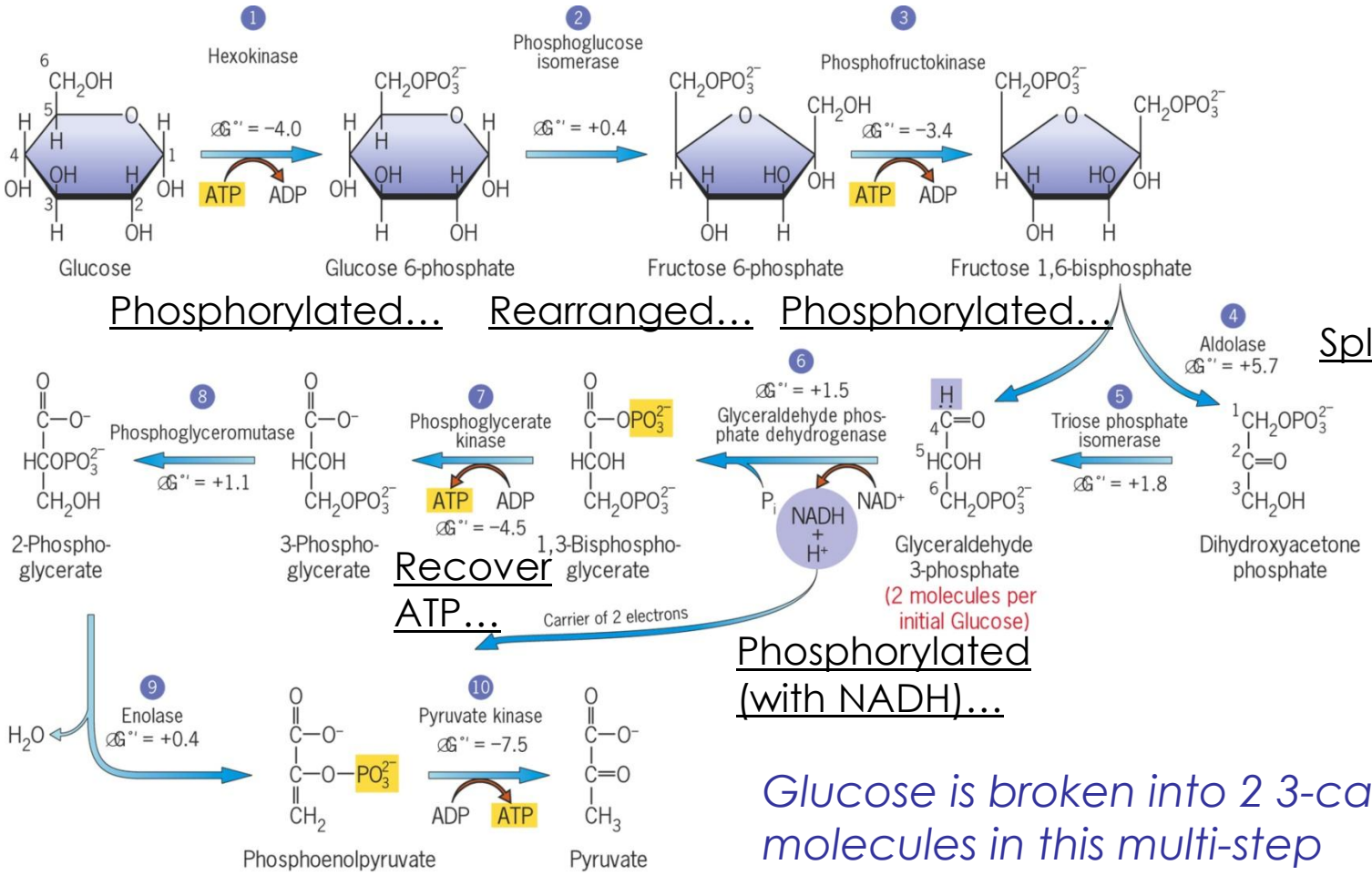
Net result: $B\text{–}OH + ATP + A\text{–}H \rightarrow A\text{–}B + ADP + P_i$

Cellular Respiration



Glycosis
"sugar" +
"breakdown"

