

MODEL EQUATIONS

1. ORDINARY DIFFERENTIAL EQUATIONS

$$\frac{d}{dt}([PhoR] + [PhoR^R]) = k_R[mRNA_R] - V_{ra} + V_{ba} - (k_{dR} + \mu)([PhoR] + [PhoR^R]) \quad (\text{eq.1})$$

$$\frac{d[PhoR^A]}{dt} = V_{ra} - V_{ba} - (k_{dR} + \mu)[PhoR^A] \quad (\text{eq.2})$$

$$\frac{d[PhoR^A]}{dt} = V_{ba} - (k'_{-ba} + k_{dB} + \mu)[PhoB^A] \quad (\text{eq.3})$$

$$\frac{d[PhoB]}{dt} = k_B[mRNA_B] - V_{ba} - (k_{dB} + \mu)[PhoB] \quad (\text{eq.4})$$

$$\frac{d}{dt}([PhoU] + [PhoR^R]) = k_U[mRNA_U] - (k_{dU} + \mu)([PhoU] + [PhoR^R]) \quad (\text{eq.5})$$

$$\frac{d}{dt}([PstS] + [PhoR^R]) = k_S[mRNA_S] - (k_{dS} + \mu)([PstS] + [PhoR^R]) \quad (\text{eq.6})$$

$$\frac{d[mRNA_R]}{dt} = V_{mRNA2} - (k_{dRNA} + \mu)[mRNA_R] \quad (\text{eq.7})$$

$$\frac{d[mRNA_B]}{dt} = V_{mRNA2} - (k_{dRNA} + \mu)[mRNA_B] \quad (\text{eq.8})$$

$$\frac{d[mRNA_U]}{dt} = V_{mRNA3} - (k_{dRNA} + \mu)[mRNA_U] \quad (\text{eq.9})$$

$$\frac{d[mRNA_S]}{dt} = V_{mRNA3} - (k_{dRNA} + \mu)[mRNA_S] \quad (\text{eq.10})$$

$$\frac{d[P_{int}]}{dt} = V_{in,pit} - V_{out,pit} + V_{in,pst} - \mu \left([P_{int}] + \frac{1}{V_{cell} \frac{V_x'}{p}} \right) \quad (\text{eq.11})$$

$$\frac{d[P_s]}{dt} = V_{mt} + V_{out,pit} - V_{in,pit} - V_{in,pst} \quad (\text{eq.12})$$

$$\frac{dX}{dt} = \mu X \quad (\text{eq.13})$$

$$\frac{d[P_{ext}]}{dt} = -\frac{V_{cell}}{V_{culture}} \frac{d}{dt} ([P_s] + [P_{int}]) \quad (\text{eq.14})$$

$$\frac{d[mRNA_{lacI}]}{dt} = V_{mRNA4} - (d_{RNA} + \mu)[mRNA_{lacI}] \quad (\text{eq.15})$$

$$\frac{d[lacI]}{dt} = k_{lacI} [mRNA_{lacI}] - (k_{dlacI} + \mu)[lacI] \quad (\text{eq.16})$$

$$\frac{d[mRNA_{GFP}]}{dt} = V_{mRNA4} - (k_{dmGFP} + \mu)[mRNA_{GFP}] \quad (\text{eq.17})$$

$$\frac{d[GFP]}{dt} = k_{GFP} [mRNA_{GFP}] - (k_{dGFP} + \mu)[GFP] \quad (\text{eq.18})$$

$$\frac{d[mRNA_{RFP}]}{dt} = \frac{c1}{1 + \left(\frac{[lacI]}{K_{lacI}}\right)} - (k_{dmRFP} + \mu)[mRNA_{RFP}] \quad (\text{eq.19})$$

$$\frac{d[RFP]}{dt} = k_{RFP} [mRNA_{RFP}] - (k_{dRFP} + \mu)[RFP] \quad (\text{eq.20})$$

2. NON-DIFFERENTIAL EQUATIONS

$$[PhoB_{free}^A] = \frac{[PhoB^A]}{1 + \frac{4[P_n]}{K_{Mpro}} + \frac{[DNA]}{K_{MDNA}}} \quad (\text{eq.21})$$

$$[P_1:B^A] = [P_2:B^A] = [P_3:B^A] = [P_4:B^A] = \frac{[P_n][PhoB_{free}^A]}{K_{Mpro}} \quad (\text{eq.22})$$

$$\eta_n = \frac{[P_n:B^A]}{4[P_n]} \quad (\text{eq.23})$$

$$V_{mRNA_n} = k_{base} + \eta_n k_{mRNA} \quad (\text{eq.24})$$

$$\mu = \frac{\mu_{max} [P_{int}]}{K_s + [P_{int}]} \quad (\text{eq.25})$$

$$V_{mt} = k_m S_V \left(\frac{V_{culture}}{V_{cell}} [P_{ext}] - [P_s] \right) \quad (\text{eq.26})$$

$$V_{in,pit} = \frac{k_{in,pit} [P_s]}{K_{in,pit} + [P_s]} \quad (\text{eq.27})$$

$$V_{in,pst} = \frac{k_{in,pst} [PstS][P_s]}{K_{in,pst} + [P_s]} \quad (\text{eq.28})$$

$$V_{out,pit} = k_{out,pit} [P_{int}] \quad (\text{eq.29})$$

$$V_{ra} = k_{ra} [PhoR] \quad (\text{eq.30})$$

$$V_{ba} = k_{ba} [PhoB][PhoR^A] - k_{-ba} [PhoB^A][PhoR] \quad (\text{eq.31})$$