

A G-protein dependent kinetic model

2IF35 Formal Modelling in Cell Biology

Technische Universiteit Eindhoven

November 29, 2010

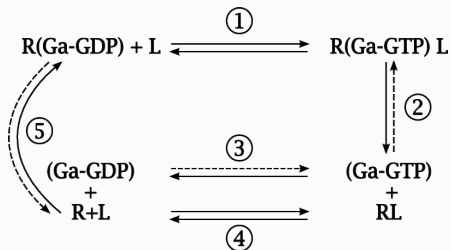
Csercsik, Hangos & Nagy

A simple reaction kinetic model rapid and slow transmission

Journal of Theoretical Biology 255(1):119–28, 2008

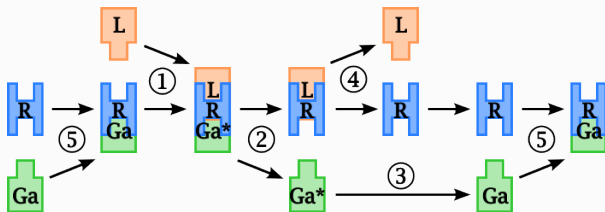
- ODE model
- Simulations
- Extensions
- Assignment

basic reaction scheme

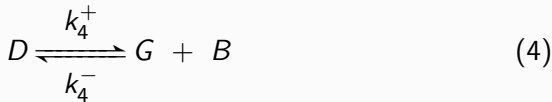
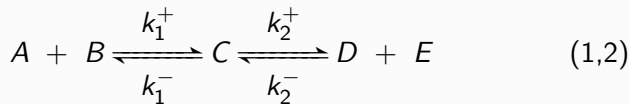


A	$R(\text{Ga-GDP})$	receptor + inactive Ga
B	L	ligand
C	$R(\text{Ga-GTP})L$	receptor + ligand + active Ga
D	RL	receptor + ligand
E	(Ga-GTP)	free active Ga
F	(Ga-GDP)	free inactive Ga
G	R	receptor

basic reaction scheme



A	R(Ga-GDP)	receptor + inactive Ga
B	L	ligand
C	R(Ga-GTP)L	receptor + ligand + active Ga
D	RL	receptor + ligand
E	(Ga-GTP)	free active Ga
F	(Ga-GDP)	free inactive Ga
G	R	receptor

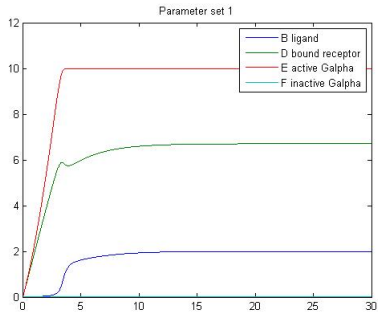


$$\begin{aligned}
 [A]' &= -k_1^+[A][B] + k_1^-[C] + k_5^+[G][F] - k_5^-[A] \\
 [B]' &= -k_1^+[A][B] + k_1^-[C] + k_4^+[D] + k_5(L_{env}, B) \\
 [C]' &= k_1^+[A][B] - k_1^-[C] - k_2^2[C] + k_2^-[D][E] \\
 [D]' &= k_2^+[C] - k_2^-[D][E] - k_4^+[D] + k_4^-[G][B] \\
 [E]' &= k_2^+[C] - k_2^-[D][E] - k_3^+[E] + k_3^-[F] \\
 [F]' &= k_3^+[E] - k_3^-[F] - k_5^+[G][F] + k_5^-[A] \\
 [G]' &= k_4^+[D] - k_4^-[G][B] - k_5^+[G][F] + k_5^-[A]
 \end{aligned}$$

initial values $A = 10$ and $B, \dots, G = 0$

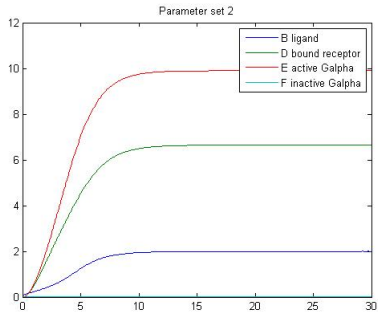
first simulation

k_1^+	40	2	40	40
k_1^1	40	2	40	40
k_2^+	30	1	30	30
k_2^1	0	0	0	0
k_3^+	0.005	0.005	0.2	2
k_3^1	0	0	0	0
k_4^+	0.4	0.4	0.4	0.4
k_4^1	0.4	0.4	0.4	0.4
k_5^+	1	1	1	1
k_5^1	0	0	0	0



