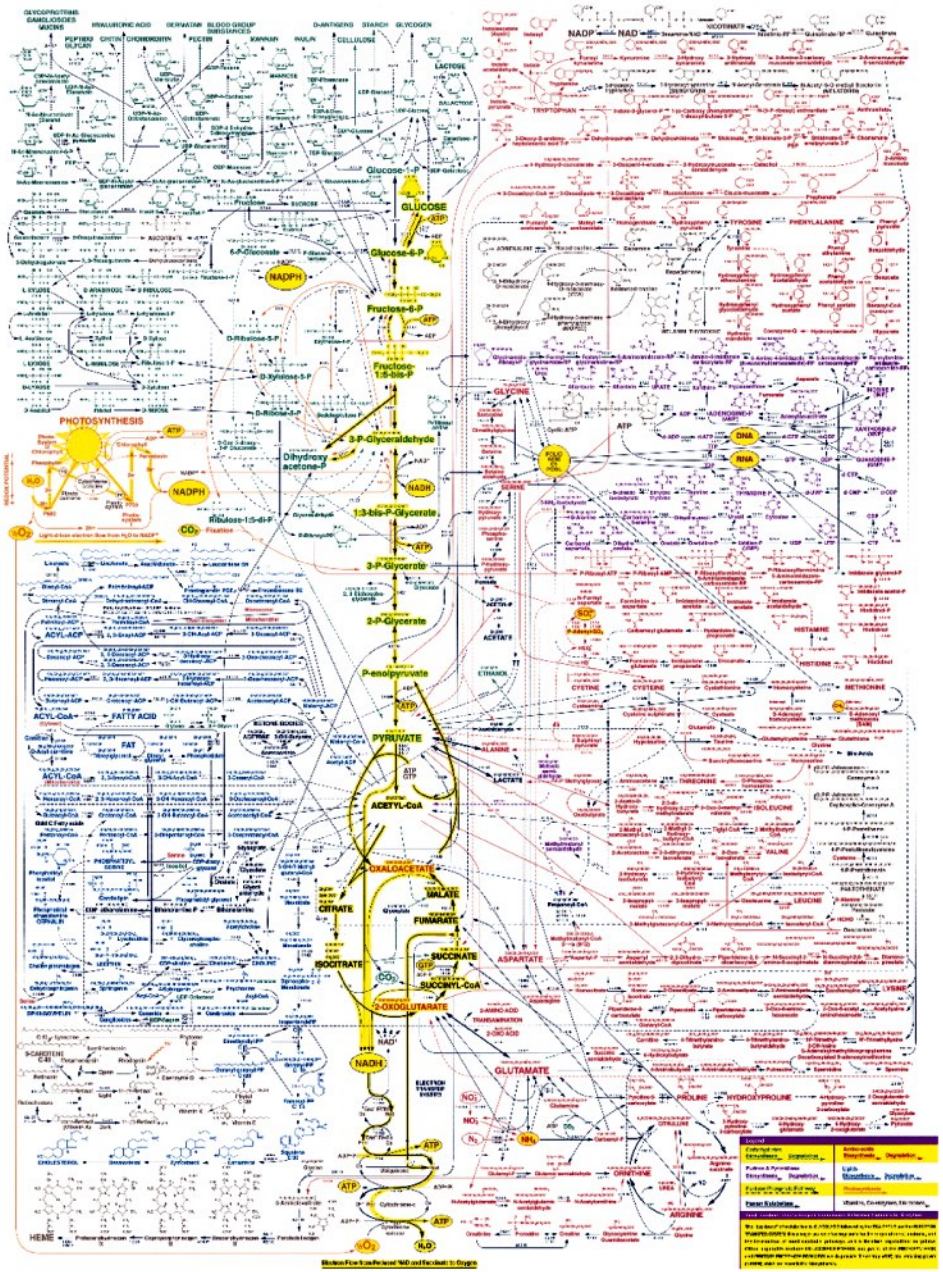
Energy metabolism

How cells obtain energy: http://www.youtube.com/watch?v=i8c5JcnFaJ0

Where is it used: Biosynthesis, active transport, heat, and movement



Chapter 13 Opener Fundamentals of Biochemistry, 2/e

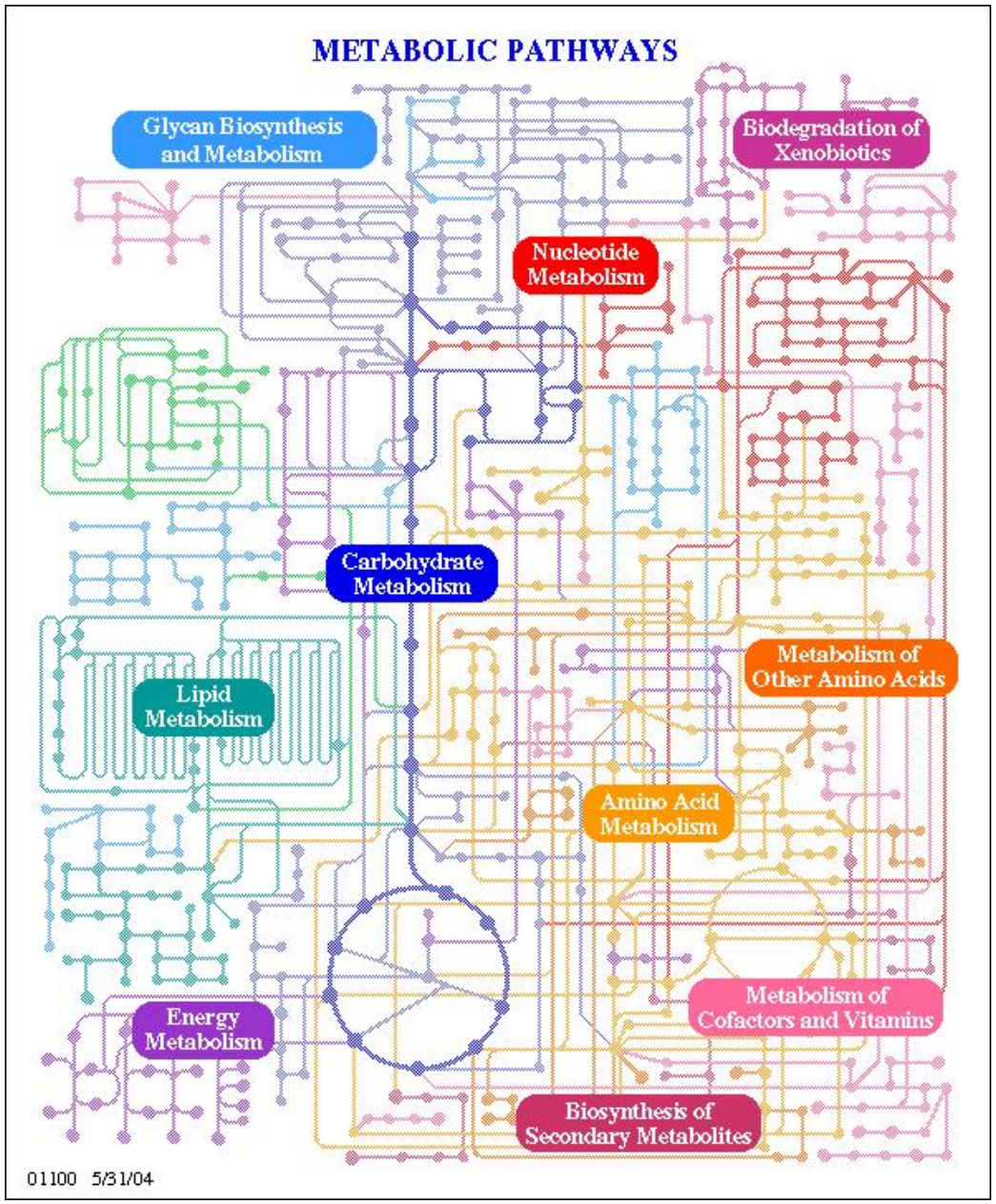
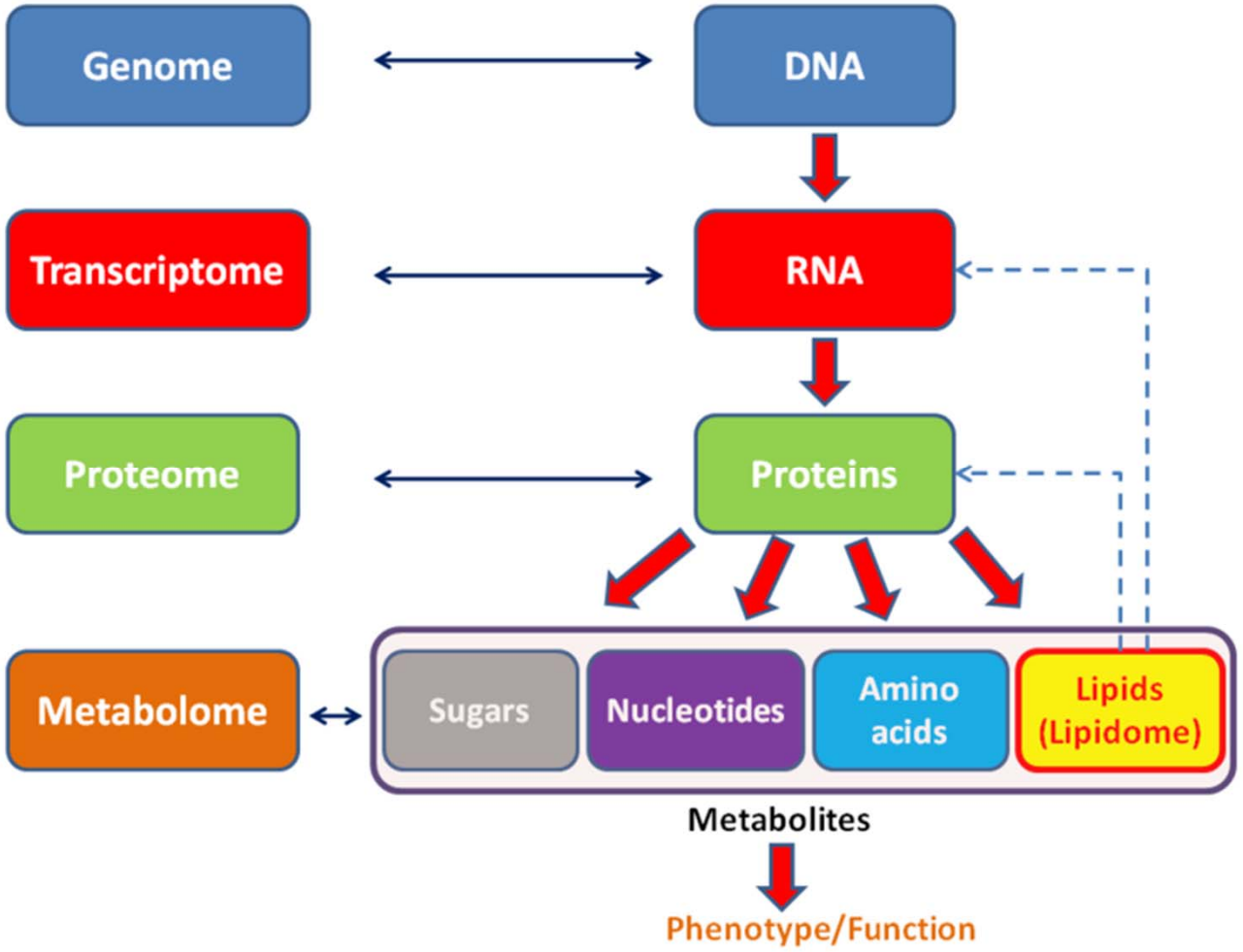
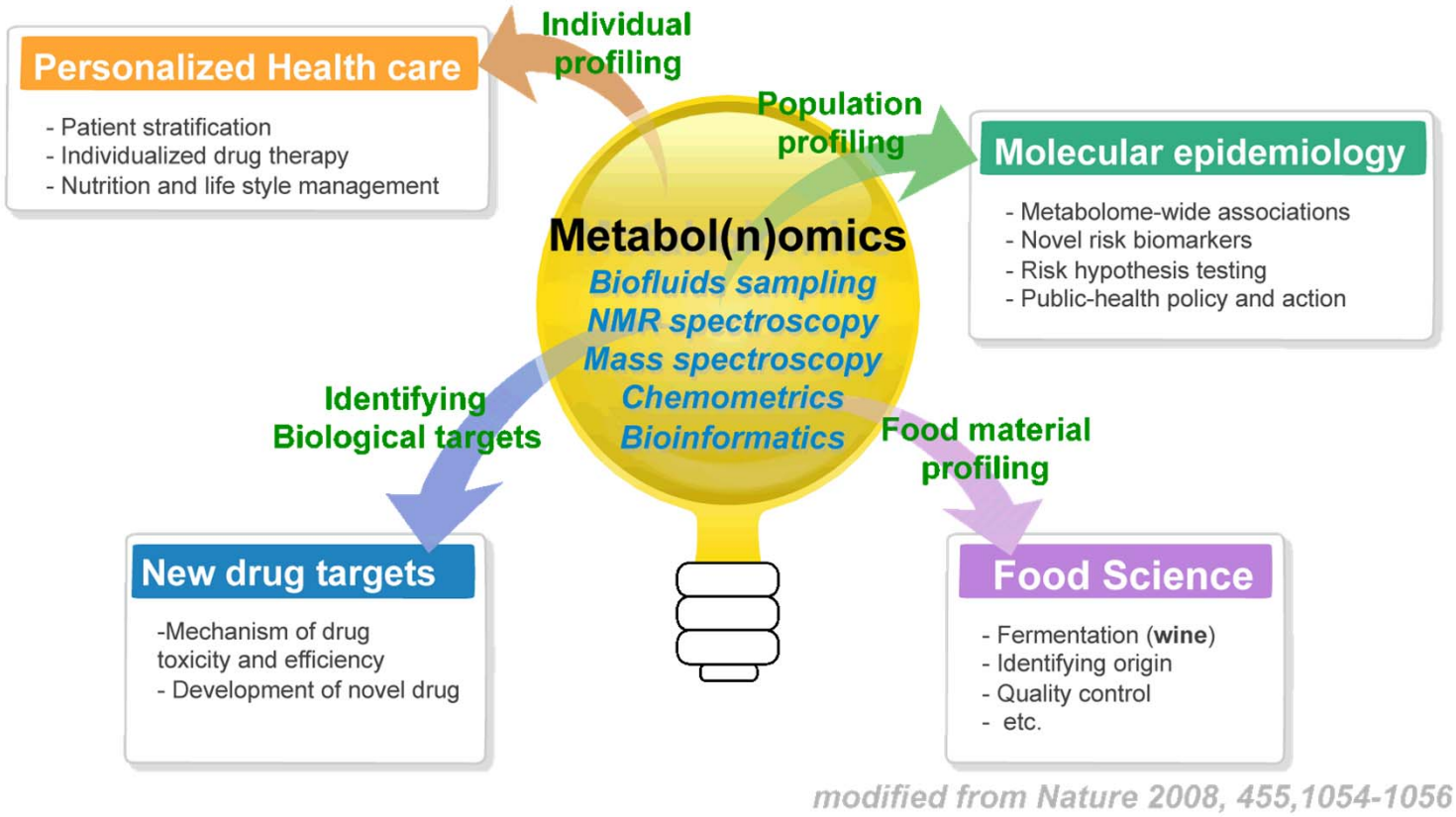


