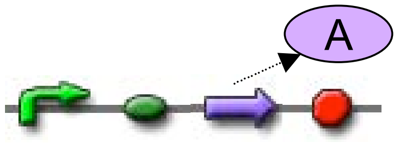
ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

iGEM 2006

Half Adder - Modelling

ODE's: Constitutive



$$\xrightarrow[u \cdot k_A]{} A \xrightarrow[k_{A\text{-}Deg}]{} \varnothing$$

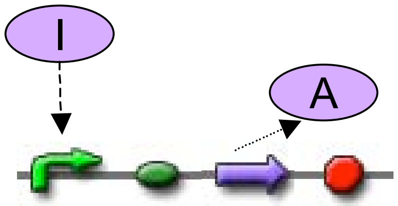
$$d[A]/dt = u \cdot k_A - [A] \cdot k_{A\text{-}Deg}$$

simplified:

$d[A]/dt = 0$

$\Rightarrow [A] =$ const. (high/low dep. on input u)

ODE's: Induction



$$I + DNA \underset{k_{-I}}{\overset{k_I}{\rightleftarrows}} I \cdot DNA \xrightarrow{k_A} I \cdot DNA + A$$

$$d[A]/dt = [I{\cdot}DNA]{\cdot}k_A$$

$$d[I]/dt = [I{\cdot}DNA]{\cdot}k_{-I} - [I]{\cdot}[DNA]{\cdot}k_I$$

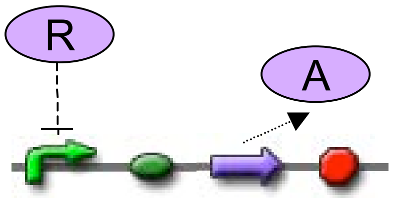
$$d[DNA]/dt = [I{\cdot}DNA]{\cdot}k_{-I} - [I]{\cdot}[DNA]{\cdot}k_I$$

$$d[I{\cdot}DNA]/dt = [I]{\cdot}[DNA]{\cdot}k_I - [I{\cdot}DNA]{\cdot}k_{-I}$$

$$[I{\cdot}DNA]+[DNA] = const.$$

$$[I{\cdot}DNA]+[I] = const.$$

ODE’s: Repression



$$R + DNA \underset{k_{-R}}{\overset{k_R}{\rightleftarrows}} R \cdot DNA$$

$$DNA \xrightarrow{k_A} DNA + A$$

$$d[A]/dt = [DNA] \cdot k_A$$

$$d[R]/dt = [R \cdot DNA] \cdot k_{-R} - [R] \cdot [DNA] \cdot k_R$$

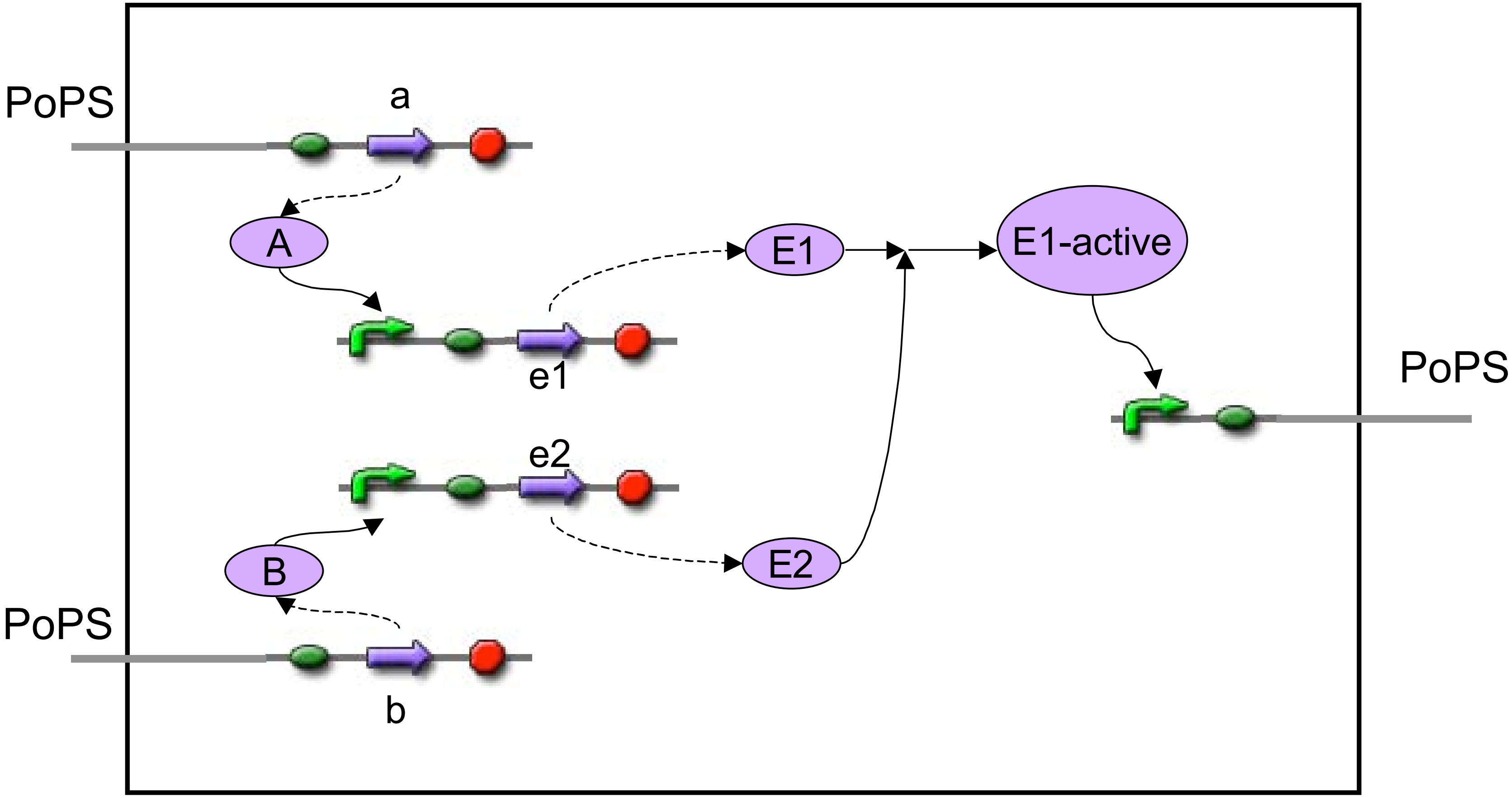
$$d[DNA]/dt = [R \cdot DNA] \cdot k_{-R} - [R] \cdot [DNA] \cdot k_R$$

