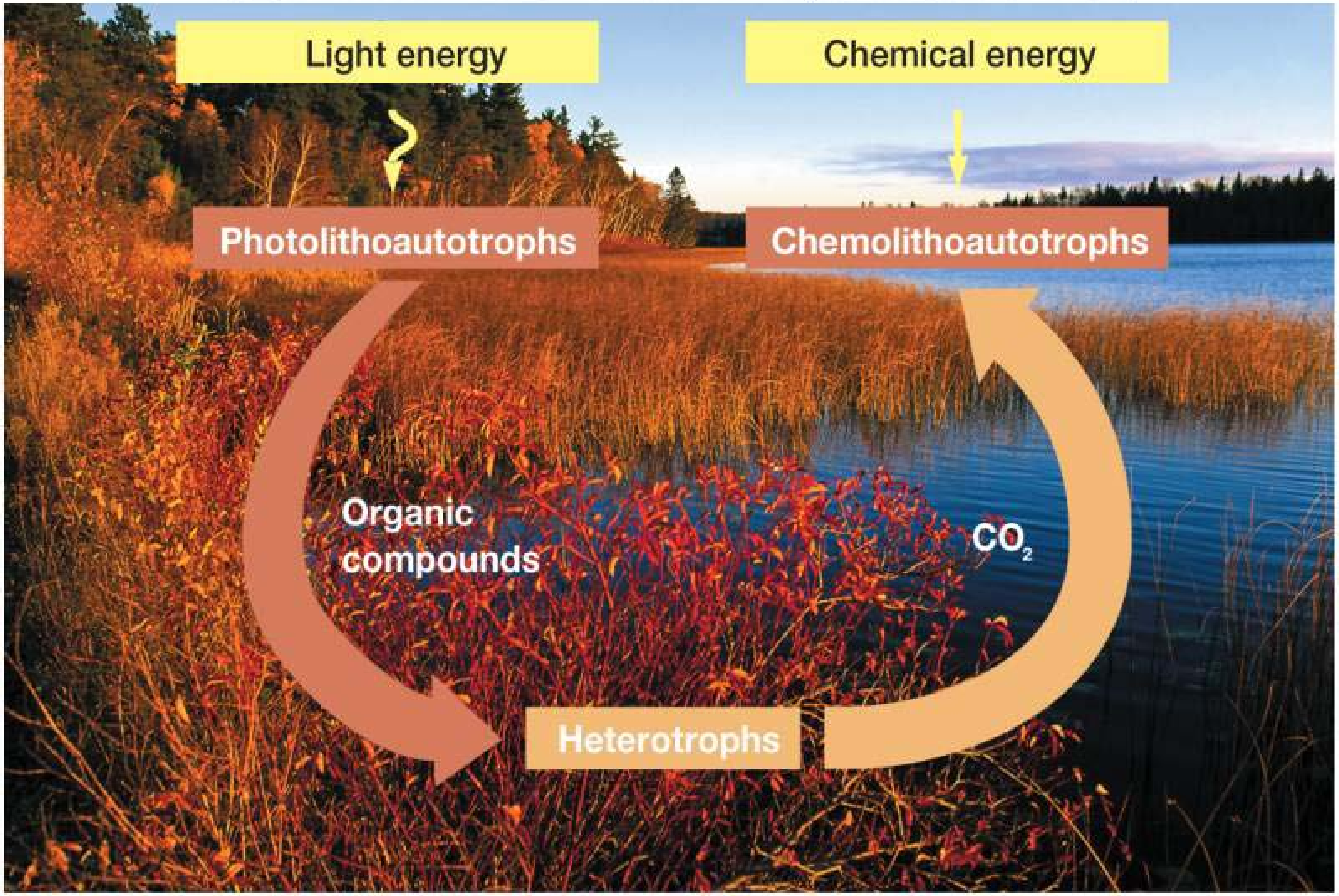

The processes used by organisms to obtain energy and to do chemical work are the basis of the functioning of ecosystems.