Glycolysis



Gain 2 ATP…

Pyruvate For Kreb's

Glucose is broken into 2 3-carbon molecules in this multi-step pathway

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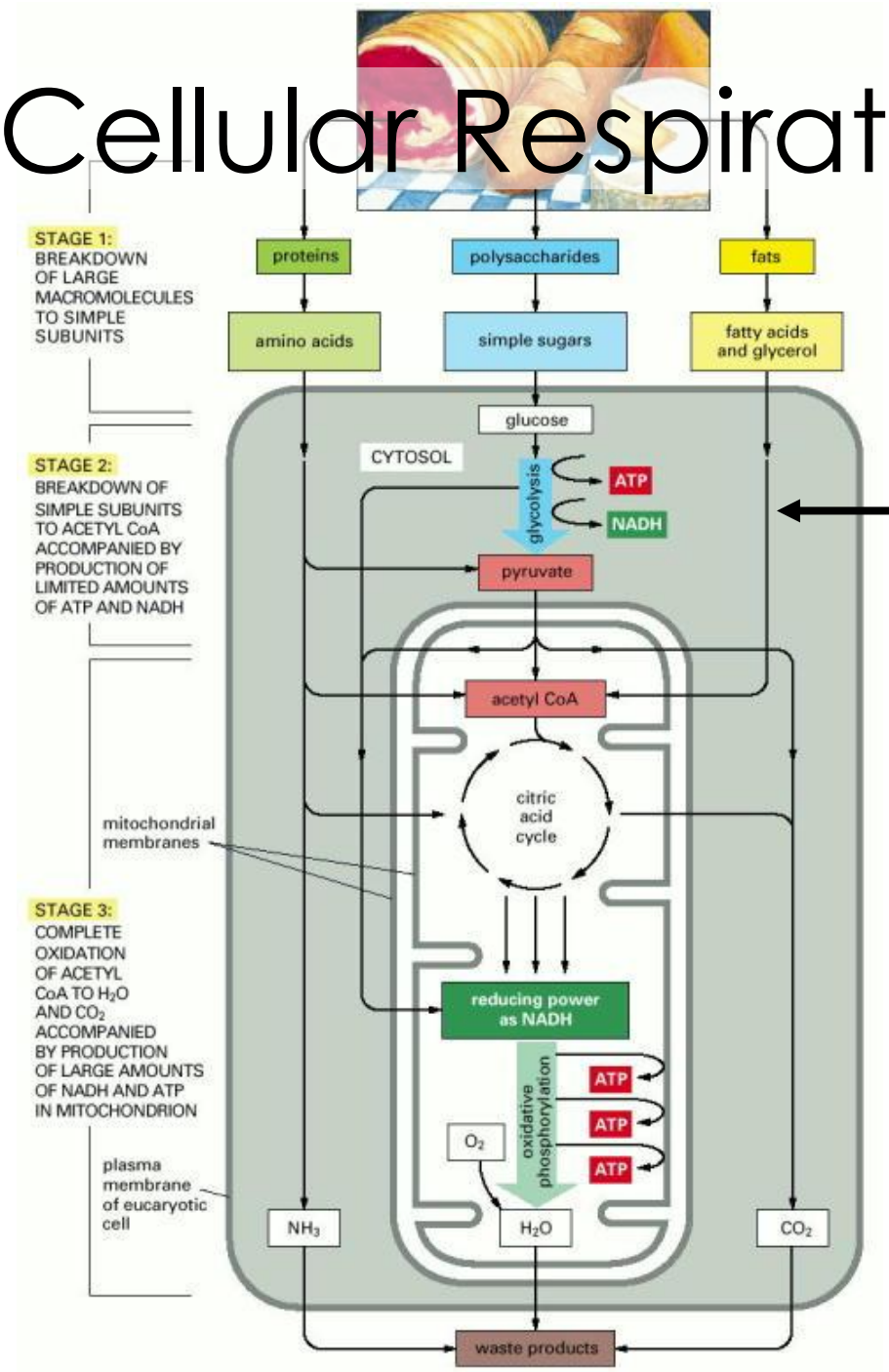
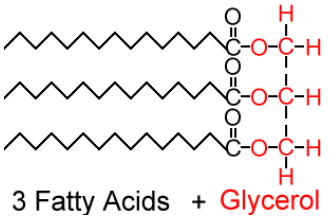
Cellular Respiration



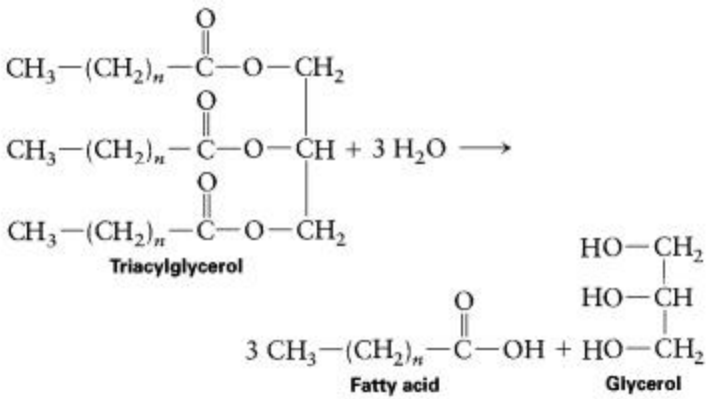
Fatty acids
"stored energy"