$$d[R \cdot DNA]/dt = [R] \cdot [DNA] \cdot k_R - [R \cdot DNA] \cdot k_{-R}$$

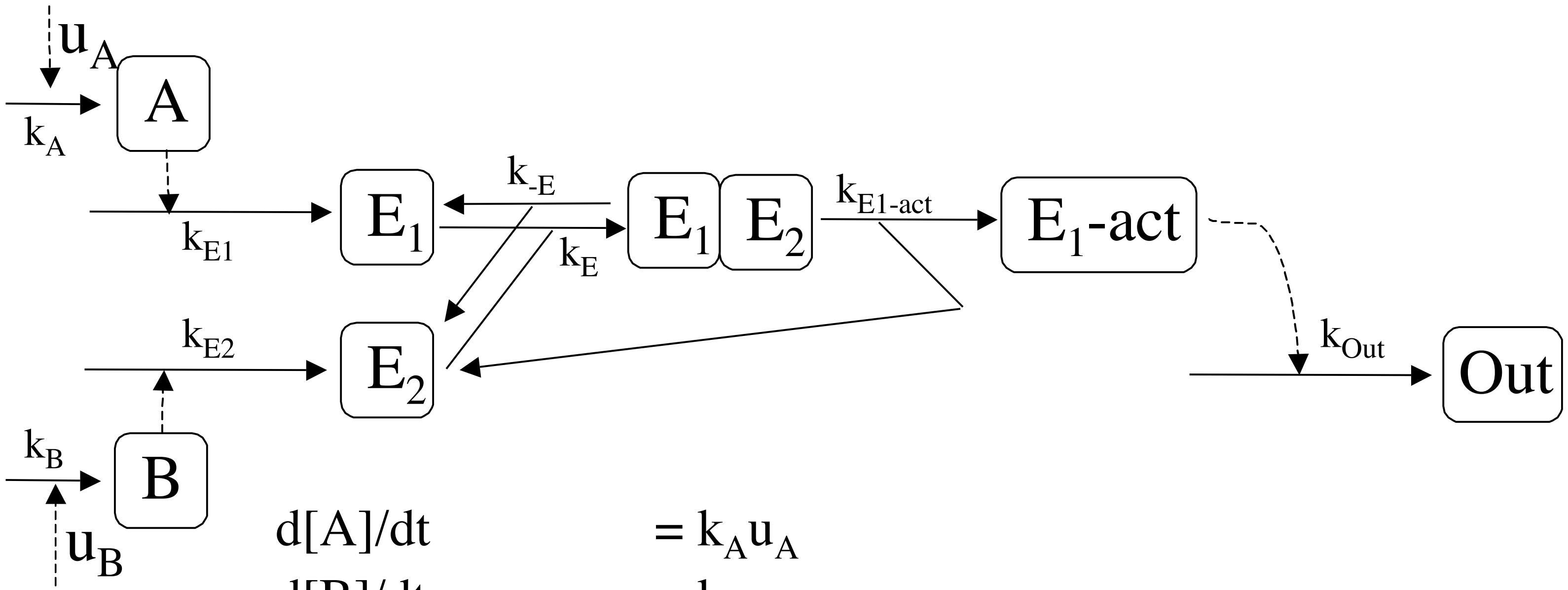
$$[R \cdot DNA] + [DNA] = const.$$

$$[R \cdot DNA] + [R] = const.$$

AND – 1

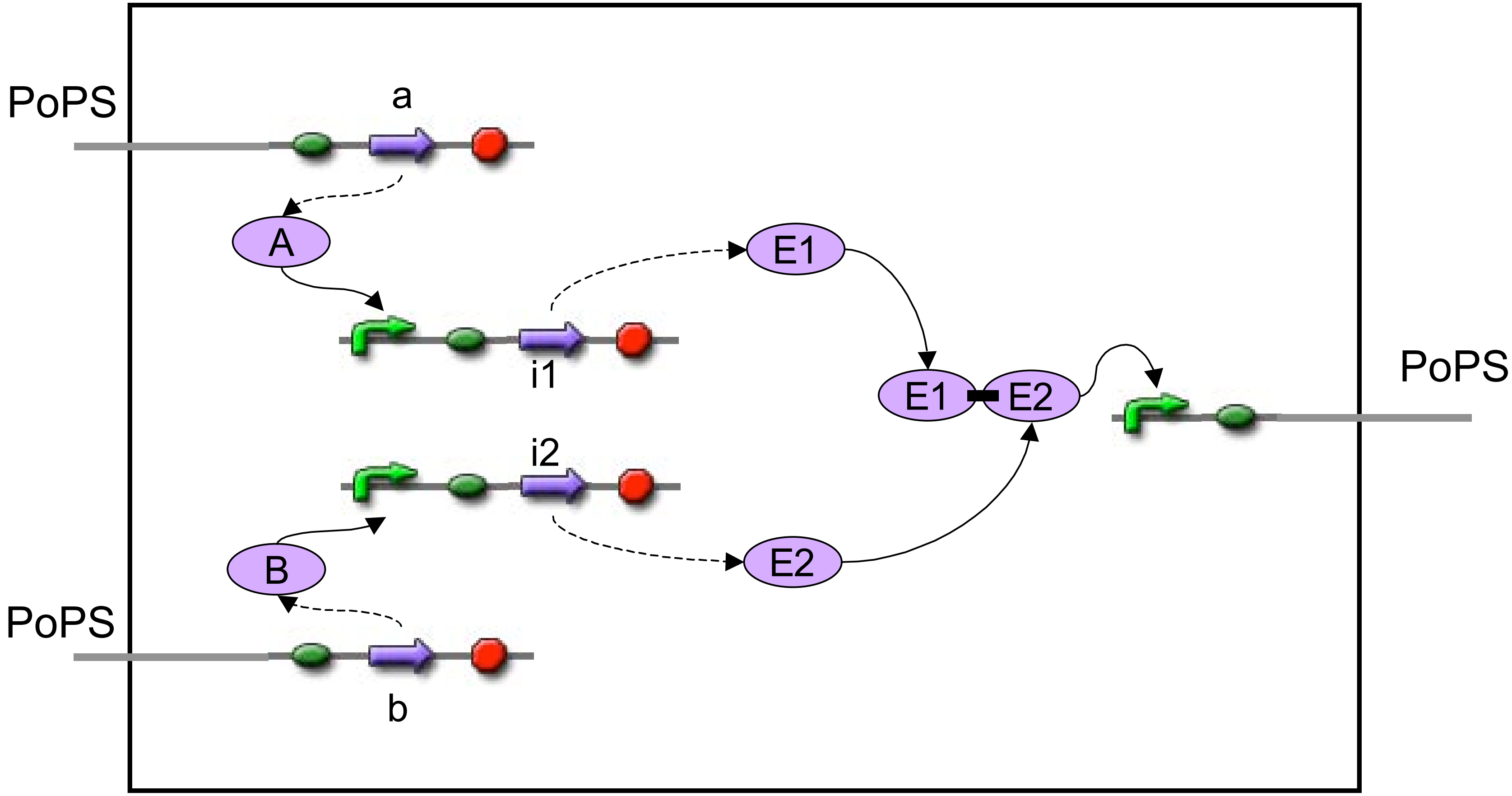


AND – 1 (ODE's)