Energy currency of cells

- ATP
  - used to transfer energy from cell's energy-conserving systems to the systems that carry out cellular work

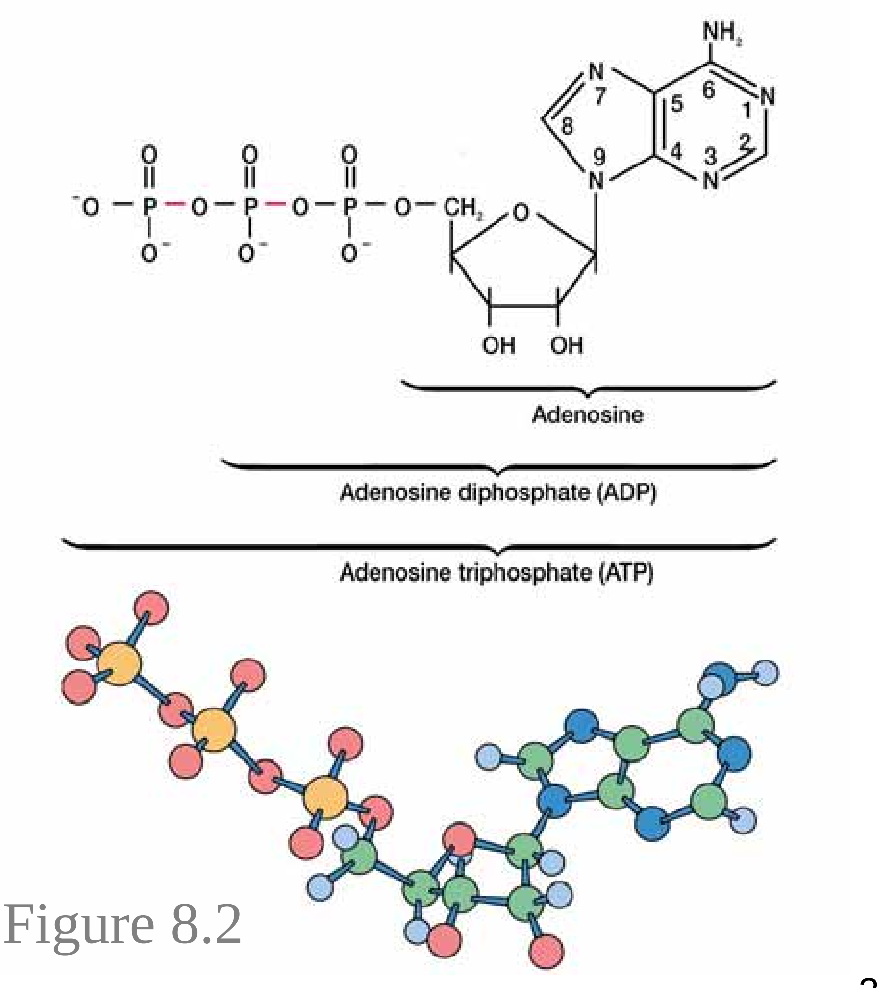

Figure 8.2

The cell's energy cycle

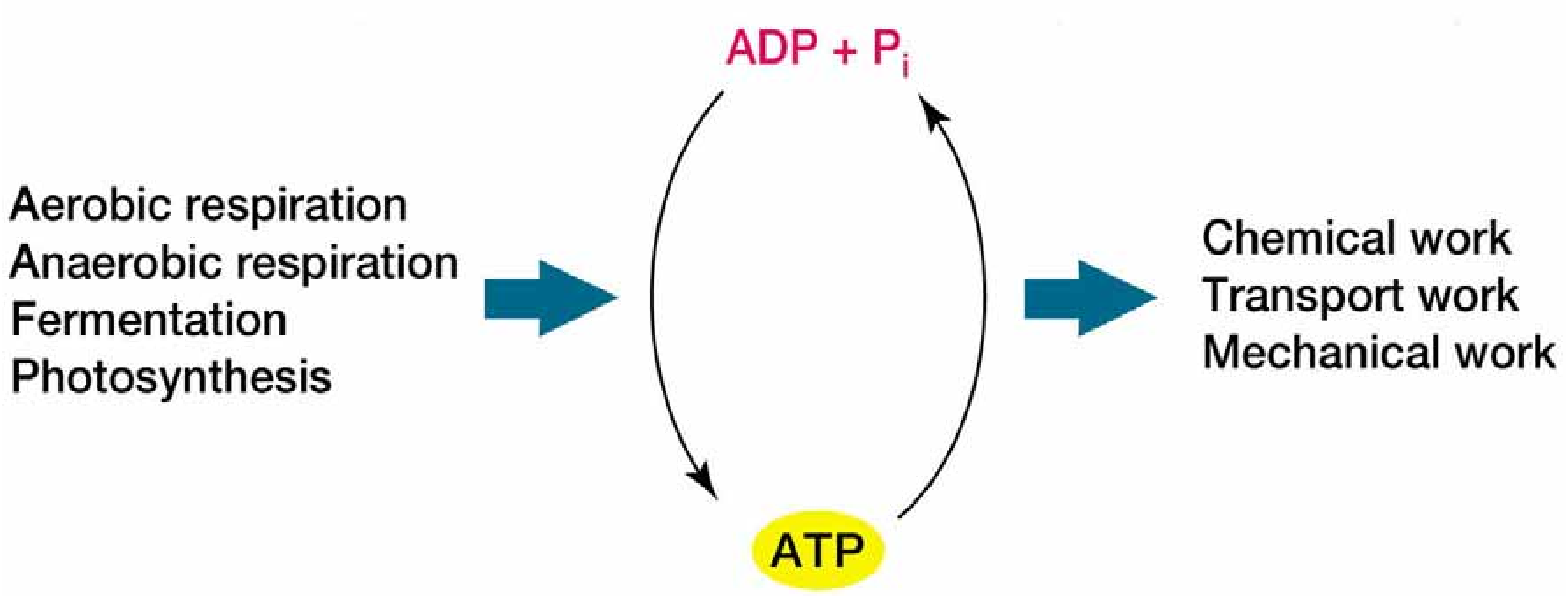

Figure 8.3

The Role of ATP in Metabolism

