BIOCHEMICKÁ ENERGETIKA

Metabolismus: **Katabolismus**
Biosyntéza (anabolismus)

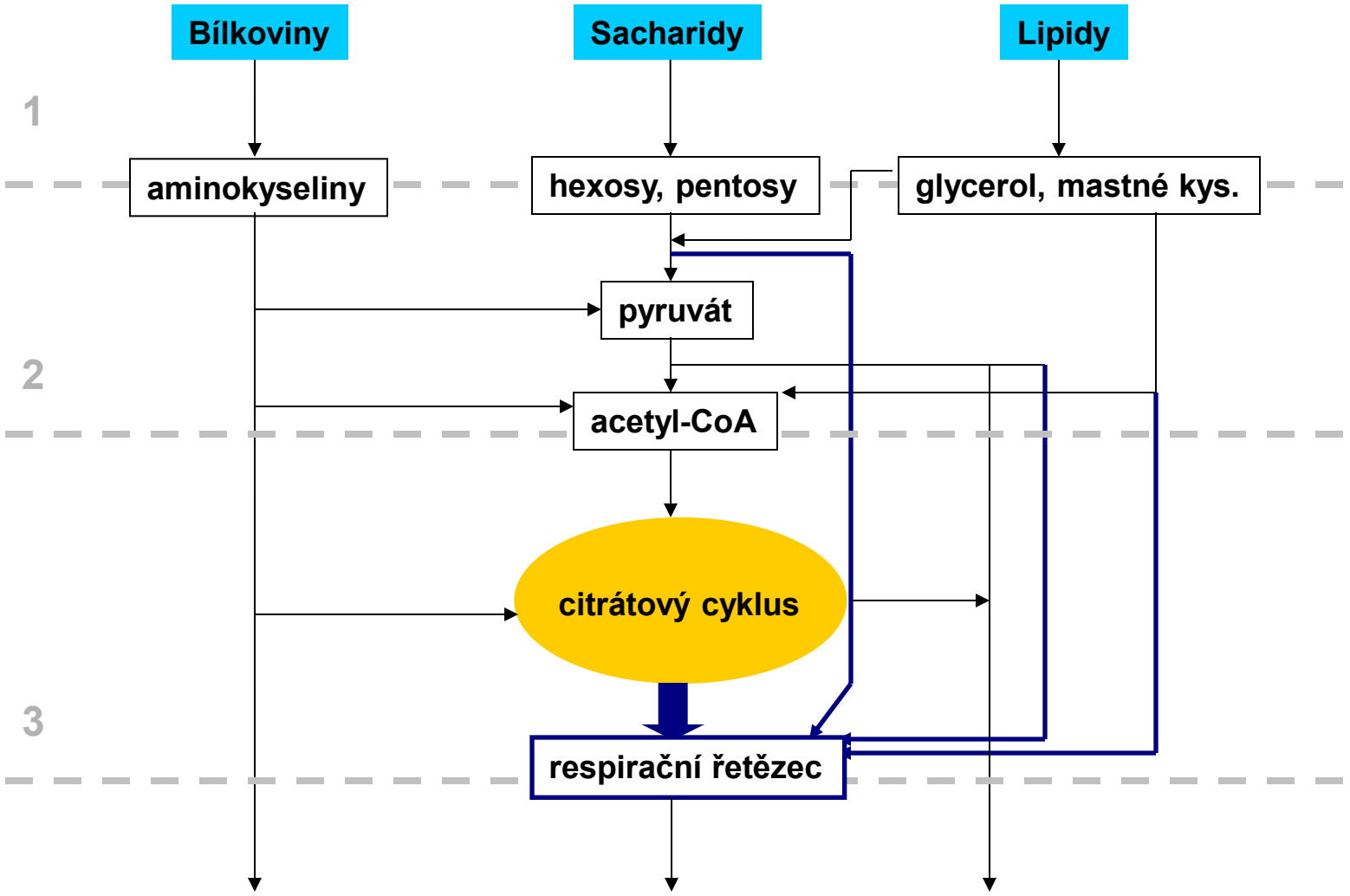
Katabolismus – degradační fáze metabolismu, která převádí složitější molekuly (redukované) s vyšším obsahem energie (cukry, tuky...) na jednodušší sloučeniny (oxid uličitý, voda, amoniak, močovina...) převážně oxidačními procesy

- produkuje energii, kterou ukládá do speciálních sloučenin - přenašečů energie (makroergické sloučeniny, zejména ATP, GTP, koenzym A...)
- poskytuje prekurzory, které se využívají v biosyntéze
- redukuje „přenašeče vodíku“ (NAD^+, FAD ...), které jsou využívány v biosyntéze nebo jako zdroj energie v dýchacím řetězci.

Anabolismus – biosyntetická fáze metabolismu, kdy z malých jednoduchých molekul prekurzorů vznikají složitější a větší molekuly vytvářející komplexní struktury organismů (bílkoviny, lipidy, polysacharidy, nukleové kyseliny ...)

- spotřebovává energii
- vychází z prekurzorů poskytovaných katabolismem (heterotrofy)
- využívá redukovaných forem přenašečů vodíku (NADH, $FADH_2$...)

KATABOLISMUS



1. stupeň

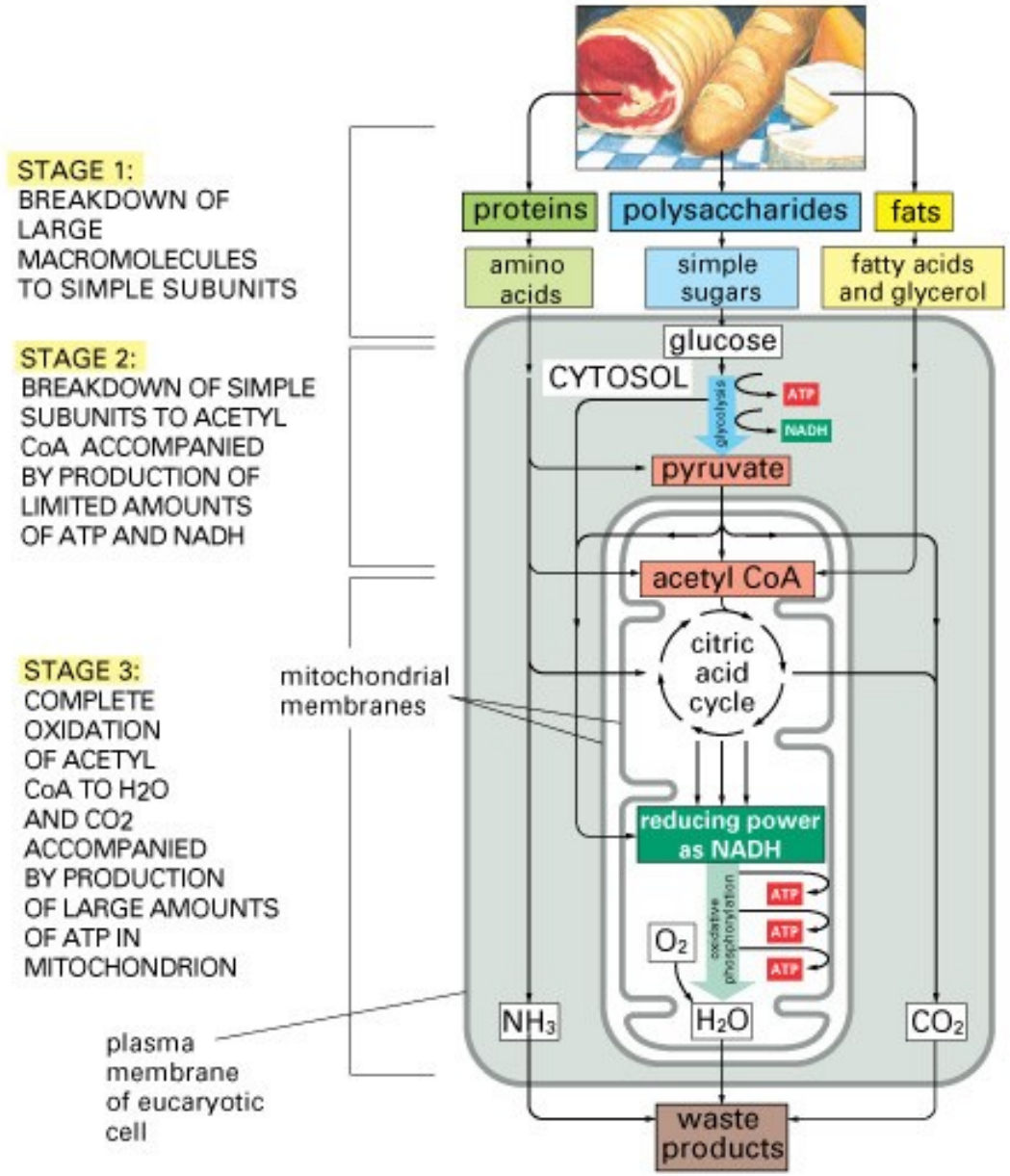
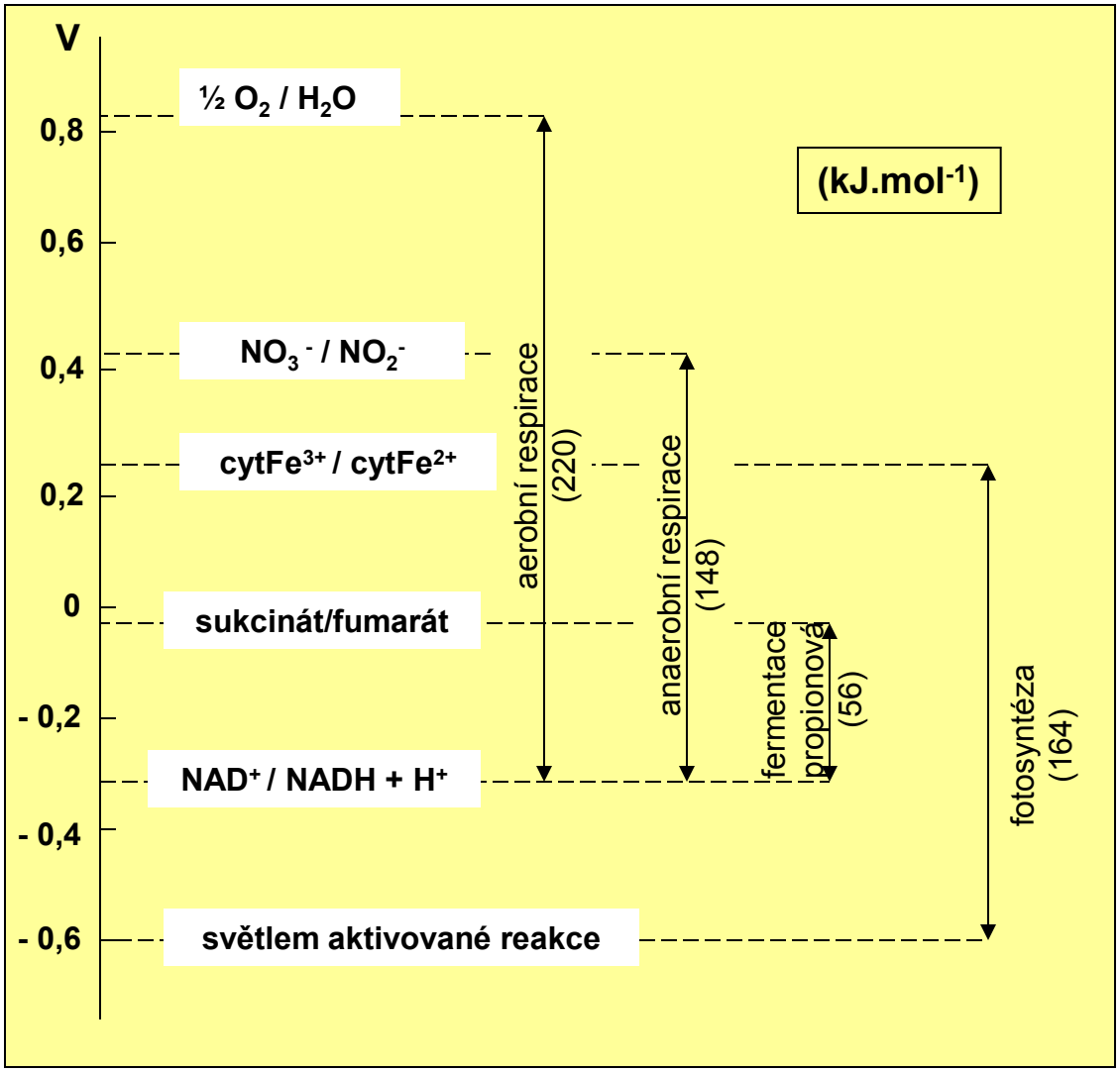