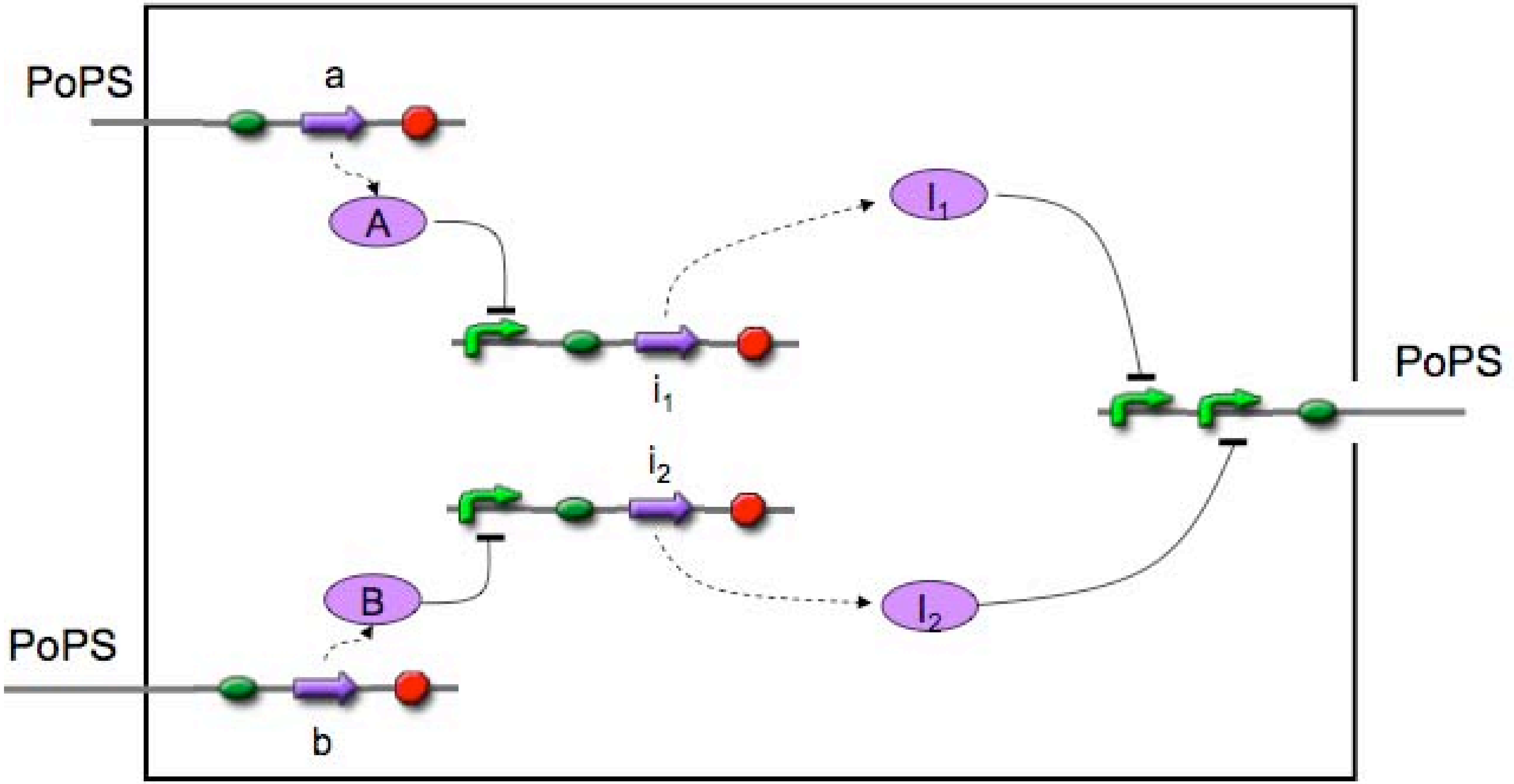


$$d[A]/dt = k_A u_A$$
$$d[B]/dt = k_B u_B$$
$$d[E_1]/dt = k_{E1}[A] - k_E[E_1][E_2] + k_{-E}[E_1E_2]$$
$$d[E_2]/dt = k_{E2}[B] - k_E[E_1][E_2] + k_{-E}[E_1E_2] + k_{E1\text{-}act}[E_1E_2]$$