Diagram taken from the [SYSFYS project](http://labrat.fieldofscience.com/2010/02/metabolomics.html) carried out by the University of Helinski Computer Department.
http://labrat.fieldofscience.com/2010/02/metabolomics.html

Metabolomics





5년내 사망위험 예측 혈액검사법 개발

http://www.e-healthnews.com/news/article_view.php?art_id=106705

Trophic strategies: nutritional requirements

Autotrophs
- chemolithotrophs
- photoautotrophs

Heterotrophs

Energy

Obligate aerobes
Anaerobes
- facultative anaerobic
- obligate anaerobic

Electron acceptor (oxidizing agent)

Metabolic pathway

Catabolic & anabolic

Enzymes & metabolites

Roles of ATP and NADP+ in metabolism

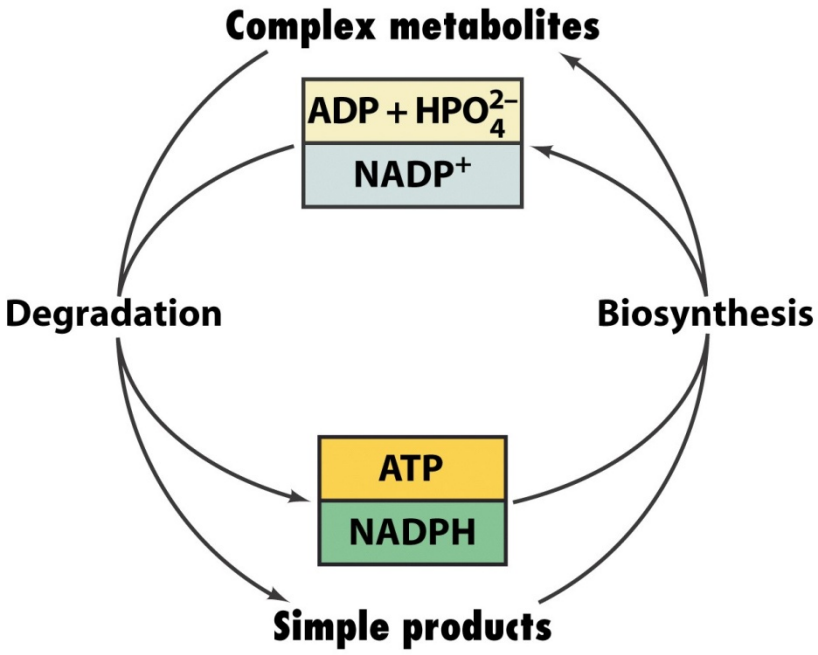


Figure 13-1 Fundamentals of Biochemistry, 2/e
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Overview of catabolism

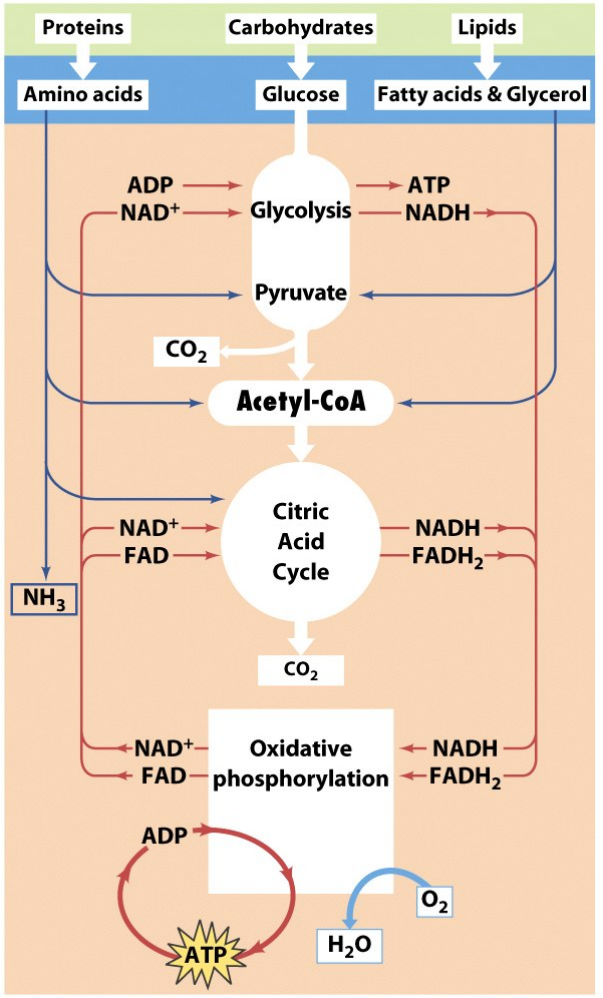

Figure 13-2 Fundamentals of Biochemistry, 2/e
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Converge to common intermediates

High-energy compounds

High-energy intermediates: phosphorylated compounds, NADH
A sort of free energy currency

