1. Functionality

The AND-Gate takes a logical AND of phosphorelated OmpR and logical NOT YcgE. If INPUT1 is present tRNA is produced which is acetylated in another light-independent reaction. INPUT2 activates the transcription of T7RNA polymerase mRNA. The T7ptag gene that is used in this AND-Gate has two amber mutations. Thus only if both acetylated tRNA and the T7RNAP mRNA are present the mRNA can be translated into the protein.

2. Equations

$$
\begin{aligned}
tRNA & \quad \dot{x}_1 = k_t \frac{\left(\frac{OmpR-P}{K1}\right)^2}{\left(1+\frac{OmpR-P}{K1}\right)^2} - (\gamma_1 + k_a)x_1 + \gamma_{2p}x_2 + 2k_{7p}x_3 \left(\frac{\gamma_3}{k_{7m}}\right)\left(\frac{x_1}{\gamma_0+x_1}\right)^2 \\
Aa-tRNA & \quad \dot{x}_2 = k_a x_1 - 2k_{7p}x_3 \left(\frac{\gamma_3}{k_{7m}}\right)\left(\frac{x_1}{\gamma_0+x_1}\right)^2 - \gamma_2 x_2 \\
T7RNAP_{mRNA} & \quad \dot{x}_3 = k_{7m}\left(1 - \frac{\left(\frac{YcgE}{K3}\right)^2}{\left(1+\frac{YcgE}{K3}\right)^2}\right) - \gamma_3 x_3 \\
T7RNAP & \quad \dot{x}_4 = k_{7p}x_3 \left(\frac{\gamma_3}{k_{7m}}\right)\left(\frac{x_1}{\gamma_0+x_1}\right)^2 - \gamma_4 x_4 \\
lacZ_{mRNA} & \quad \dot{x}_5 = \alpha_M\left(1 - \frac{\left(\frac{x_4}{K5}\right)^{n_l}}{\left(1+\frac{x_4}{K5}\right)^{n_l}}\right) - \gamma_M x_5 \\
\beta-Galactosidase & \quad \dot{x}_6 = \alpha_B x_5 - \gamma_B x_6 \\
dye & \quad \dot{x}_7 = \alpha_A x_6
\end{aligned}
$$

3. Parameters

Parameter	Value	Unit	Name	Source
k_t	$\frac{46.67}{60}$	$\frac{nM}{s}$	max transcription rate tRNA	PKU Beijing 2009
k_a	$\frac{0.08}{60}$	$\frac{1}{s}$	synthesis rate Aa-tRNA	PKU Beijing 2009
k_{7p}	$\frac{1.5625}{60}$	$\frac{nM}{s}$	max transcription rate T7RNAP	PKU Beijing 2009
k_{7m}	$\frac{268*0.05}{60}$	$\frac{1}{s}$	max translateion rate T7RNAP	PKU Beijing 2009
k_S	0.3	$\frac{1}{nM}$	AND Gate rate	PKU Beijing 2009
γ_0	1	-	threshold Aa-tRNA	guessed
γ_1	$\frac{1}{60*60}$	$\frac{1}{s}$	degradation of tRNA	PKU Beijing 2009
γ_2	$\frac{1}{40*60}$	$\frac{1}{s}$	degradation of Aa-tRNA	PKU Beijing 2009
γ_3	$\frac{1}{4.4*60}$	$\frac{1}{s}$	degradation of T7RNAP mRNA	PKU Beijing 2009
γ_4	$\frac{46.67}{40*60}$	$\frac{1}{s}$	degradation of T7RNAP	PKU Beijing 2009
$K1$	5	nM	response param. OmpR-P,tRNA	guessed
$K3$	600	nM	response param. YcgE,T7RNAP	guessed
$K5$	$\frac{k7p}{4*gamma}$	nM	response param T7RNAP,lacZ	guessed

4. Reference

The model for our AND-Gate is based on the model of the iGEM team PKU Beijing 2009 for their AND-Gate1. We modified the equations such that the change in tRNA and Aa-tRNA does not include the degradation of the mRNA which caused negativity of some concentrations in our model.