$$d[E_1E_2]/dt = k_E[E_1][E_2] - k_{-E}[E_1E_2] - k_{E1\text{-}act}[E_1E_2]$$
$$d[E_1\text{-}act]/dt = k_{E1\text{-}act}[E_1 E_2]$$
$$d[Out]/dt = k_{out}[E_1\text{-}act]$$

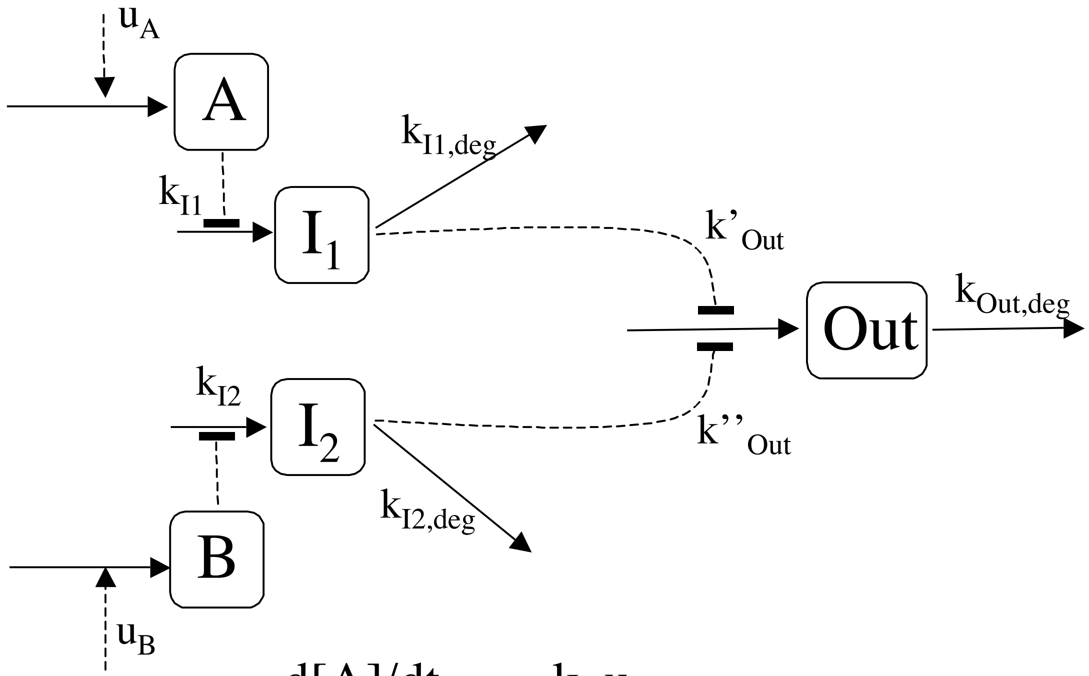
AND – 2

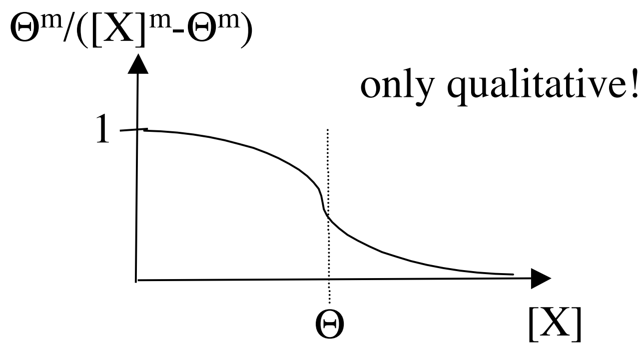


AND – 3



AND – 3 (ODE's)





