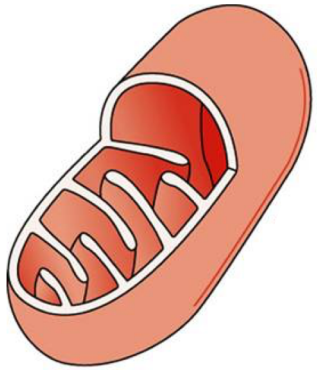
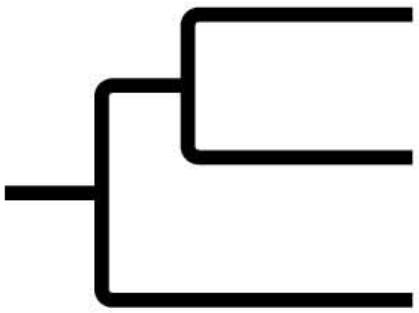
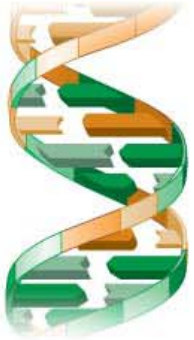
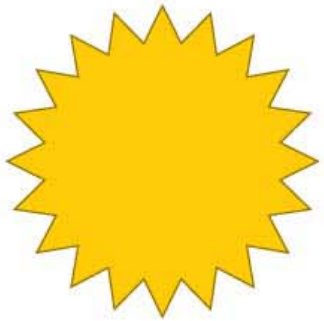
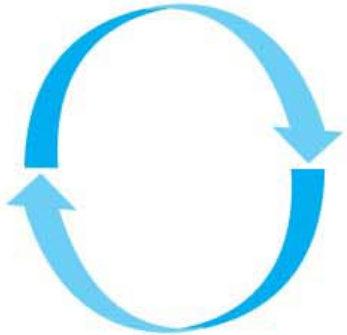
We will discuss:

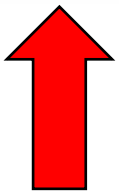
1. Cells and Organs
2. Chemical Components of Cells
3. Proteins, Enzymes
4. **Energy, Metabolism**
5. DNA, Chromosomes, Replication
6. Gene expression
7. Recombinant Techniques
8. Membrane and Transport
9. Intracellular Trafficking
10. Cytoskeleton
11. Cell division, Mitosis
12. Genetics, Meiosis
13. Cell communication, Signaling
14. Tissue, Tissue regeneration

Key organelle : mitochondrion



Mitochondrion
(ATP synthesis)

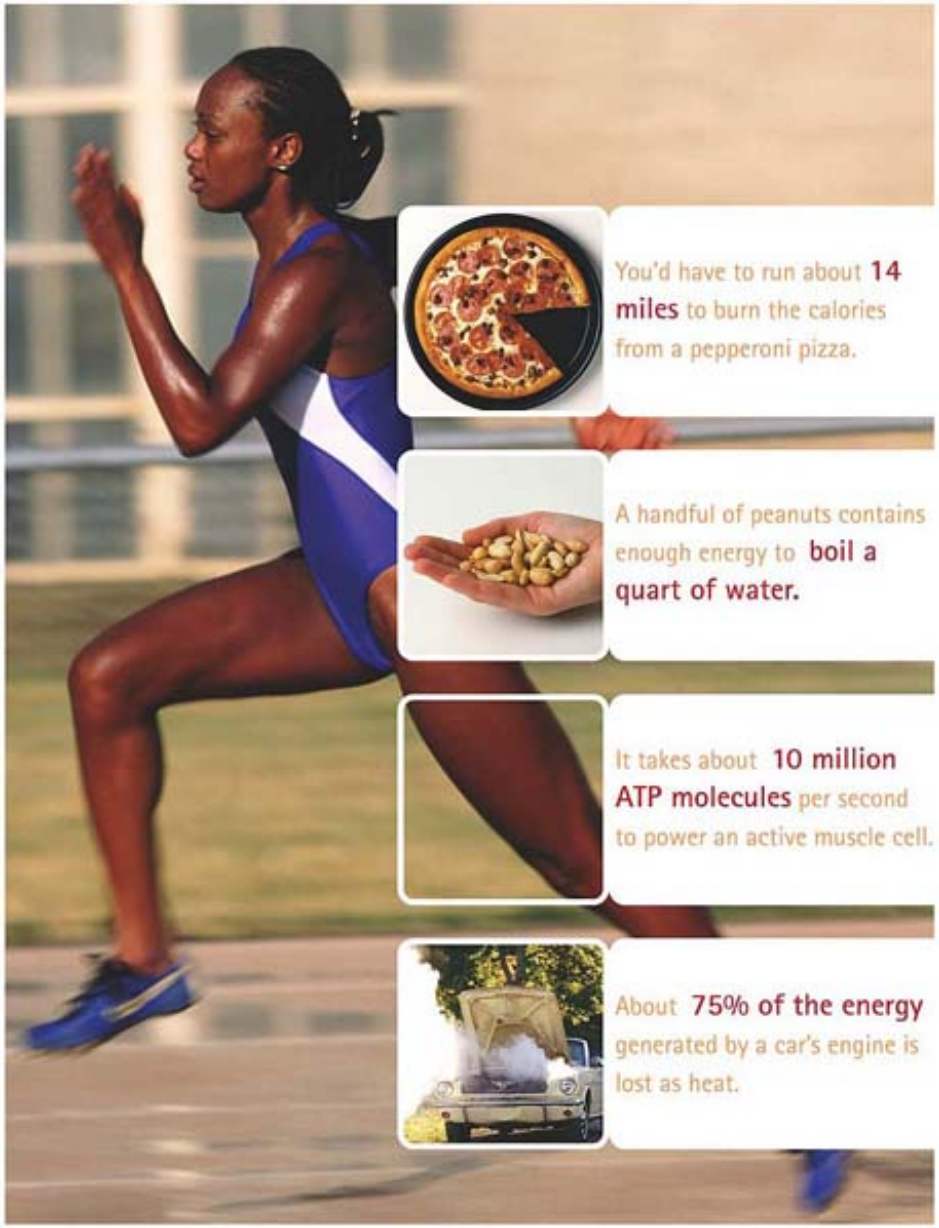
MAJOR THEMES IN BIOLOGY				
Evolution	Structure/ Function	Information Flow	Energy Transformations	Interconnections within Systems
				



Today

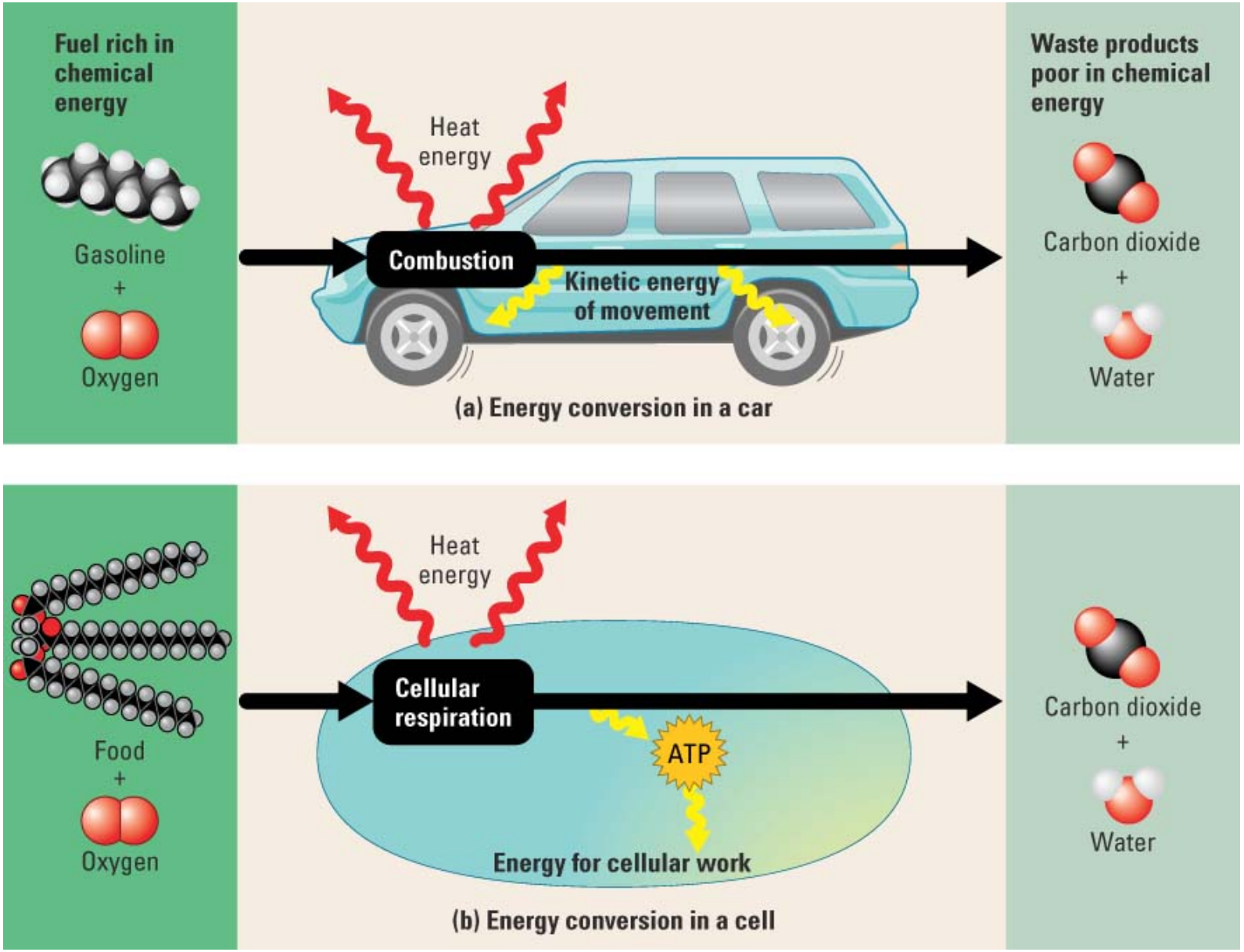
Essential Biology :