- exergonic breakdown of ATP is coupled with endergonic reactions to make them more favorable

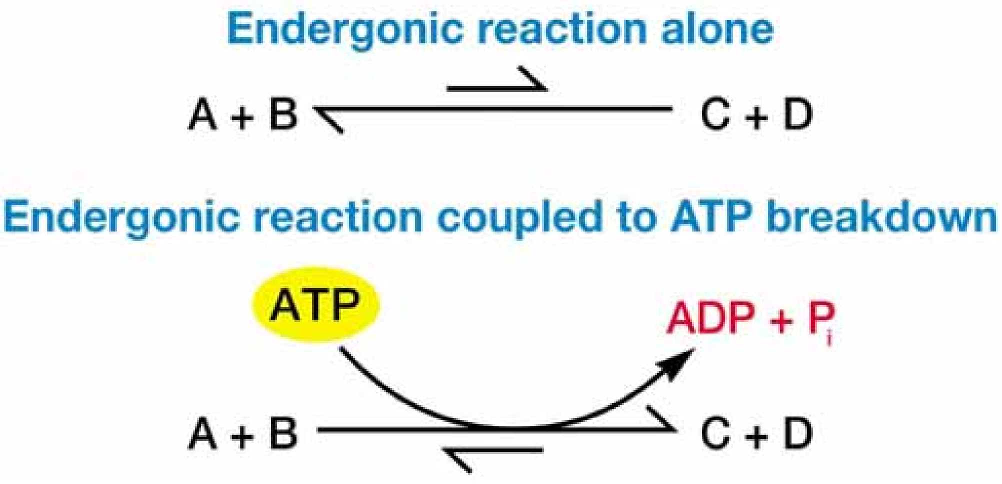

Figure 8.6

Oxidation-Reduction Reactions and Electron Carriers

- many metabolic processes involve oxidation-reduction reactions (electron transfers)
- electron carriers are often used to transfer electrons from an electron donor to an electron acceptor