$$d[A]/dt = k_A u_A$$

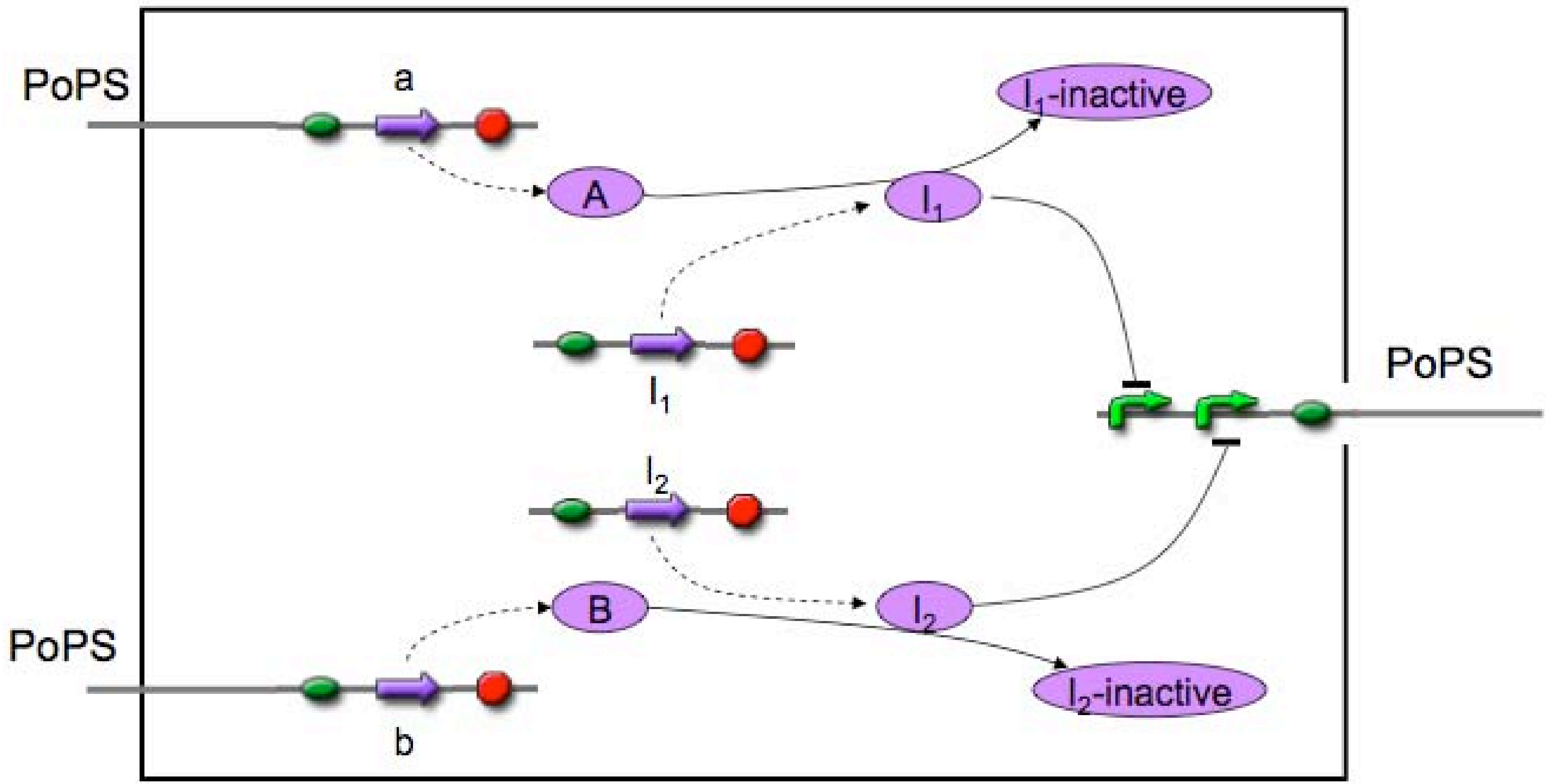
$$d[B]/dt = k_B u_B$$

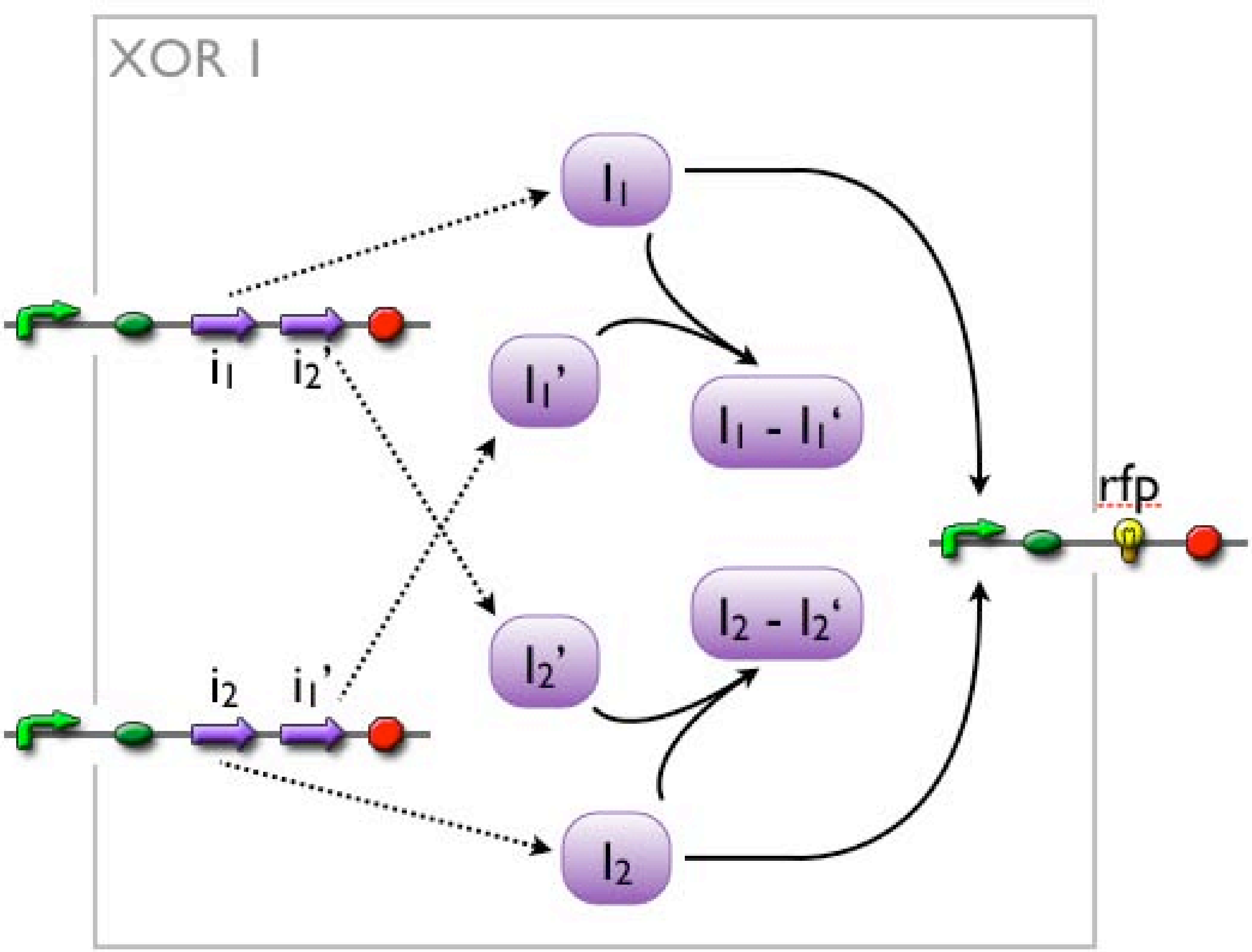
$$d[I_1]/dt = k_{I1}\,\Theta^{m1}/([A]^{m1}-\Theta^{m1}) - k_{I1,deg}[I_1]$$

