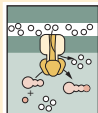(A)

ATP synthesis
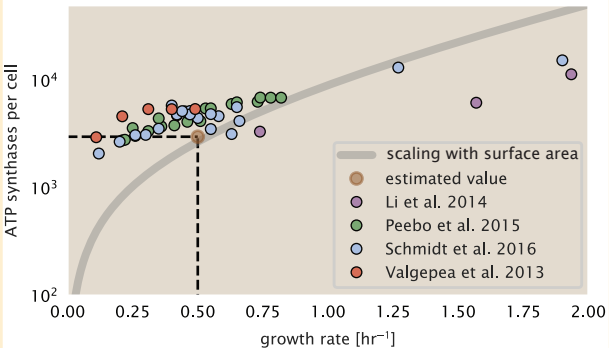

$N_{\text{peptide bonds}} \approx 3\times10^6 \text{ proteins} \times \dfrac{300 \text{ peptide bonds}}{1 \text{ protein}}$

$\sim 10^9 \text{ peptide bonds}$

$N_{\text{ATP}} \approx \dfrac{4 \text{ ATP}}{\text{peptide bond}} \times 10^9 \text{ peptide bonds} \sim 5\times10^9 \text{ ATP}$
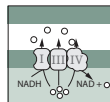
BNID: 101442

$r_{\text{ATP synthesis}} \approx \dfrac{300 \text{ ATP / sec}}{\text{synthase}}$ BNID: 114701

$N_{\text{ATP synthases}} \approx \dfrac{5\times10^9 \text{ ATP}}{1 \text{ cell}} \times \dfrac{1 \text{ sec}\times\text{synthase}}{300 \text{ ATP}} \times \dfrac{1 \text{ cell}}{5000 \text{ sec}} \approx 3000 \dfrac{\text{synthases}}{\text{cell}}$

(B)

maintenance of proton gradient

BNID: 114701   BNID: 101442

$r_{\text{proton use for ATP synthesis}} \approx N_{\text{ATP synthases}} \times \dfrac{300 \text{ ATP}}{1 \text{ sec}} \times \dfrac{4 \text{ protons}}{1 \text{ ATP}}$

$\sim 5\times10^6 \dfrac{\text{protons}}{\text{sec}}$

$r_{\text{proton transport}} \approx 1500 \dfrac{\text{protons / sec}}{\text{electron transport chain}}$ BNID: 114704
BNID: 114687

$N_{\text{electron transport chains}} \approx \dfrac{5\times10^6 \text{ protons}}{1 \text{ sec}\times\text{cell}} \times \dfrac{1 \text{ sec}\times\text{electron transport chain}}{1500 \text{ protons}}$

$\approx 3000 \text{ electron transport chains / cell}$