1.89, Environmental Microbiology
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Lecture 8

Biosynthesis & Fueling

1. Energy: all energy generation in biological systems is based on Redox reactions.

Example: $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ (e^- donor; e^- acceptor) can separate into $\frac{1}{2}$ reactions

$+ H_2 \rightarrow 2e^- + 2H^+$

$\frac{1}{2} O_2 + 2e^- \rightarrow O_2^{2-}$

Electron tower = conceptualization for quick assessment about whether energy generation from specific combinations is possible.
→ $\frac{1}{2}$ reactions according to reduction potential E_o' (per e^-)

$AG = -n E_o' F = -nEF$
- F → Faraday constant
- E → Reduction potential
- n → Number of e^- transferred in full reaction

(oxidized on left, reduced on right)

Energy currency: (ATP)

Between CM and e^- transport chain (want oxidized form)

want reduced form

Electron carriers: (NADH) (fueling reactions) & (NADPH) (biosynthesis reactions)

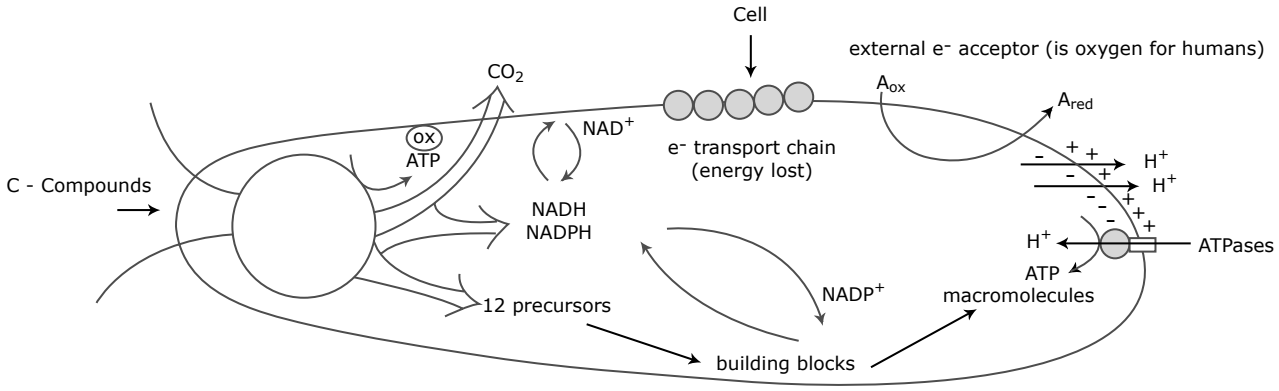
One goal of metabolism is to regenerate these compounds:
- NAD^+/NADH → often is half reaction in the oxidation of C-substrates inside the cell
- $NADP^+$/NADPH → reductant in biosynthesis

Energy generation/use & carbon flow within cells:
- In bacteria, you need to conceptually separate energy & carbon flow

Carbon:
- Heterotrophy: biomass generated from organic carbon.
- Autotrophy: biomass generated from CO_2.

Energy:
- Chemotrophy: energy derived from oxidation of (organic or inorganic) chemicals.
- Phototrophy: energy derived from light.

A. Chemoheterotrophy



exception – fermentation

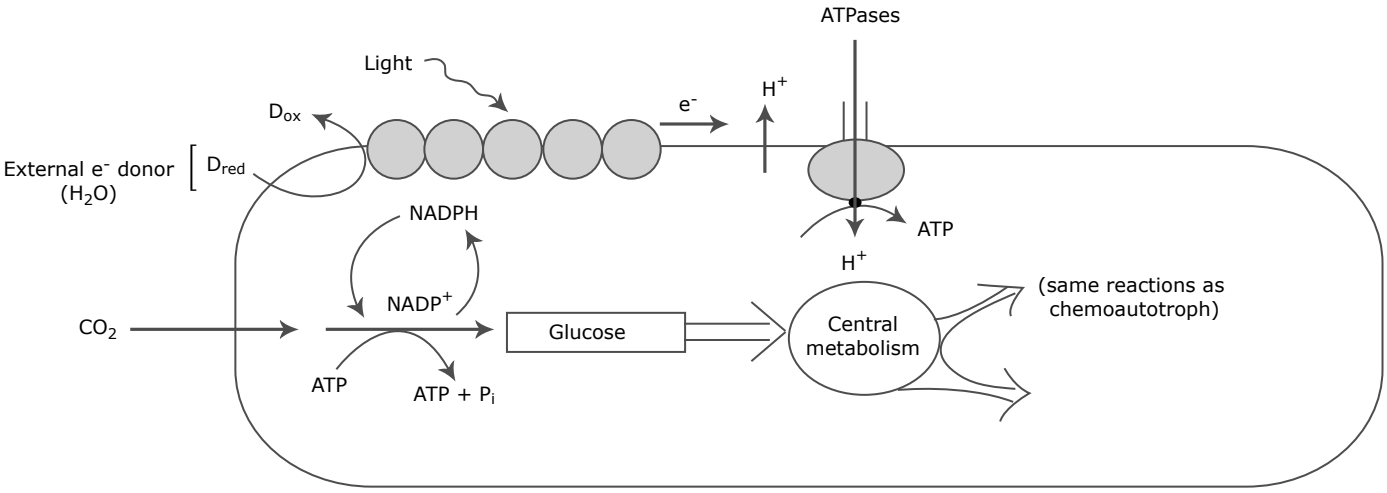
<u>Energy currency</u> – ATP

2 mechanisms of ATP generation

1. e^- transport chain phosphorylation: electrochemical gradient across membrane is equilibrated through ATPases → synthesize ATP (reversible!)

2. substrate level phosphorylation in cell membrane has 3 phosphorylated intermediates → can transfer ~ Ⓟ to ADP

B. Photoautotrophy



- NADPH comes from a reaction in which light energy is used to drive the e^- transport chain
- NADH → involved in respiration & fermentation
- NADPH → involved in biosynthesis reactions

Autotrophs just start a little earlier with CO_2. Autotrophs fix CO_2 into organic C (example glucose), which is then converted to 12 precursors (or also respired during darkness) via central metabolism. Autotrophs have central metabolism, like heterotrophs.

Central Metabolism

4 sets of reactions: Glycolysis (EMP pathway)