ATP and phosphoryl group transfer:
thermodynamically favored
but kinetically disfavored

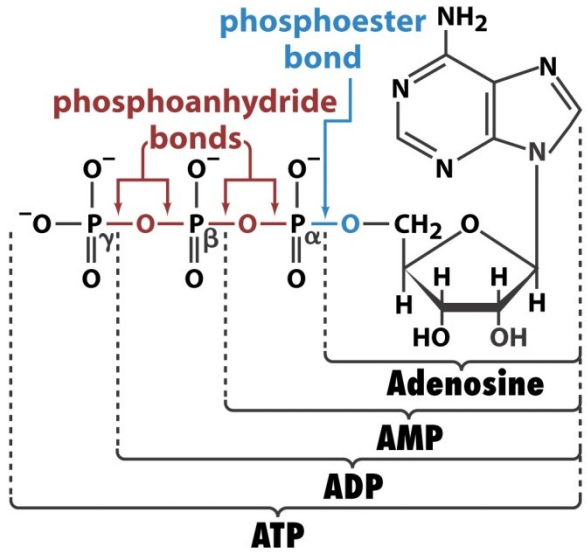

Figure 13-3 Fundamentals of Biochemistry, 2/e
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Table 13-2 Standard Free Energies of Phosphate Hydrolysis of Some Compounds of Biological Interest

Compound	$\Delta G^{\circ\prime}$ (kJ · mol^{-1})
Phosphoenolpyruvate	−61.9
1,3-Bisphosphoglycerate	−49.4
ATP (→ AMP + PP$_i$)	−45.6
Acetyl phosphate	−43.1
Phosphocreatine	−43.1
ATP (→ ADP + P$_i$)	−30.5
Glucose-1-phosphate	−20.9
PP$_i$	−19.2
Fructose-6-phosphate	−13.8
Glucose-6-phosphate	−13.8
Glycerol-3-phosphate	−9.2

Source: Mostly from Jencks, W.P., *in* Fasman, G.D. (Ed.), *Handbook of Biochemistry and Molecular Biology* (3rd ed.), Physical and Chemical Data, Vol. I, pp. 296–304, CRC Press (1976).

Table 13-2 Fundamentals of Biochemistry, 2/e
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Glycolysis & Fermentation

Aerobic condition: pyruvate to citric acid cycle
Anaerobic condition: lactate or alcohol fermentation
reduction of pyruvate
regeneration of NAD+

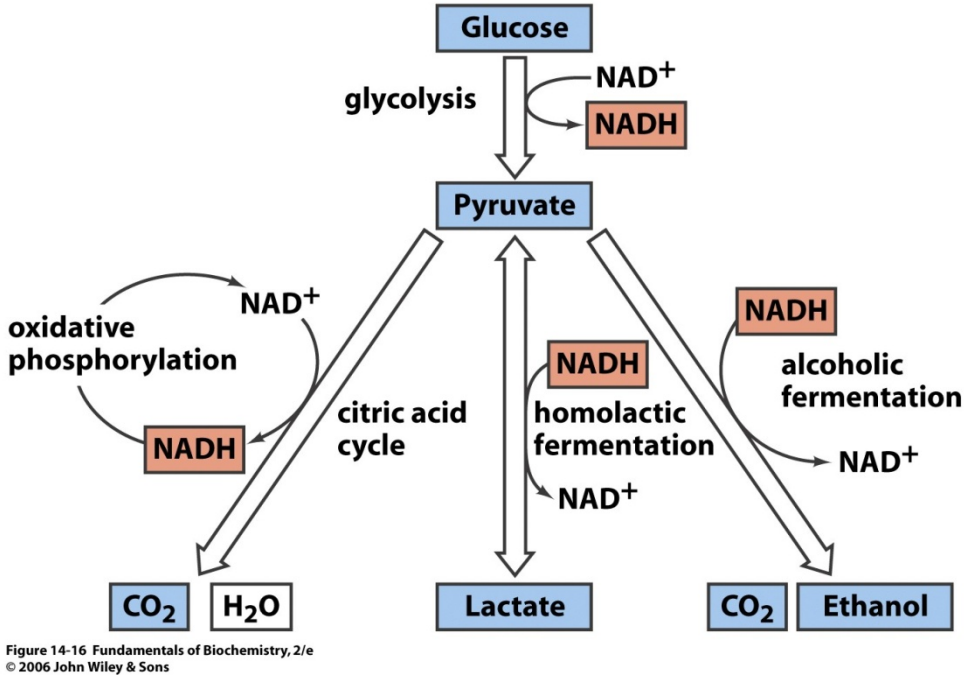

Figure 14-16 Fundamentals of Biochemistry, 2/e
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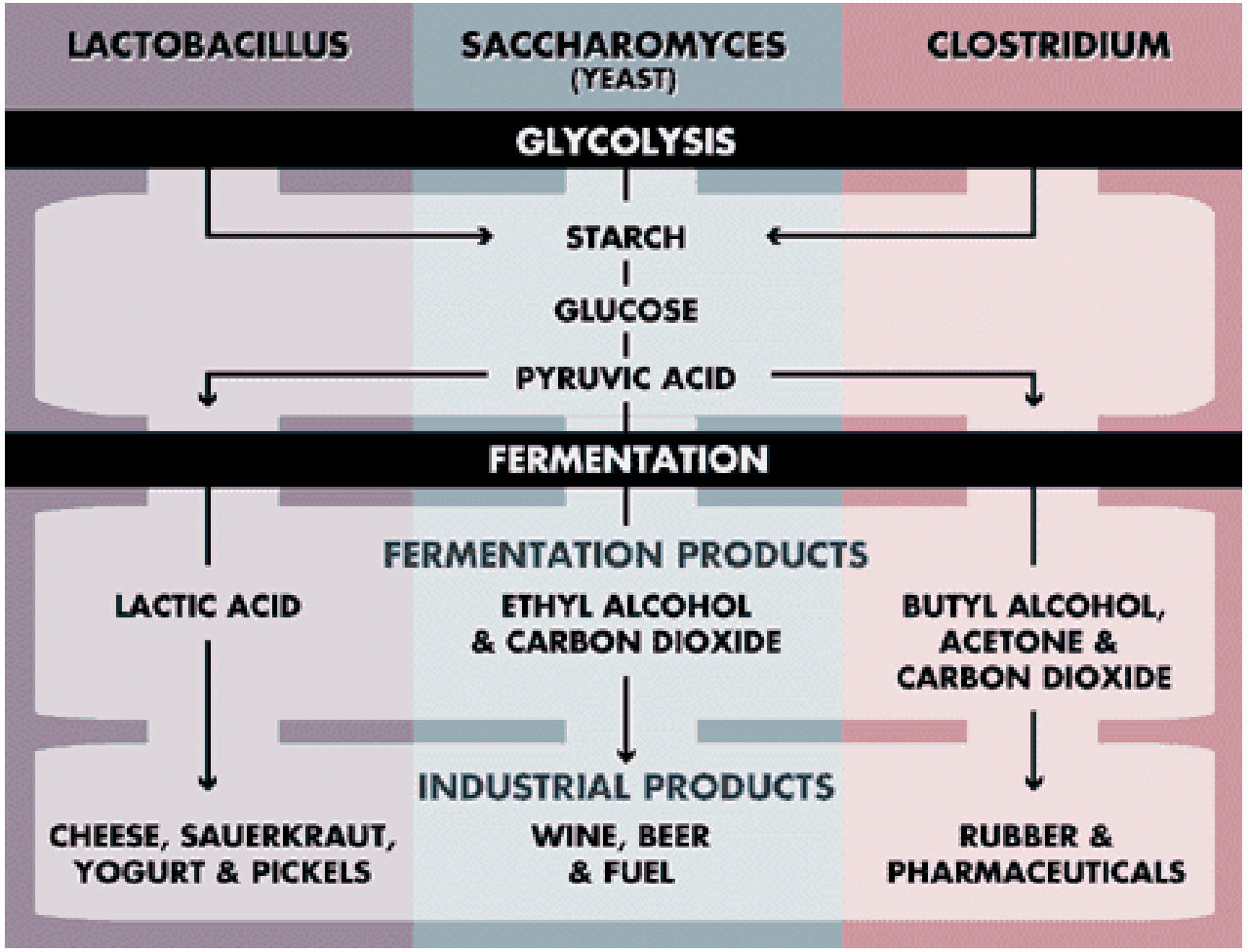
muscle
erythrocyte


LACTOBACILLUS
SACCHAROMYCES
(YEAST)
CLOSTRIDIUM
GLYCOLYSIS
STARCH
GLUCOSE
PYRUVIC ACID
FERMENTATION
FERMENTATION PRODUCTS
LACTIC ACID
ETHYL ALCOHOL
& CARBON DIOXIDE
BUTYL ALCOHOL,
ACETONE &
CARBON DIOXIDE
INDUSTRIAL PRODUCTS
CHEESE, SAUERKRAUT,
YOGURT & PICKELS
WINE, BEER
& FUEL
RUBBER &
PHARMACEUTICALS

Citric acid cycle (CAC)