$$d[I_2]/dt = k_{I2}\,\Theta^{m1}/([B]^{m1}-\Theta^{m1}) - k_{I2,deg}[I_1]$$

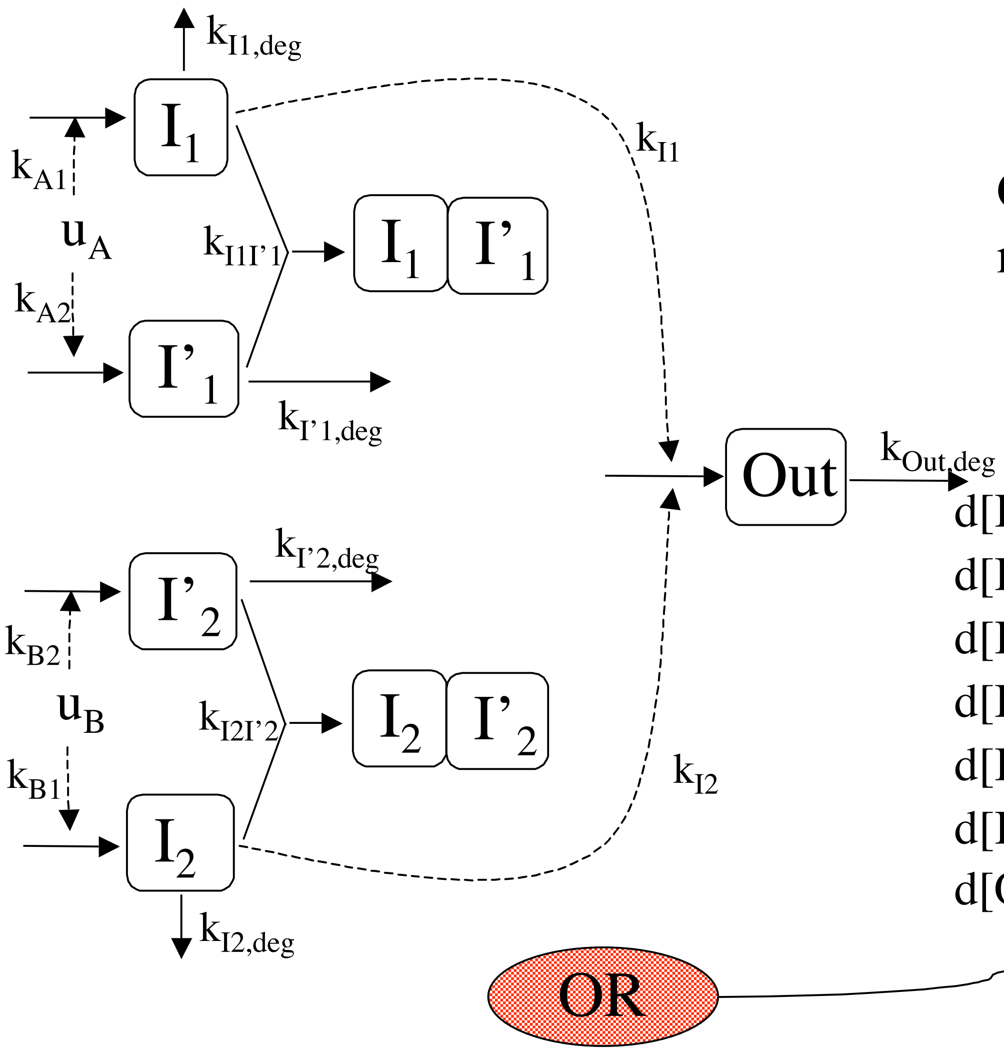
$$d[Out]/dt = k'_{Out}\Theta^{m3}/([I_1]^{m3}-\Theta^{m3})\; k''_{Out}\Theta^{m4}/([I_2]^{m4} - \Theta^{m4}) - k_{Out,deg}[Out]$$