Chapter 5

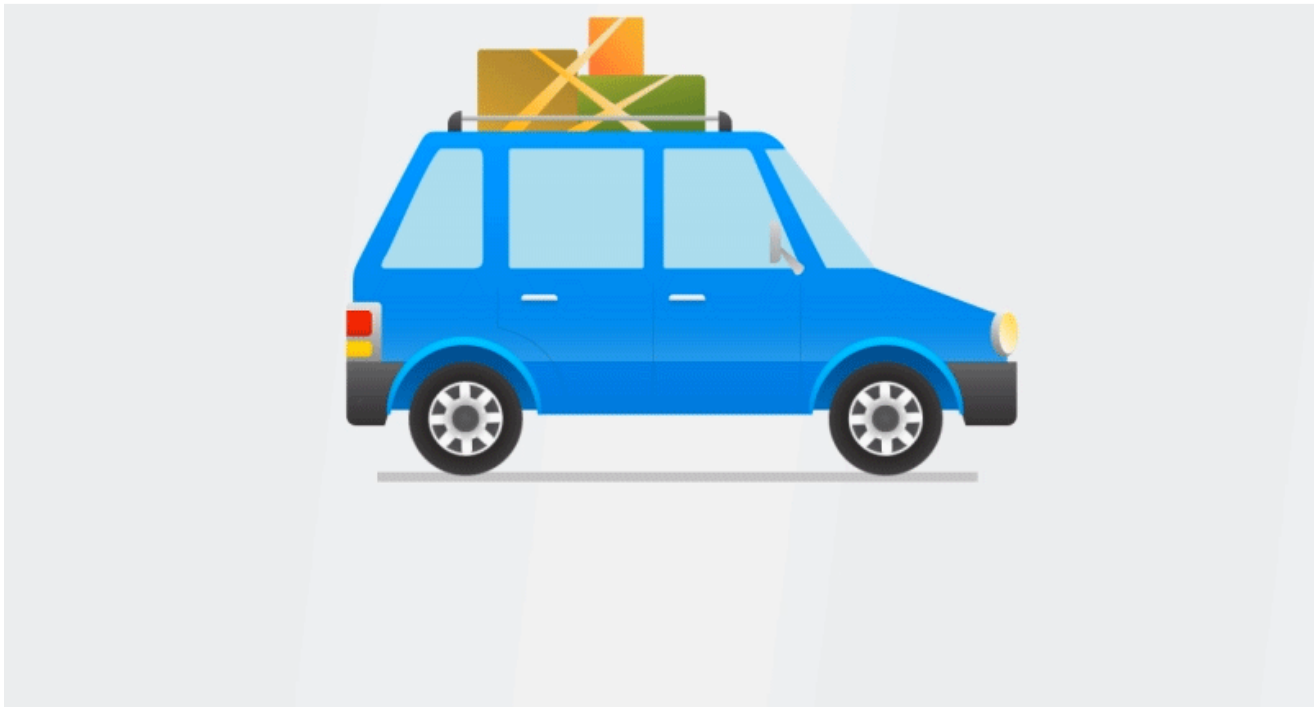


Per day, it takes as much ATP as your own body weight to power your life.

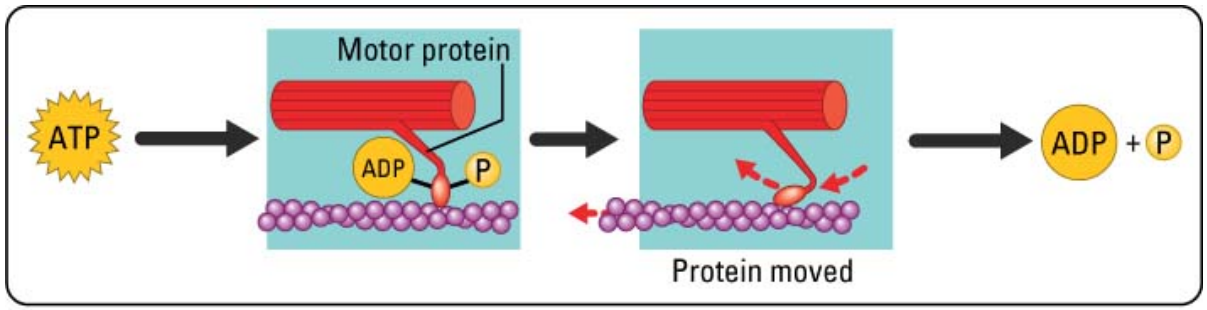
Efficiency


Fuel rich in chemical energy
Gasoline
+
Oxygen
Heat energy
Combustion
Kinetic energy of movement
Waste products poor in chemical energy
Carbon dioxide
+
Water
(a) Energy conversion in a car
Food
+
Oxygen
Heat energy
Cellular respiration
ATP
Energy for cellular work
Carbon dioxide
+
Water
(b) Energy conversion in a cell

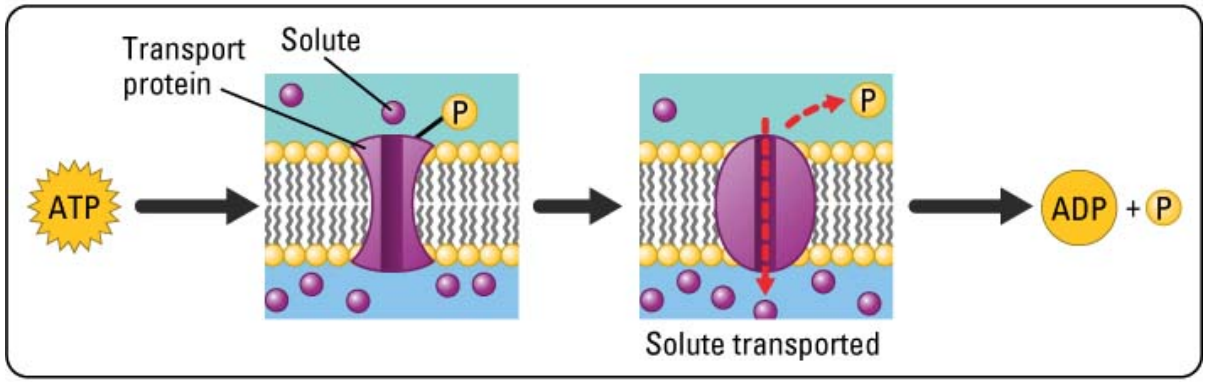
Energy for mechanical work.



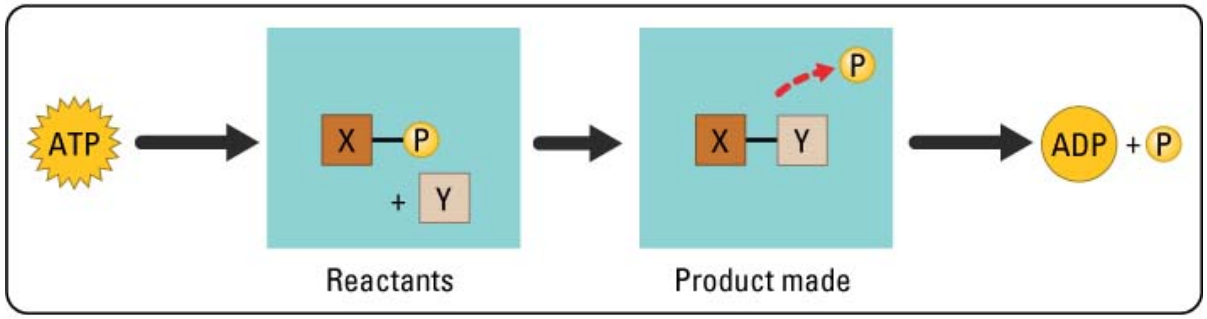
Obvious !!



(a) Mechanical work



(b) Transport work



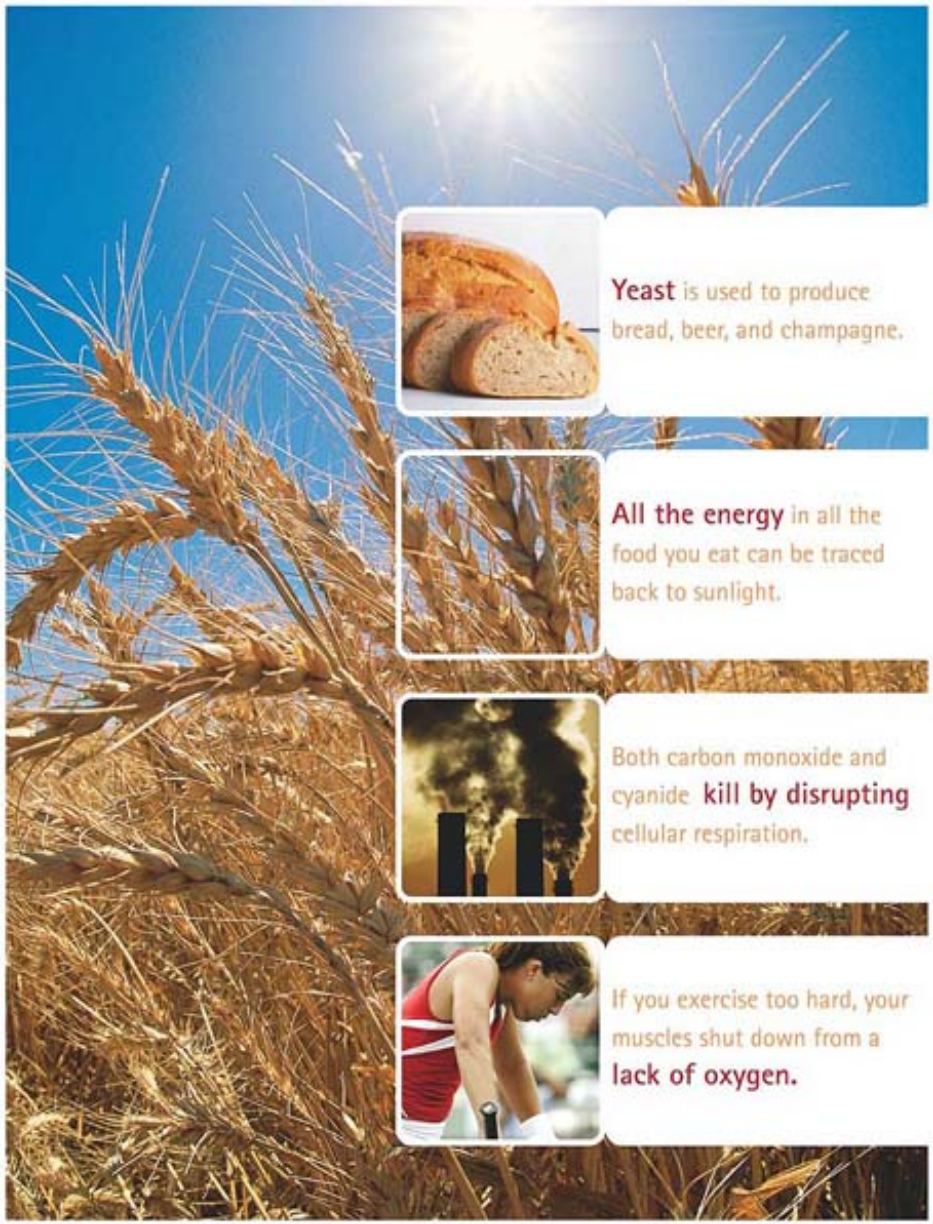
(c) Chemical work

Think about
resting membrane potential

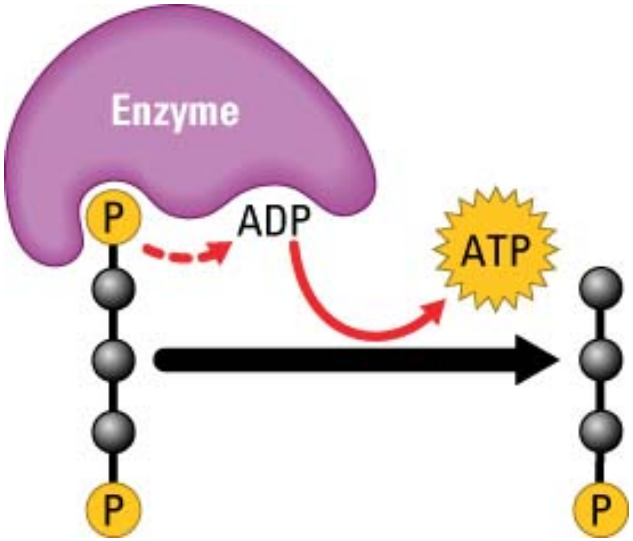
Think about
assembling monomers
into polymers :
amino acids → proteins
nucleotides → nucleic acids

