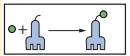
(A)

tRNA charging

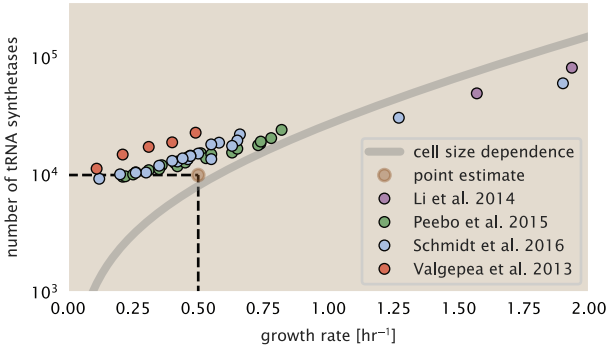


$$N_{\text{amino-acyl tRNA}} \approx 3\times10^{6}\ \text{proteins} \times \frac{300\ \text{amino acids}}{1\ \text{protein}} \times \frac{1\ \text{amino-acyl tRNA}}{1\ \text{amino acid}} \approx 10^{9}\ \text{amino-acyl tRNAs}$$

$$r_{\text{tRNA supply}} \approx \frac{N_{\text{amino-acyl tRNA}}}{t_{\text{division}}} = \frac{10^{9}\ \text{amino-acyl tRNAs}}{5{,}000\ \text{sec}} = 2\times10^{5}\ \text{amino-acyl tRNAs}$$

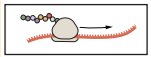
$$r_{\text{tRNA charging}} \approx 20\ \text{amino-acyl tRNA / tRNA synthetase} \times \text{sec}$$ BNID: 105279

$$N_{\text{tRNA synthetase}} \approx \frac{r_{\text{tRNA supply}}}{r_{\text{tRNA charging}}} \approx 10^{4}\ \text{tRNA synthetases}$$



(B)

translation



$$N_{\text{peptide bonds}} \approx 3\times10^{6}\ \text{proteins} \times \frac{300\ \text{amino acids}}{1\ \text{protein}} \times \frac{1\ \text{peptide bond}}{1\ \text{amino acid}} \approx 10^{9}\ \text{peptide bonds}$$

$$r_{\text{translation}} \approx 15\ \text{peptide bonds / ribosome} \times \text{sec}$$ BNID: 109043

$$N_{\text{ribosomes}} \approx \frac{N_{\text{peptide bonds}}}{r_{\text{translation}} \times t_{\text{division}}} \approx 1.5\times10^{4}\ \text{ribosomes}$$