Figure 13-2 Essential Cell Biology, 2/e. (© 2004 Garland Science)

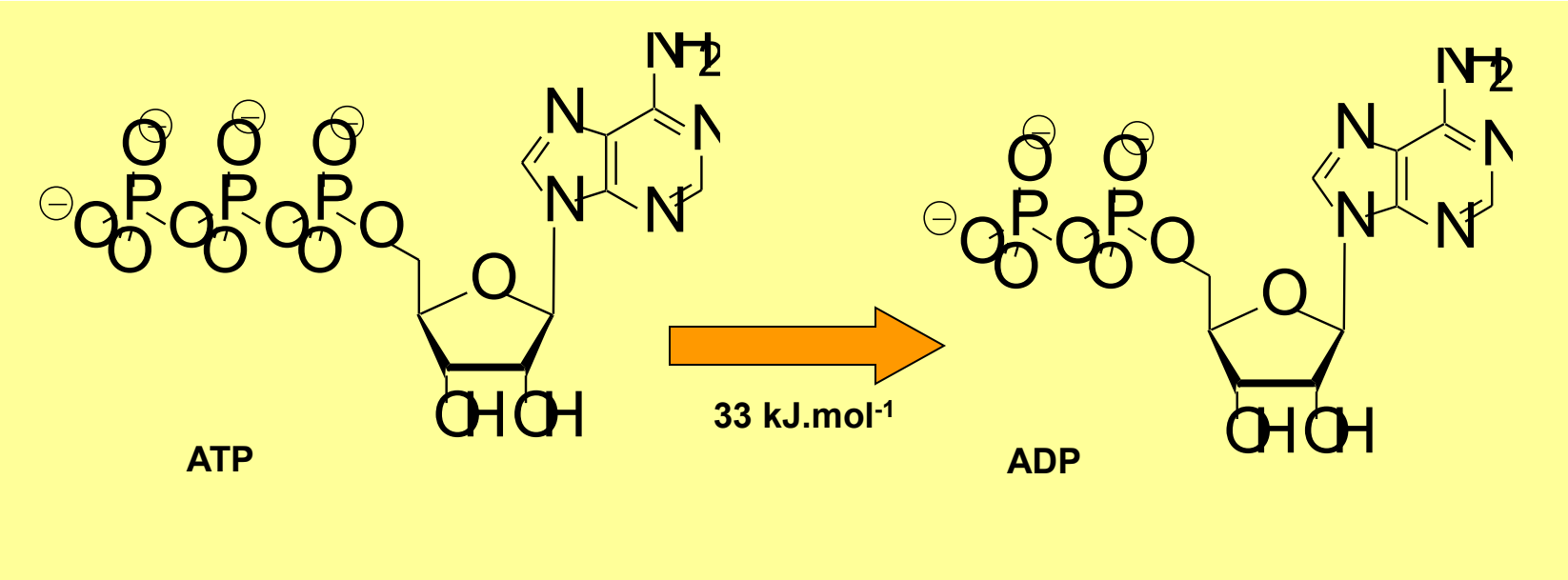
BIOCHEMICKÁ ENERGETIKA



Různé způsoby získávání energie

BIOCHEMICKÁ ENERGETIKA

Přenašeče energie - nukleosid trifosfáty

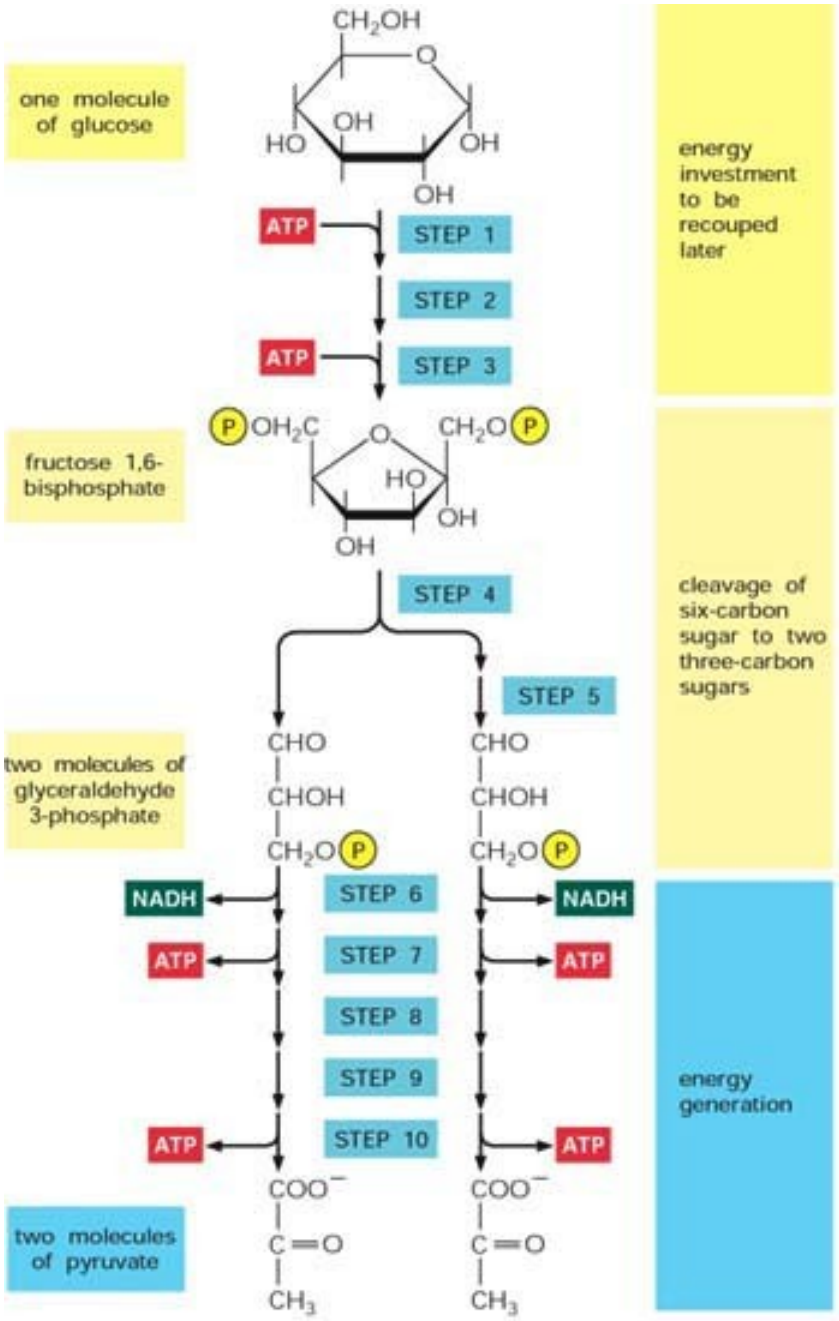


Podobně GTP (citr.cyklus), UTP (syntéza sacharidů) a další

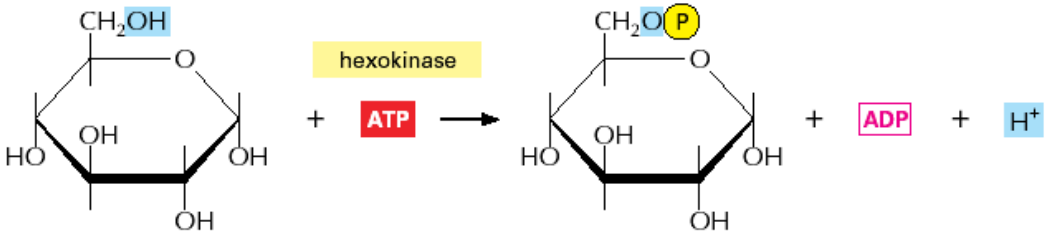
Další makroergické sloučeniny: acylfosfáty, acylthioestery, guanidinium fosfáty,

BIOCHEMICKÁ ENERGETIKA

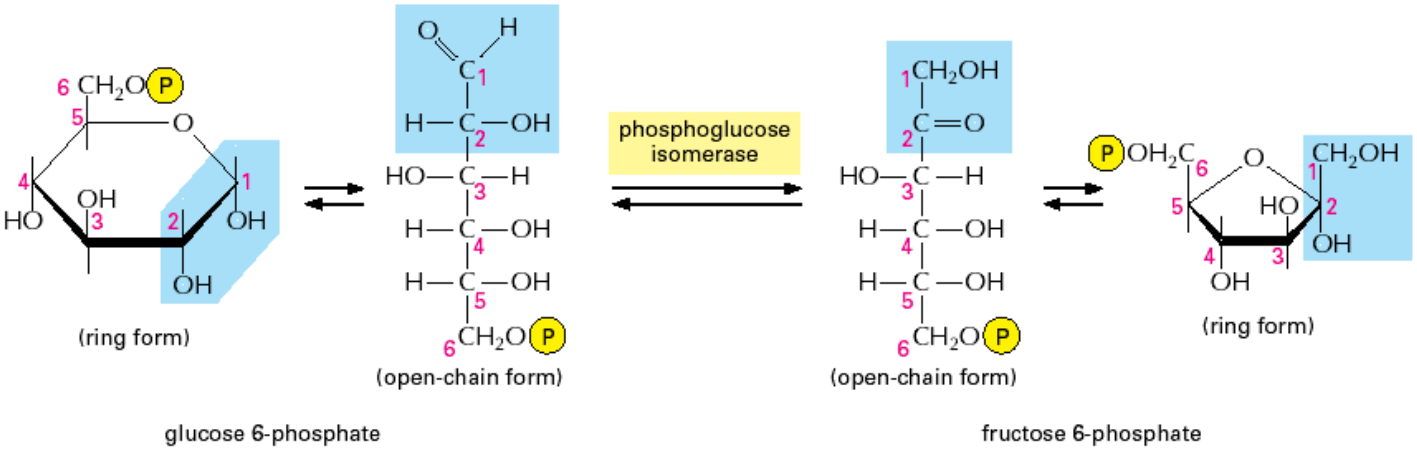
Glykolýza



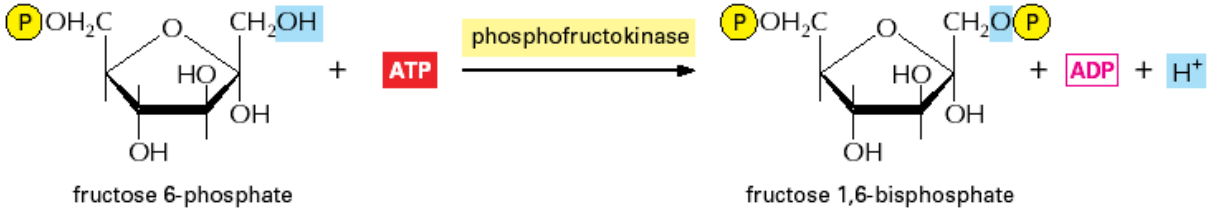
Step 1 Glucose is phosphorylated by ATP to form a sugar phosphate. The negative charge of the phosphate prevents passage of the sugar phosphate through the plasma membrane, trapping glucose inside the cell.