Chapter 6

Cellular Respiration:
Obtaining Energy from Food



Two ways to synthesize ATP



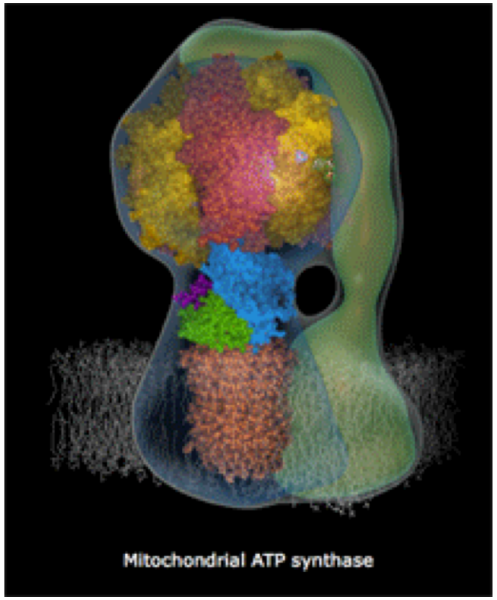
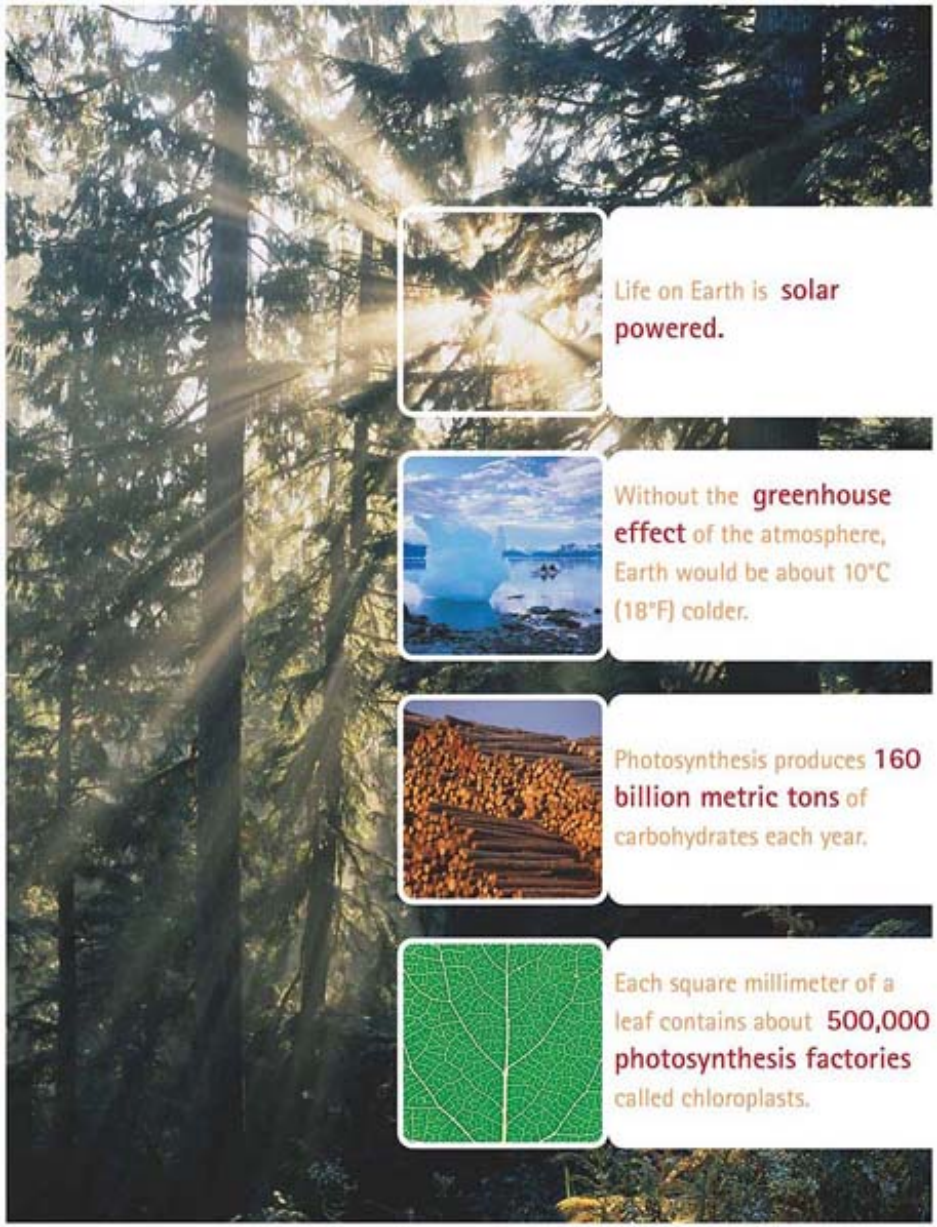


Figure 6.9 ATP synthesis by direct phosphate transfer.
Glycolysis generates ATP when enzymes transfer phosphate groups directly from fuel molecules to ADP.

Chapter 7

Photosynthesis: Using Light to Make Food

Energy considered at
the biosphere organization level



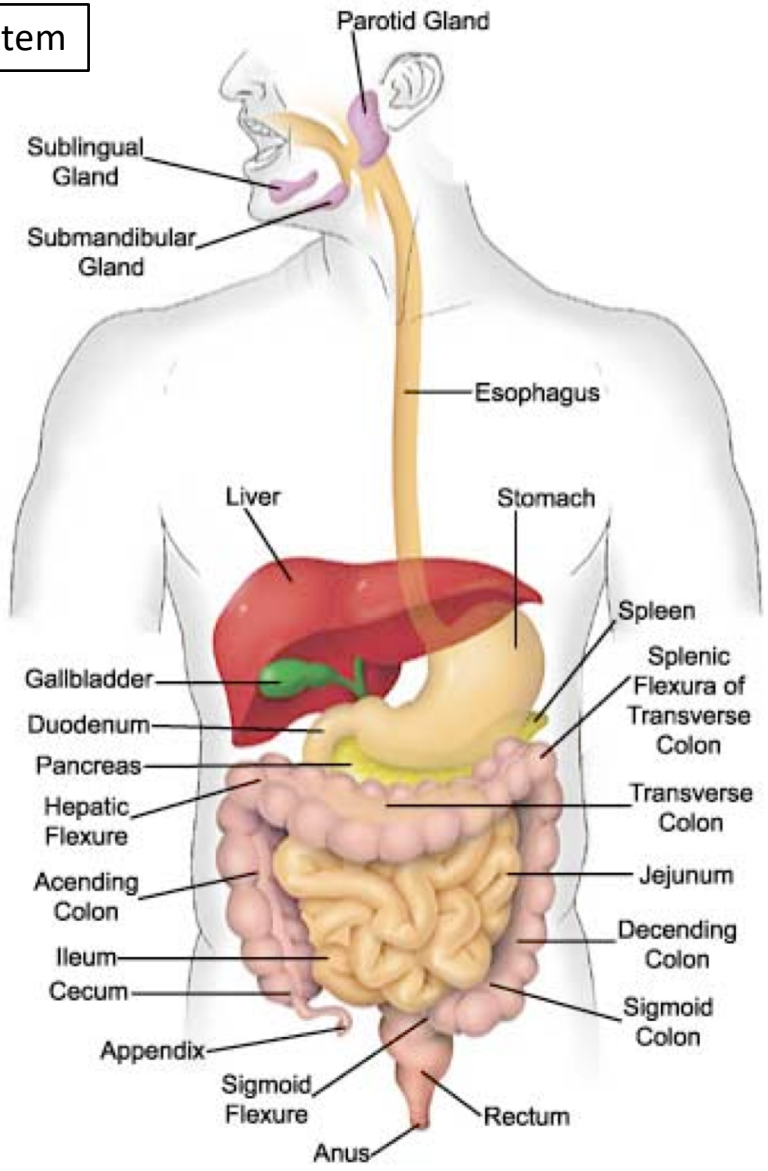
The Alimentary Canal

Organization level : system

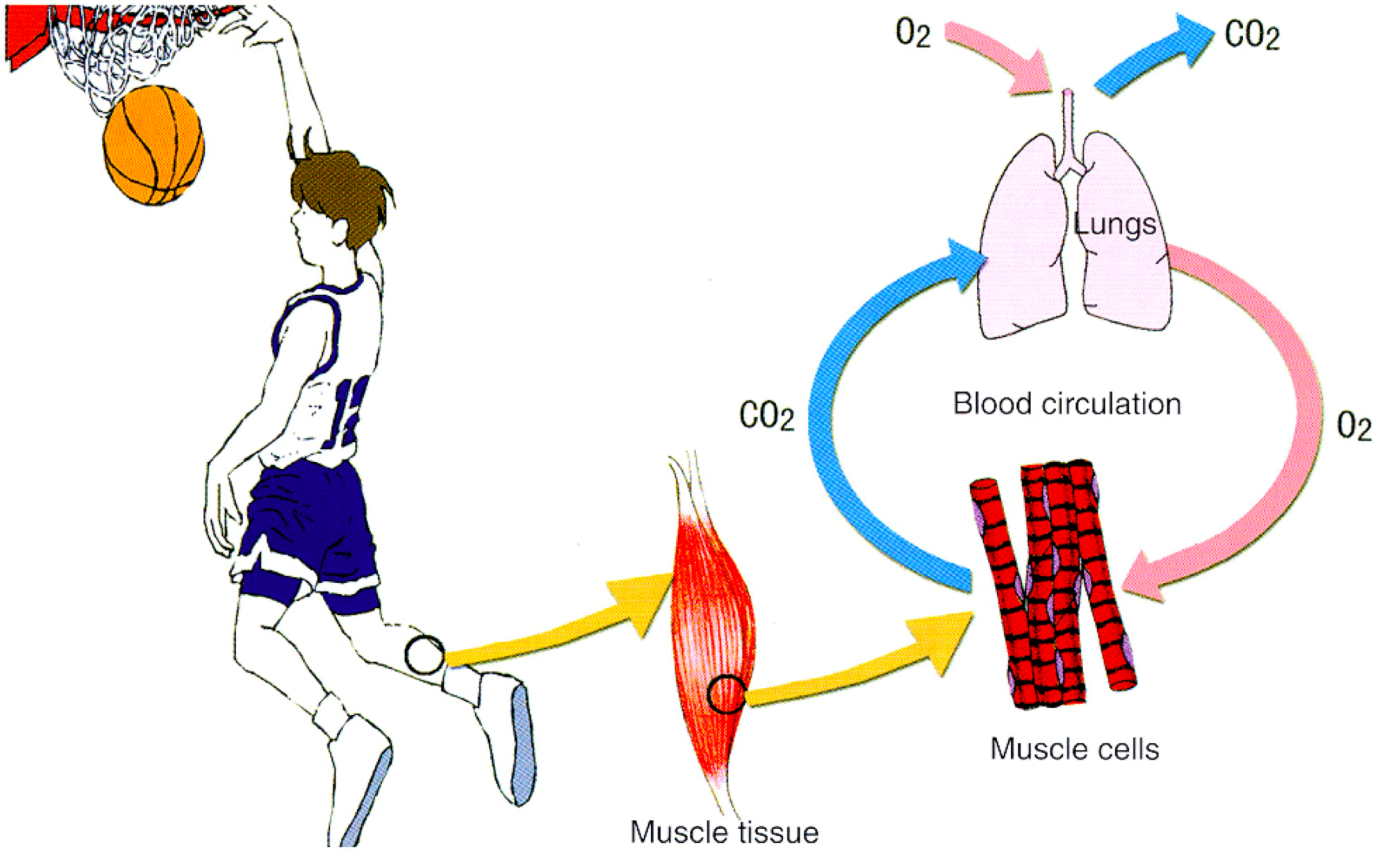
The alimentary canal (or gut): food passes through and is processed in various ways