Not merely an oxidation of pyruvate to CO_2

A central pathway for recovering energy from several metabolic fuels

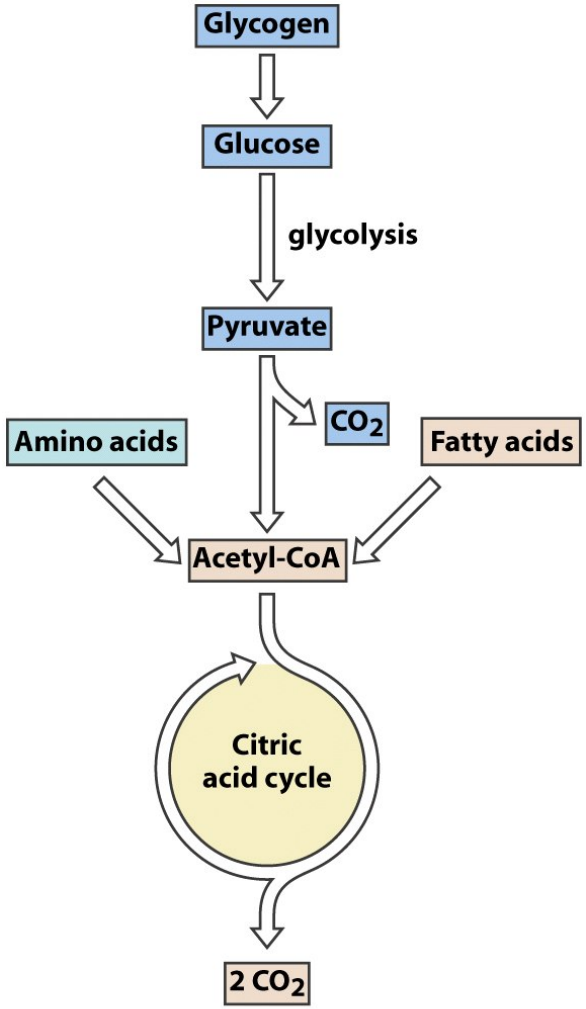


Figure 16-1 Fundamentals of Biochemistry, 2/e
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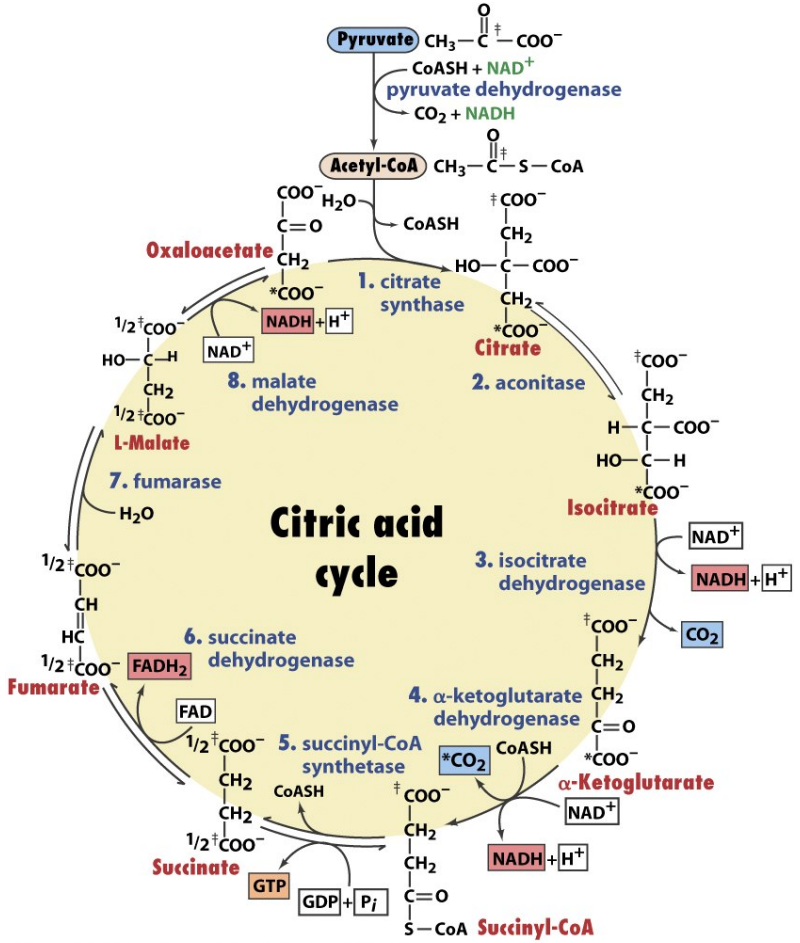

Figure 16-2 Fundamentals of Biochemistry, 2/e
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Mitochondrial electron-transport chain

- Electron transfer to O_2
- Regeneration of NAD^+ & FAD
- Proton transfer
- Electrochemical gradient
- Oxidative phosphorylation

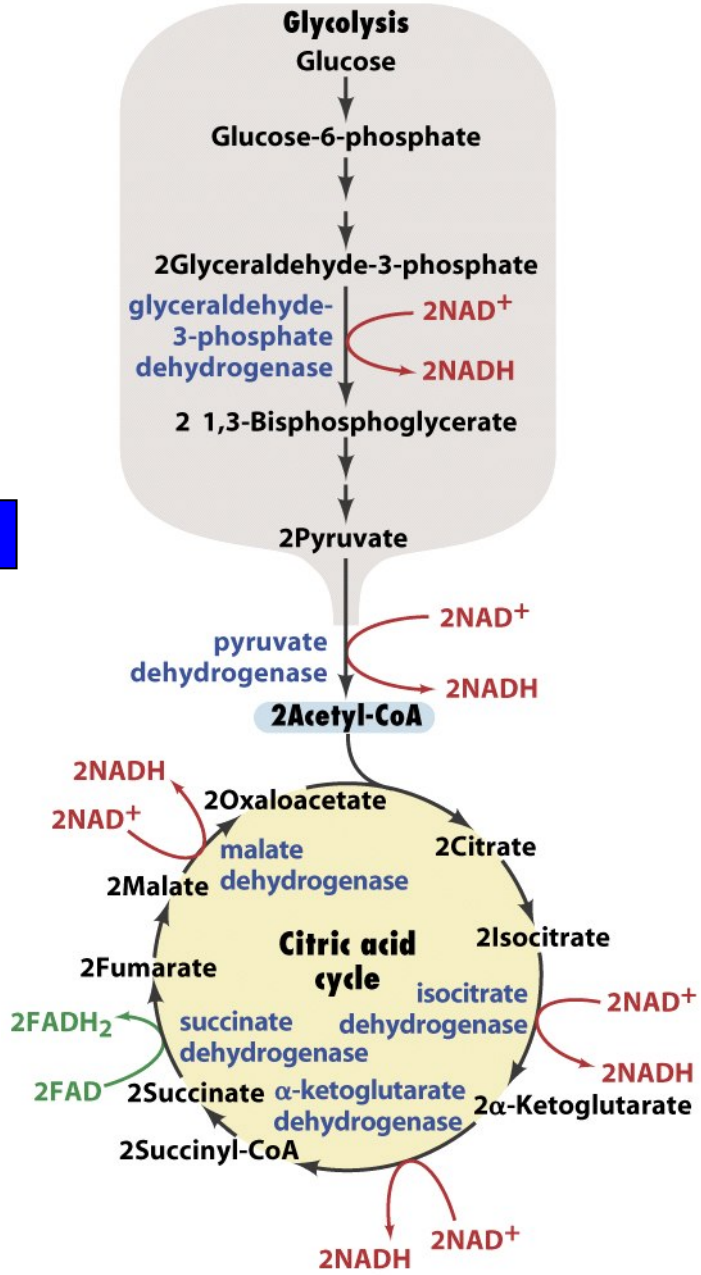


Figure 17-1 Fundamentals of Biochemistry, 2/e

ETC proteins: http://www.youtube.com/watch?v=xbJ0nbzt5Kw

Complex I
Complex II
Complex III
Complex IV
Complex V (ATP synthase)

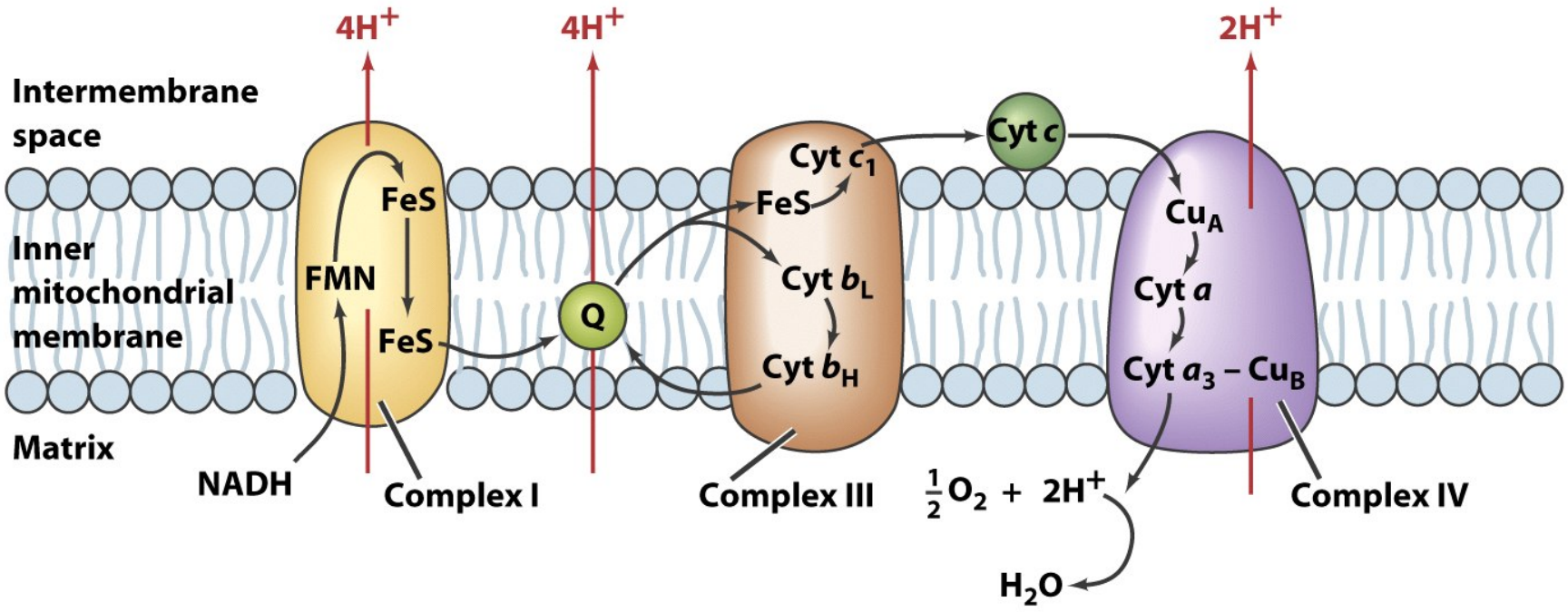
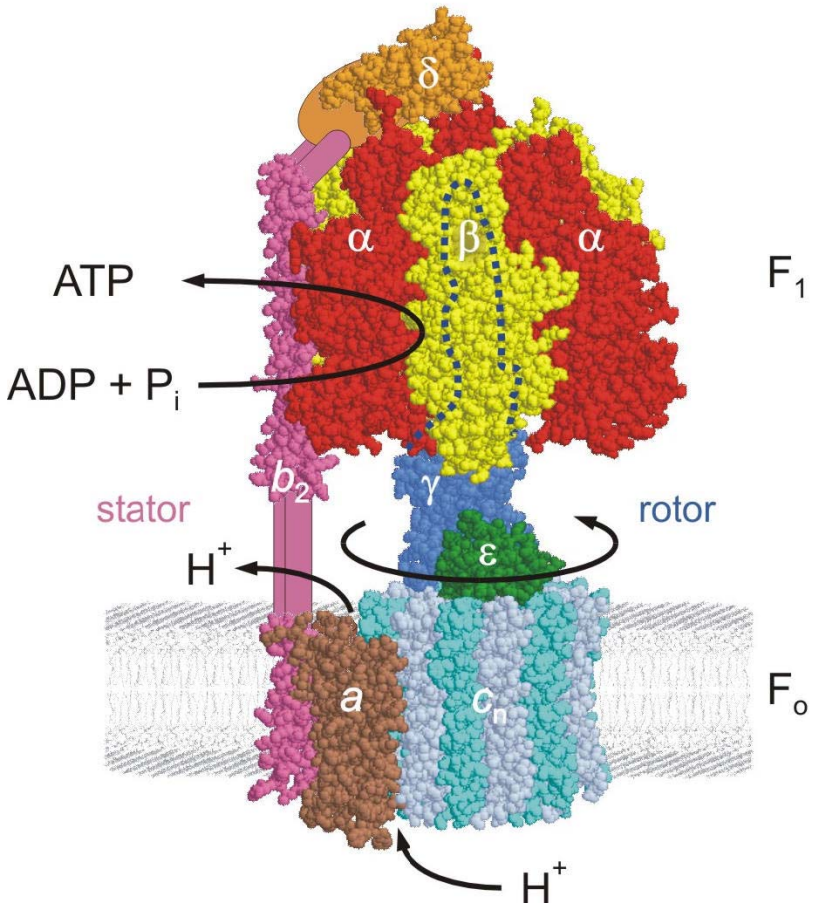