Oxidation-reduction (redox) reactions

- transfer of electrons from a donor to an acceptor
- can result in energy release, which can be conserved and used to form ATP

Table 8.1
Selected Biologically Important Redox Couples

Redox Couple	E'_0 (Volts) [a]
$2H^+ + 2e^- \longrightarrow H_2$	−0.42
Ferredoxin(Fe^{3+}) + e^- ⟶ ferredoxin (Fe^{2+})	−0.42
$NAD(P)^+ + H^+ + 2e^- \longrightarrow NAD(P)H$	−0.32
$S + 2H^+ + 2e^- \longrightarrow H_2S$	−0.274
Acetaldehyde + $2H^+$ + $2e^-$ ⟶ ethanol	−0.197
Pyruvate$^-$ + $2H^+$ + $2e^-$ ⟶ lactate^{2-}	−0.185
$FAD + 2H^+ + 2e^- \longrightarrow FADH_2$	−0.18[b]
Oxaloacetate^{2-} + $2H^+$ + $2e^-$ ⟶ malate^{2-}	−0.166
Fumarate^{2-} + $2H^+$ + $2e^-$ ⟶ succinate^{2-}	0.031
Cytochrome *b* (Fe^{3+}) + e^- ⟶ cytochrome *b* (Fe^{2+})	0.075
Ubiquinone + $2H^+$ + $2e^-$ ⟶ ubiquinone H_2	0.10
Cytochrome *c* (Fe^{3+}) + e^- ⟶ cytochrome *c* (Fe^{2+})	0.254
Cytochrome *a* (Fe^{3+}) + e^- ⟶ cytochrome *a* (Fe^{2+})	0.29
Cytochrome a_3 (Fe^{3+}) + e^- ⟶ cytochrome a_3 (Fe^{2+})	0.35
$NO_3^- + 2H^+ + 2e^- \longrightarrow NO_2^- + H_2O$	0.421
$NO_2^- + 8H^+ + 6e^- \longrightarrow NH_4^+ + 2H_2O$	0.44
$Fe^{3+} + e^- \longrightarrow Fe^{2+}$	0.771[c]
$O_2 + 4H^+ + 4e^- \longrightarrow 2H_2O$	0.815

[a]E'_0 is the standard reduction potential at pH 7.0.
[b]The value for FAD/$FADH_2$ applies to the free cofactor because it can vary considerably when bound to an apoenzyme.
[c]The value for free Fe, not Fe complexed with proteins (e.g., cytochromes).

The greater the difference between the E_0 of the donor and the E_0 of the acceptor