1. **Mechanical digestion**
   → teeth

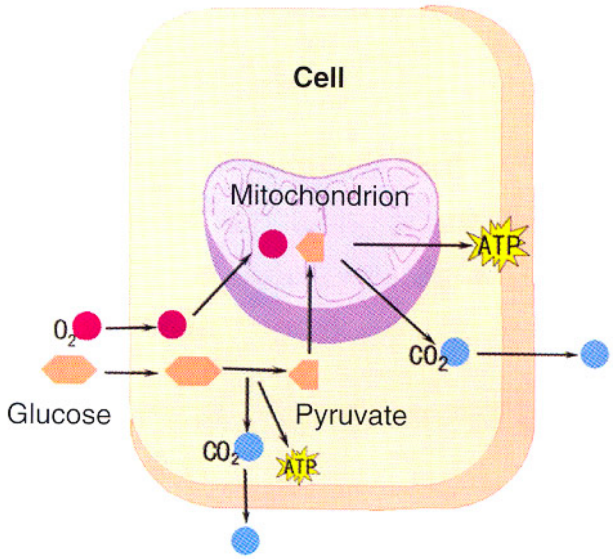
2. **Chemical digestion**
   → Enzymes: breakdown of macromolecules (stomach)
   → absorption of small unitary molecules (small intestine)
   → delivery to the blood stream



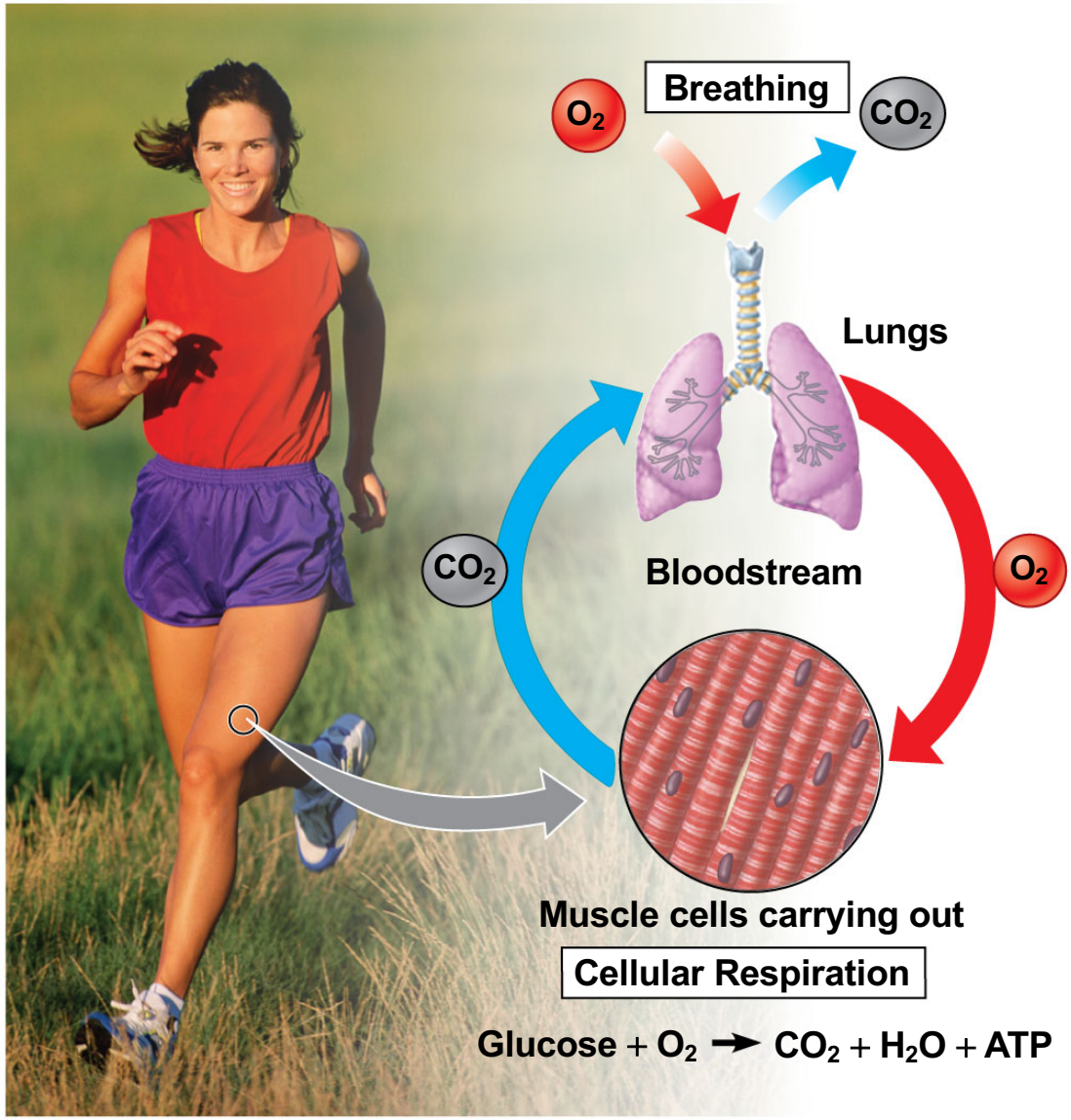
Aerobic metabolism consumes O_2 and produces CO_2



$O_2 + 4\ H^+ \rightarrow 2\ H_2O$

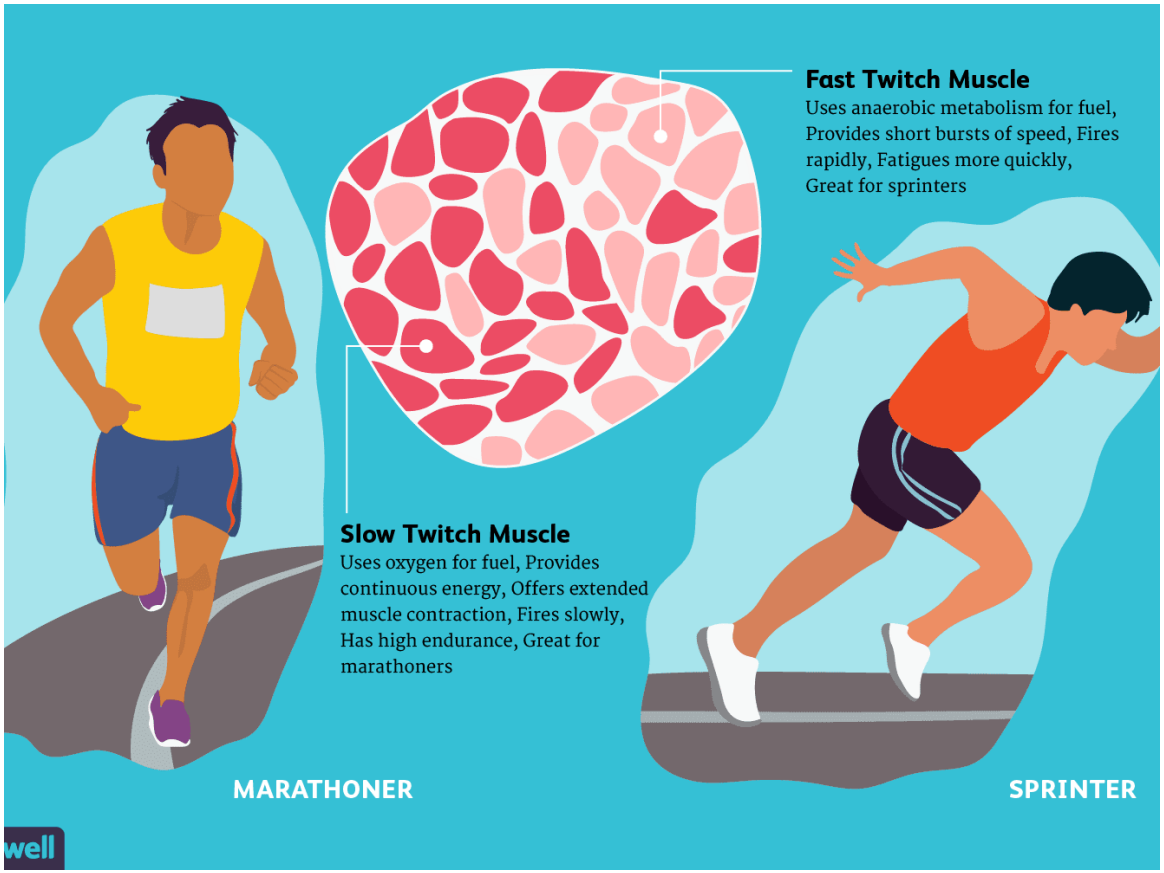


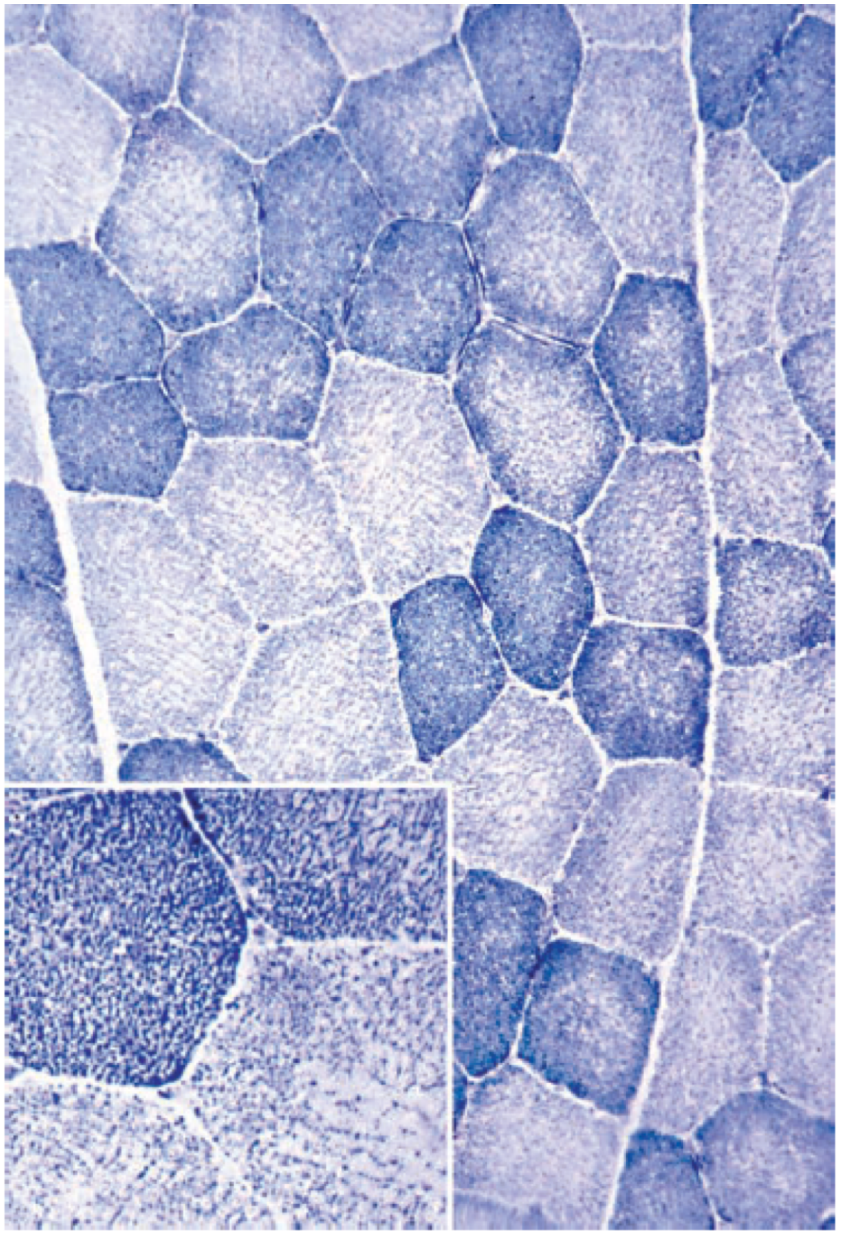
Energy



Two types of muscle fibers

Some muscle fibers have a lot of mitochondria.