Fatty Acid Oxidation

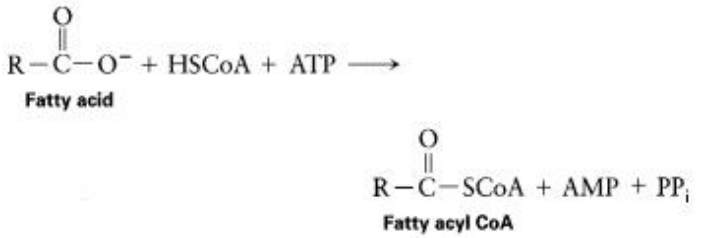
1) Storage



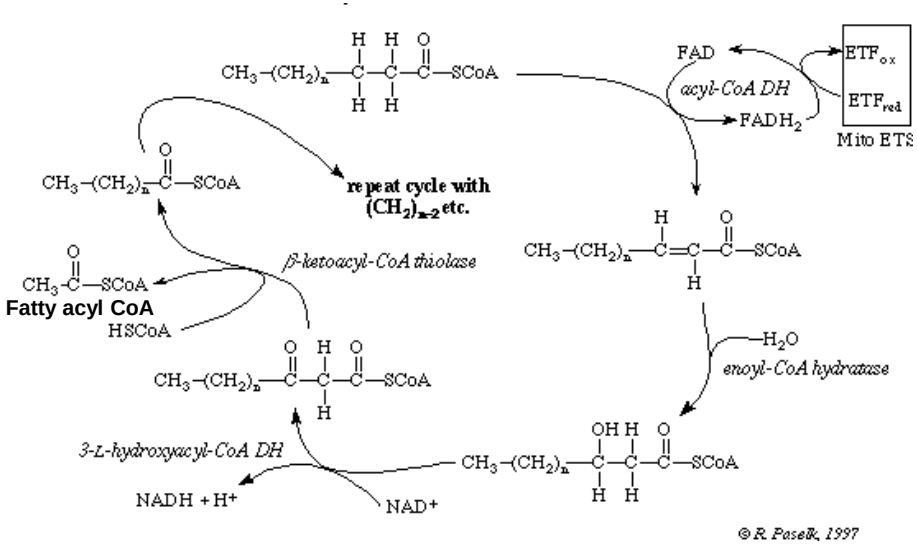
2) Hydrolysis



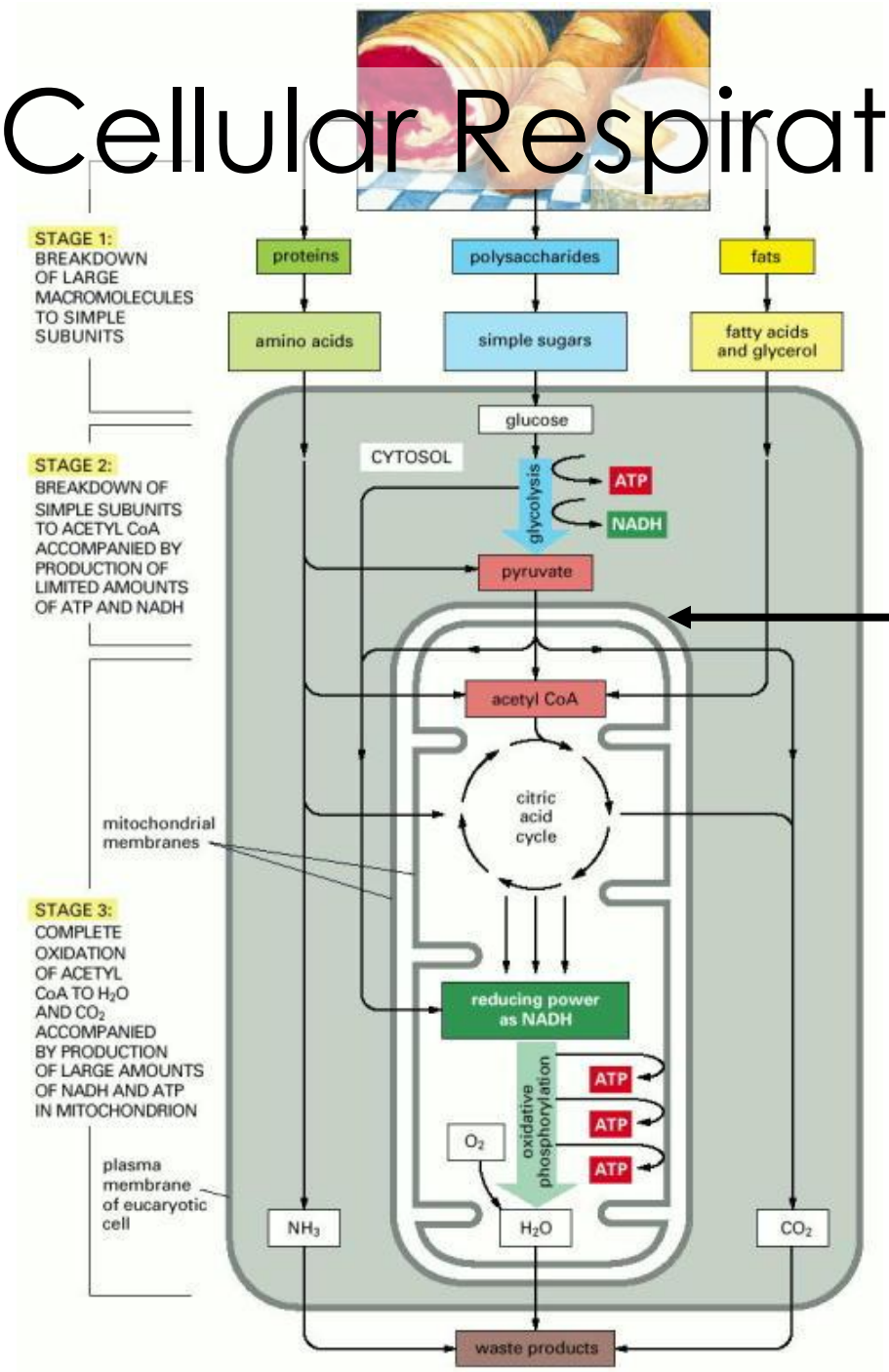
3) Conversion