⇓

the more negative

the **ΔGº´**

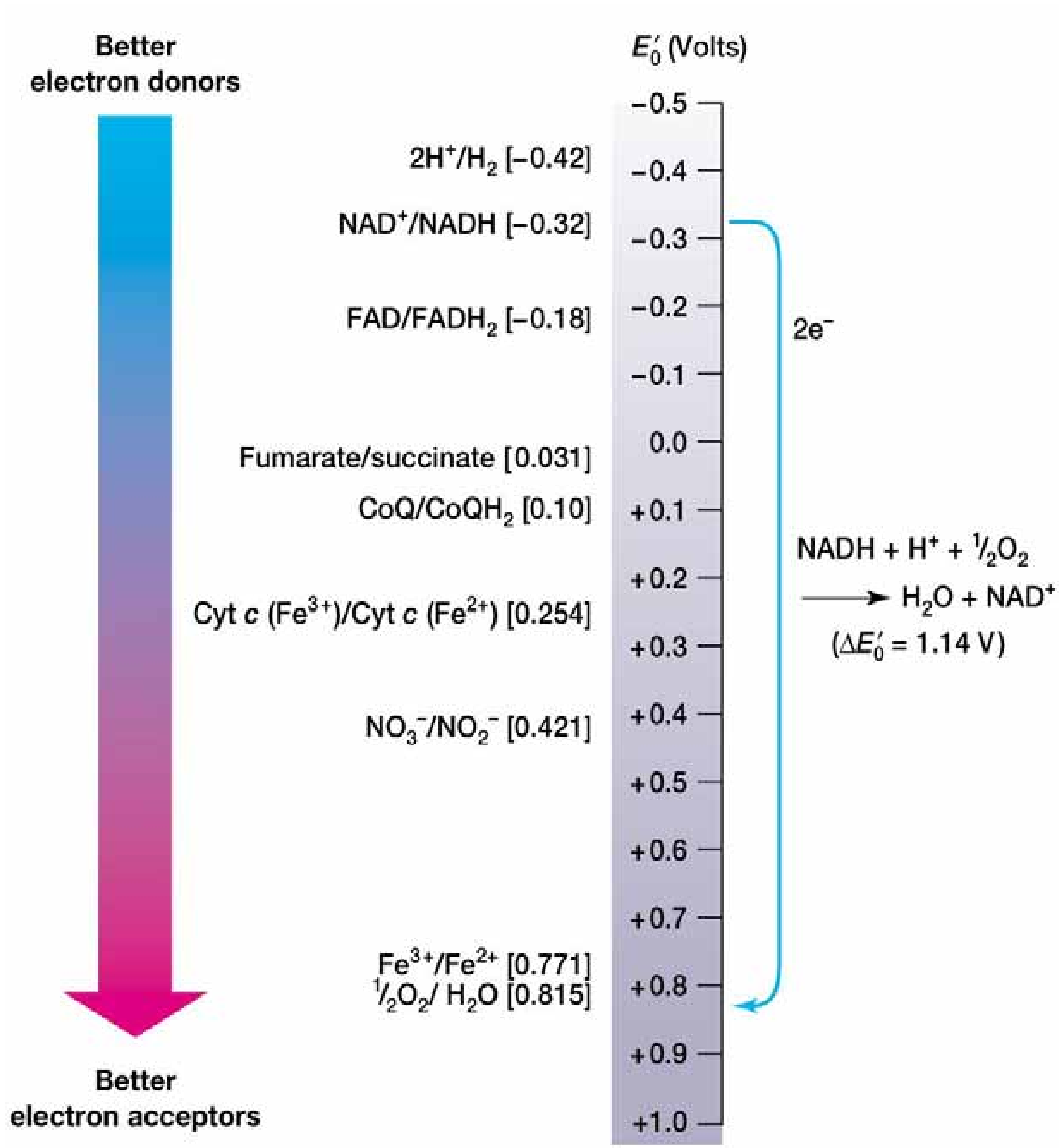

Figure 8.7

Energy and electron flow in metabolism

- flow of electrons down the tower releases energy
- light energy is used to drive electrons up the tower during photosynthesis