Link between photosynthesis and respiration

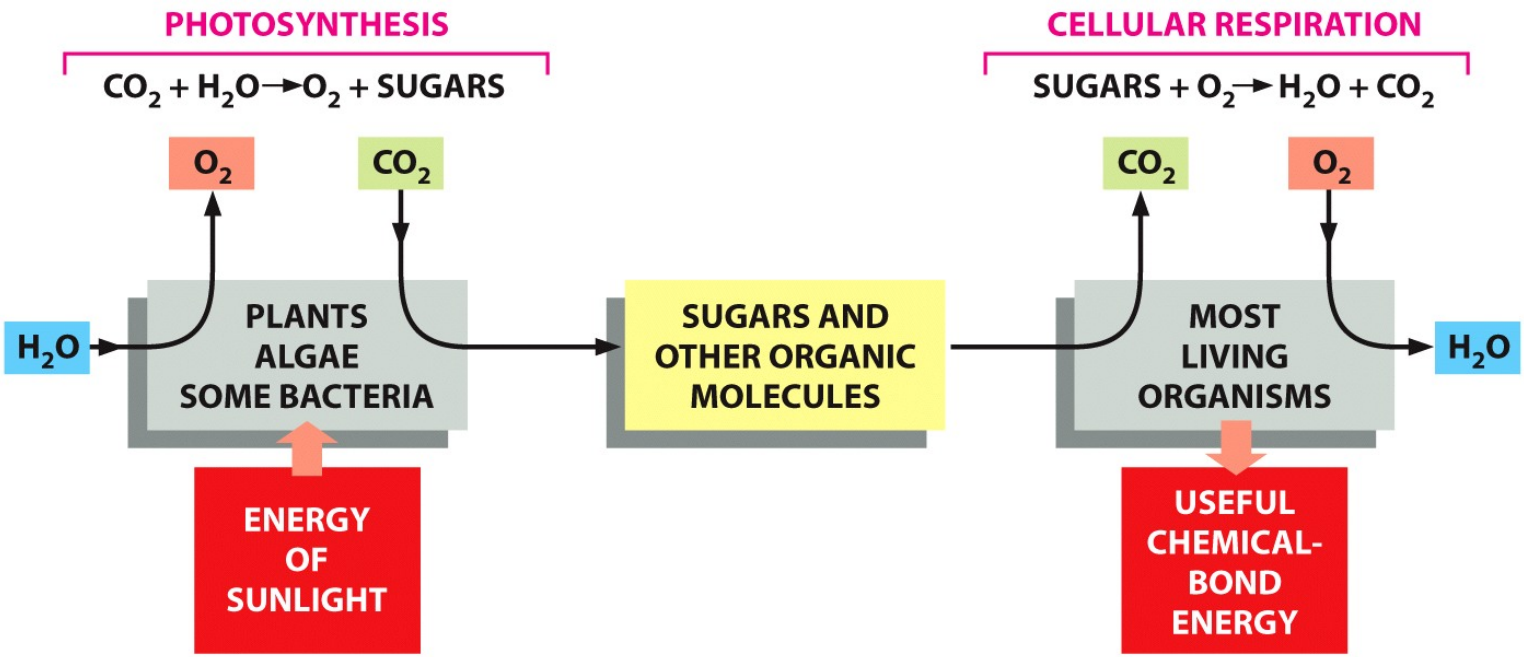
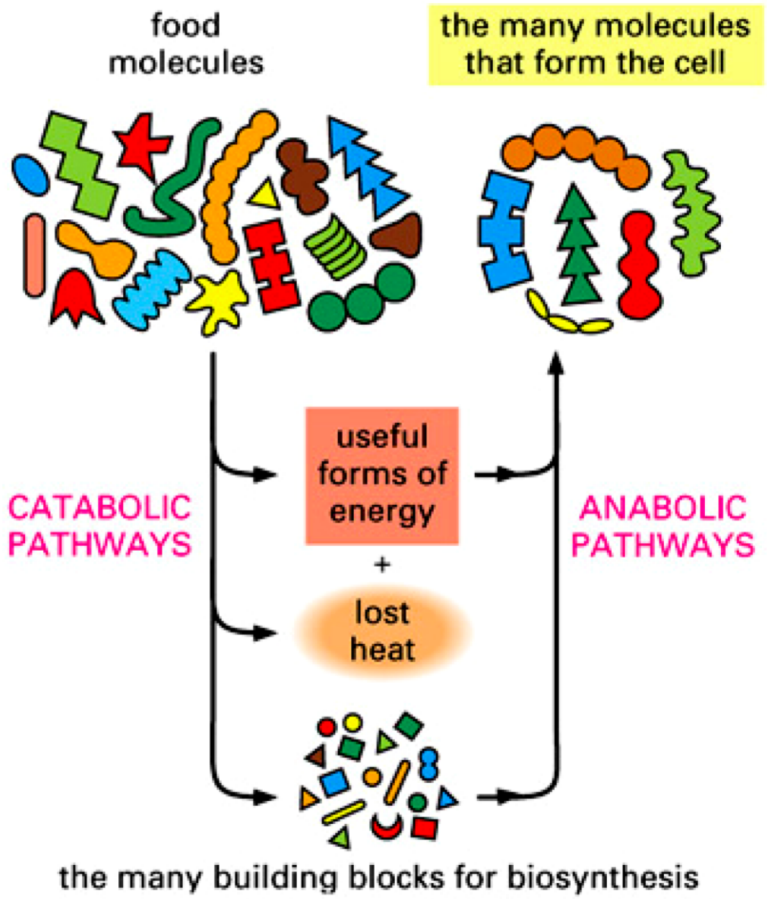


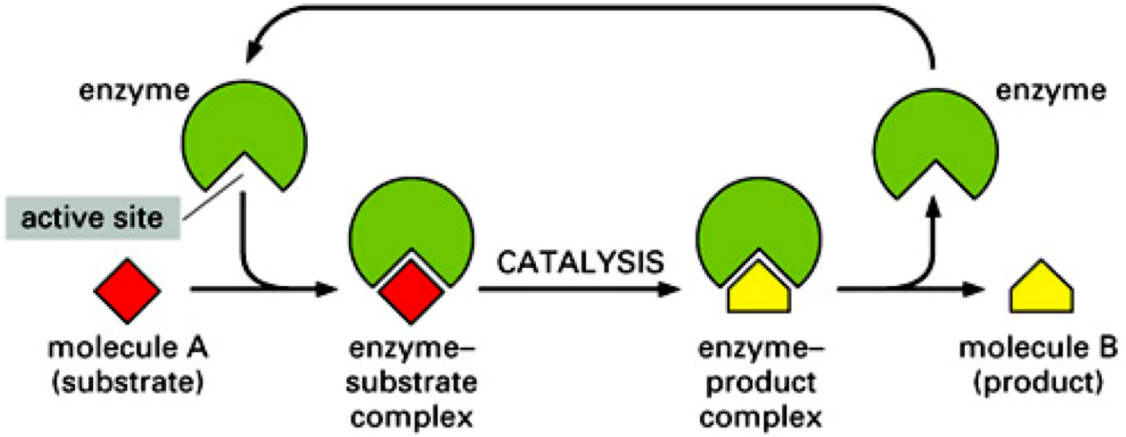
Figure 3-9 Essential Cell Biology, 4th ed. (© Garland Science 2014)