4) Oxidation

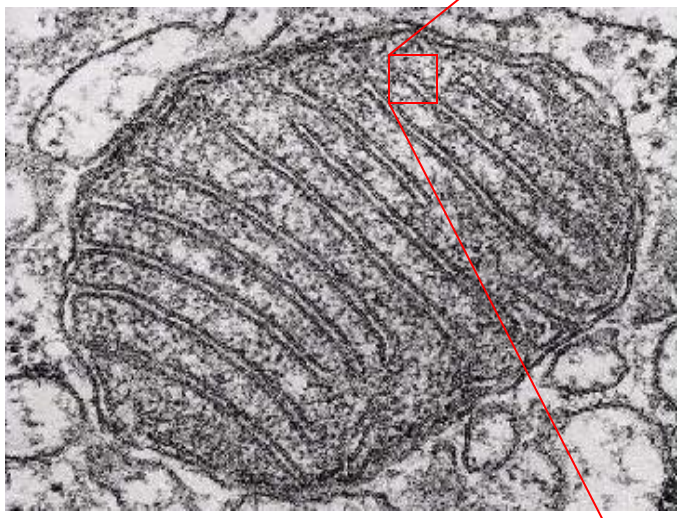


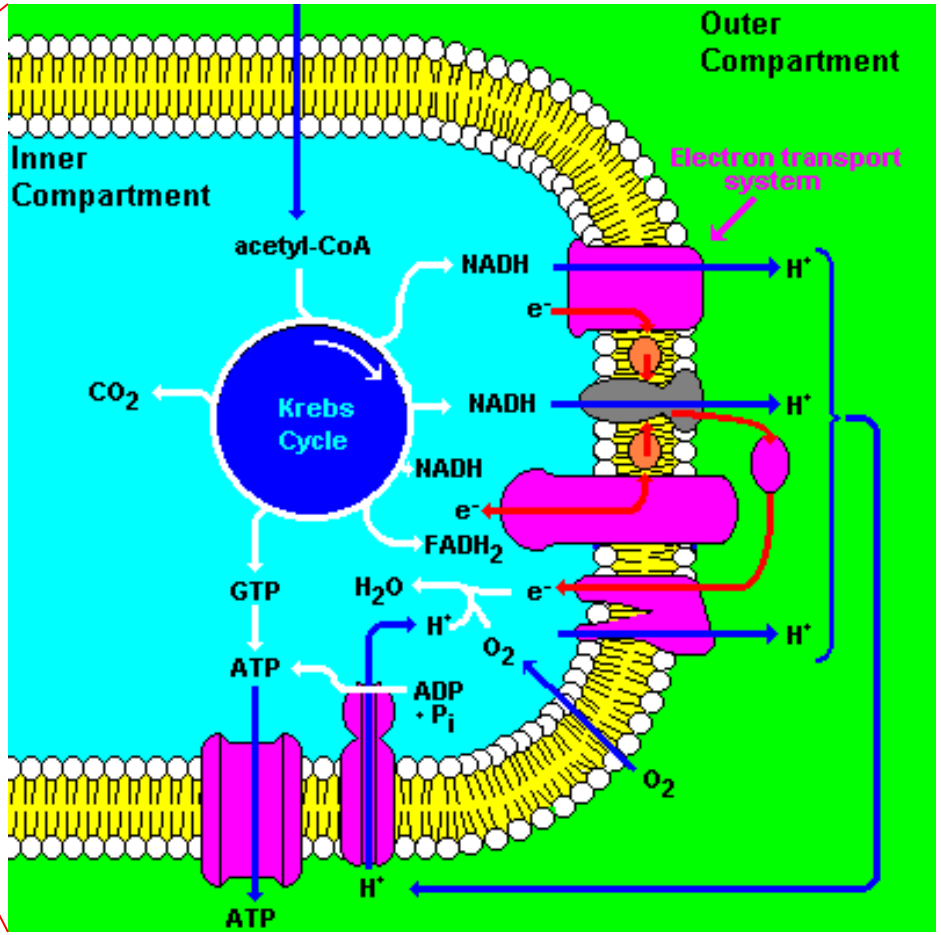
Cellular Respiration



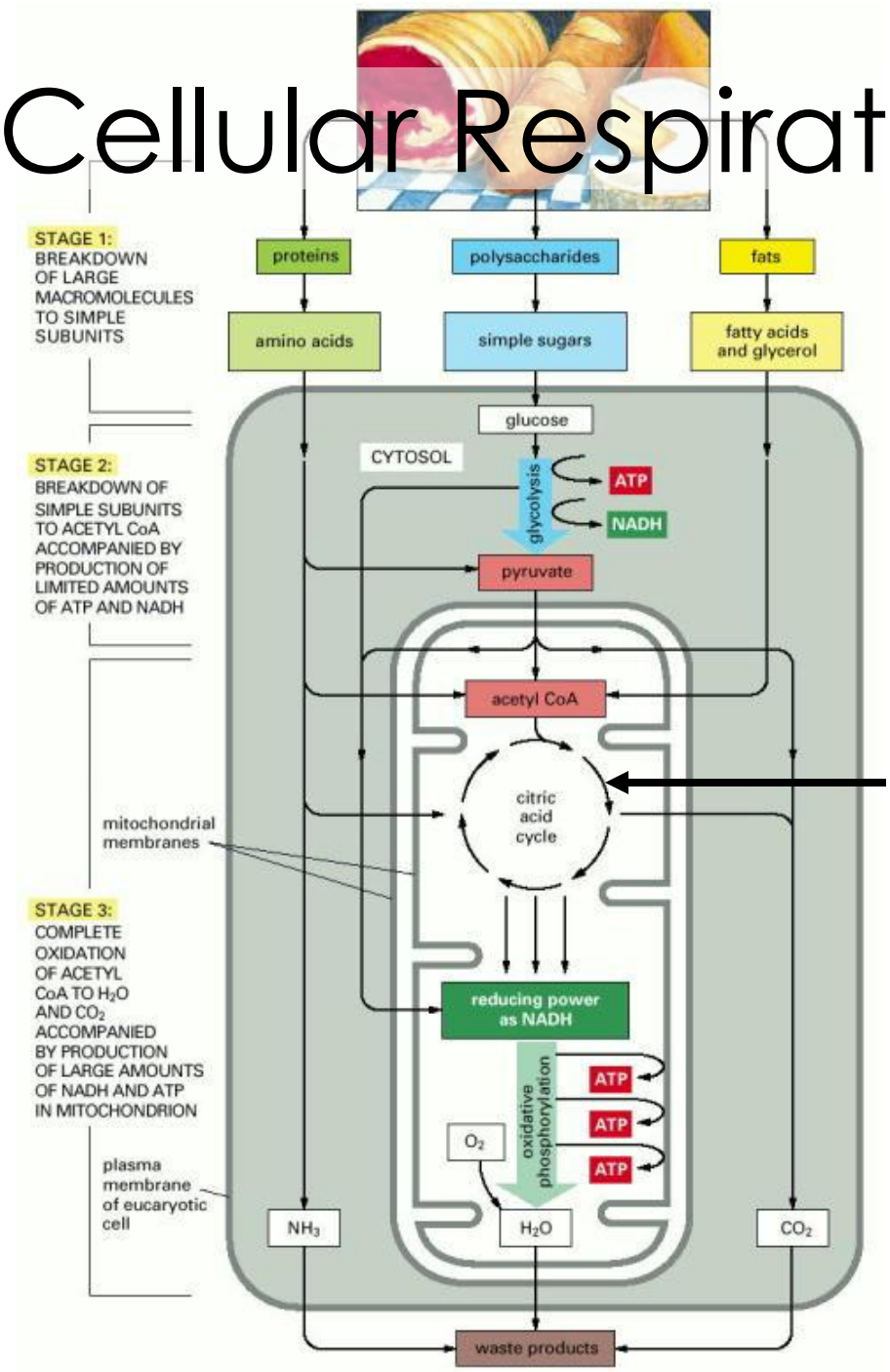
Into the mitrochondria…