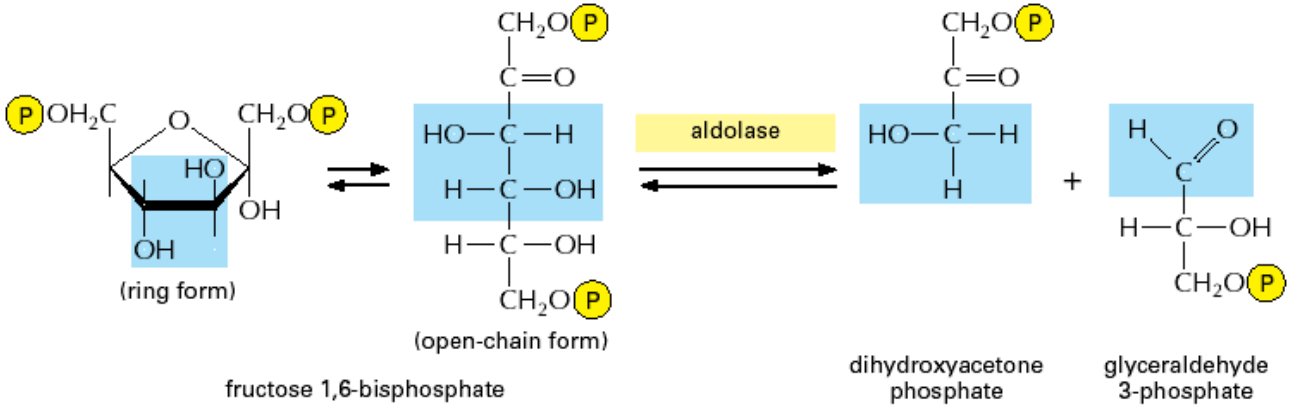
Step 2 A readily reversible rearrangement of the chemical structure (isomerization) moves the carbonyl oxygen from carbon 1 to carbon 2, forming a ketose from an aldose sugar. (See Panel 2–3, pp. 70–71.)



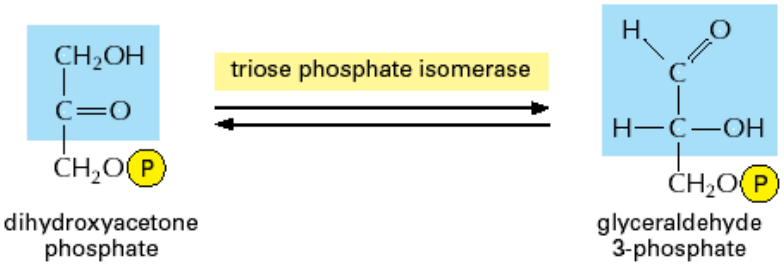
Step 3 The new hydroxyl group on carbon 1 is phosphorylated by ATP, in preparation for the formation of two three-carbon sugar phosphates. The entry of sugars into glycolysis is controlled at this step, through regulation of the enzyme *phosphofructokinase*.



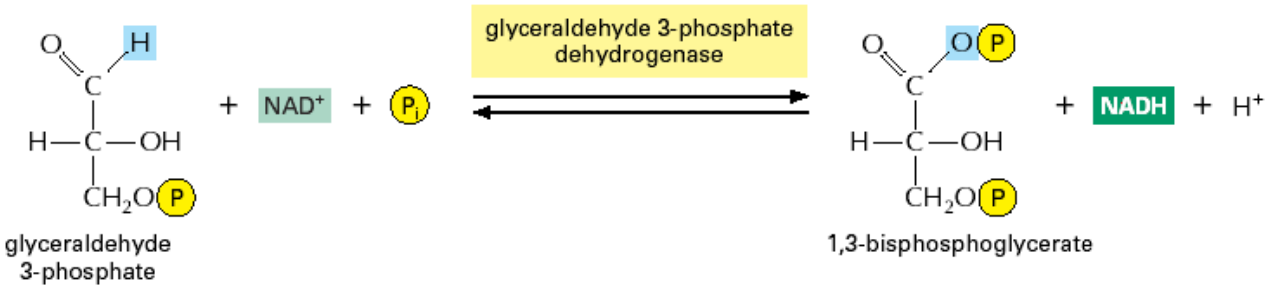
Step 4 The six-carbon sugar is cleaved to produce two three-carbon molecules. Only the glyceraldehyde 3-phosphate can proceed immediately through glycolysis.



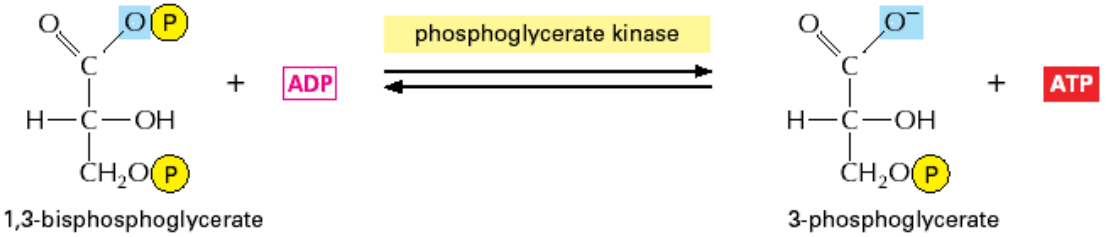
Step 5 The other product of step 4, dihydroxyacetone phosphate, is isomerized to form glyceraldehyde 3-phosphate.



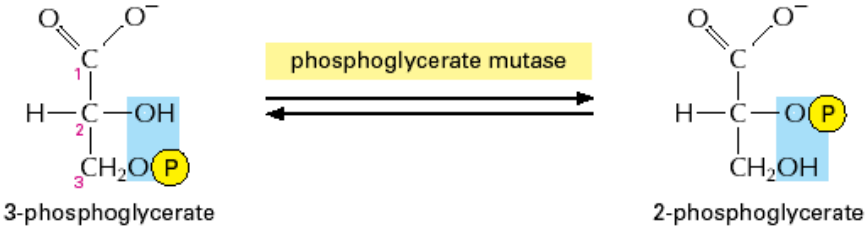
Step 6 The two molecules of glyceraldehyde 3-phosphate are oxidized. The energy-generation phase of glycolysis begins, as NADH and a new high-energy anhydride linkage to phosphate are formed (see Figure 13–5).



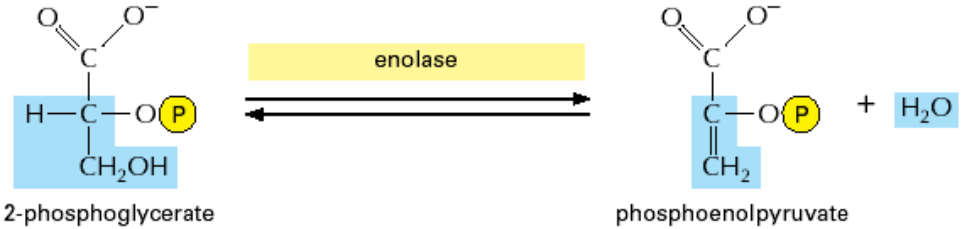
Step 7 The transfer to ADP of the high-energy phosphate group that was generated in step 6 forms ATP.



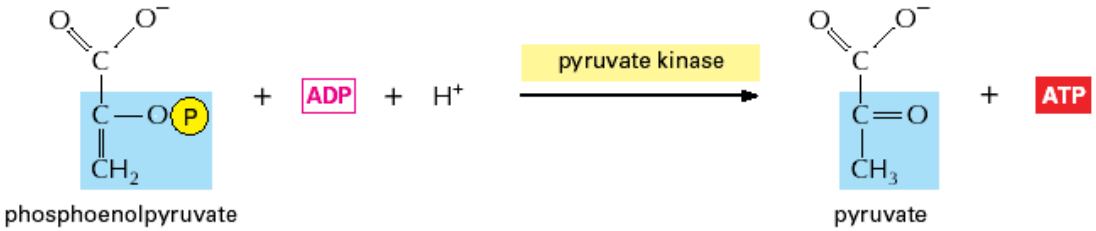
Step 8 The remaining phosphate ester linkage in 3-phosphoglycerate, which has a relatively low free energy of hydrolysis, is moved from carbon 3 to carbon 2 to form 2-phosphoglycerate.



Step 9 The removal of water from 2-phosphoglycerate creates a high-energy enol phosphate linkage.

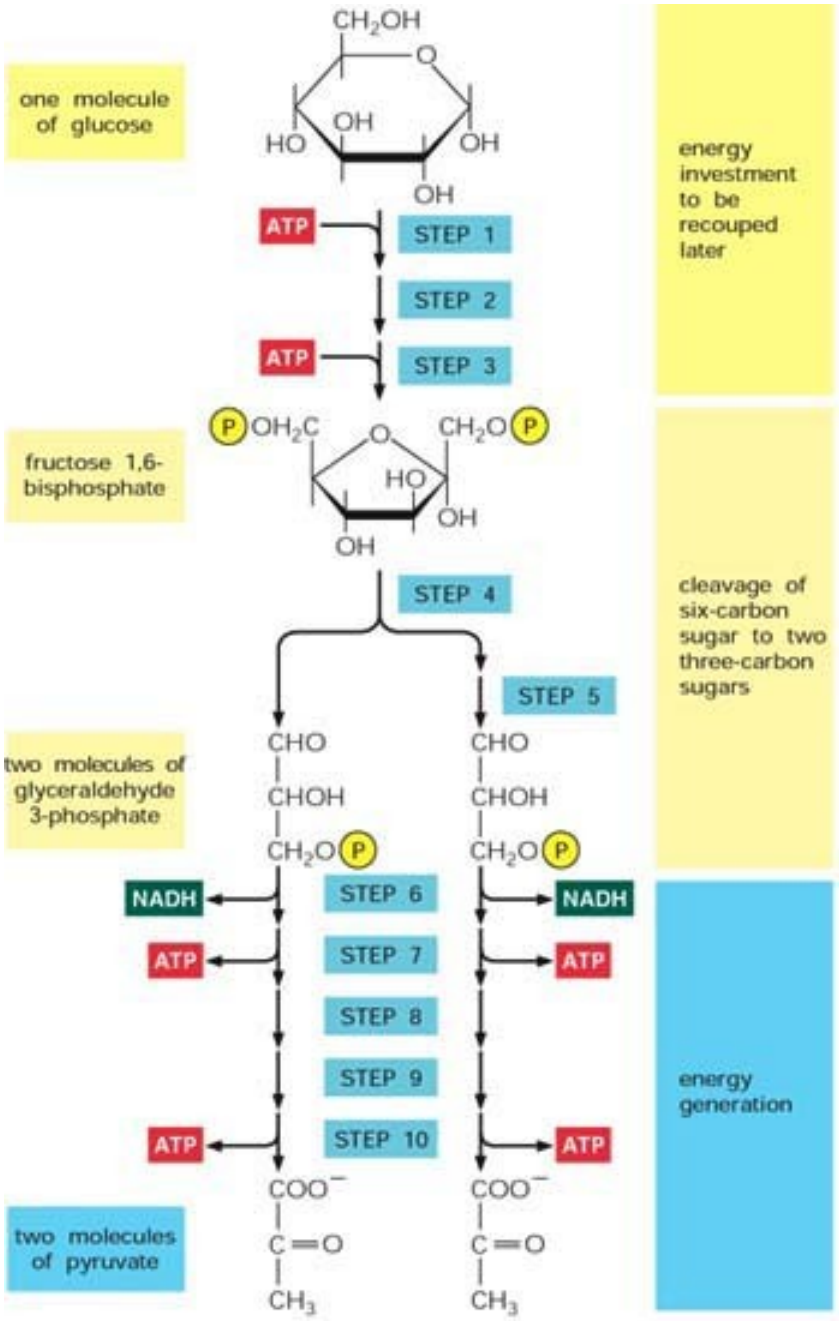


Step 10 The transfer to ADP of the high-energy phosphate group that was generated in step 9 forms ATP, completing glycolysis.