AND – 4



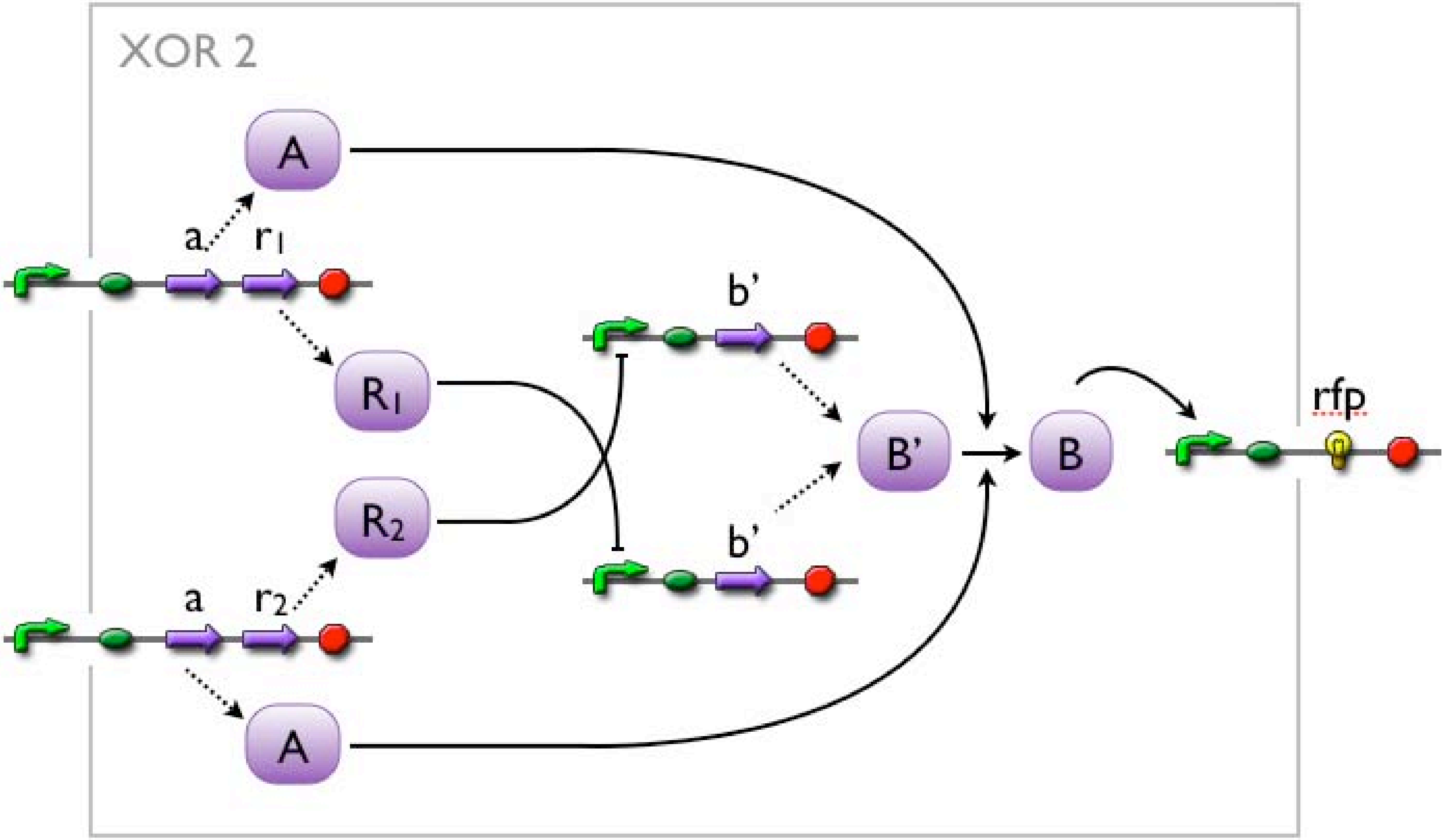

XOR I
I1
I1'
I1 - I1'
i1
i2'
rfp
i2
i1'
I2 - I2'
I2'
I2

XOR – 1 (ODE's)

