Appendix B. Parameters

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Abstract

This appendix show the parameters we applied to the model we establish. The parameters are determined by model assumptions, references, and estimation calculation.

1 Model Review

1.1 Oleic acid induction system

$$\begin{aligned}
\frac{dR}{dt} &= r_{\mathrm{x,R}} - r_{\mathrm{seq}} - \lambda\left(E_{\mathrm{g}}\right) R, \\
\frac{dD}{dt} &= r_{\mathrm{x,D}} - \lambda\left(E_{\mathrm{g}}\right) D, \\
\frac{dA}{dt} &= r_{\mathrm{D}} - r_{\mathrm{B}} - 2 \cdot r_{\mathrm{seq}} - \lambda\left(E_{\mathrm{g}}\right) A, \\
\frac{dC}{dt} &= r_{\mathrm{seq}} - \lambda\left(E_{\mathrm{g}}\right) C, \\
\frac{dE_{\mathrm{g}}}{dt} &= r_{\mathrm{x},E_{\mathrm{g}}} - \lambda\left(E_{\mathrm{g}}\right) \cdot E_{\mathrm{g}}, \\
\frac{dF}{dt} &= r_{\mathrm{f}}.
\end{aligned} \tag{1}$$

1.2 Comparison of oleic acid inducer with native circuit

$$\text{Native circuit} : P_{\mathrm{R}}(R) = \frac{a_{\mathrm{R}}}{1 + K_{\mathrm{R}} R} \tag{2}$$

$$\text{Oleic acid inducer} : P_{\mathrm{R}}(R) = \begin{cases} \frac{a_{\mathrm{R}}}{1+K_{\mathrm{R}}R}, & \text{for } R > \frac{1}{K_p} = 0.0033\mu\mathrm{M} \cdot \mathrm{h}^{-1} \\ \frac{a_{\mathrm{R}}K_{\mathrm{R}}R}{1+K_{\mathrm{R}}R}, & \text{for } R \leq \frac{1}{K_p} = 0.0033\mu\mathrm{M} \cdot \mathrm{h}^{-1} \end{cases} \tag{3}$$

1.3 Parameter estimation

$$\begin{gathered}
AFI = \frac{RFI}{OD600} \\
\text{Corrected } AFI_{n\%} = AFI_{n\%} - Empty
\end{gathered} \tag{4}$$

$$\text{Exp } F_{n\%} = A \cdot AFI_{n\%} + B \tag{5}$$

2 Parameters

Parameter description	Term	Value	Units	Reference
Forward sequestration	k_{f}	612.55	$\mu\mathrm{M}^{-2}\cdot\mathrm{h}^{-1}$	[2]
Reverse sequestration	k_{r}	900.73	h^{-1}	[2]
PlsB turnover rate	$k_{\mathrm{cat\ ,B}}$	192.91	h^{-1}	[2]
FadD turnover rate	$k_{\mathrm{cat\ ,D}}$	49	h^{-1}	[2]
FadR'strength to promote itself(NAR)	a_{R}	0.0131	$\mu\mathrm{M}\cdot\mathrm{h}^{-1}$	[2]
FadR leaky expression (NAR)	b_{R}	0.0007	$\mu\mathrm{M}\cdot\mathrm{h}^{-1}$	[2]
FadD'strength to promote itself	a_{D}	0.0517	$\mu\mathrm{M}\cdot\mathrm{h}^{-1}$	[2]
FadD leaky expression	b_{D}	0.0108	$\mu\mathrm{M}\cdot\mathrm{h}^{-1}$	[2]
FadR affinity to own promoter (NAR)	K_{R}	4.3222	$\mu\mathrm{M}^{-1}$	[2]
FadR affinity to fadD	K_{D}	305.95	$\mu\mathrm{M}^{-1}$	[2]
Michaelis constant	$K_{\mathrm{m,B}}$	45429	$\mu\mathrm{M}$	[2]
Michaelis constant	$K_{\mathrm{m,D}}$	0.0672	$\mu\mathrm{M}$	[2]
PlsB concentration	B	0.1369	$\mu\mathrm{M}$	[2]
Cell growth parameter	$\lambda_{\max}$	0.1818	h^{-1}	[2], E. coli DH1Δ fadE strain.
E_{g} promoter strength	a_{g}	$\lambda_{\max}$	$\mu\mathrm{M}\cdot\mathrm{h}^{-1}$	To ensure full express at $\lambda_{\max}$.
FadR'strength to promote itself(PAR)	a_{R}	0.0131	$\mu\mathrm{M}\cdot\mathrm{h}^{-1}$	Same as NAR by assumption
FadR leaky expression (PAR)	b_{R}	0.0007	$\mu\mathrm{M}\cdot\mathrm{h}^{-1}$	Same as NAR by assumption
Decrease paramameter in growth	s_{T}	0.7	–	[3], By pgi down-regulation.
FadR affinity to own promoter (PAR)	K_{R}	4.3222×7	$\mu\mathrm{M}^{-1}$	Multiple times the value of NAR
FadR affinity to E_{g} promoter	K_{g}	$=K_{\mathrm{R}}=$ 4.9114	$\mu\mathrm{M}^{-1}$	the same promoter as FadR with PAR
Affinity of FadR for prod synthesis enzyme E_{p}	K_{p}	$=K_{\mathrm{D}}=$ 305.95	$\mu\mathrm{M}\cdot\mathrm{h}^{-1}$	[1], Designed with FadR operator site from fadD promoter.
Aerobic coefficient	A_{ae}	1.59	–	Parameter estimation calculation
Aerobic intercept	B_{ae}	1.82	–	Parameter estimation calculation
Anaerobic coefficient	A_{an}	1.73	–	Parameter estimation calculation
Anaerobic intercept	B_{an}	0.98	–	Parameter estimation calculation

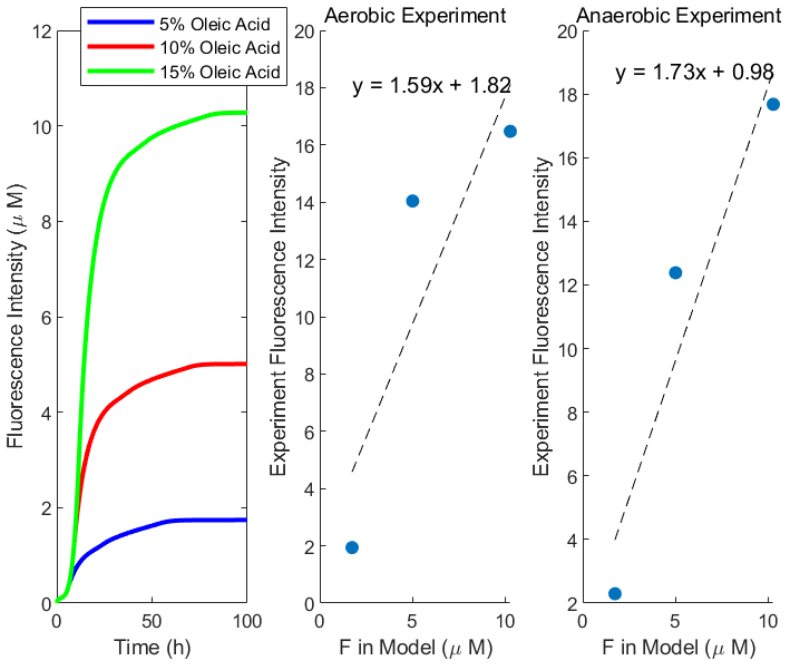

Figure 1: Parameter estimation by measuring the fluorescence intensity and fitting