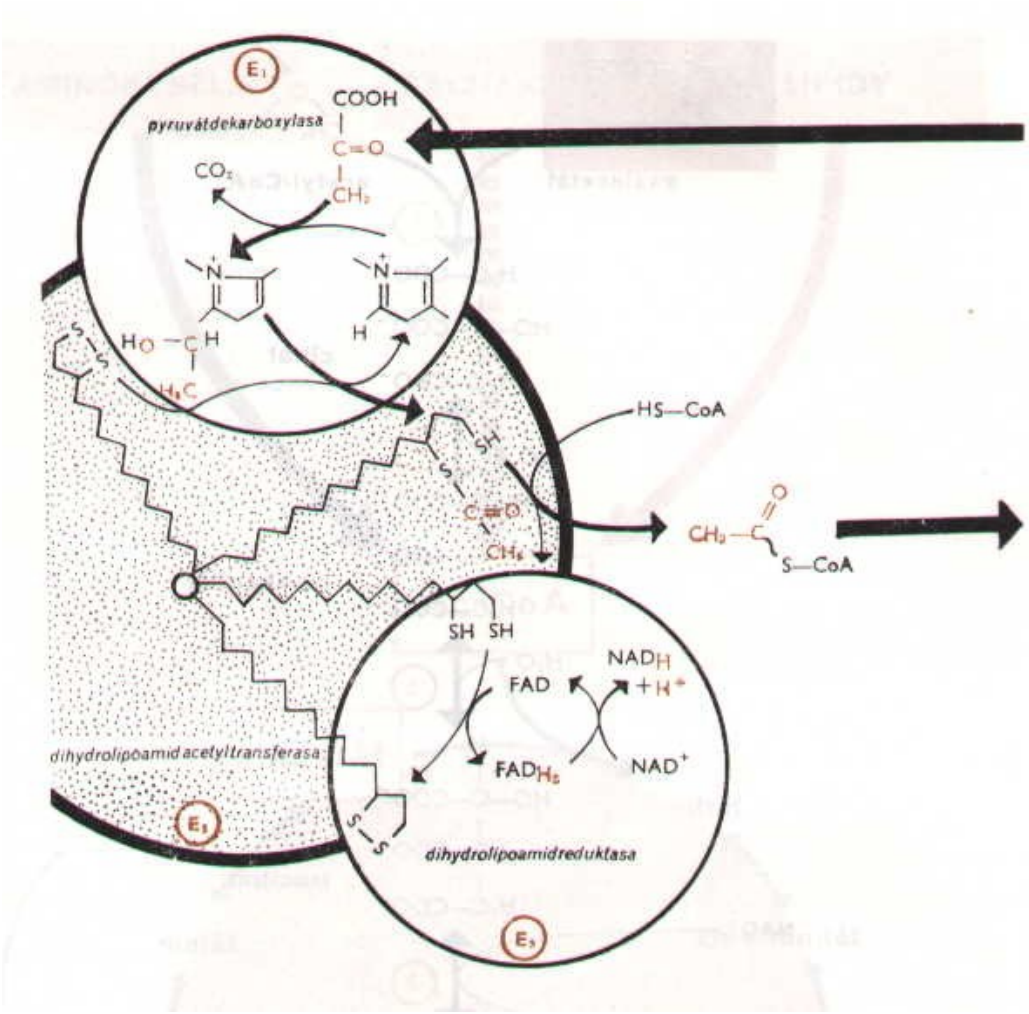


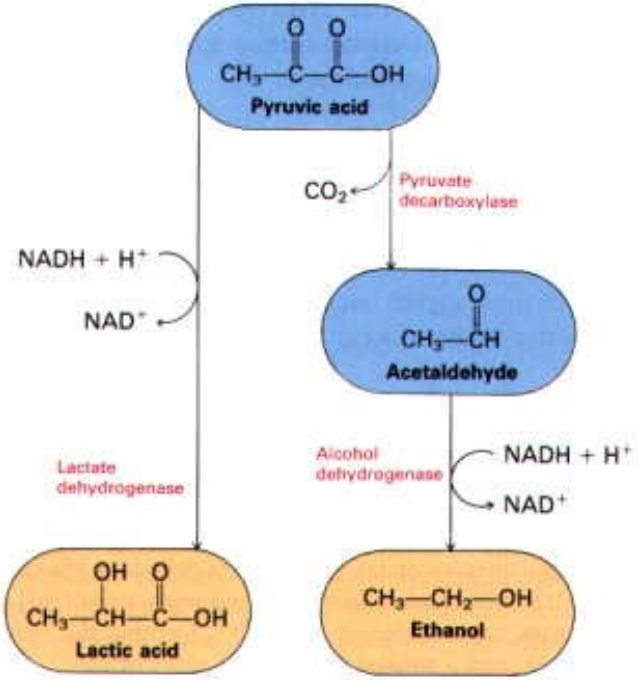
BIOCHEMICKÁ ENERGETIKA

Glykolýza



BIOCHEMICKÁ ENERGETIKA



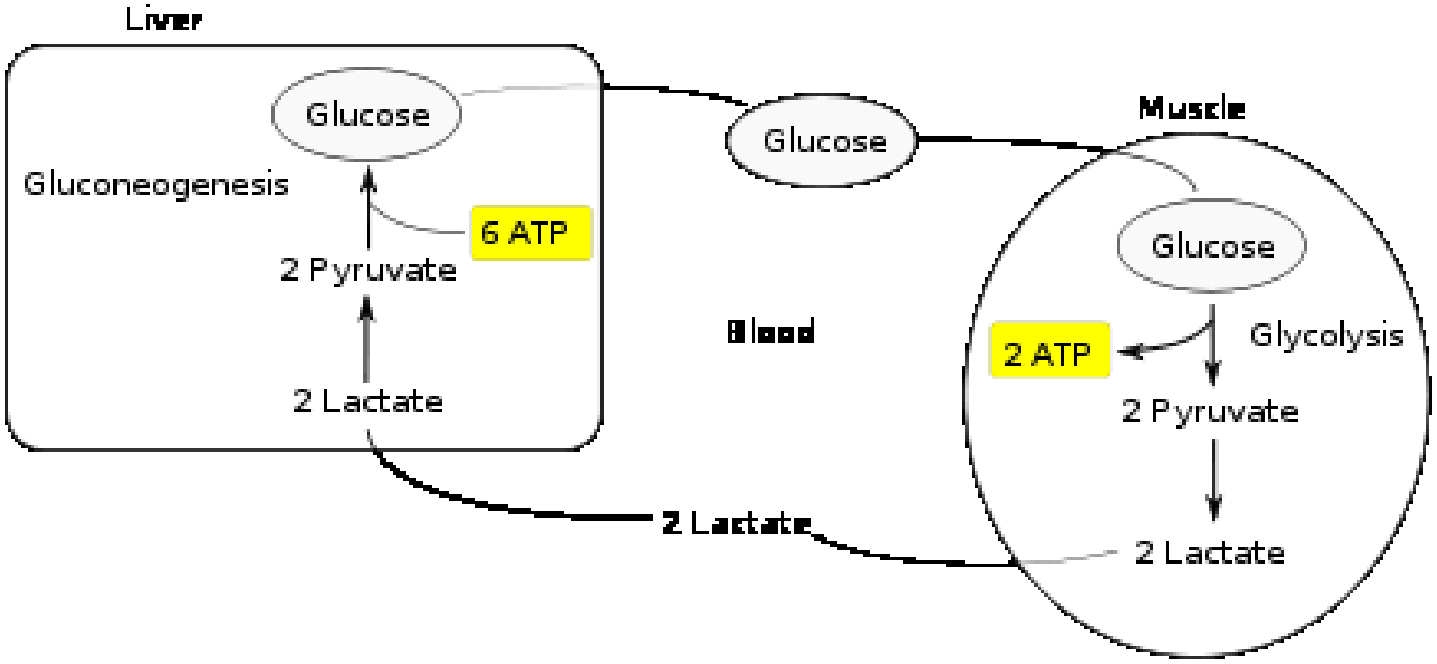


Overall reactions of anaerobic metabolism:

Glucose + 2ADP + $2P_i$ ⟶ 2 lactate + 2ATP

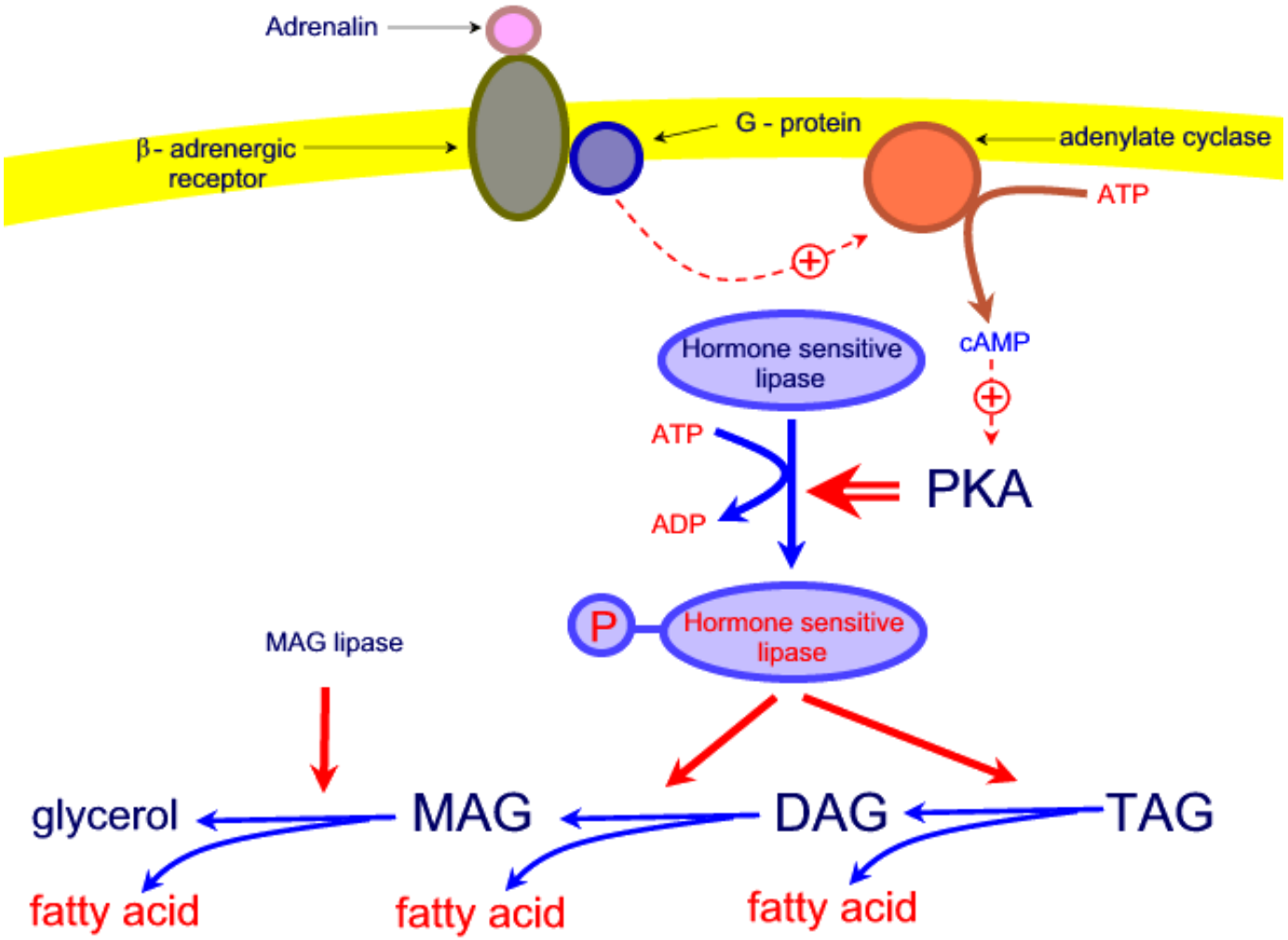
Glucose + 2ADP + $2P_i$ ⟶ 2 ethanol + $2CO_2$ + 2ATP

