iGEM 2006 – University of Toronto/University of Waterloo Cell-See-Us Project Model

<u>System as a set of Reactions</u>

Translation

$$M_{RFP} \xrightarrow{\beta_{RFP}} M_{RFP} + RFP$$

$$M_{GFP} \xrightarrow{\beta_{GFP}} M_{GFP} + GFP$$

$$M_{tetR} \xrightarrow{\beta_{tetR}} M_{tetR} + tetR$$

$$M_{LacI} \xrightarrow{\beta_{LacI}} M_{LacI} + LacI2$$

Degradation

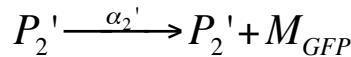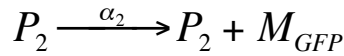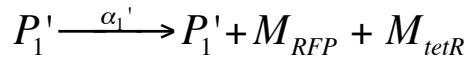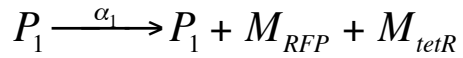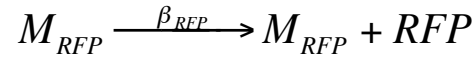$$RFP \xrightarrow{\delta_{RFP}} \varnothing$$

$$GFP \xrightarrow{\delta_{GFP}} \varnothing$$

$$LacI4 \xrightarrow{\delta_{LacI2}} \varnothing$$

$$LacI2 \xrightarrow{\delta_{LacI}} \varnothing$$

$$tetR \xrightarrow{\delta_{tetR}} \varnothing$$

$$M_{RFP} \xrightarrow{\delta_{mRFP}} \varnothing$$

$$M_{GFP} \xrightarrow{\delta_{mGFP}} \varnothing$$

$$M_{tetR} \xrightarrow{\delta_{mtetR}} \varnothing$$

$$M_{LacI} \xrightarrow{\delta_{mLacI}} \varnothing$$

Promoter Binding

$$LacI4 + P_1 \underset{\theta_1}{\overset{\gamma_1}{\longleftrightarrow}} P_1{}'$$

$$tetR + P_2 \underset{\theta_2}{\overset{\gamma_2}{\longleftrightarrow}} P_2{}'$$

$$araC + P_L \underset{\theta_L}{\overset{\gamma_L}{\longleftrightarrow}} P_L{}'$$

Transcription

$$P_1 \xrightarrow{\alpha_1} P_1 + M_{RFP} + M_{tetR}$$

$$P_1{}' \xrightarrow{\alpha_1{}'} P_1{}' + M_{RFP} + M_{tetR}$$

$$P_2 \xrightarrow{\alpha_2} P_2 + M_{GFP}$$

$$P_2{}' \xrightarrow{\alpha_2{}'} P_2{}' + M_{GFP}$$

$$P_L \xrightarrow{\alpha_L} P_L + M_{LacI}$$

$$P_L{}' \xrightarrow{\alpha_L{}'} P_L{}' + M_{LacI}$$
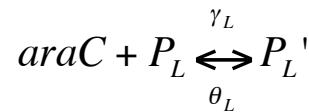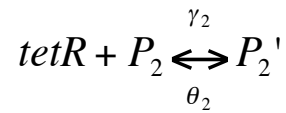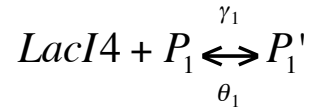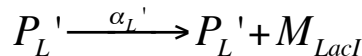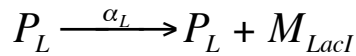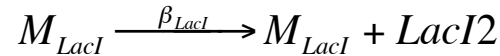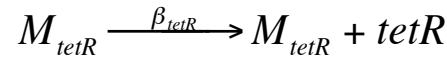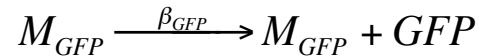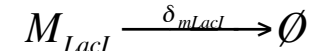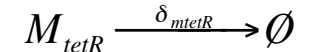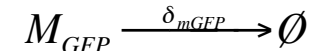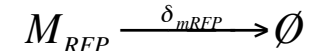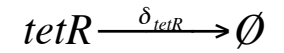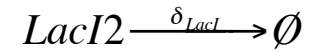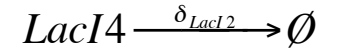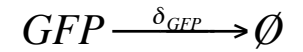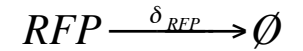
Control and Auxilliary Mechanisms

$$LacI2 + LacI2 \underset{k_{LacI}}{\overset{K_{LacI}}{\longleftrightarrow}} LacI4$$

$$LacI4 + IPTG \underset{k_{LacI4}}{\overset{K_{LacI4}}{\longleftrightarrow}} LacI4IPTG$$