Figure 17-8 Fundamentals of Biochemistry, 2/e

ATP synthase: http://www.youtube.com/watch?v=3y1dO4nNaKY



Photosynthesis: light reaction: http://www.youtube.com/watch?v=g78utcLQrJ4

http://www.youtube.com/watch?v=joZ1EsA5_NY

PSI & PSII

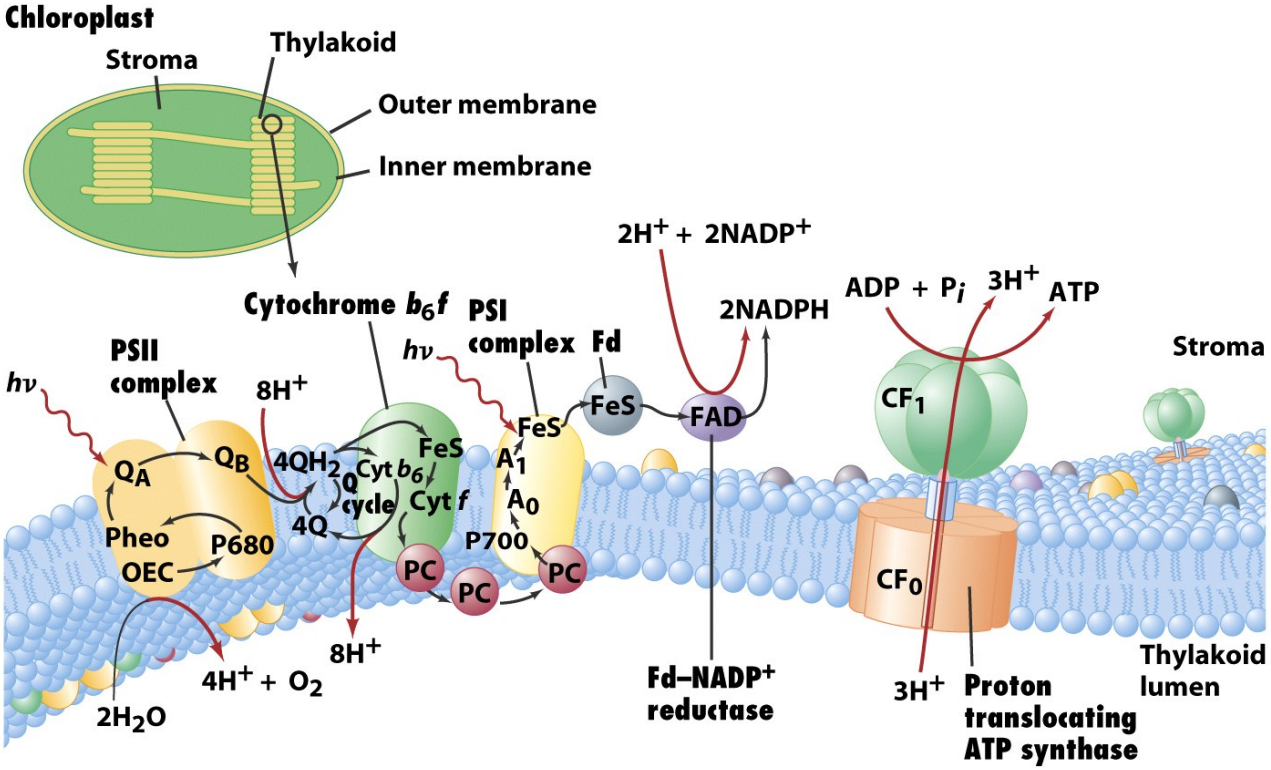


Figure 18-11 Fundamentals of Biochemistry, 2/e

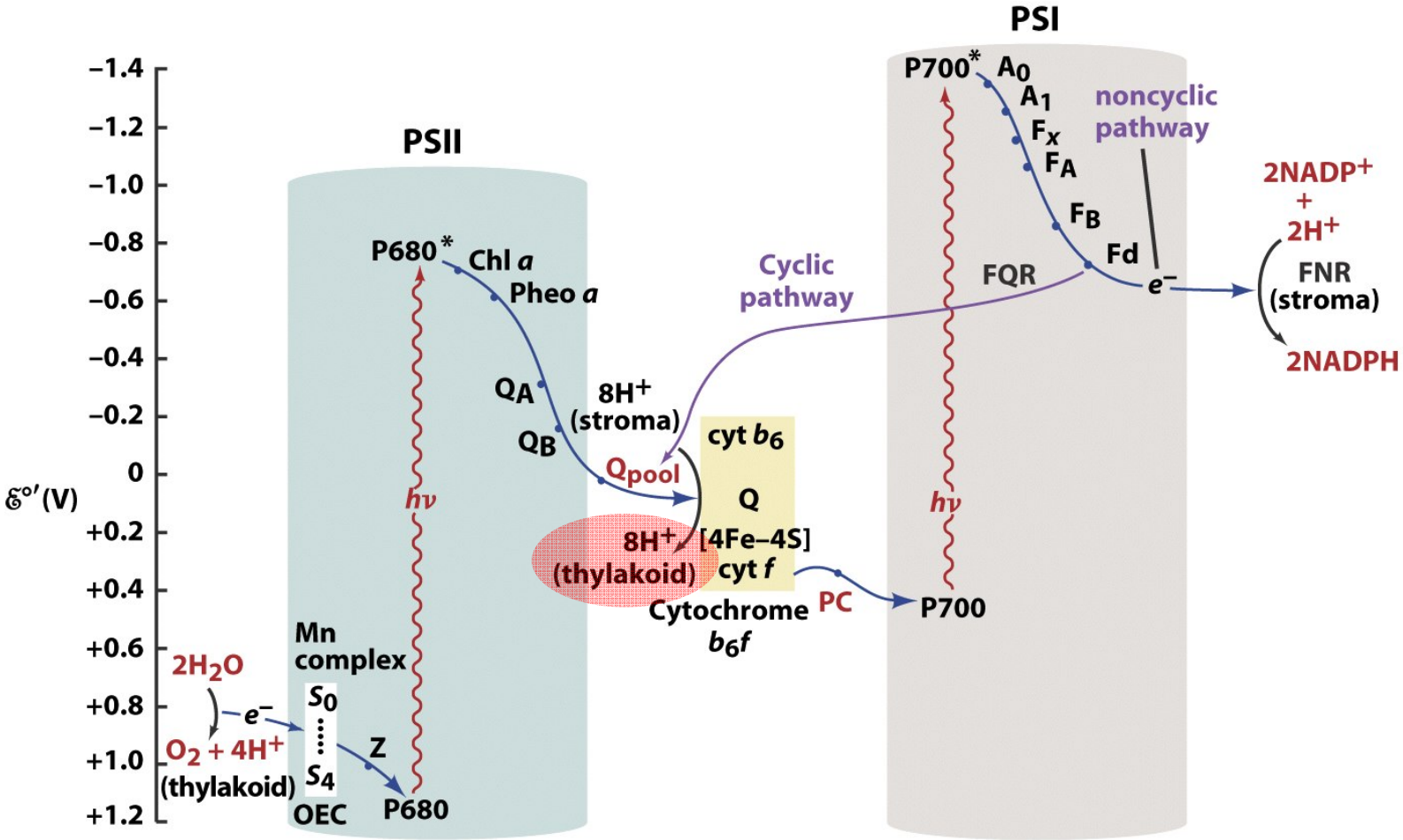
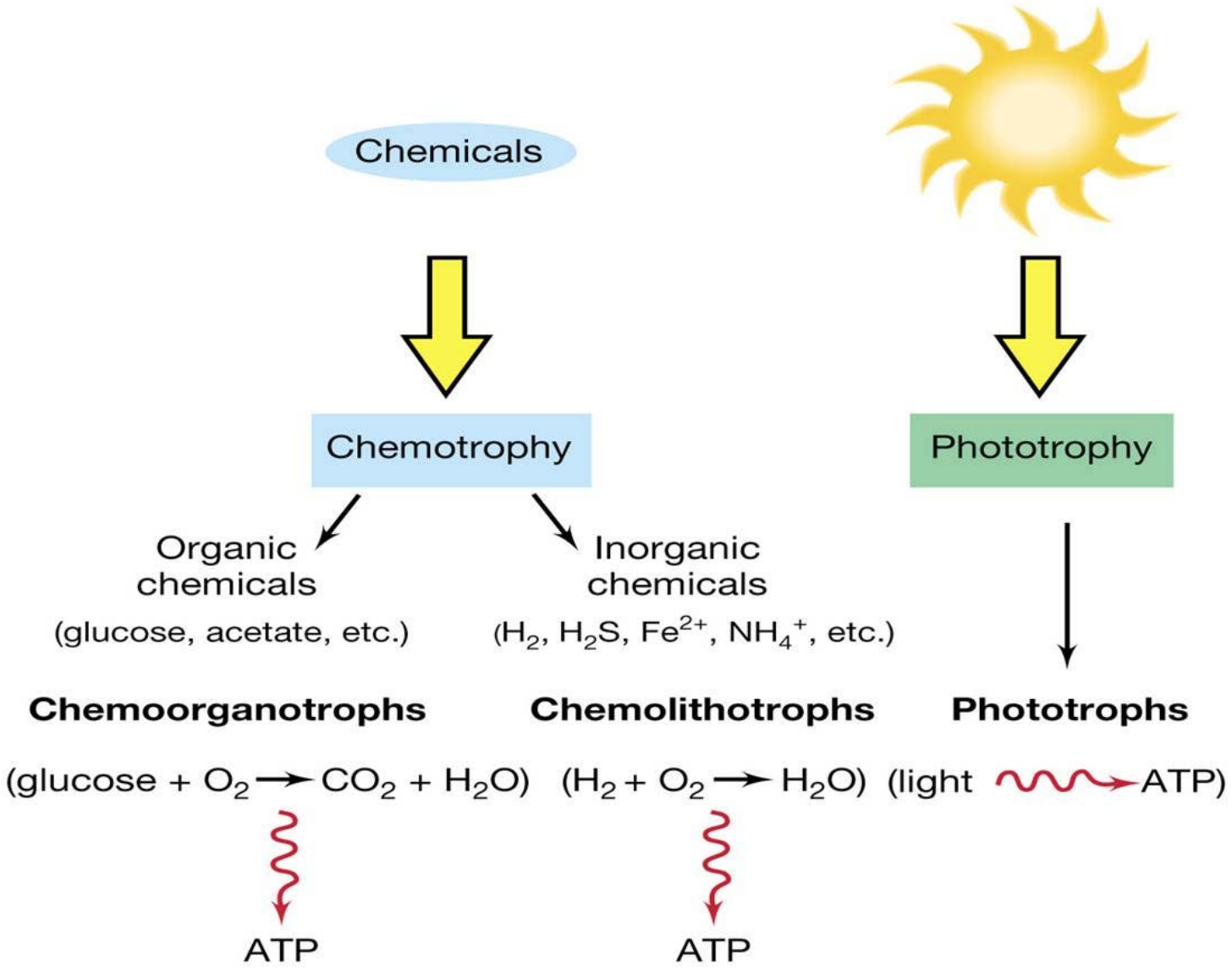