Anaerobní metabolismus - Coriho cyklus



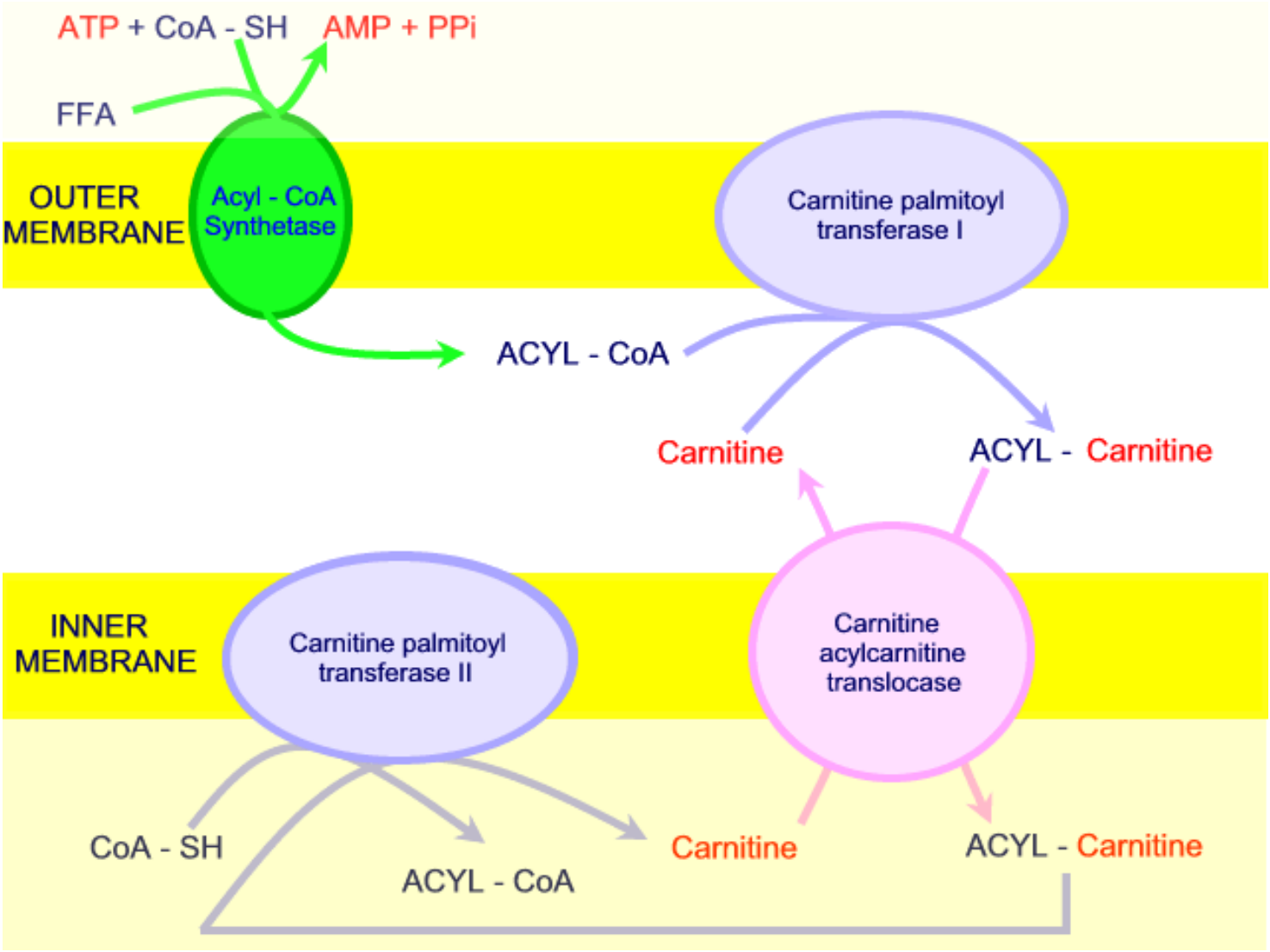
BIOCHEMICKÁ ENERGETIKA

Tuky

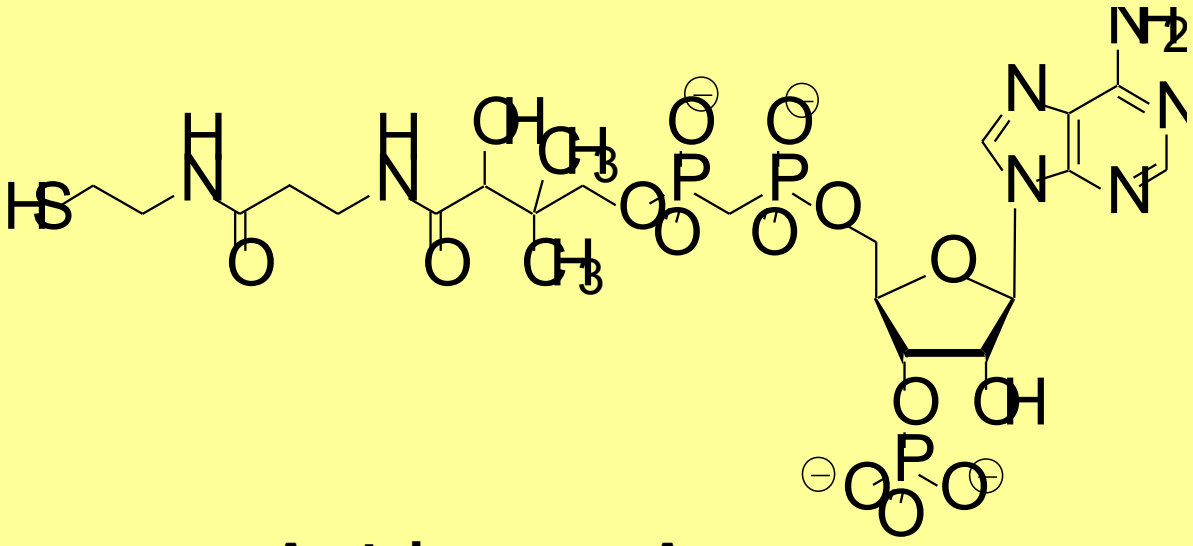


BIOCHEMICKÁ ENERGETIKA

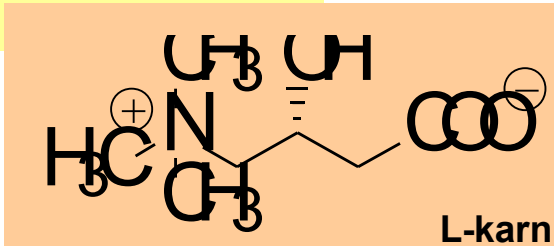
Tuky



BIOCHEMICKÁ ENERGETIKA



Acetylcoenzym A

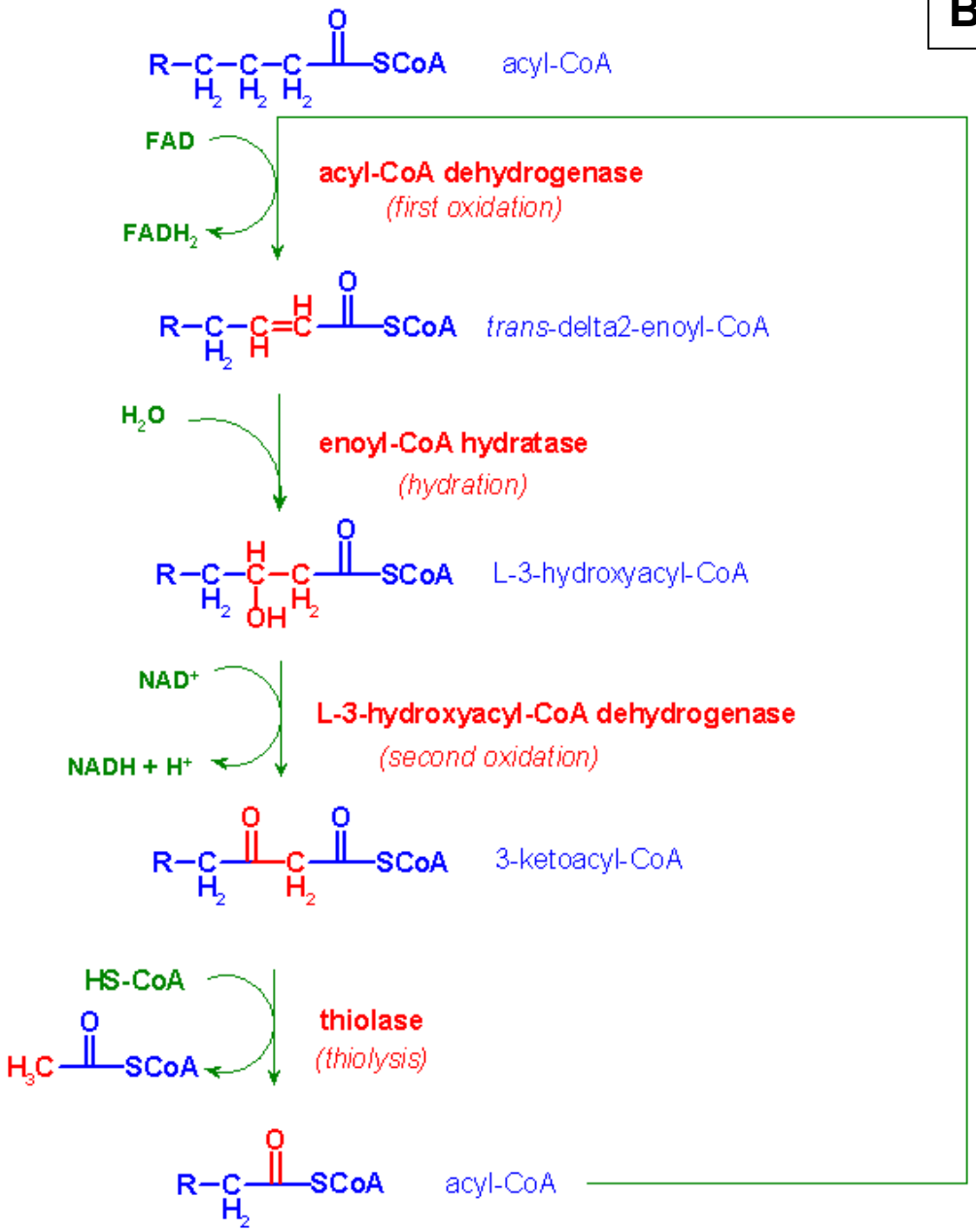


L-karnitin

http://brookscole.cengage.com/chemistry_d/templates/student_resources/shared_resources/animations/carnitine/carnitine1.html

