AraC-LacI circuit Model

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Variables:

A: Concentration of AraC
L: Concentration of LacI
G: Concentration of GFP
I: Concentration of IPTG
L_A: Concentration of L-Arabinose

Parameters:

P: Strengh of the consecutive promoter at the upstream of AraC
a_{BAD}: Protein synthesis coefficient of p_{BAD} promoter
a_{LacI}: Protein synthesis coefficient of $LacI$ promoter
b_{BAD}: Basal expression of the p_{BAD} promoter
b_{LacI}: Basal expression of the $LacI$ promoter
K_{deg}^{AraC}: Degradation rate of AraC
K_{deg}^{LacI}: Degradation rate of LacI
K_{deg}^{GFP}: Degradation rate of GFP
K_L: L-arabinose dissociation constant
n_L: L-arabinose cooperativity
K_{BAD}: pBAD binding affinity
n_{BAD}: pBAD cooperativity
K_I: IPTG dissociation constant
n_I: IPTG cooperativity
K_{LacI}: pLacI binding affinity
n_{LacI}: LacI cooperativity

Equations

$\frac{dA}{dt} = P - K_{deg}^{AraC} A$

$\theta_1 = \frac{K_L^{n_L}}{L_A^{n_L} + K_L^{n_L}}$

$\frac{dL}{dt} = b_{BAD} + \frac{a_{BAD}}{1 + K_{BAD}(\theta_1 A)^{n_{BAD}}} - K_{deg}^{L} L$

$\theta_2 = \frac{K_I^{n_I}}{I^{n_I} + K_I^{n_I}}$

$\frac{dG}{dt} = b_{LacI} + \frac{a_{LacI}}{1 + K_{LacI}(\theta_2 L)^{n_{LacI}}} - K_{deg}^{GFP} G$

Parameters	Values	Units	References
P	0.9		+
a_{BAD}	0.8		+
a_{LacI}	0.11		+
b_{BAD}	0.05		+
b_{LacI}	0.0005		+
K_{deg}^{AraC}	0.04	min^{-1}	+
K_{deg}^{LacI}	0.0693	min^{-1}	[1]
K_{deg}^{GFP}	0.0063	min^{-1}	[3]
K_L	0.0014		+
n_L	1.7		+
K_{BAD}	80		+
n_{BAD}	1.5		+
K_I	193		+
n_I	1		[2]
K_{LacI}	205		+
n_{LacI}	2		[2]

References

[1] Subhayu Basu. A synthetic multicellular system for programmed pattern formation. *Nature*, 2005.

[2] Sergio Iadevaia and Nikos V. Mantzaris. Genetic network driven control of PHBV copolymer composition. *Journal of Biotechnology*, 2006.

[3] Andersen JB, Sternberg C, Poulsen LK, Bjorn SP, Givskov M, Molin S. New Unstable Variants of Green Fluorescent Protein for Studies of Transient Gene Expression in Bacteria. *Appl Environ Microbiol*. 1998.