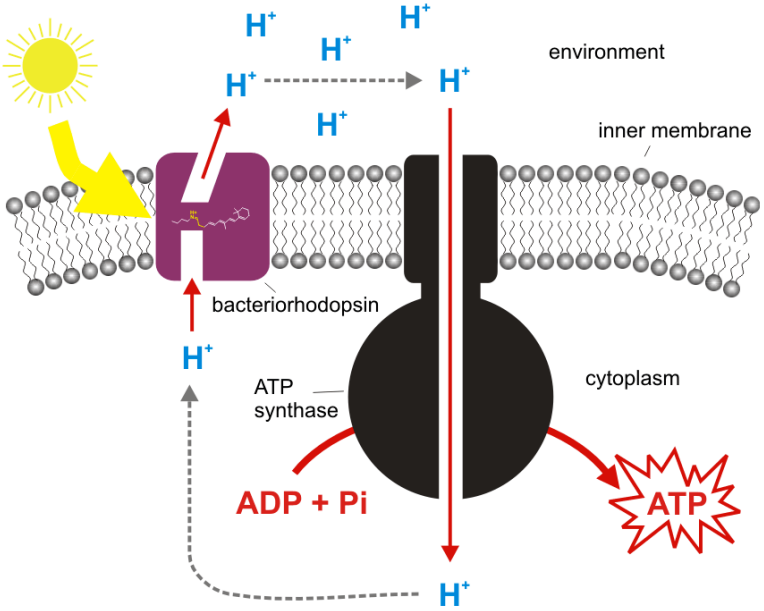
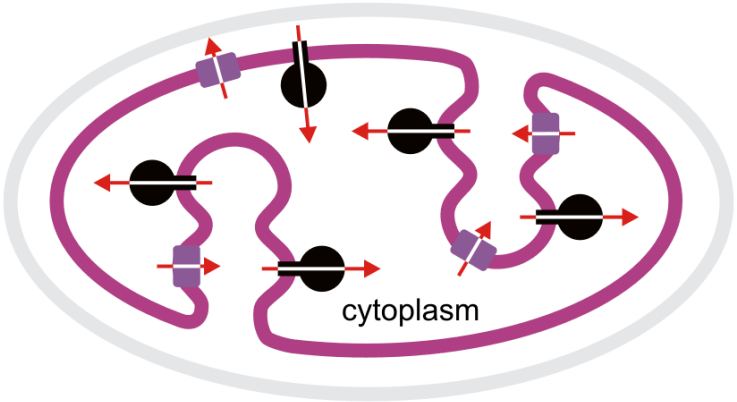


Figure 18-12 Fundamentals of Biochemistry, 2/e

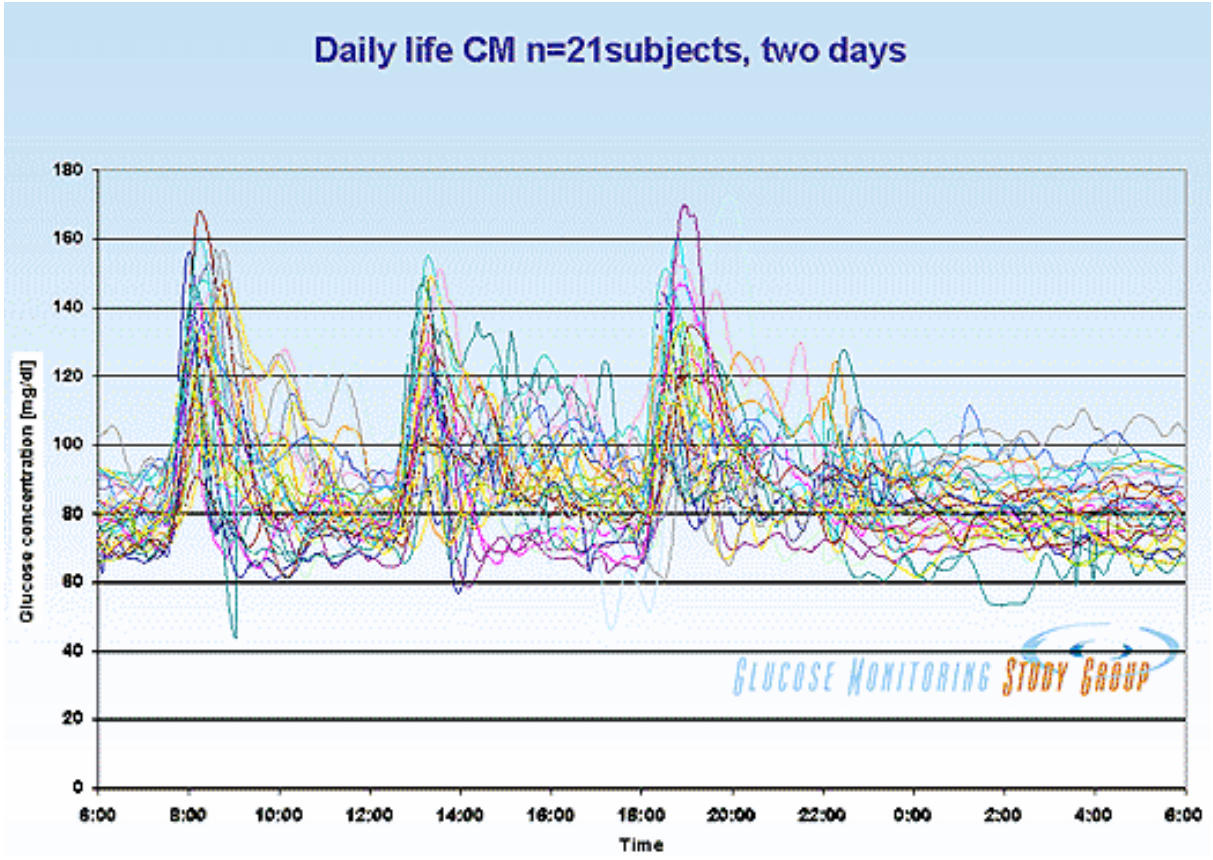

Chemicals
Chemotrophy
Phototrophy
Organic chemicals
(glucose, acetate, etc.)
Inorganic chemicals
(H_2, H_2S, Fe^{2+}, NH_4^+, etc.)
Chemoorganotrophs
Chemolithotrophs
Phototrophs
(glucose + O_2 → CO_2 + H_2O)
(H_2 + O_2 → H_2O)
(light → ATP)
ATP
ATP