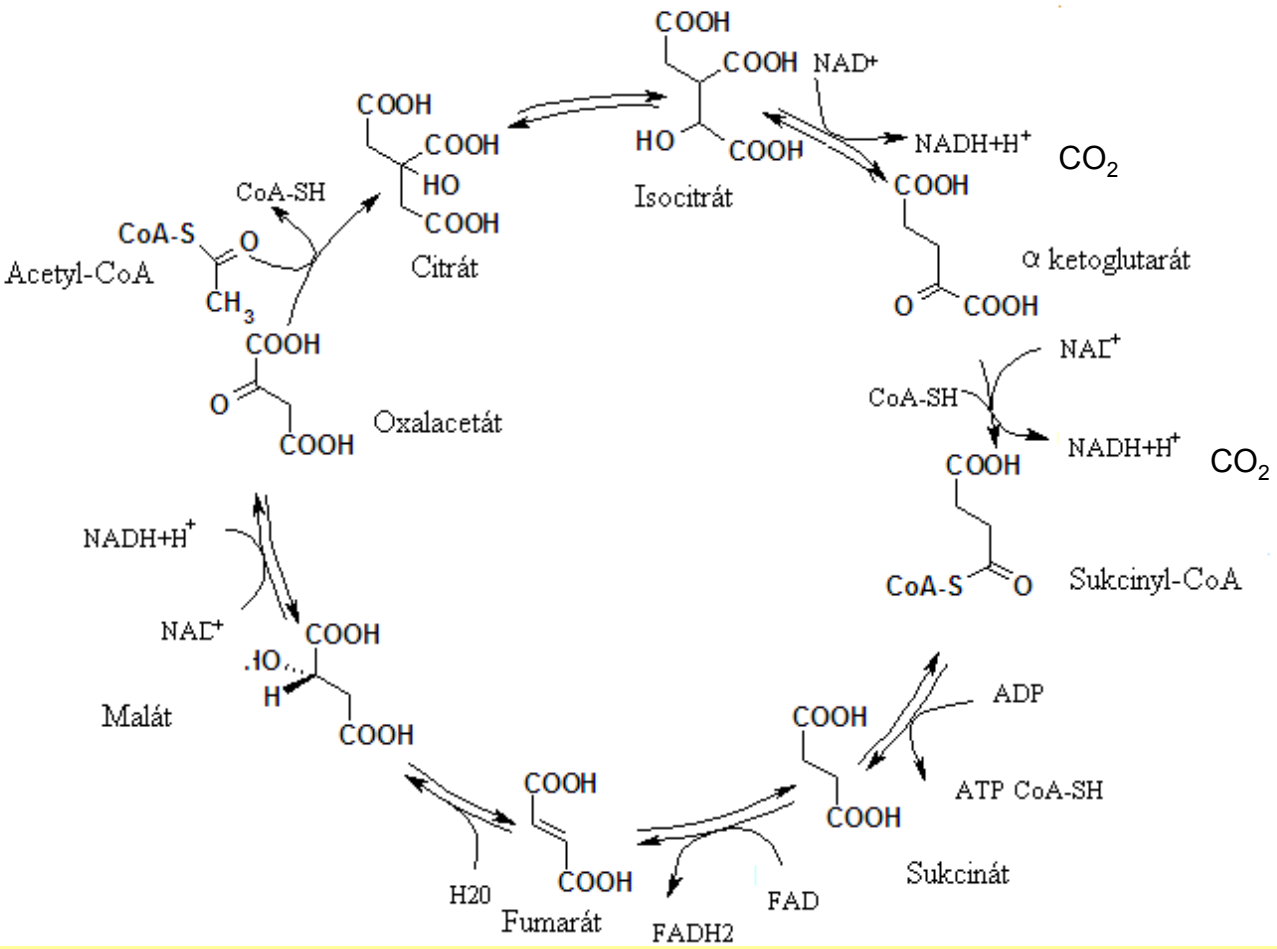
Tuky

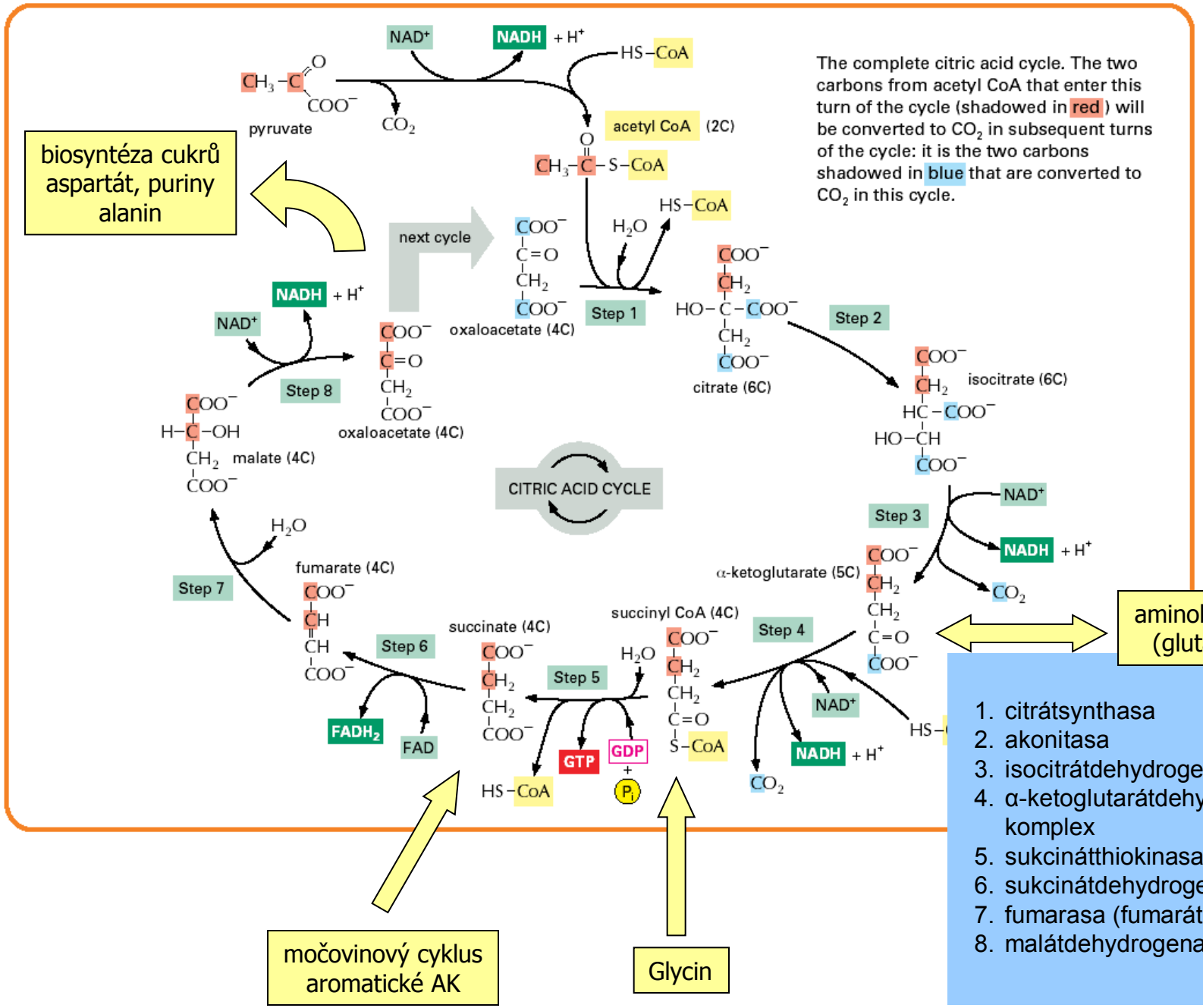
β-oxidace mastných kyselin



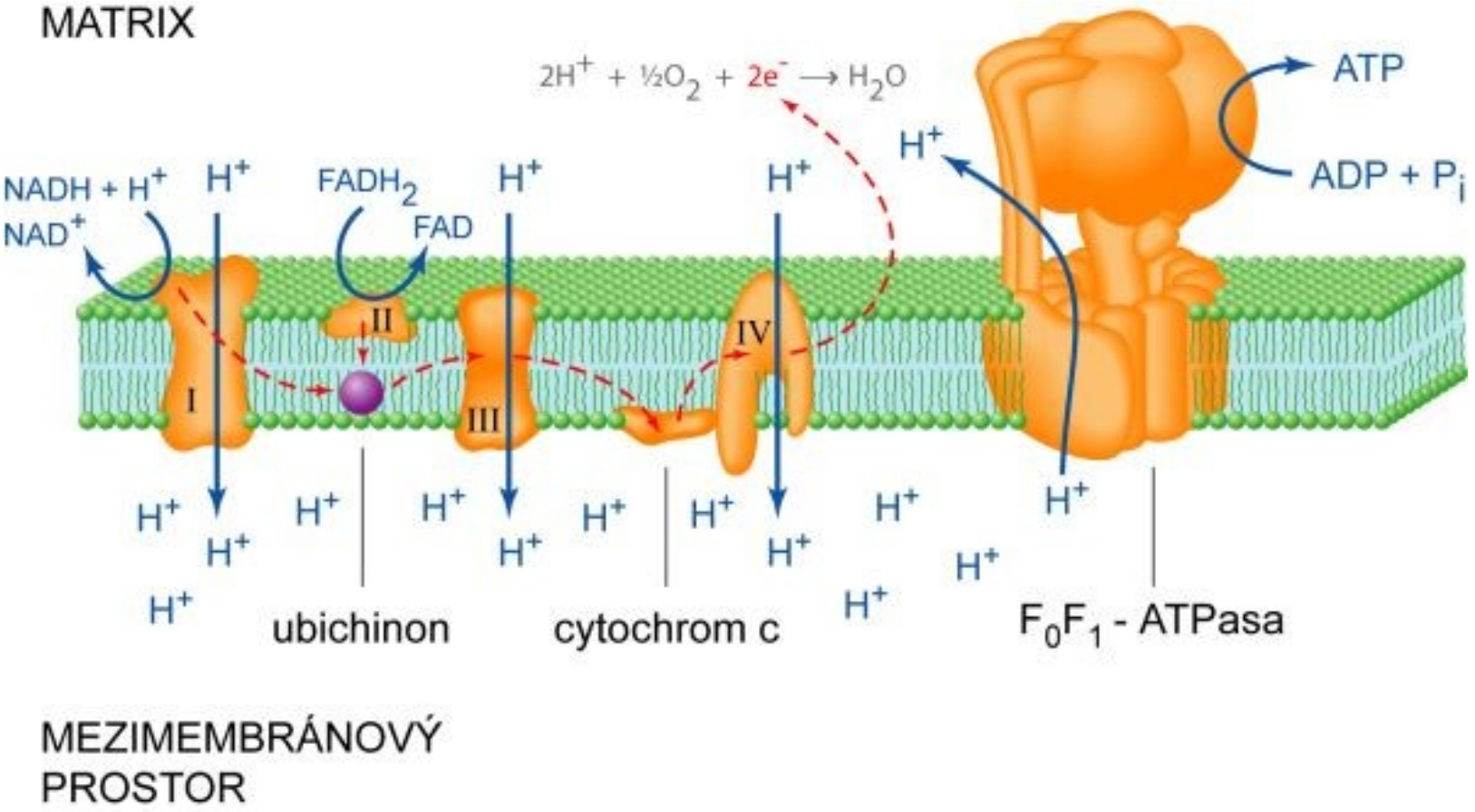
BIOCHEMICKÁ ENERGETIKA

Citrátový (Krebsův) cyklus

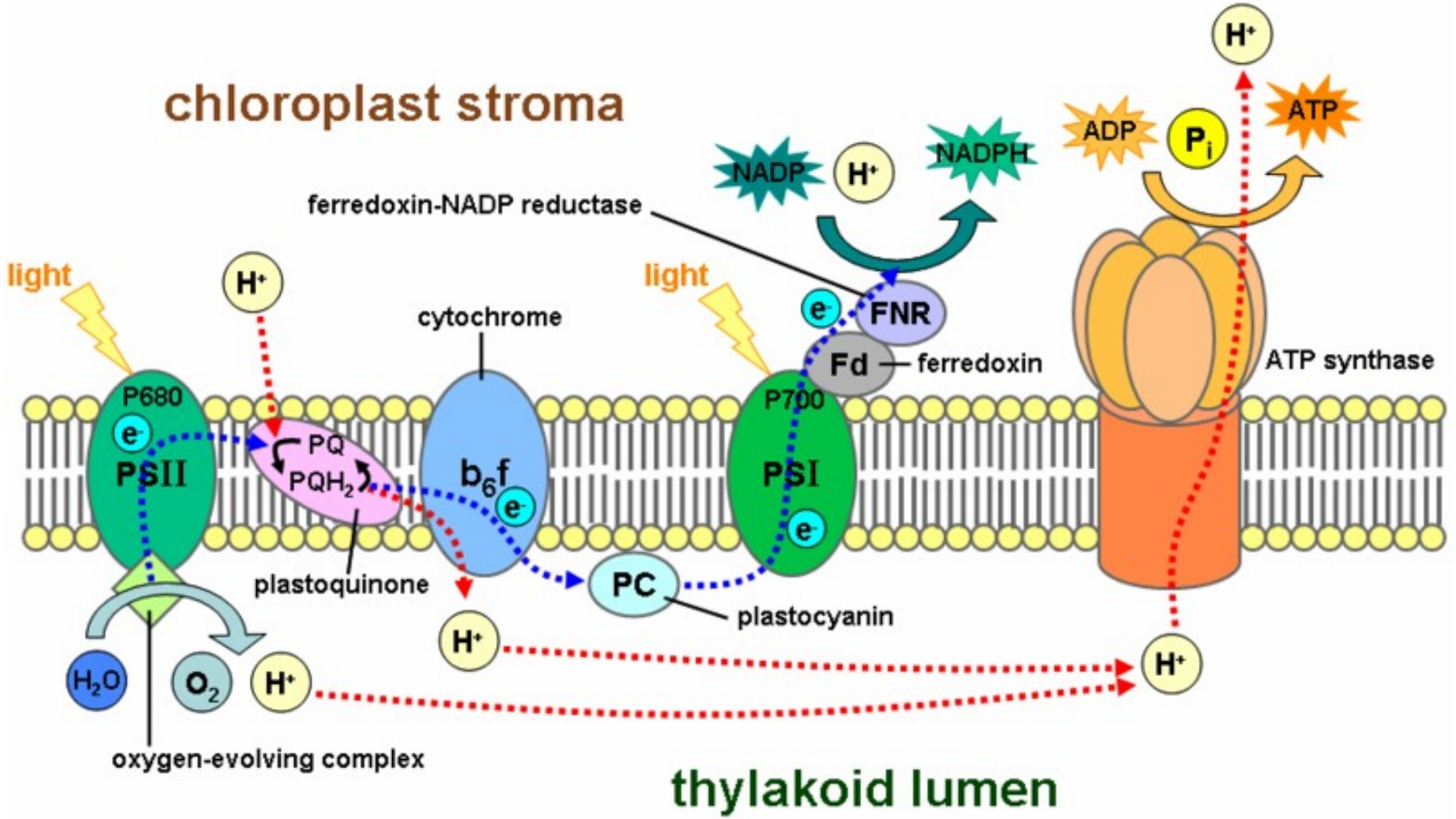



The complete citric acid cycle. The two carbons from acetyl CoA that enter this turn of the cycle (shadowed in red) will be converted to CO_2 in subsequent turns of the cycle: it is the two carbons shadowed in blue that are converted to CO_2 in this cycle.
CITRIC ACID CYCLE
pyruvate
NAD+
NADH + H+
HS–CoA
CO2
acetyl CoA (2C)
oxaloacetate (4C)
next cycle
Step 1
citrate (6C)