Into the Mitochondria



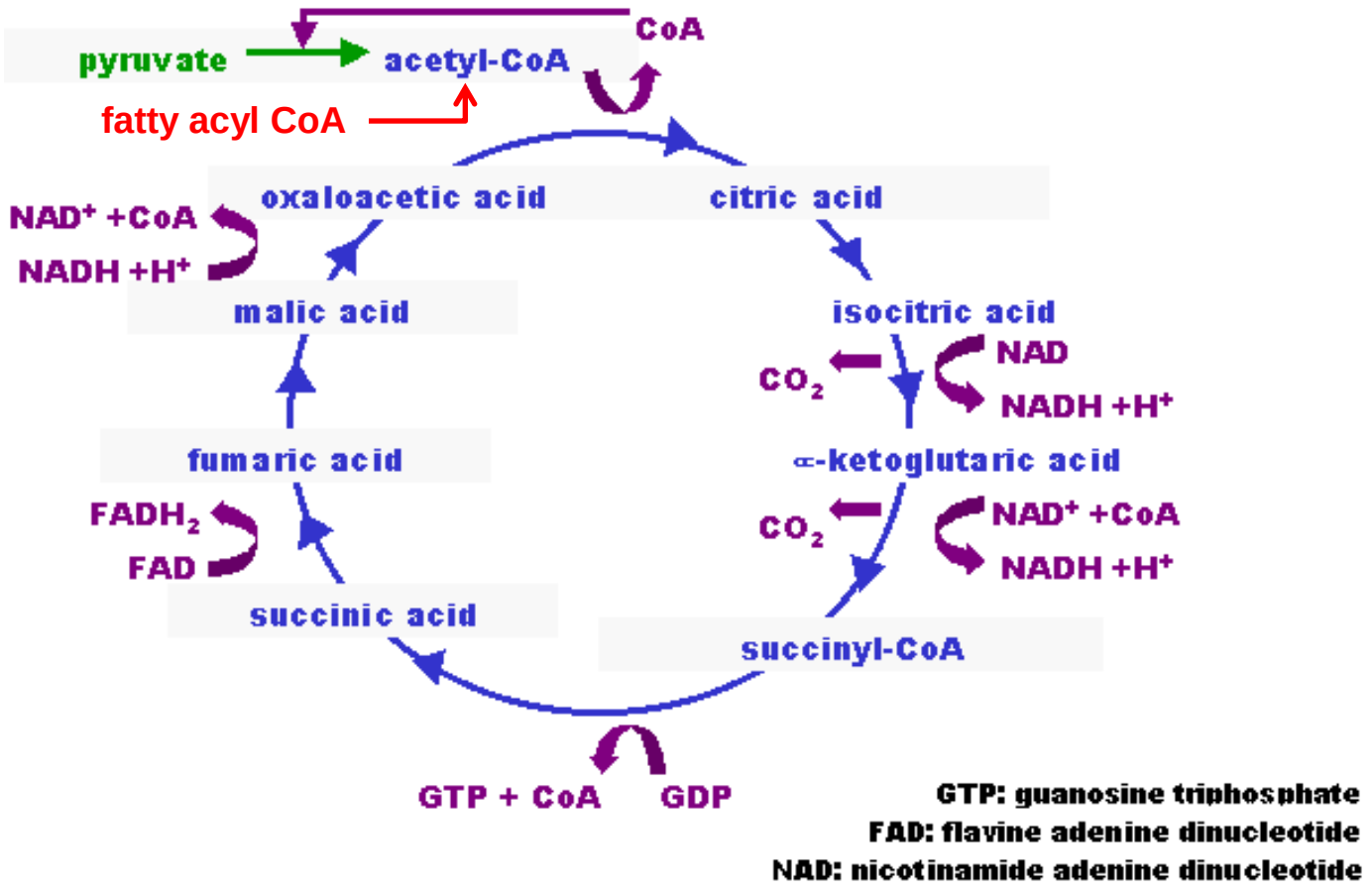


Cellular Respiration



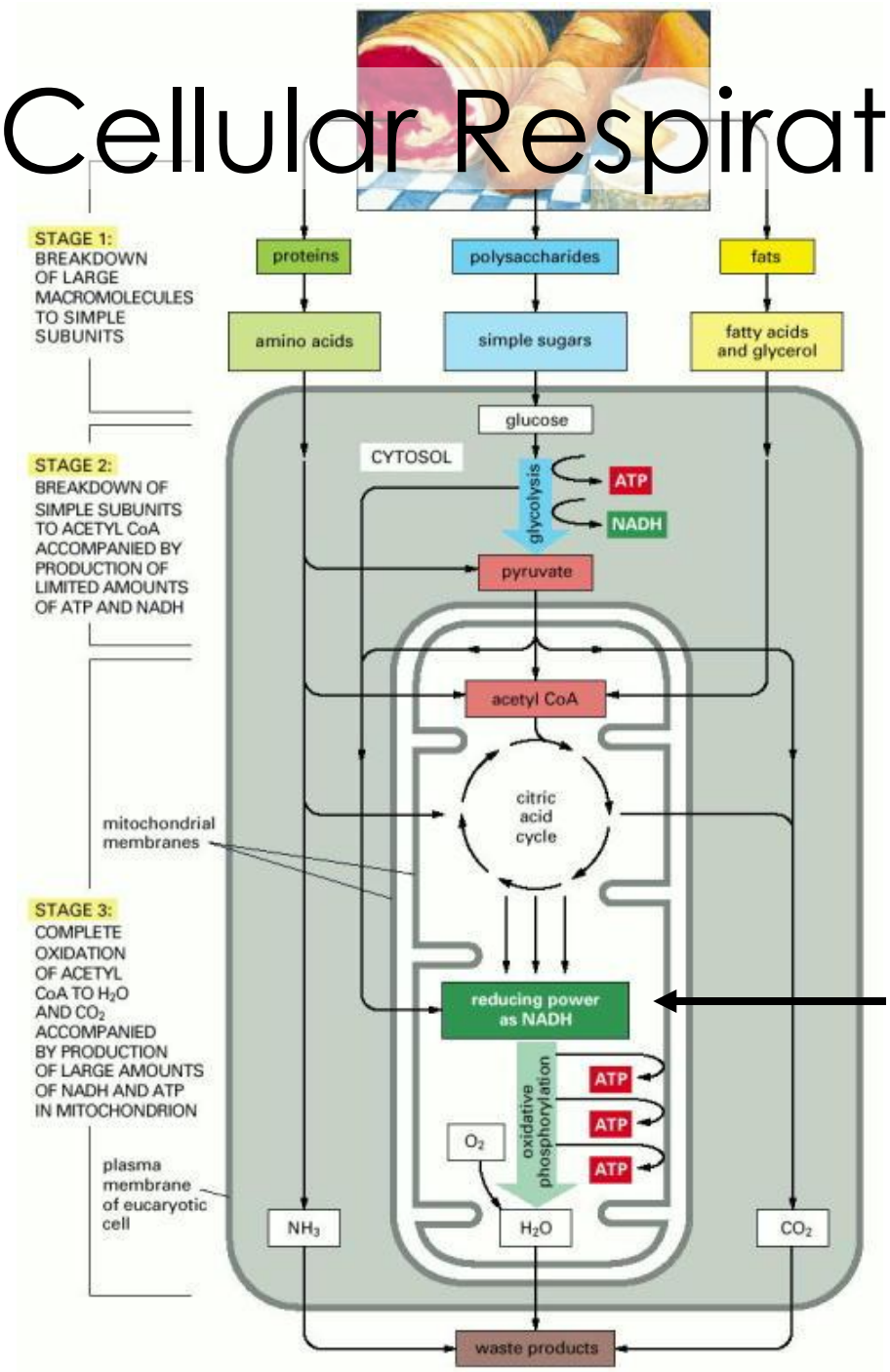
Kreb's Cycle

Krebs Cycle



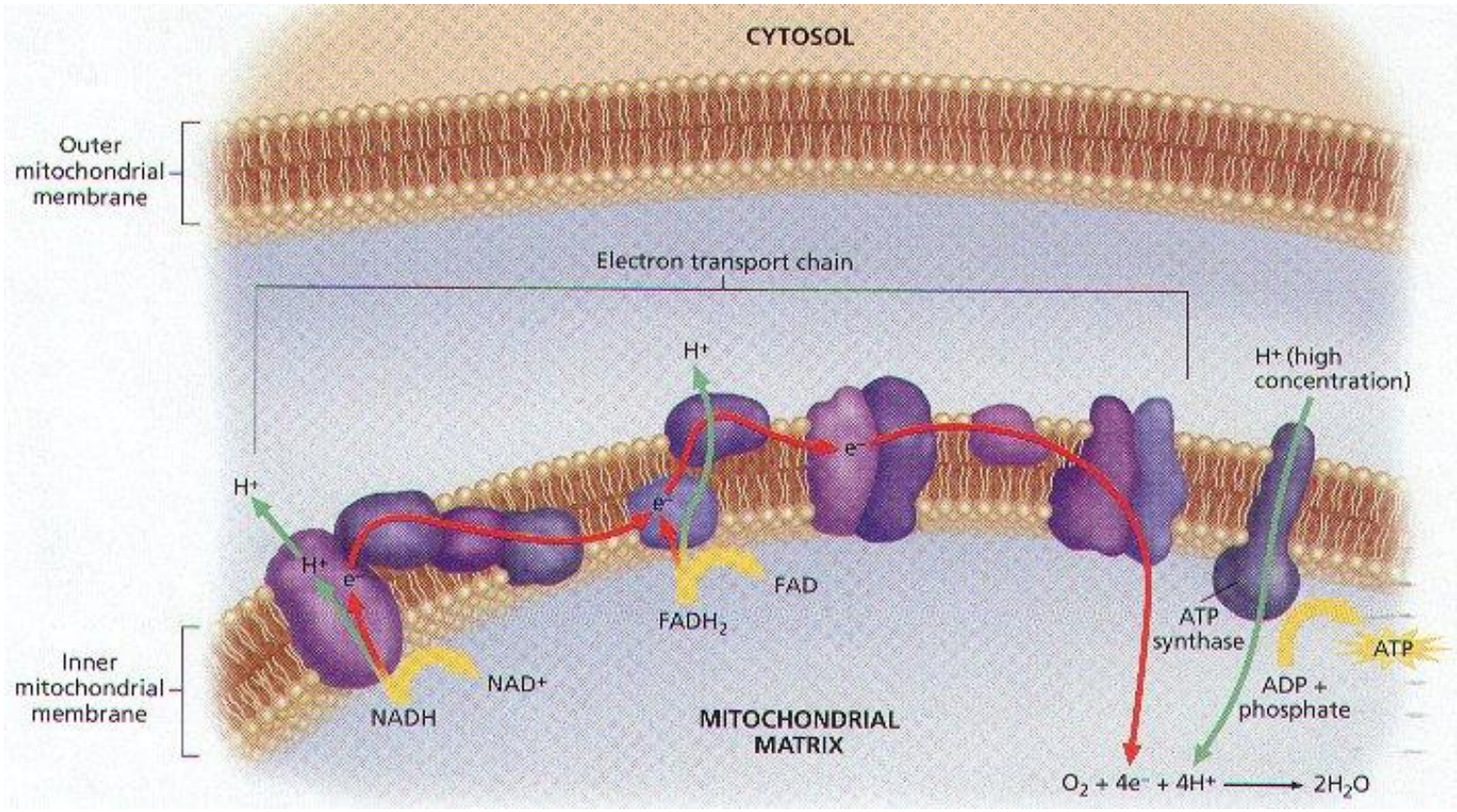
1. *Acetyl Coenzyme A (acetyl CoA) + oxaloacetic acid = Citric Acid*
2. *Rearranged, dehydrated, carbon theft, e^- stealing*
3. *Yields 3 NADH, 3 H+, $FADH_2$ = energy to produce ATP*

Cellular Respiration



Electron Transport Chain

Electron Transport Chain



1. *Proteins in mitochondrial membrane pump out H^+ ions*
2. *Pumps powered by electron transport (e^-) along membrane*
3. *H^+ ions fuels **F0F1-ATP Synthase** which produces ATP*
4. *<u>Result</u>: $H^+ + 2e^-$ from NADH → 3 ATP and $2H^+ + 2e^-$ from $FADH_2$ → 2 ATP*

Questions?