Halobacterium: bacterirhodopsin





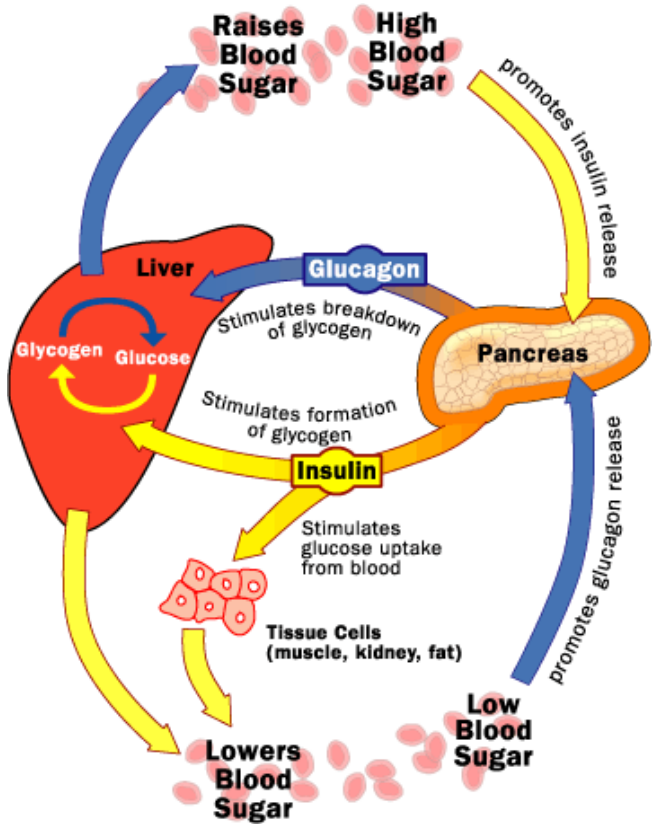
Blood glucose maintenance: ~5.5 mM



Hormonal effects on blood glucose

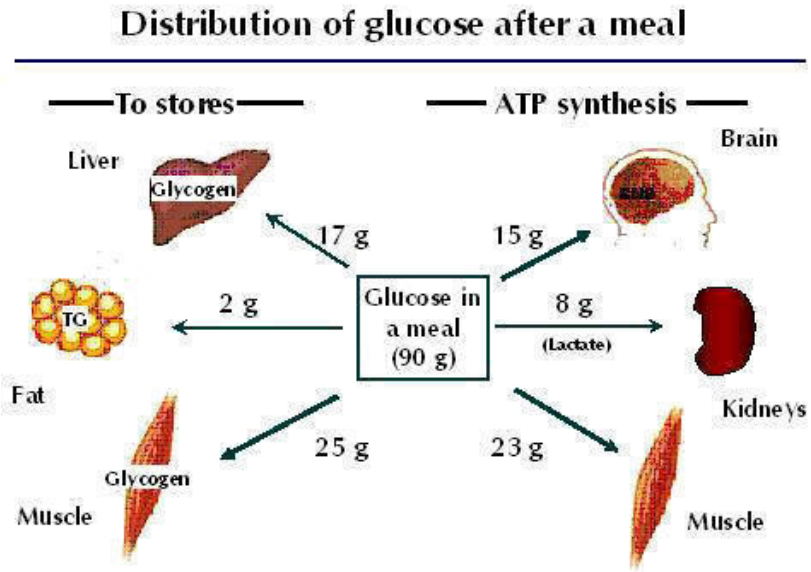
Insulin & glucagon: control blood glucose

Epinephrine & norepinephrine (in response to stress) from adrenal gland



Glucose storage

Glycogen: animals, fungi, and bacteria
Starch: plants



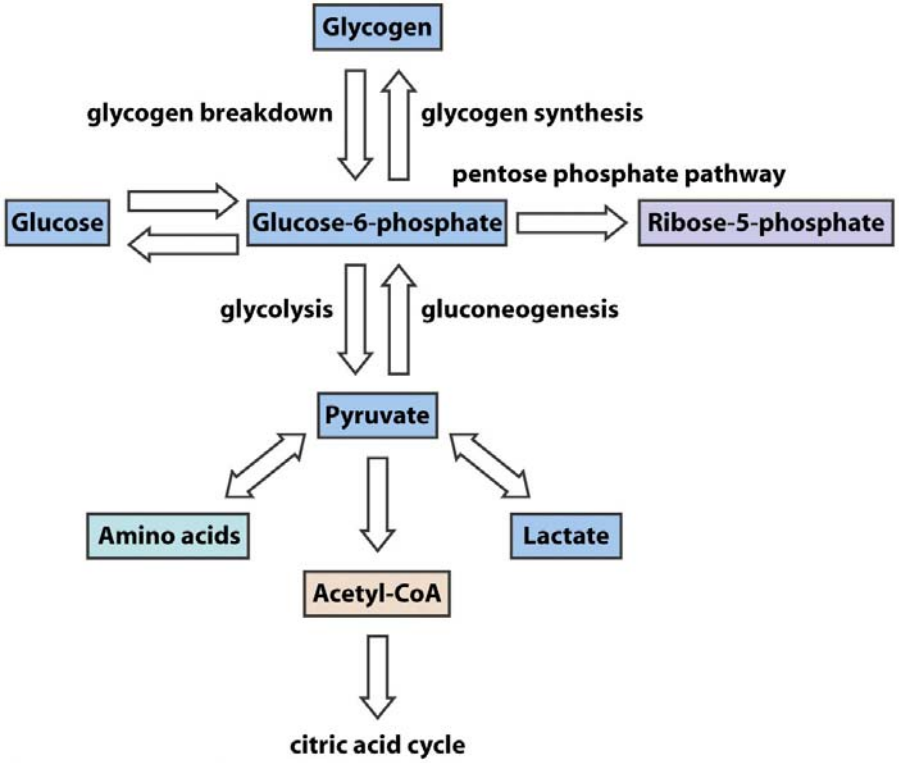
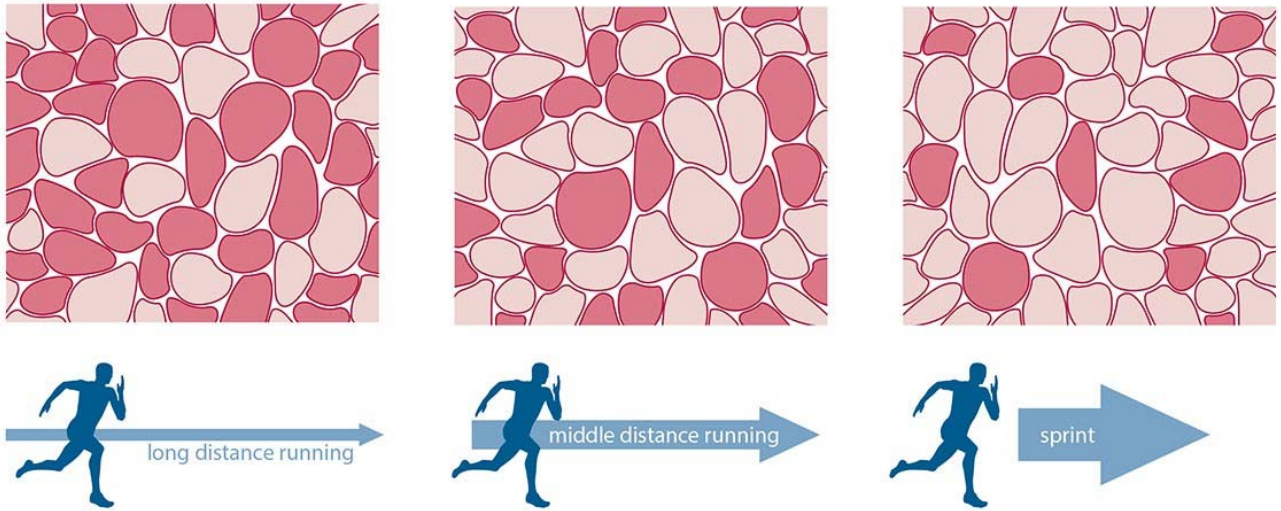


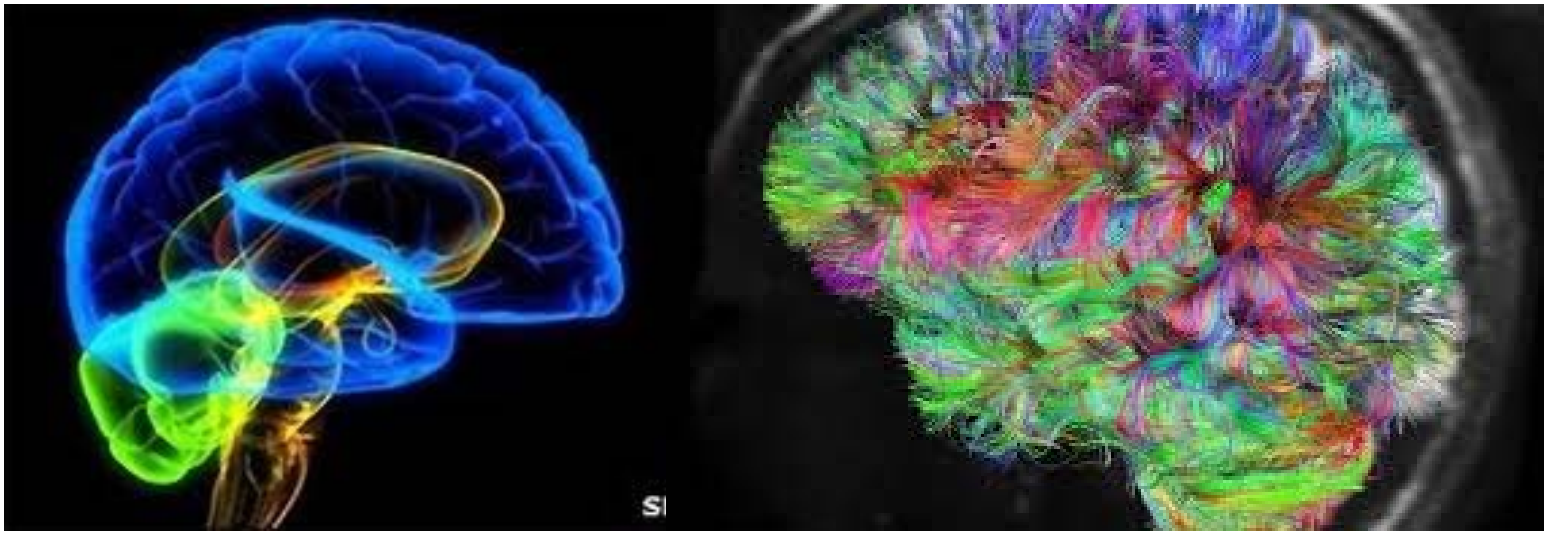
Figure 15-1 Fundamentals of Biochemistry, 2/e