Step 2
isocitrate (6C)
Step 3
α-ketoglutarate (5C)
Step 4
succinyl CoA (4C)
Step 5
GTP
GDP
Pi
succinate (4C)
Step 6
FADH2
FAD
fumarate (4C)
Step 7
malate (4C)
Step 8
biosyntéza cukrů aspartát, puriny alanin
aminokyseliny (glutamát)
močovinový cyklus aromatické AK
Glycin
1. citrátsynthasa
2. akonitasa
3. isocitrátdehydrogenasa
4. α-ketoglutarátdehydrogenasový komplex
5. sukcinátthiokinasa
6. sukcinátdehydrogenasa
7. fumarasa (fumaráthydratasa)
8. malátdehydrogenasa

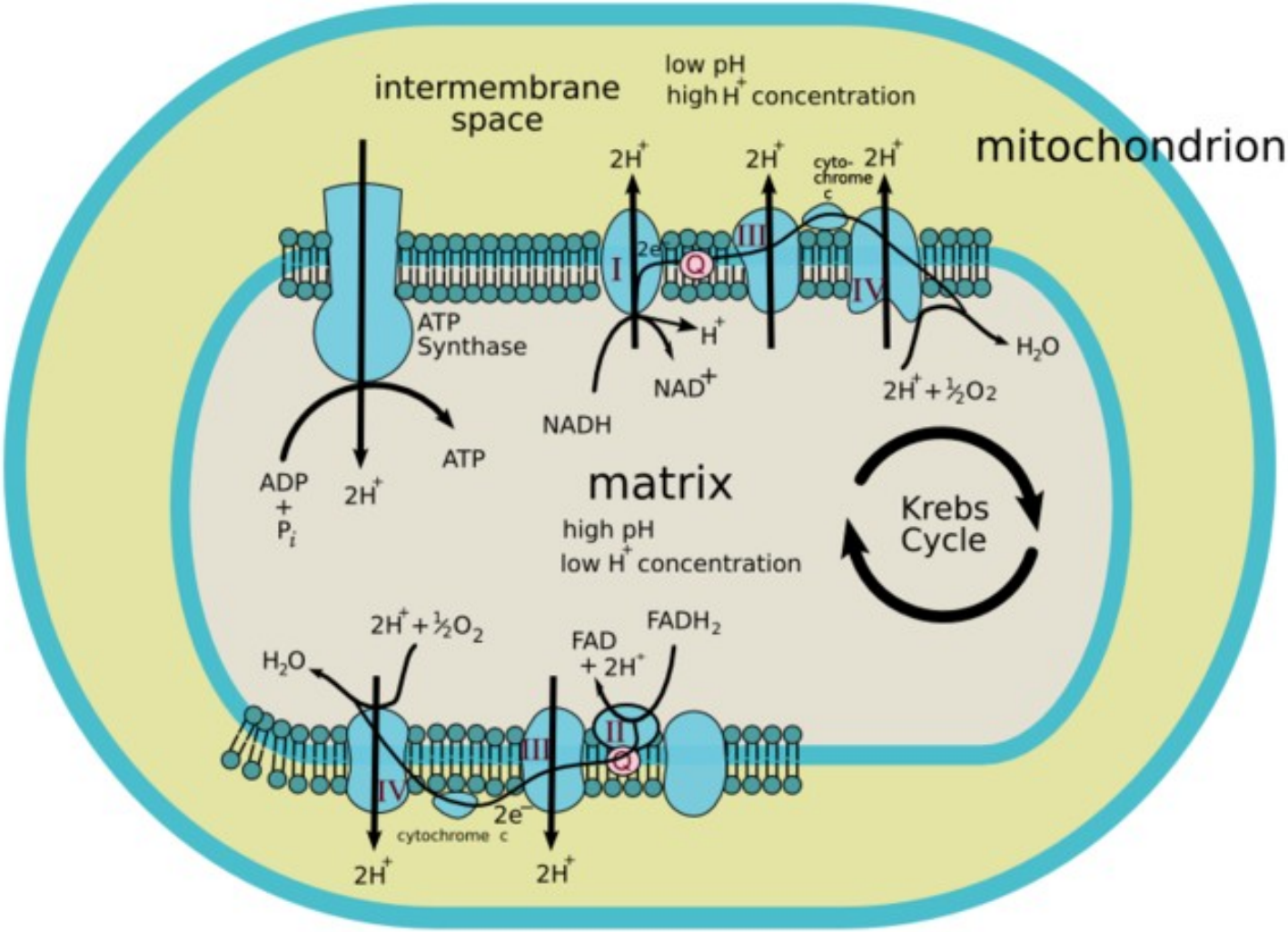
BIOCHEMICKÁ ENERGETIKA



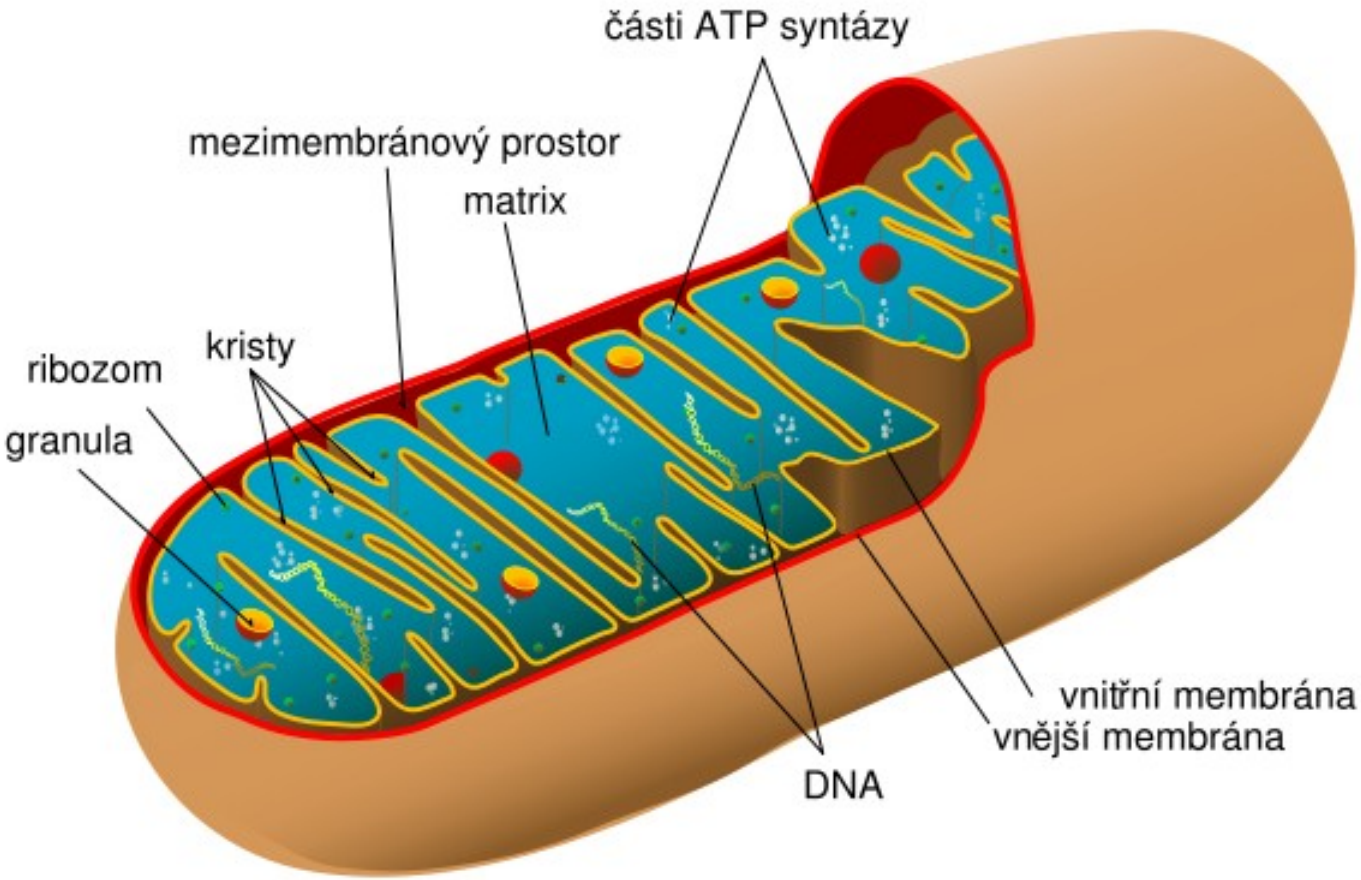
http://www.sp.uconn.edu/~terry/images/anim/ETS.html

