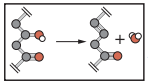
CELL ENVELOPE BIOSYNTHESIS

(A)

lipid synthesis



$A_{surface} \approx 5\ \mu m^2$ BNID: 101792

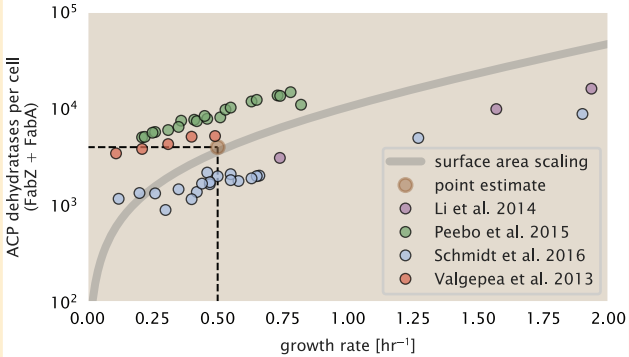
$A_{lipid} \approx 0.5\ nm^2$ BNID: 106993

$A^{(lipid)}_{surface} \approx 40\%$ BNID: 100078

$$N_{lipids} \approx \frac{4\ leaflets}{1\ cell} \times \frac{0.4 \times 5\ \mu m^2}{1\ leaflet} \times \frac{1\ lipid}{0.5\ nm^2} \times \frac{10^6\ nm^2}{1\ \mu m^2} \sim 2 \times 10^7\ lipids\ /\ cell$$

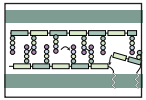
$r_{ACP\ dehydratase} \approx 1\ lipid\ /\ sec$ Ruppe & Fox 2018; Fiers et al. 2016; Heath et al. 1996

$$N_{ACP\ dehydratases} \approx \frac{2 \times 10^7\ lipids}{1\ cell} \times \frac{1\ sec \times enzyme}{1\ lipid} \times \frac{1\ cell}{5000\ sec} \approx 4000\ \frac{ACP\ dehydratases}{cell}$$



(B)

peptidoglycan synthesis



$m_{peptidoglycan} \approx 0.03 \times m_{dry} \approx 10\ fg$ BNID: 101936

$m_{amino\ acid} \approx 110\ Da$ BNID: 104877

$m_{murein\ sugar} \approx 250\ Da$ average molecular weight GlcNac and NAMA

$$m_{monomer} \approx 5 \times m_{amino\ acid} + 2 \times m_{murein\ sugar} \approx 1000\ Da$$

$$N_{monomer} \approx \frac{10\ fg}{1\ cell\ wall} \times \frac{1\ monomer}{1000\ Da} \times \frac{5 \times 10^8 Da}{1\ fg} \approx \frac{5 \times 10^6\ monomers}{cell\ wall}$$

$N_{crosslinks} \approx 0.2 \times N_{murein\ monomers} \sim 10^6\ crosslinks$ Vollmer et al. 2008; Rogers et al. 1980

$r_{transpeptidase} \approx 2\ crosslinks\ /\ sec$ Catherwood et al. 2020

$$N_{transpeptidases} \approx \frac{10^6\ crosslinks}{1\ cell} \times \frac{1\ sec \times enzyme}{2\ crosslinks} \times \frac{1\ cell}{5000\ sec} \approx 100\ \frac{transpeptidases}{cell}$$