Course 2851 Principles of Metabolism
Metabolism and endocrinology programme, Karolinska Institutet

Lecture 10
Respiration

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What's a good way to oxidize NADH ?

NADH oxidation by O_2 releases a large amount of energy

$$NADH + H^+ + \tfrac{1}{2} O_2 \xrightarrow{2\,e^-} NAD^+ + H_2O$$

$\Delta E = 1.14 V$
$\Delta G = -220$ kJ / mol

electrons transferred — Faraday constant, 96.48 kJ / V / mol

$$\Delta G = -n F \Delta E$$

Use a "chain" of redox reactions, with oxygen as the terminal e- acceptor.

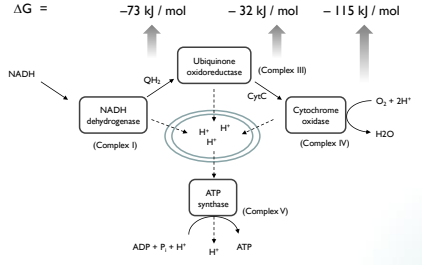
$$NADH + H^+ + Q \xrightarrow{2\,e^-} NAD^+ + QH_2 \qquad \Delta G = -2 F * 0.38 V = -73 \text{ kJ / mol}$$

$$QH_2 + 2\,CytC(ox) \xrightarrow{2\,e^-} Q + 2\,CytC(red) + 2\,H^+ \qquad \Delta G = -2 F * 0.16 V = -32 \text{ kJ / mol}$$

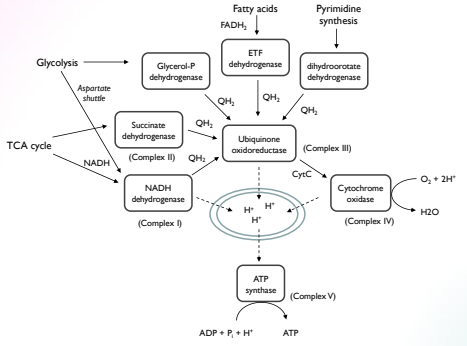
$$2\,CytC(red) + \tfrac{1}{2} O_2 + 2\,H^+ \xrightarrow{2\,e^-} CytC(ox) + H_2O \qquad \Delta G = -2 F * 0.60 V = -115 \text{ kJ / mol}$$

Chemiosmosis: capturing energy as a proton gradient

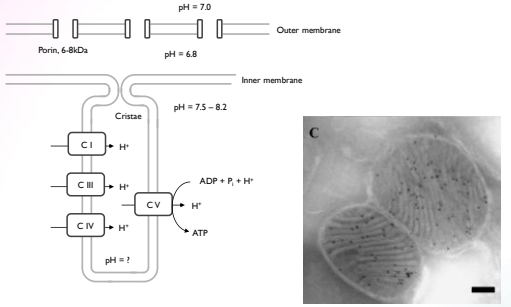
Respiratory chain converts chemical to potential energy



The respiratory "hub"



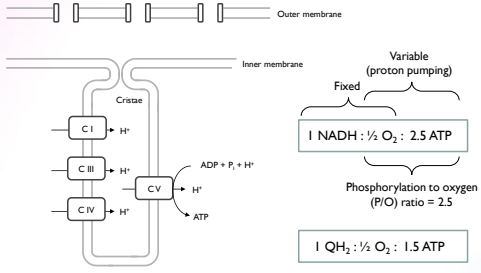
Location, location



Complex III localization in bovine heart mitochondria.

Manella et al, IUBMB Life 52:93—100, 2001.
Gellerich et al, Biochem soc trans 28:164—169, 2000.
Gilkerson et al, FEBS Letters 546:355-358, 2003.

Stochiometry of respiration

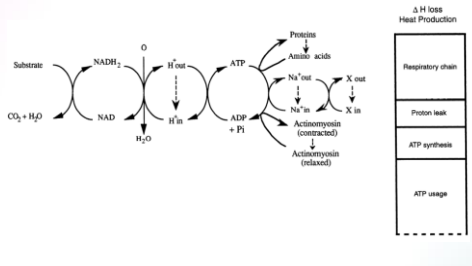


Example: pyruvate oxidation

4 NADH + 1QH_2 → 11.5 ATP

Adjustable thermodynamics

- Respiration is the source of most metabolic heat production
- The ATP yield/rate of the respiratory chain can be adjusted



Rolfe & Brown, Physiological reviews 77:731—758, 1997