$$tetR + aTc \underset{k_{aTc}}{\overset{K_{aTc}}{\longleftrightarrow}} tetRaTc$$

$$arabinose + araC \underset{k_{araC}}{\overset{K_{araC}}{\longleftrightarrow}} araC'$$
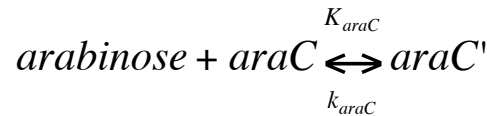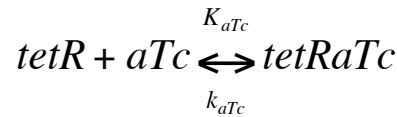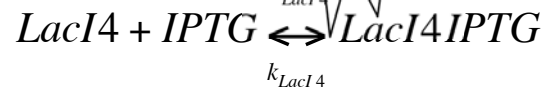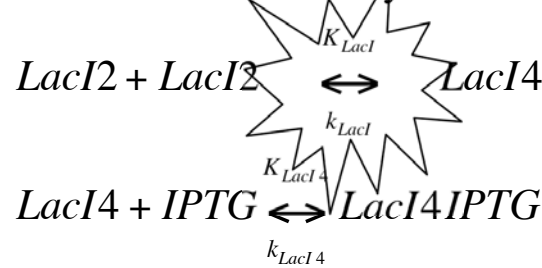
Translated into a System of Ordinary Differential Equation

$$\frac{d[LacI2]}{dt} = -\delta_{LacI}[LacI2] + \beta_L[M_{LacI}] - K_{Lac}[LacI2]^2 + k_{Lac}[LacI4]$$

$$\frac{d[LacI4]}{dt} = -\delta_{LacI2}[LacI4] + K_{Lac}[LacI2]^2 - k_{Lac}[LacI4] - K_{LacI4}[LacI4][IPTG] + k_{LacI4}[LacI4IPTG]$$

$$\frac{d[LacI4IPTG]}{dt} = K_{LacI4}[LacI4][IPTG] - k_{LacI4}[LacI4IPTG]$$

$$\frac{d[tetR]}{dt} = -\delta_{tetR}[tetR] + \beta_T[M_{tetR}] - K_{aTc}[tetR][aTc] + k_{aTc}[tetRaTc] - \gamma_2[tetR][P_2] + \theta_2[P_2']$$

$$\frac{d[aTc]}{dt} = -\frac{d[tetRaTc]}{dt} = -K_{aTc}[tetR][aTc] + k_{aTc}[tetRaTc]$$

$$\frac{d[RFP]}{dt} = -\delta_{RFP}[RFP] + \beta_1[M_{RFP}]$$

$$\frac{d[GFP]}{dt} = -\delta_{GFP}[GFP] + \beta_2[M_{GFP}]$$

$$\frac{d[IPTG]}{dt} = -K_{LacI4}[LacI4][IPTG] + k_{LacI4}[LacI4IPTG]$$

$$\frac{d[M_{RFP}]}{dt} = -\delta_{mRFP}[M_{RFP}] + \alpha_1[P_1] + \alpha_1'[P_1'] + \alpha_1''[P_1'']$$

$$\frac{d[M_{GFP}]}{dt} = -\delta_{mGFP}[M_{GFP}] + \alpha_2[P_2] + \alpha_2'[P_2']$$

$$\frac{d[M_{tetR}]}{dt} = -\delta_{mTetR}[M_{tetR}] + \alpha_1[P_1] + \alpha_1'[P_1'] + \alpha_1''[P_1'']$$

$$\frac{d[M_{LacI}]}{dt} = -\delta_{mLacI}[M_{LacI}] + \alpha_L[P_L] + \alpha_L'[P_L']$$

$$\frac{d[P_1]}{dt} = -\gamma_1[LacI4][P_1] + \theta_1[P_1']$$

$$\frac{d[P_1']}{dt} = \gamma_1[LacI4][P_1] - \theta_1[P_1']$$

$$\frac{d[P_2]}{dt} = -\frac{d[P_2']}{dt} = -\gamma_2[tetR][P_2] + \theta_2[P_2']$$

$$\frac{d[P_L]}{dt} = -\frac{d[P_L']}{dt} = -\gamma_L[araC][P_L] + \theta_L[P_L']$$

$$\frac{d[araC]}{dt} = -K_{araC}[arabinose][araC] + k_{araC}[araC'] - \gamma_L[araC][P_L] + \theta_L[P_L']$$

$$\frac{d[araC']}{dt} = K_{araC}[arabinose][araC] - k_{araC}[araC']$$