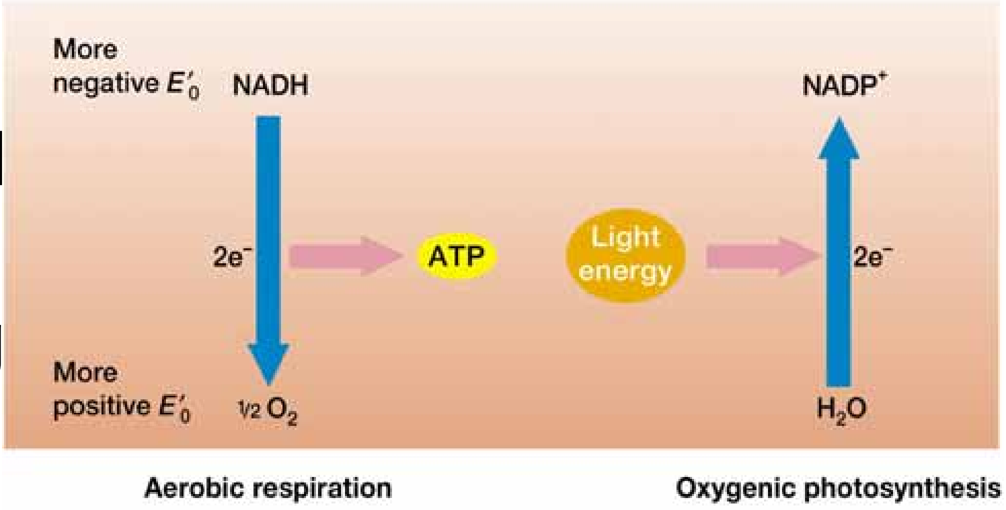

Figure 8.8

Electron carriers

- NAD
  - nicotinamide adenine dinucleotide
- NADP
  - nicotinamide adenine dinucleotide phosphate

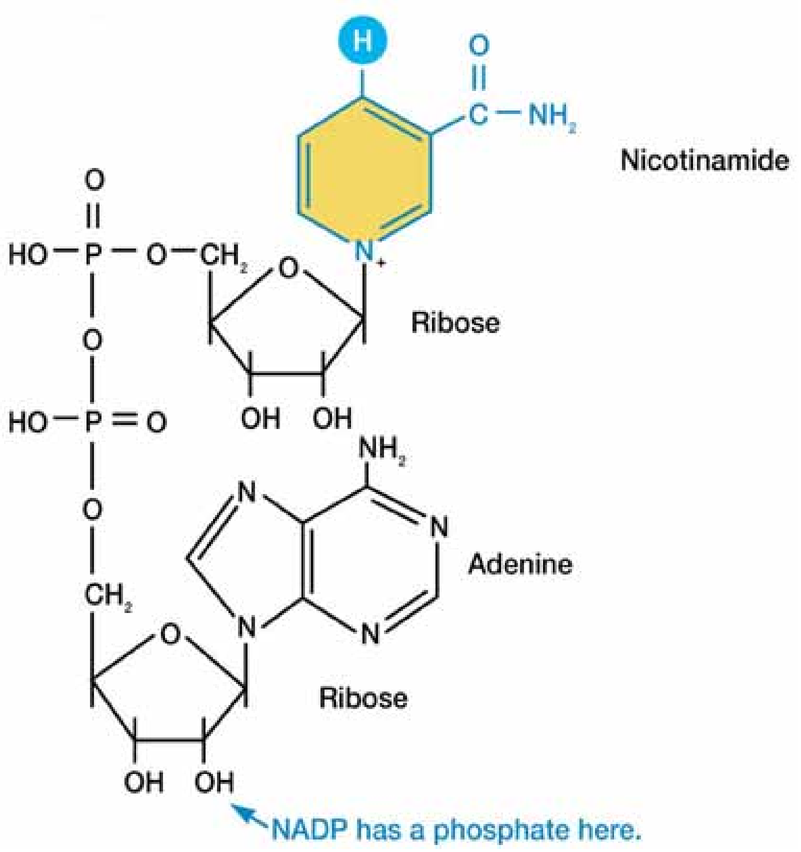

Figure 8.9a

Enzymes

- protein catalysts
  - have great specificity for the reaction catalyzed and the molecules acted on
- catalyst
  - substance that increases the rate of a reaction without being permanently altered
- substrates
  - reacting molecules
- products
  - substances formed by reaction

