

# CONTENTS

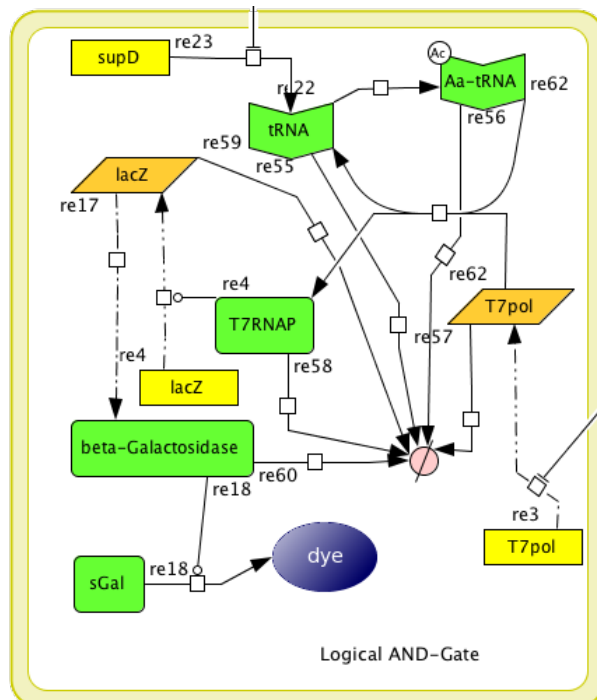
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## 1. MODEL

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.[1]

For more details see the paper by Anderson [2].

the dye output was an adaption of the model propose in the paper by Yildirim[3].



## 2. EQUATIONS

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

## 3. PARAMETERS

| Parameter  | Value                       | Unit           | Name                          | Source  |
|------------|-----------------------------|----------------|-------------------------------|---------|
| $k_t$      | $\frac{46.67}{60}$          | $\frac{nM}{s}$ | max transcription rate tRNA   | [1]     |
| $k_a$      | $\frac{0.08}{60}$           | $\frac{1}{s}$  | synthesis rate Aa-tRNA        | [1]     |
| $k_{7p}$   | $\frac{1.5625}{60}$         | $\frac{nM}{s}$ | max transcription rate T7RNAP | [1]     |
| $k_{7m}$   | $\frac{268*0.05}{60}$       | $\frac{1}{s}$  | max translation rate T7RNAP   | [1]     |
| $k_S$      | 0.3                         | $\frac{1}{nM}$ | AND Gate rate                 | [1]     |
| $\gamma_0$ | 1                           | -              | threshold Aa-tRNA             | guessed |
| $\gamma_1$ | $\frac{1}{60*60}$           | $\frac{1}{s}$  | degradation of tRNA           | [1]     |
| $\gamma_2$ | $\frac{1}{40*60}$           | $\frac{1}{s}$  | degradation of Aa-tRNA        | [1]     |
| $\gamma_3$ | $\frac{1}{4.4*60}$          | $\frac{1}{s}$  | degradation of T7RNAP mRNA    | [1]     |
| $\gamma_4$ | $\frac{46.67}{40*60}$       | $\frac{1}{s}$  | degradation of T7RNAP         | [1]     |
| $K1$       | 5                           | nM             | response param. OmpR-P,tRNA   | guessed |
| $K3$       | 600                         | nM             | response param. YcgE,T7RNAP   | guessed |
| $K5$       | $\frac{k_{7p}}{4*\gamma_4}$ | nM             | response param T7RNAP,lacZ    | guessed |
| $\alpha_M$ | $\frac{0.997}{60}$          | $\frac{nM}{s}$ | max transcription rate lacZ   | [3]     |
| $\alpha_B$ | $\frac{1.661e-5}{60}$       | $\frac{1}{s}$  | max translation rate lacZ     | [3]     |

| Parameter  | Value                 | Unit          | Name                               | Source |
|------------|-----------------------|---------------|------------------------------------|--------|
| $\alpha_A$ | $\frac{20}{60}$       | $\frac{1}{s}$ | enzymatic reaction rate            | [3]    |
| $\gamma_M$ | $\frac{0.411}{60}$    | $\frac{1}{s}$ | degradation lacZ mRNA              | [3]    |
| $\gamma_B$ | $\frac{8.331e-4}{60}$ | $\frac{1}{s}$ | degradation $\beta$ -Galactosidase | [3]    |

#### 4. INITIAL DATA

| Name                    | Variable | Initial Value | Comment | Source |
|-------------------------|----------|---------------|---------|--------|
| $tRNA$                  | $x_1$    | 0             |         |        |
| $Aa - tRNA$             | $x_2$    | 0             |         |        |
| $T7RNAP_{mRNA}$         | $x_3$    | 0             |         |        |
| $T7RNAP$                | $x_4$    | 0             |         |        |
| $lacZ_{mRNA}$           | $x_5$    | 0             |         |        |
| $\beta - Galactosidase$ | $x_6$    | 0             |         |        |
| $dye$                   | $x_7$    | 0             |         |        |

#### 5. SIMULATION

Since the AND-Gate is only an intermediate part, no additional simulation was done here.

#### REFERENCES

1. PKU Beijing 2009, *And gate 1*, 2009.
2. J Christopher Anderson, Christopher A Voigt, and Adam P Arkin, *Environmental signal integration by a modular and gate*, Mol Syst Biol **3** (2007).
3. N Yildirim, M Santillan, D Horike, and MC Mackey, *Dynamics and bistability in a reduced model of the lac operon*, CHAOS **14** (2004), no. 2, 279–292 (English).