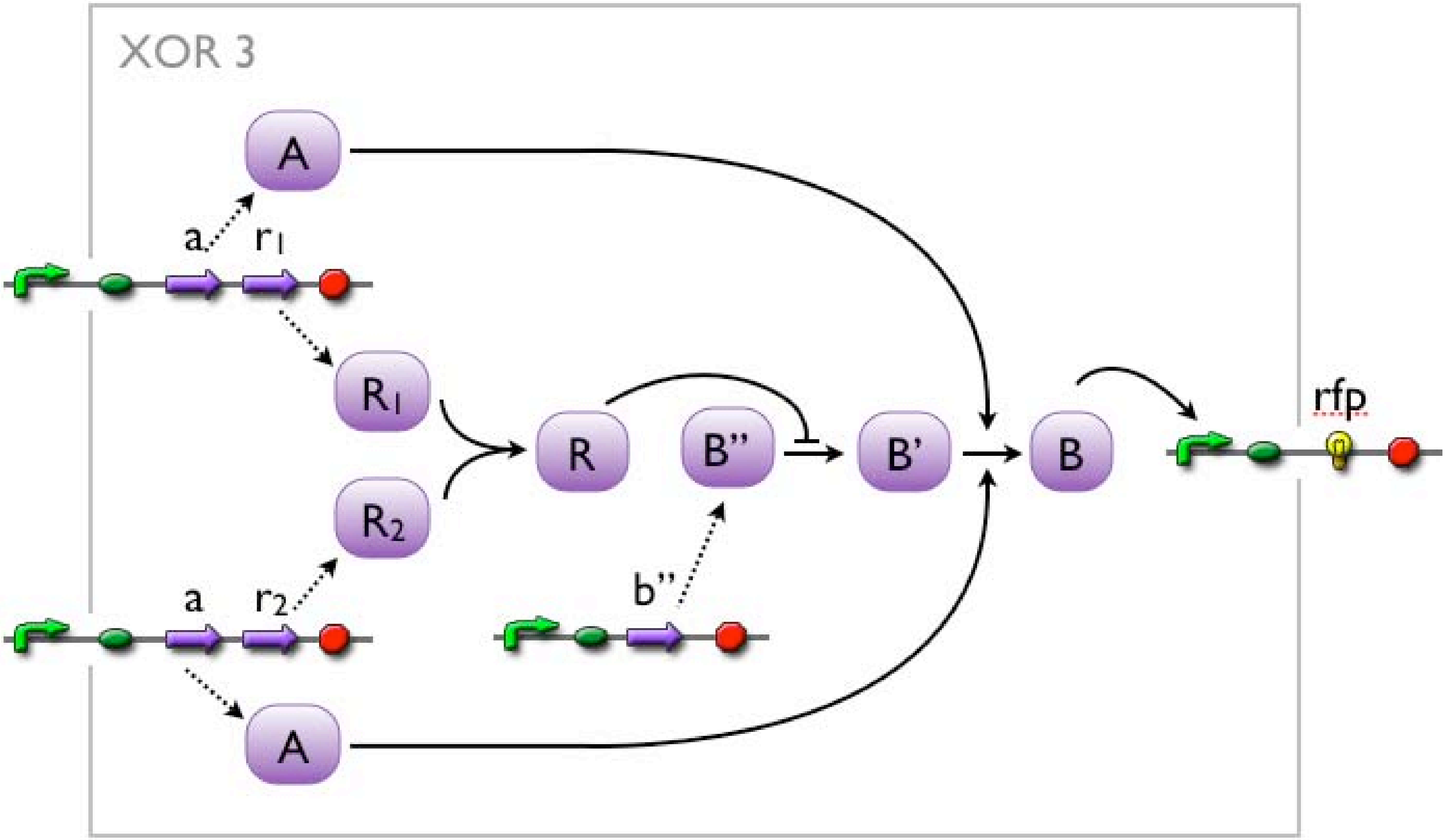


Question: Should $k_{I1I'1}$ and $k_{I2I'2}$ be modelled as reversible reactions?

$$d[I_1]/dt = k_{A1}u_A - k_{I1I'1}[I_1][I'_1] - k_{I1,deg}[I_1]$$
$$d[I'_1]/dt = k_{A2}u_A - k_{I1I'1}[I_1][I'_1] - k_{I'1,deg}[I'_1]$$
$$d[I_2]/dt = k_{B1}u_B - k_{I2I'2}[I_2][I'_2] - k_{I2,deg}[I_2]$$
$$d[I'_2]/dt = k_{B2}u_B - k_{I2I'2}[I_2][I'_2] - k_{I'2,deg}[I'_2]$$
$$d[I_1I'_1]/dt = k_{I1I'1}[I_1][I'_1]$$
$$d[I_2I'_2]/dt = k_{I2I'2}[I_2][I'_2]$$
$$d[Out]/dt = k_{I1}(1- \Theta^{m1}/([I_1]^{m1}-\Theta^{m1})) \oplus k_{I2}(1- \Theta^{m2}/([I_2]^{m2} - \Theta^{m2})) - k_{Out,deg}[Out]$$


XOR 2
A
a
r1
b'
R1
B'
B
rfp
R2
b'
a
r2
A

XOR – 2 (ODE’s)


XOR 3
A
a
r1
R1
R2
R
B''
B'
B
rfp
a
r2
b''
A

XOR – 3 (ODE's)