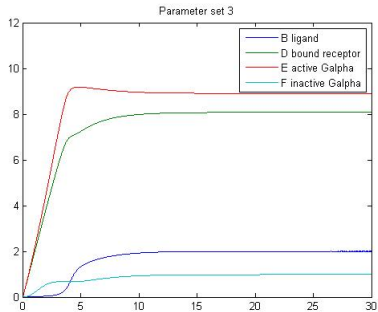
second simulation

k_1^+	40	2	40	40
k_1^1	40	2	40	40
k_2^+	30	1	30	30
k_2^1	0	0	0	0
k_3^+	0.005	0.005	0.2	2
k_3^1	0	0	0	0
k_4^+	0.4	0.4	0.4	0.4
k_4^1	0.4	0.4	0.4	0.4
k_5^+	1	1	1	1
k_5^1	0	0	0	0



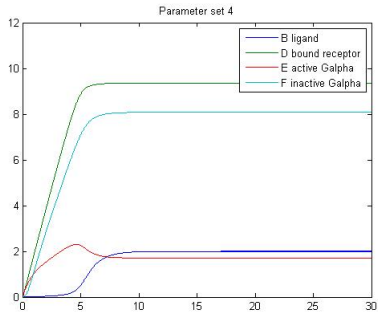
third simulation

k_1^+	40	2	40	40
k_1^1	40	2	40	40
k_2^+	30	1	30	30
k_2^1	0	0	0	0
k_3^+	0.005	0.005	0.2	2
k_3^1	0	0	0	0
k_4^+	0.4	0.4	0.4	0.4
k_4^1	0.4	0.4	0.4	0.4
k_5^+	1	1	1	1
k_5^1	0	0	0	0

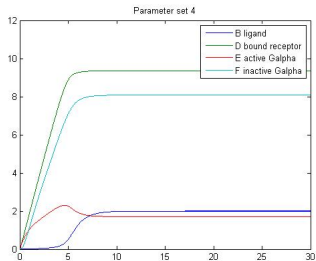
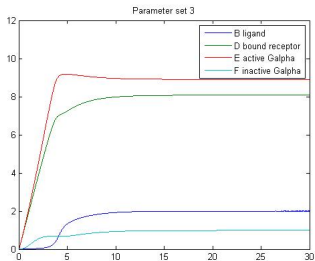
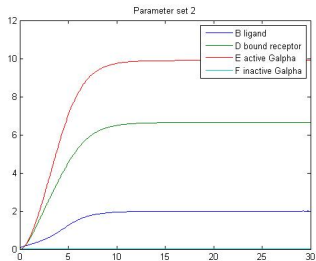
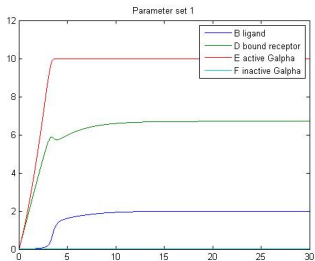


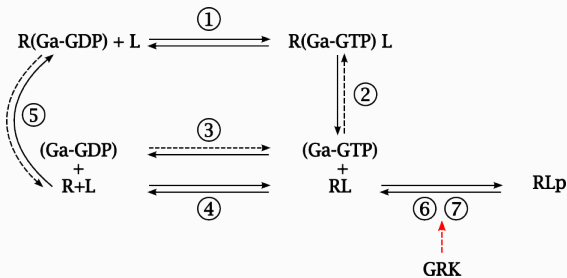
fourth simulation

k_1^+	40	2	40	40
k_1^1	40	2	40	40
k_2^+	30	1	30	30
k_2^1	0	0	0	0
k_3^+	0.005	0.005	0.2	2
k_3^1	0	0	0	0
k_4^+	0.4	0.4	0.4	0.4
k_4^1	0.4	0.4	0.4	0.4
k_5^+	1	1	1	1
k_5^1	0	0	0	0



overview simulation results





- model the basic structure with your tool
- improve on the treatment of ligand concentration
- incorporate GRK and model slow transmission
- explain differences between the basic and enhanced model