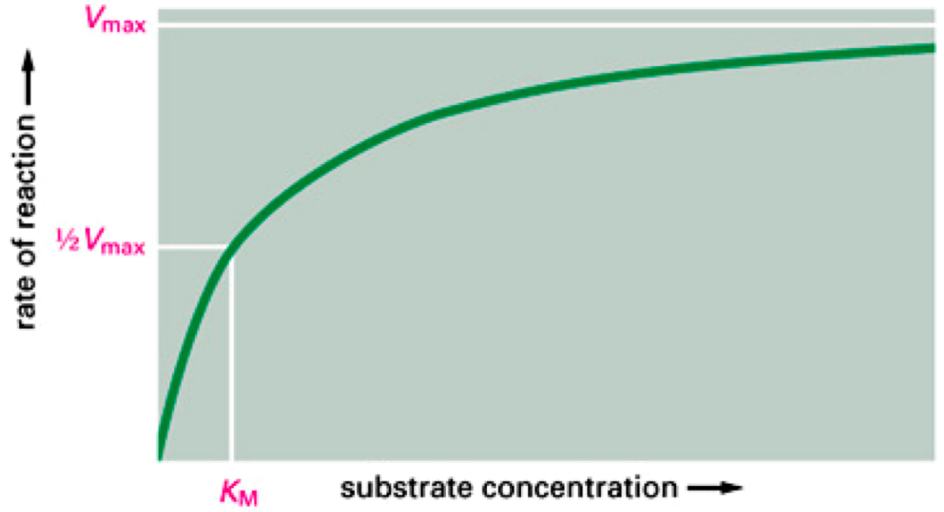
→ ATP

Catabolic (breakdown) and Anabolic (synthesis) pathways



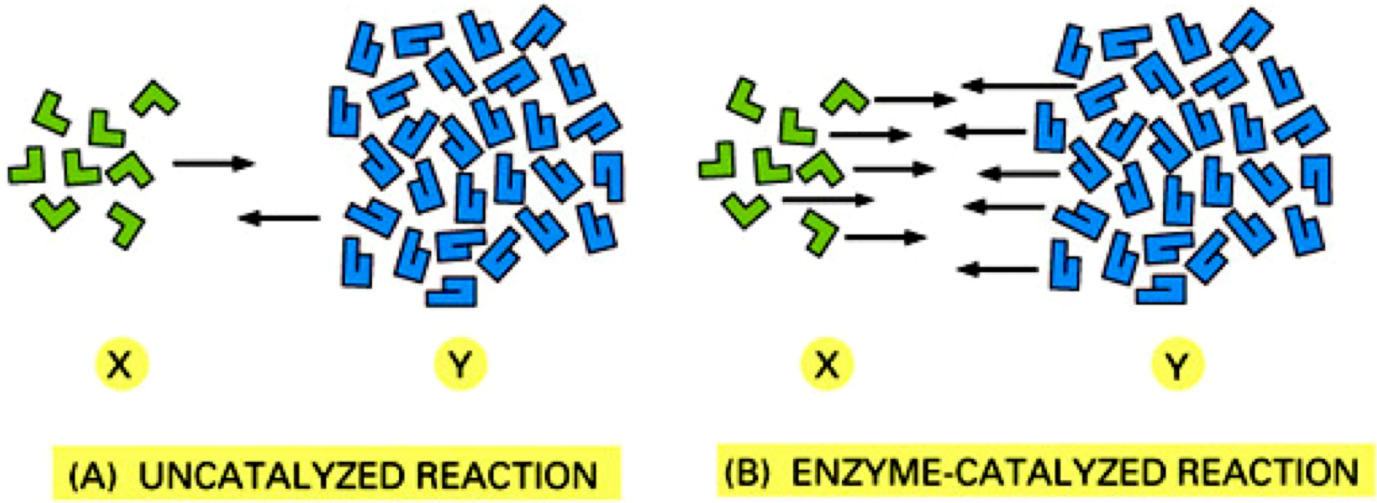
Enzymes catalyze metabolic reactions





Enzymes accelerate reactions

-> faster at equilibrium

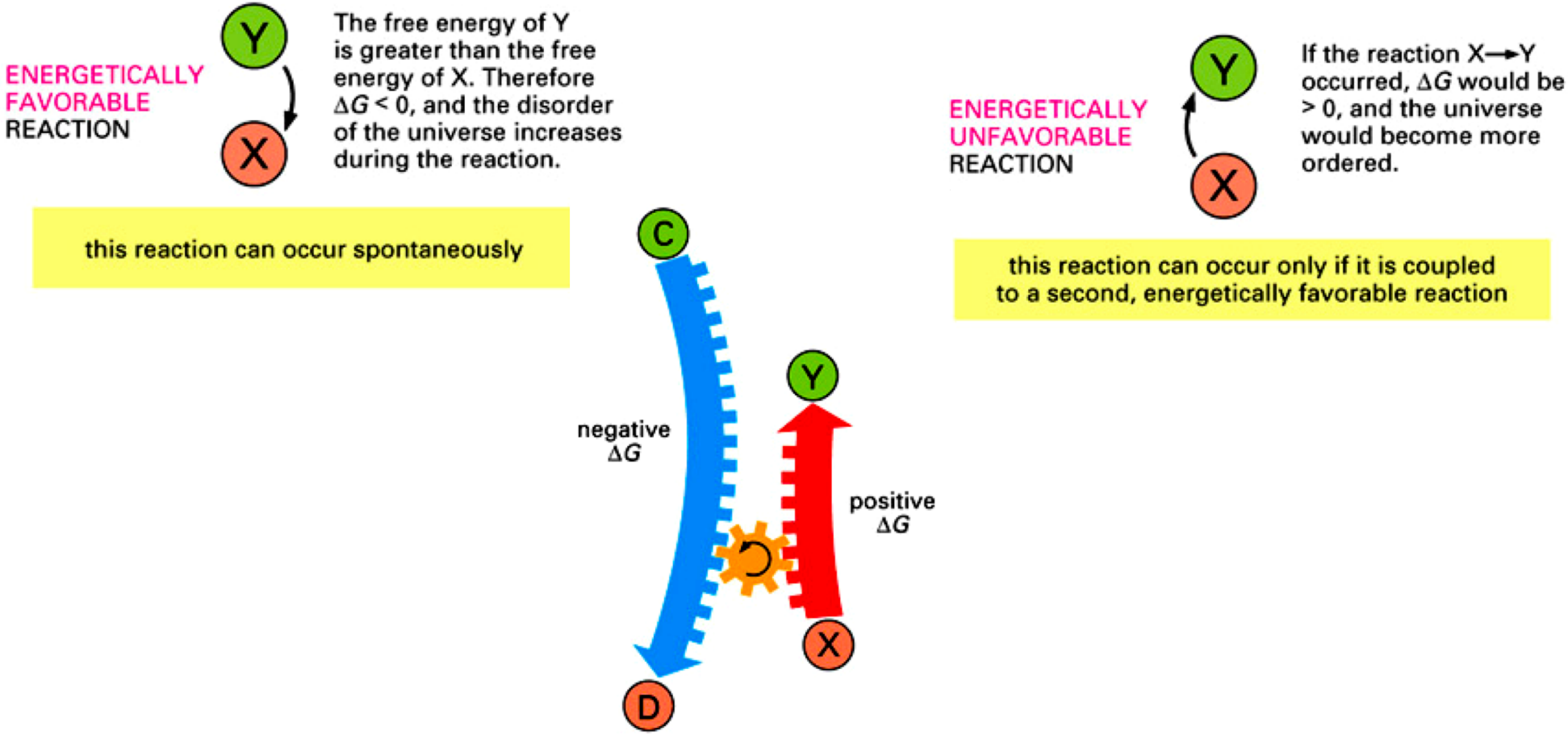


(A) UNCATALYZED REACTION

(B) ENZYME-CATALYZED REACTION

Enzymes can couple ΔG<0 reaction with ΔG>0 reaction

-> ΔG>0 becomes possible



COUPLED REACTIONS

SINGLE REACTION

glucose + fructose → sucrose

ΔG° = +5.5 kcal/mole

NET RESULT: reaction will not occur

ATP → ADP + P $\Delta G^\circ = -7.3$ kcal/mole

NET RESULT: reaction is highly favorable

COUPLED REACTIONS

glucose + ATP → glucose-1-P + ADP

glucose-1-P + fructose → sucrose + P

ΔG° = 5.5 – 7.3 = –1.8 kcal/mole

NET RESULT: sucrose is made in a reaction driven by the hydrolysis of ATP

Panel 3-1g Essential Cell Biology, 4th ed. (© Garland Science 2014)

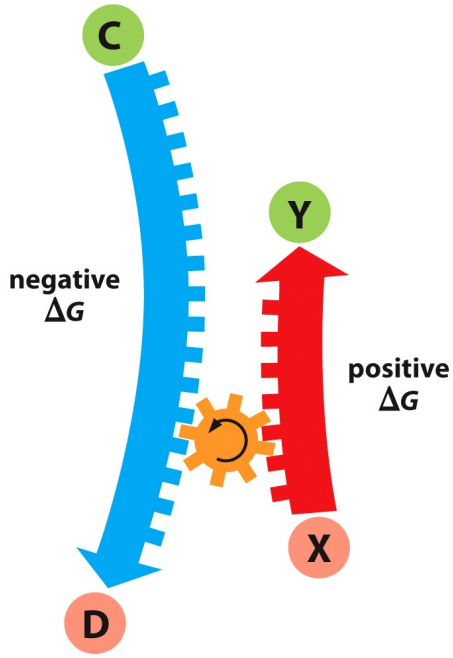
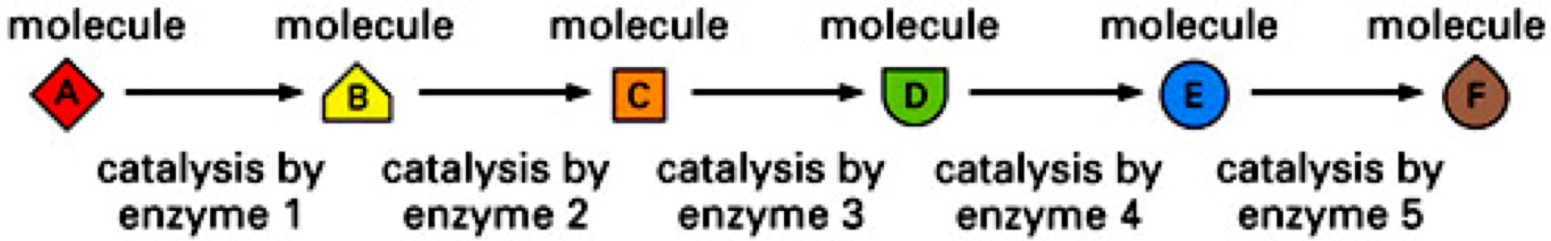


Figure 3-17 Essential Cell Biology, 4th ed. (© Garland Science 2014)

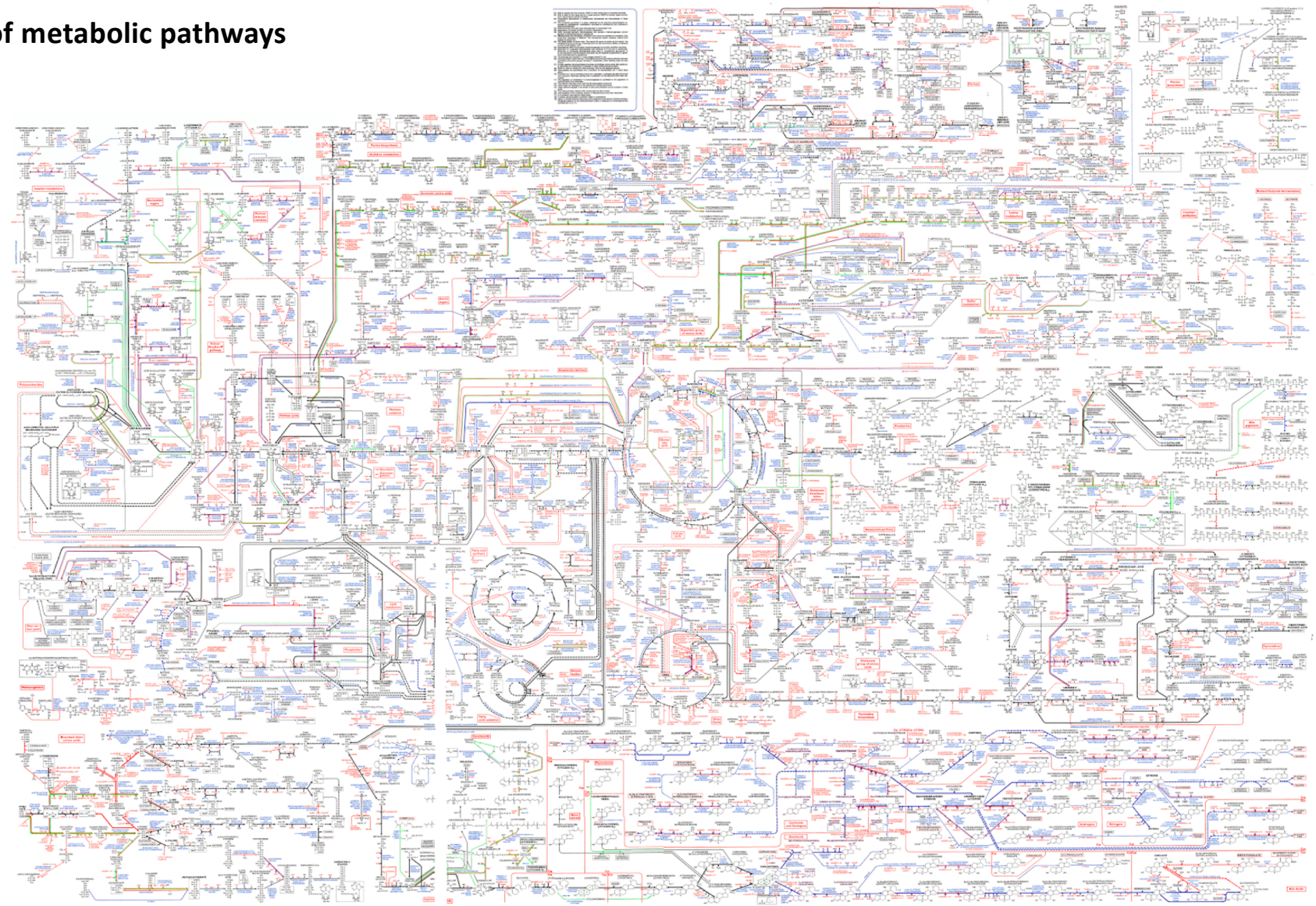
Metabolic pathways:



-> a chain of separate enzymatic reactions

-> product of one reaction is substrate for next reaction

Network of metabolic pathways

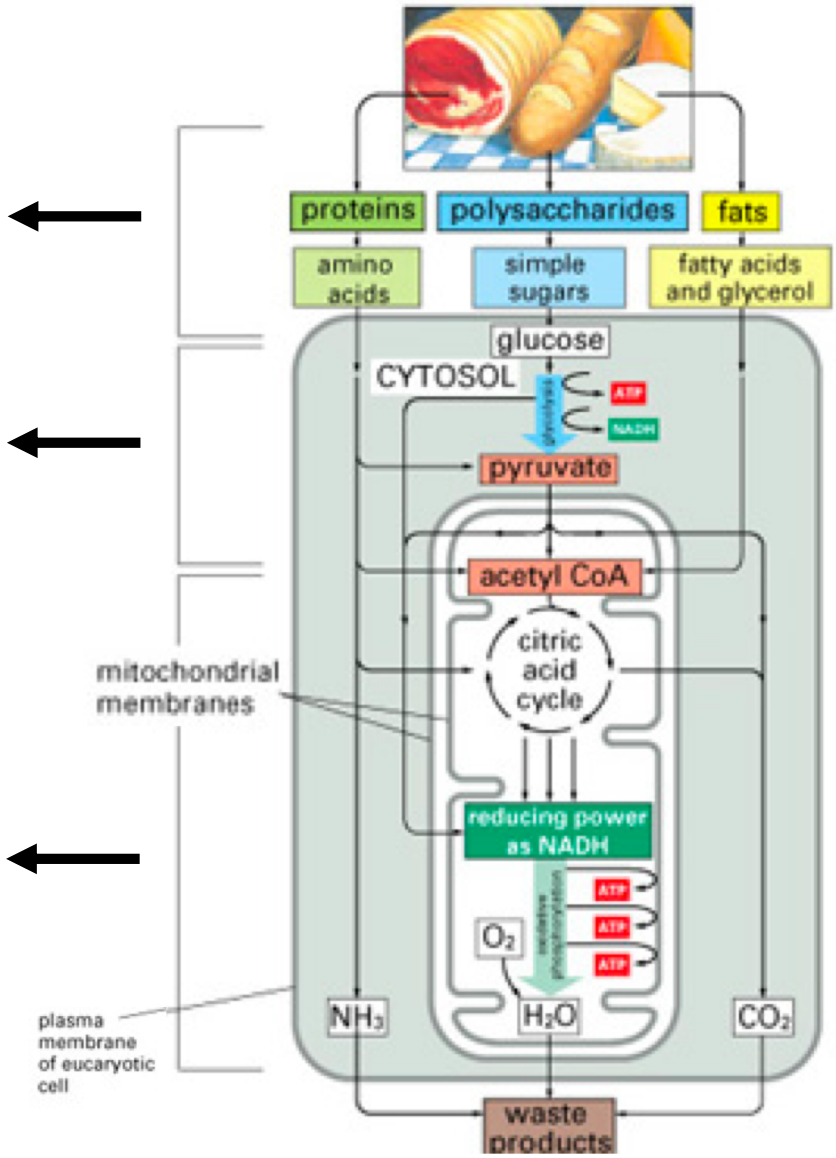


How food ends up as H_2O, CO_2 and ATP

1. breakdown of macromolecules into their subunits (in stomach, intestines)

2. breakdown of subunits into intermediates Acetyl-Coenzyme A or pyruvate (in the **cytosol**)

3. oxidation of Acetyl-Coenzyme A into CO_2 and H_2O, with production of ATP (in **mitochondria**)



ATP is the universal energy carrier in the cell

-> metabolism of food must lead to ATP synthesis

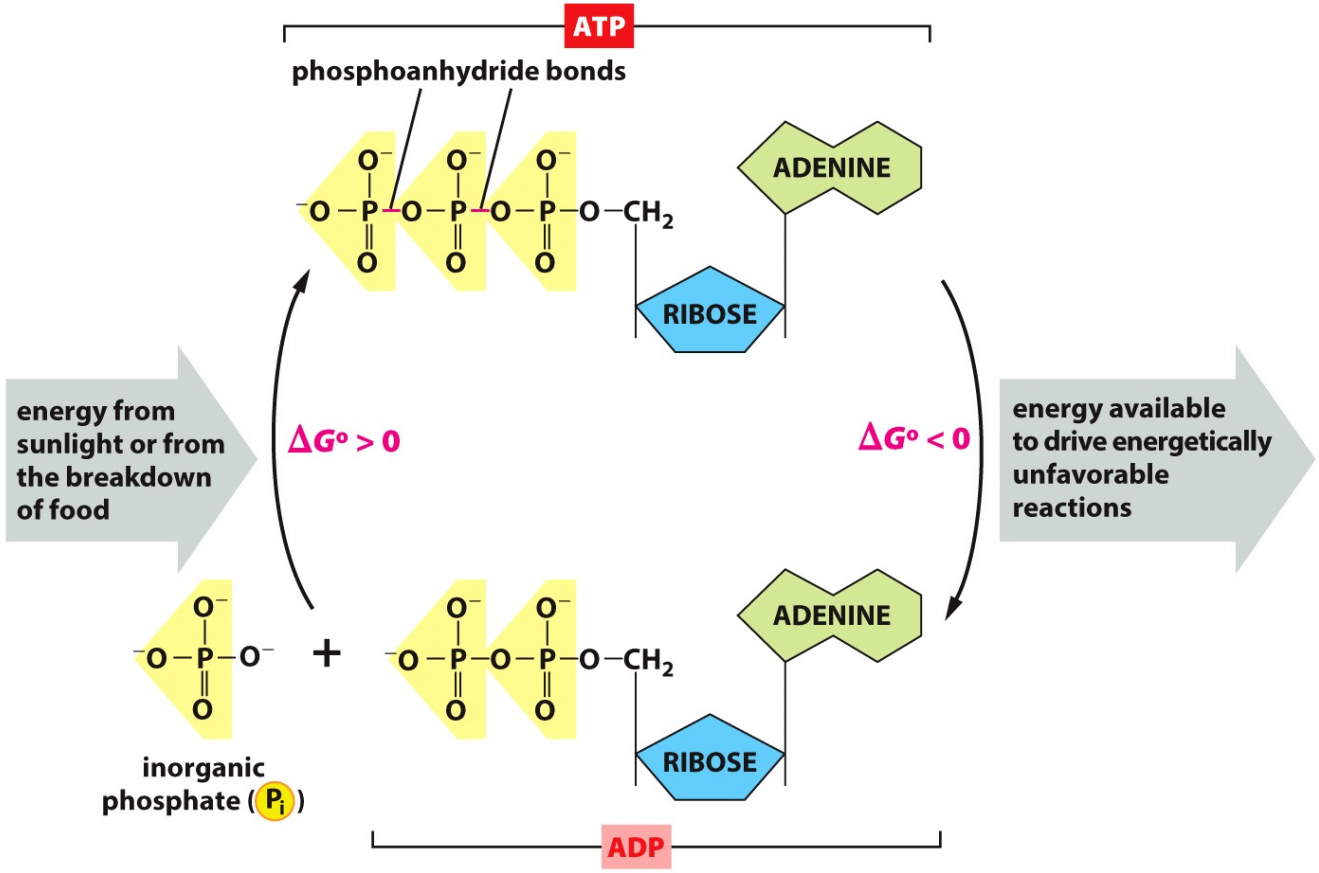
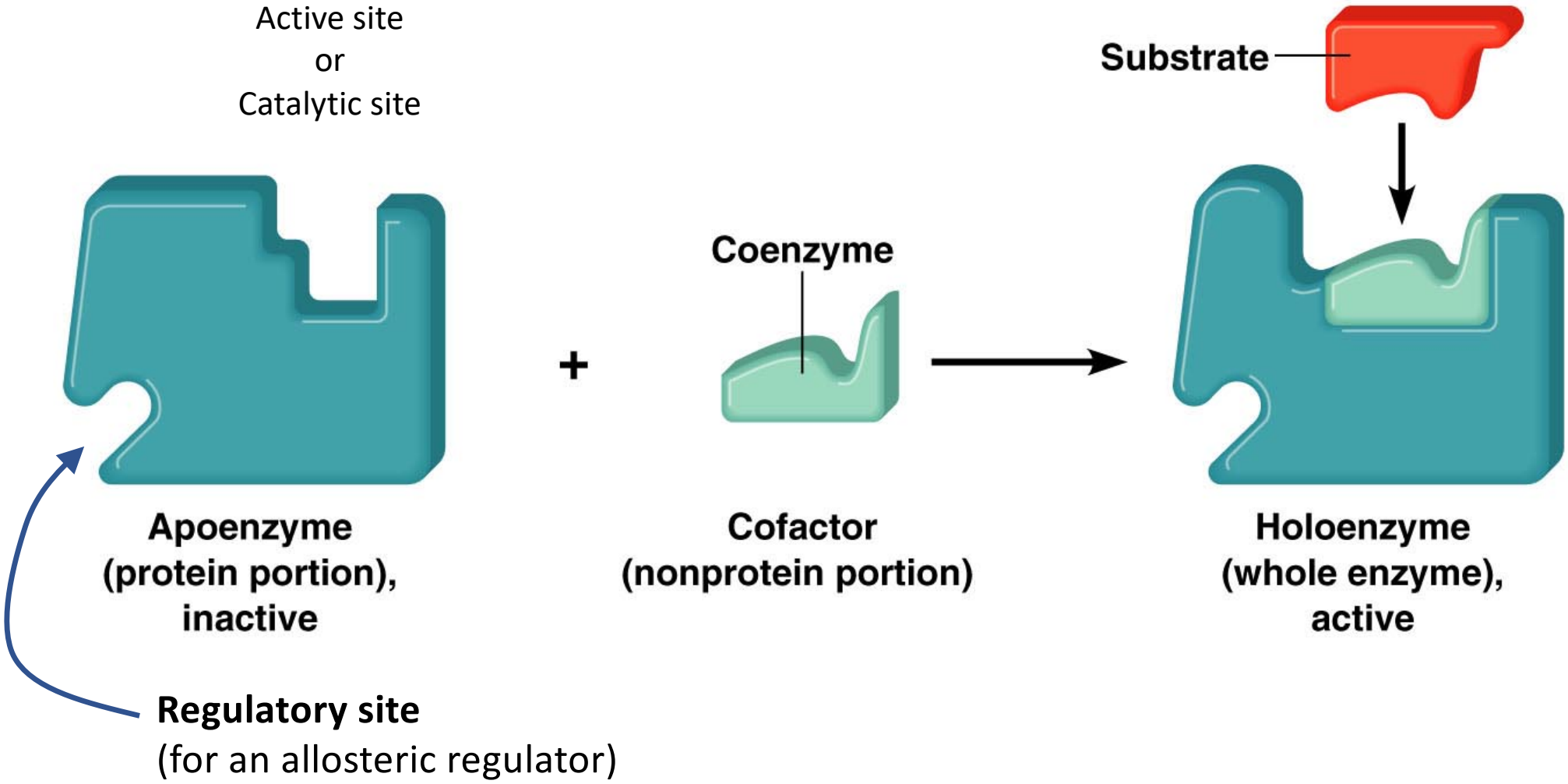