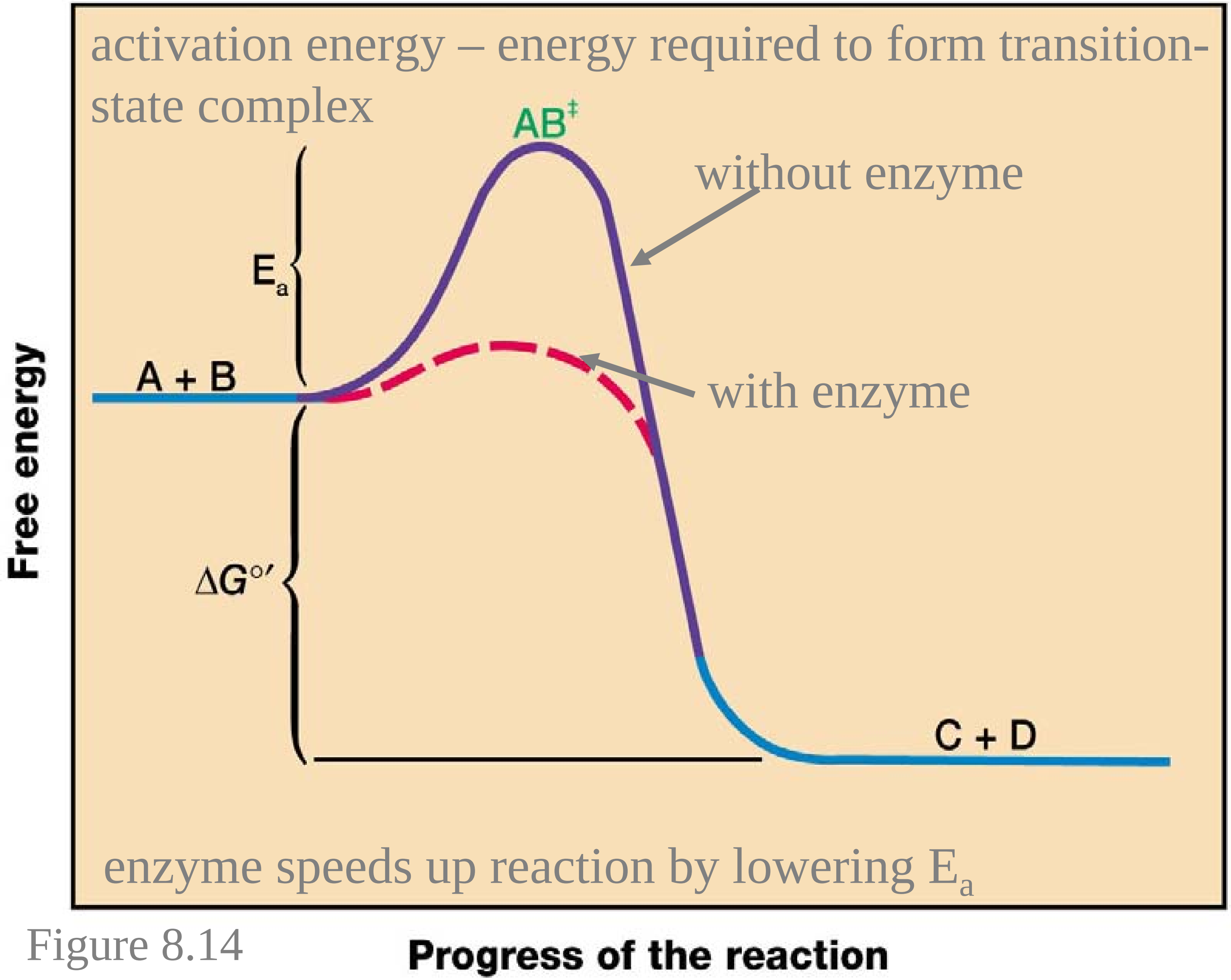
activation energy – energy required to form transition-state complex
AB‡
without enzyme
E$_a$
A + B
with enzyme
ΔG°′
C + D
enzyme speeds up reaction by lowering E$_a$
Free energy
Progress of the reaction

Figure 8.14

The Nature and Significance of Metabolic Regulation

- conservation of energy and materials
- maintenance of metabolic balance despite changes in environment
- three major mechanisms
  - metabolic channeling
  - control enzyme activity
  - control number of enzyme molecules present (discussed in Chapter 12)