Sprinters & long distance runners

Skeletal muscle: fast and slow fibers



Action potential



http://www.youtube.com/watch?v=GIGqp6_PG6k

http://www.youtube.com/watch?v=ifD1YG07fB8

Active transport

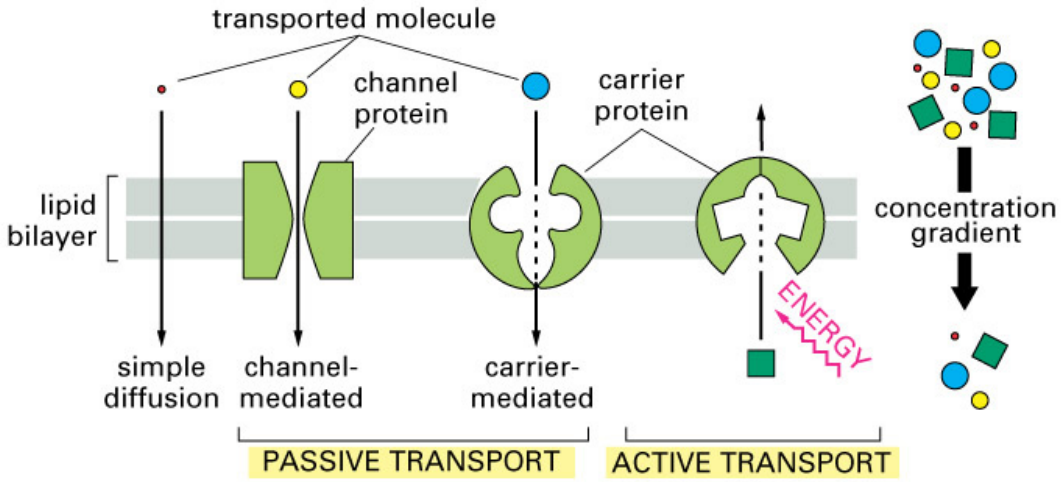
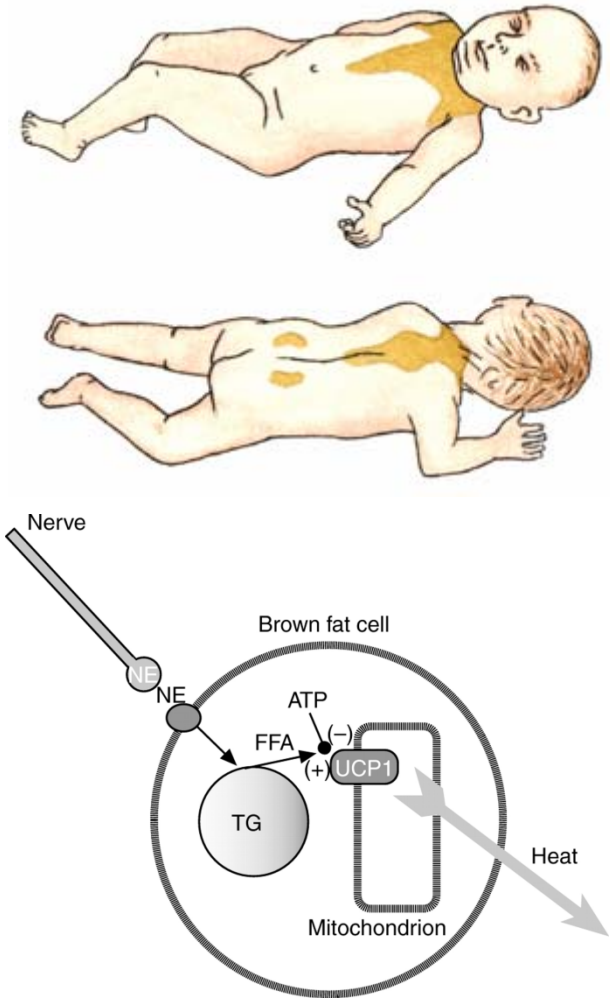
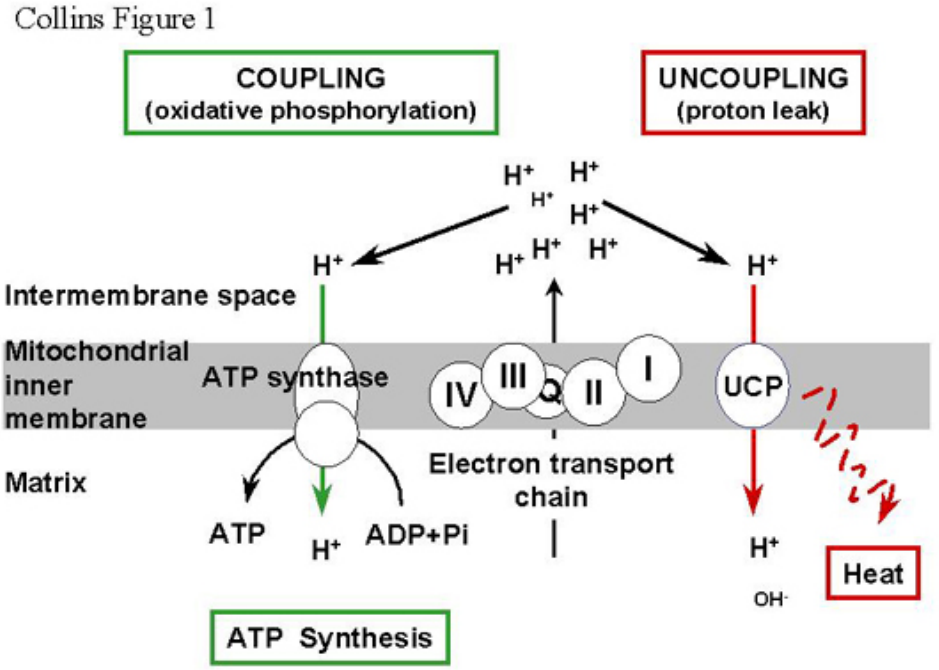


Figure 12-4 Essential Cell Biology, 2/e. (© 2004 Garland Science)

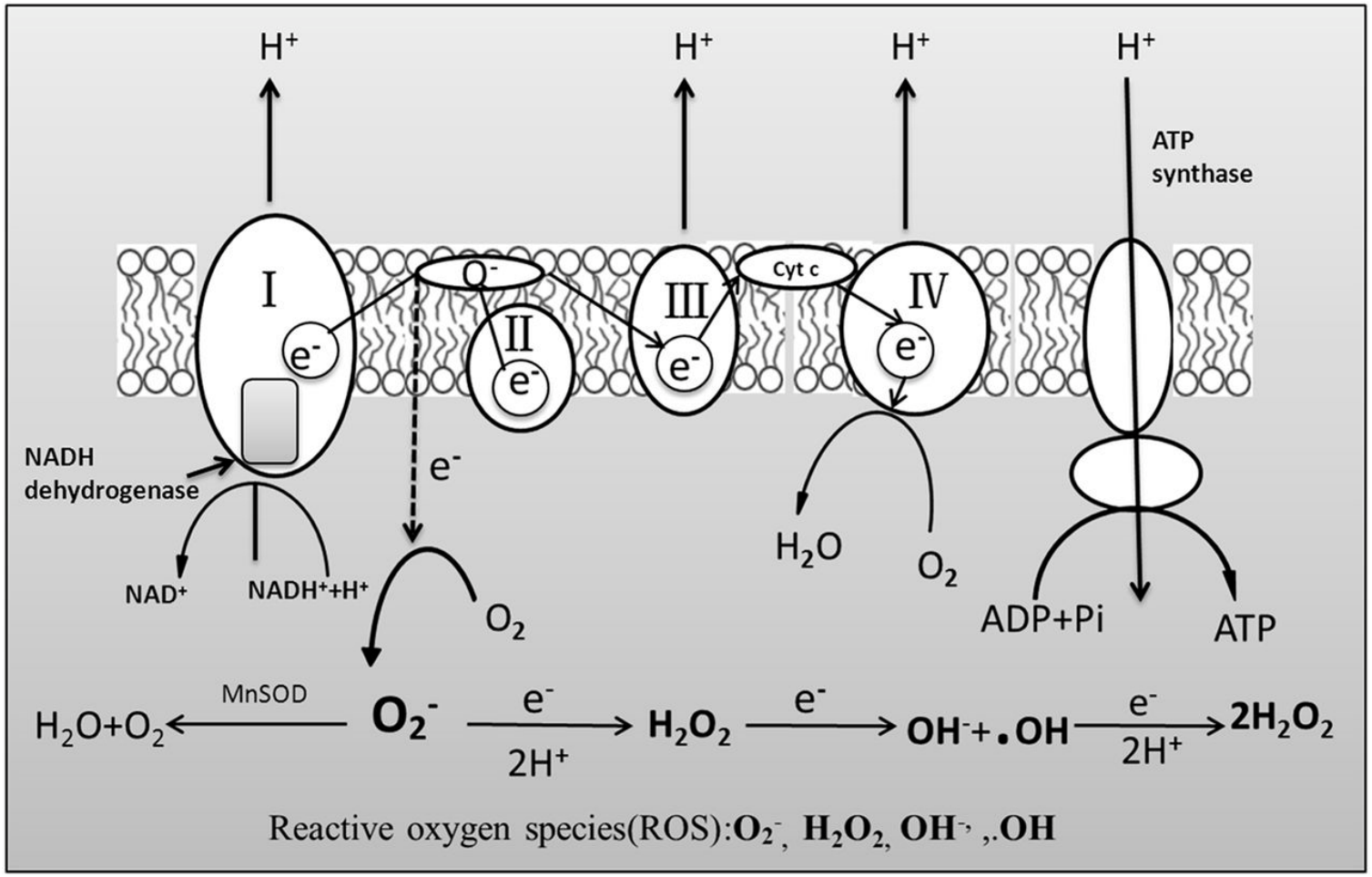
Sodium potassium pump:
http://www.youtube.com/watch?v=P-imDC1txWw

Nonshivering thermogenesis





http://www.neurogenol.co.uk/images/oxidativestress.gif



http://www.youtube.com/watch?v=dlZ5ROca0KI

http://www.youtube.com/watch?v=JBmykor-2kU