Figure 3-31 Essential Cell Biology, 4th ed. (© Garland Science 2014)

The concept of **coenzyme**



NADH and NADPH are Activated Carriers of Electrons

Some enzymes work with the help of a co-enzyme

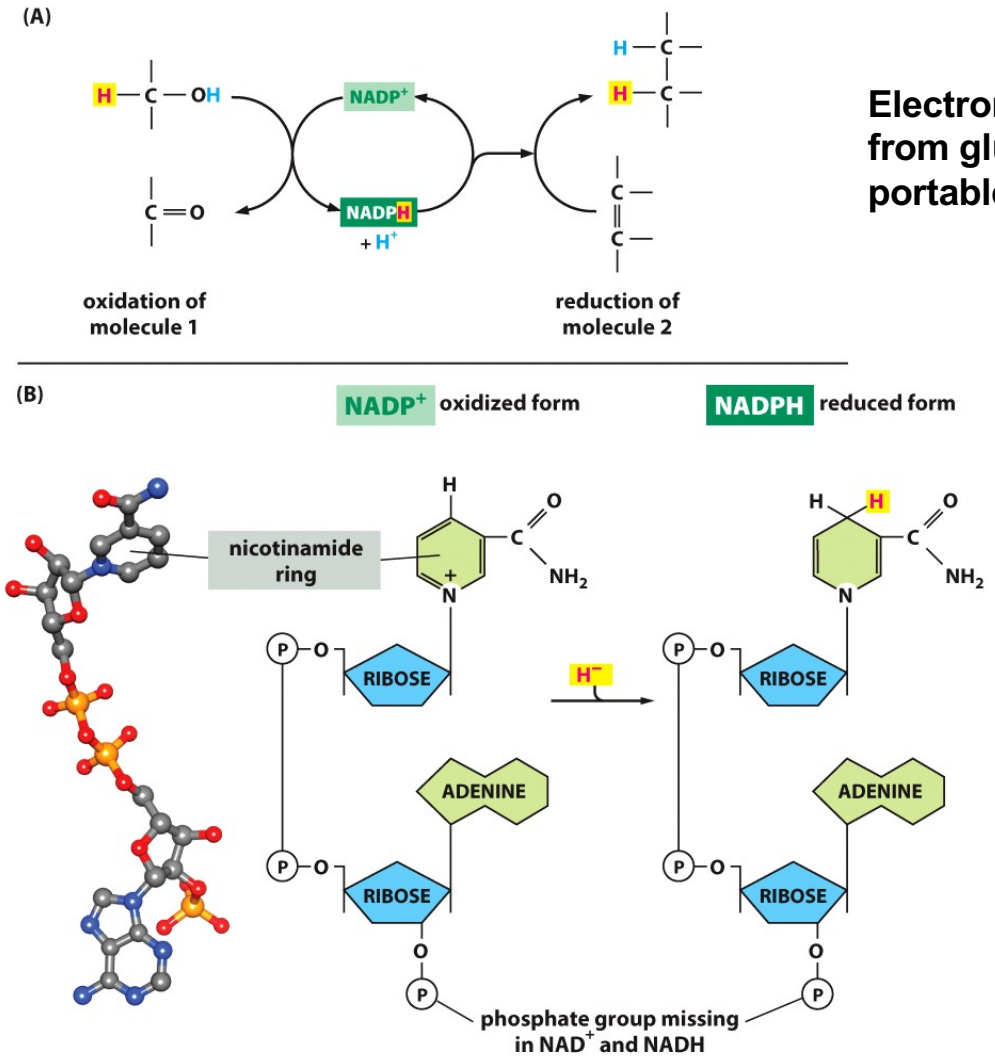


Figure 3-34 Essential Cell Biology, 4th ed. (© Garland Science 2014)

Electrons are transferred from glucose to these portable electron carriers.

co-enzymes :

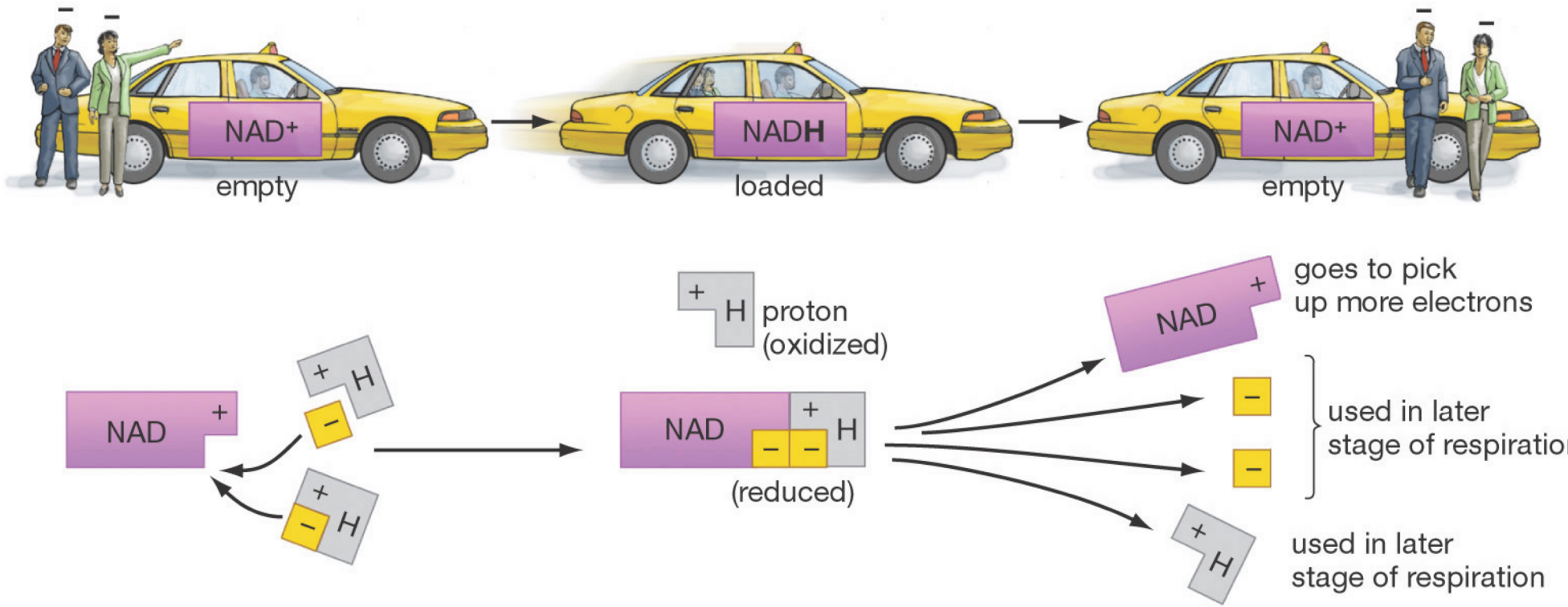
NAD^+ / NADH + H^+

FAD^+ / $FADH_2$

CoA / Acetyl-CoA

The structure if shown for your information only

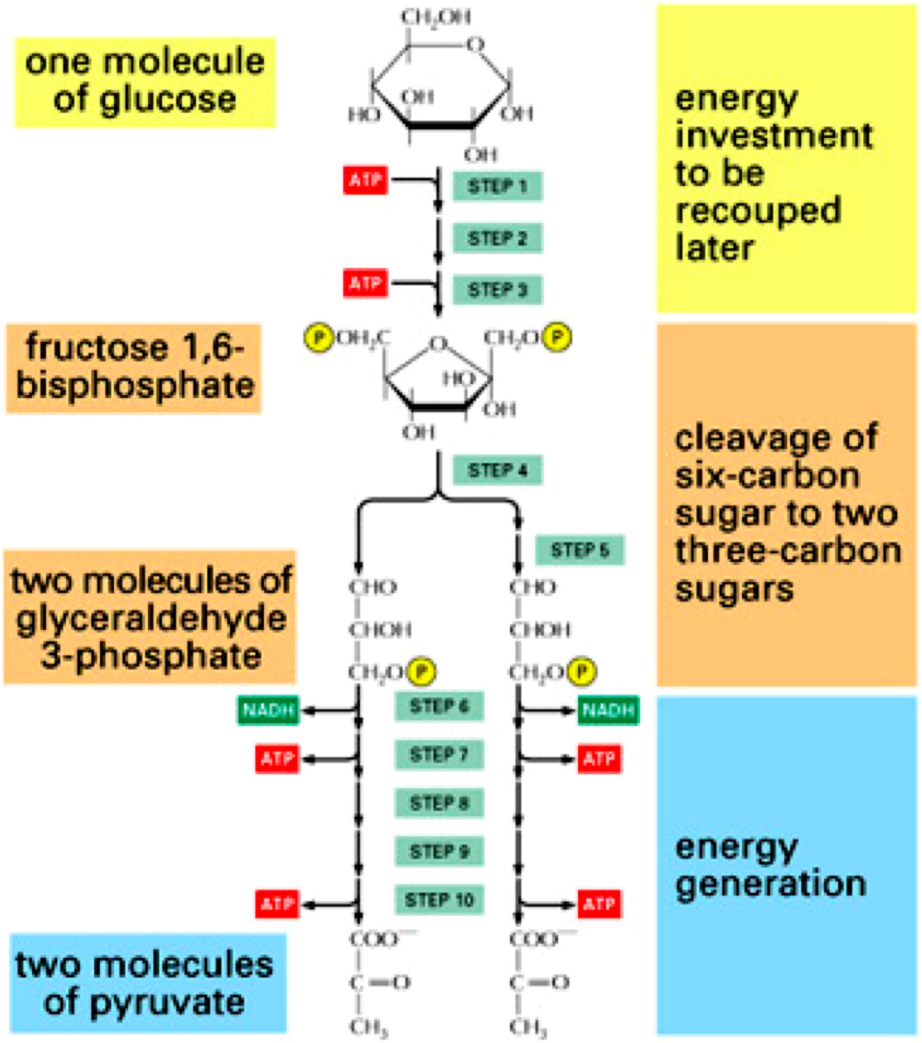
Coenzyme : an analogy



1. NAD^+ within a cell, along with two hydrogen atoms that are part of the food that is supplying energy for the body.

2. NAD^+ is reduced to NAD by accepting an electron from a hydrogen atom. It also picks up another hydrogen atom to become NADH.

3. NADH carries the electrons to a later stage of respiration then drops them off, becoming oxidized to its original form, NAD^+.



Glycolysis

input: 1 glucose
2 ATP
2 NAD^+

output: 2 pyruvate
4 ATP
2 NADH + H^+