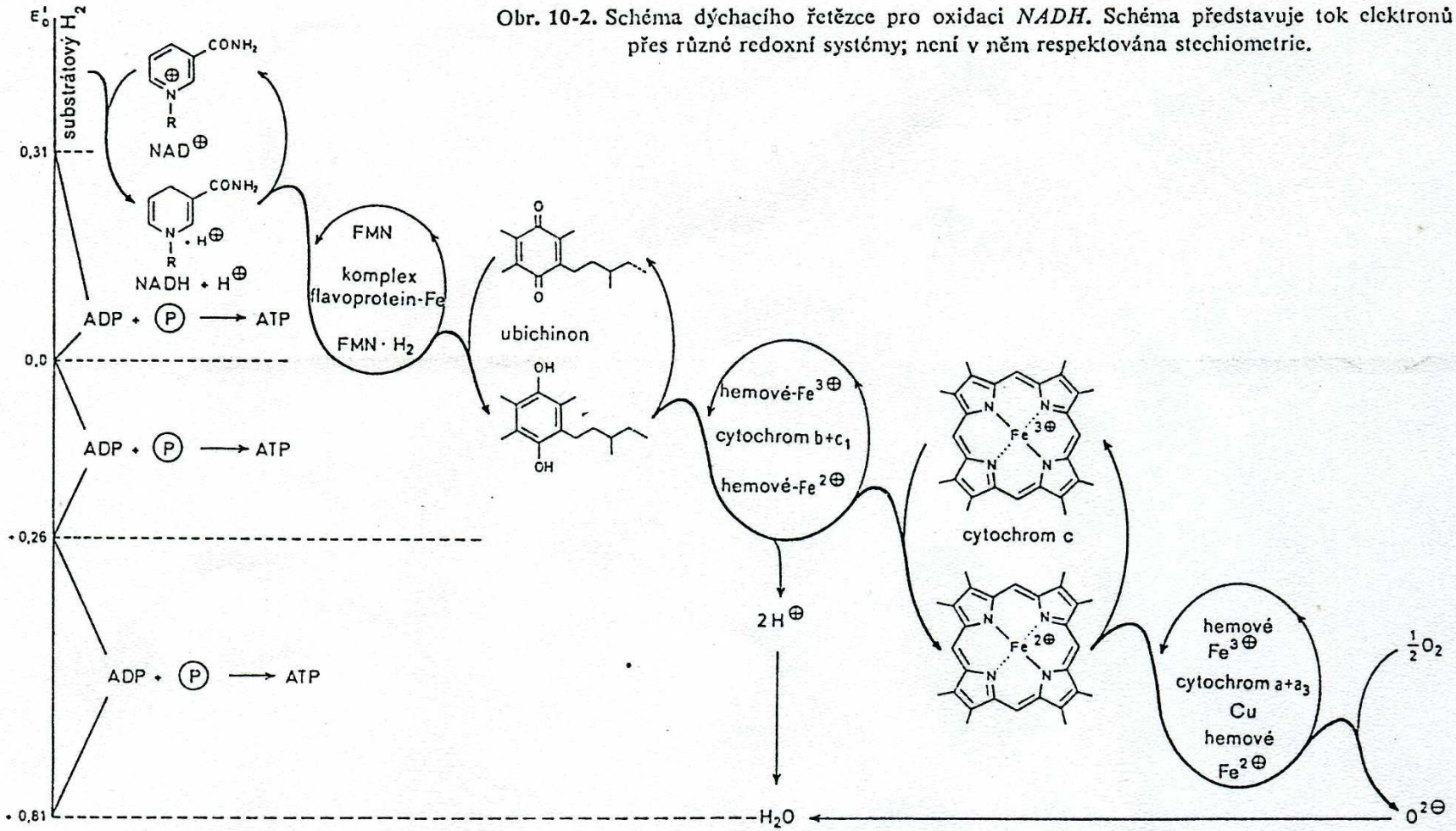

chloroplast stroma
H+
ATP
ADP
Pi
NADP
H+
NADPH
ferredoxin-NADP reductase
light
H+
cytochrome
light
e-
FNR
Fd
ferredoxin
ATP synthase
P680
e-
PSII
PQ
PQH2
b6f
P700
PSI
e-
e-
plastoquinone
PC
plastocyanin
H+
H+
H2O
O2
H+
oxygen-evolving complex
thylakoid lumen

Mitochondrial Electron Transport Chain



BIOCHEMICKÁ ENERGETIKA





Obr. 10-2. Schéma dýchacího řetězce pro oxidaci *NADH*. Schéma představuje tok elektronů přes různé redoxní systémy; není v něm respektována stechiometrie.

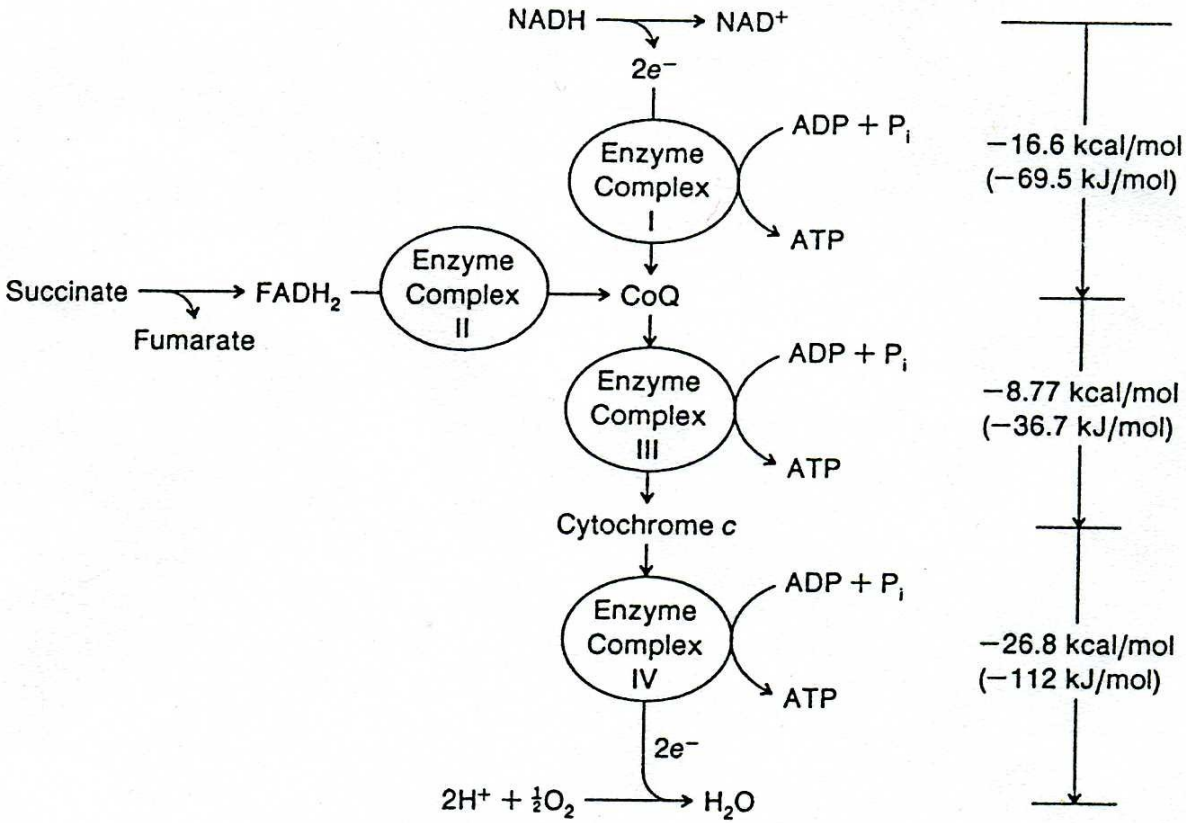


FIGURE 25.4
The enzyme complexes of the respiratory chain and the energy drop from NAD^+ to reduced oxygen (water). The figures for energy refer to the portion of the energy change that is not unavoidably dissipated as heat. The symbols for the enzymes are as follows.

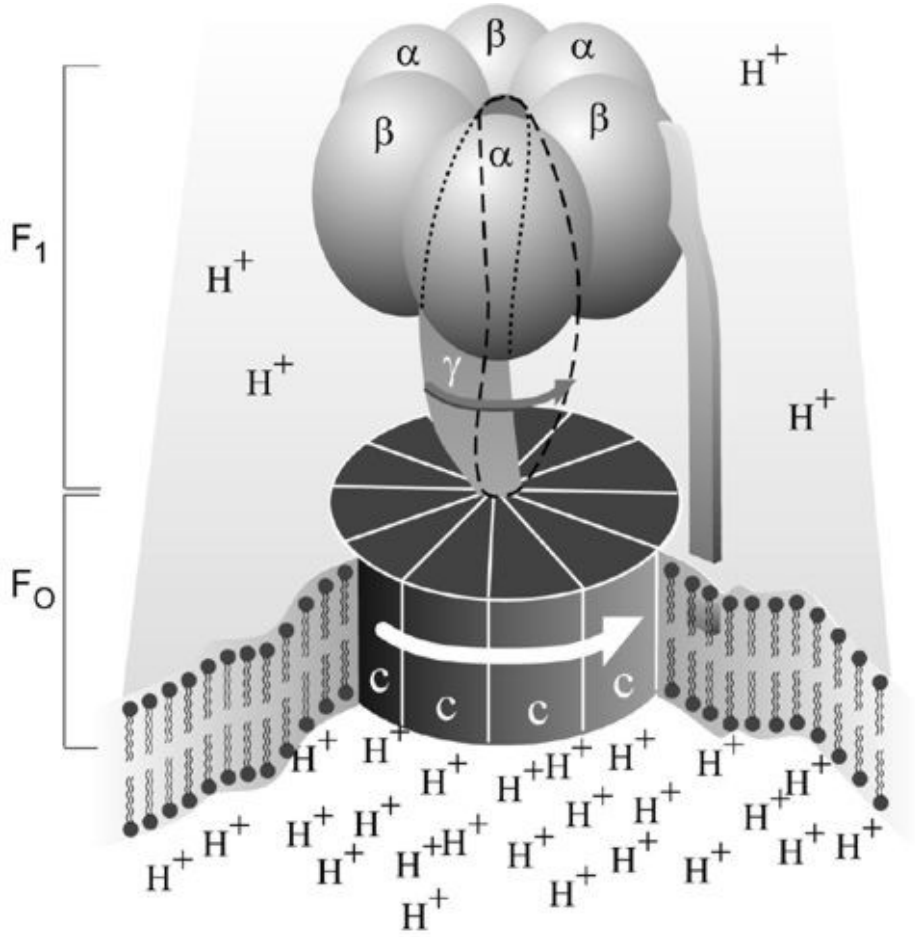
NADH = enzyme with reduced nicotinamide cofactor

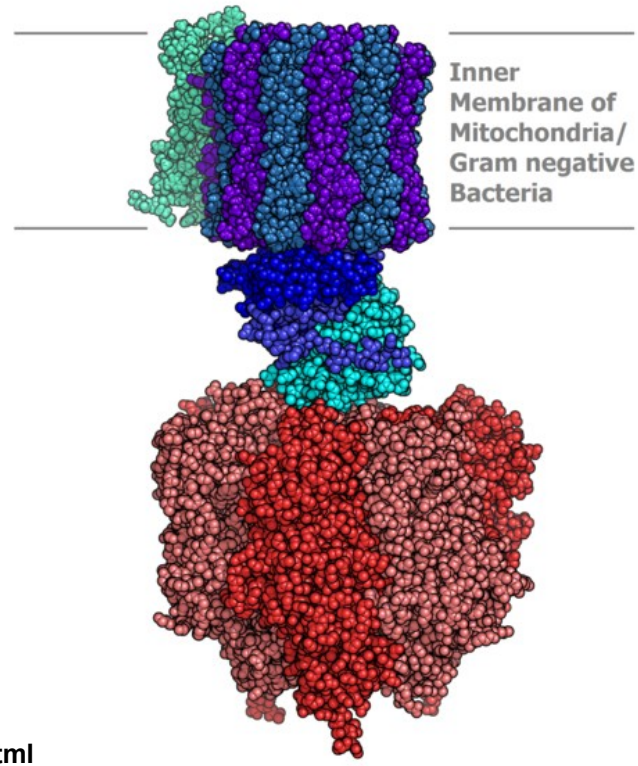
$FADH_2$ = enzyme with reduced riboflavin cofactor

CoQ = enzyme with coenzyme *Q* cofactor

BIOCHEMICKÁ ENERGETIKA

ATP synthasa





http://www.sumanasinc.com/webcontent/animations/content/atpsynthase.html