Structure and function of the feed-forward loop network motif

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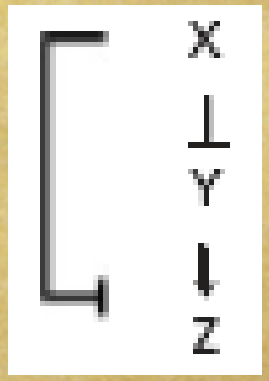
The Coherent Feedforward Loop Serves as a Sign-sensitive Delay Element in Transcription Networks

Mangan, Zaslaver Alon

Oct, Nov 2003 PNAS&JMB



FeedForward

Etude théorique du filtrage dynamique

Vérification par mesures invivo du module L-arabinose E.Coli

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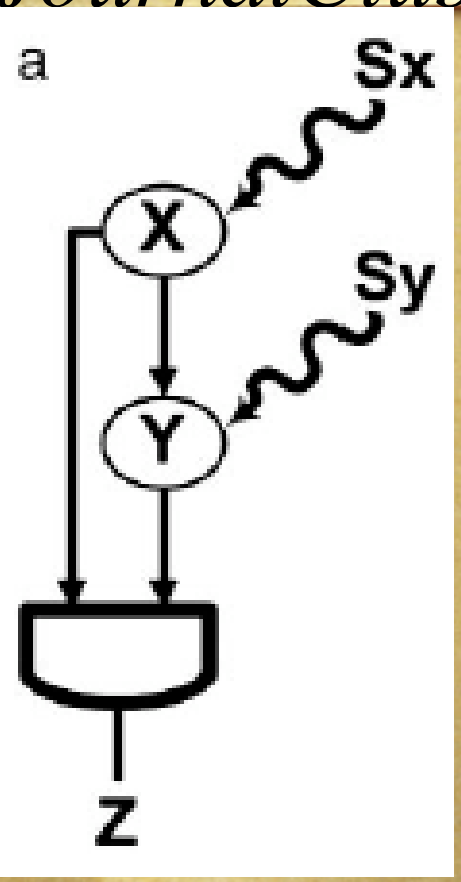
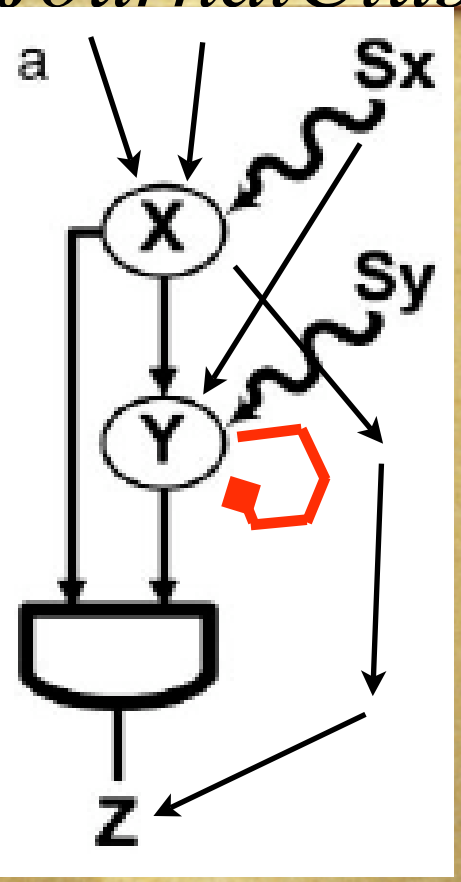


Définitions

- *X ,Y régulent Z*
- *+Inducteurs*
- *(Activation V Inhibition)->2^8*



Définitions-Hypothèses

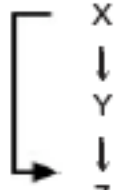
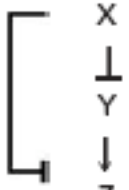
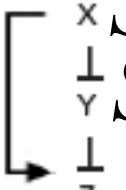
- *X ,Y régulent Z*
- *+Inducteurs*
- *(Activation+ ou Inhibition-)=2^3=8*
- *Module isolable*
- *(In)Coherent:* **+=++** , -=-+ ...
- *Porte logique 'AND'*

(ou un 'OR')

	0	1
0	0	1
1	1	2

Propriété: Accélérer le switch (ON xou OFF)

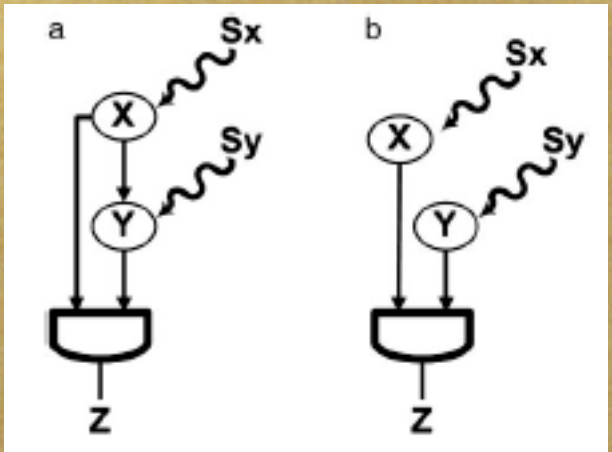
Occurrences

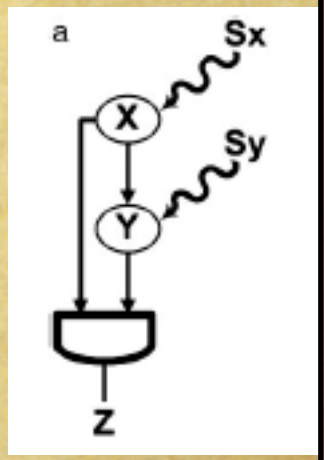
Species	Coherent type 1		Coherent type 2		Coherent type 3		Coherent type 4	
	Structure	Abundance	Structure	Abundance	Structure	Abundance	Structure	Abundance
E. coli		28		2		4		1
S. cerevisiae		26		5		0		0

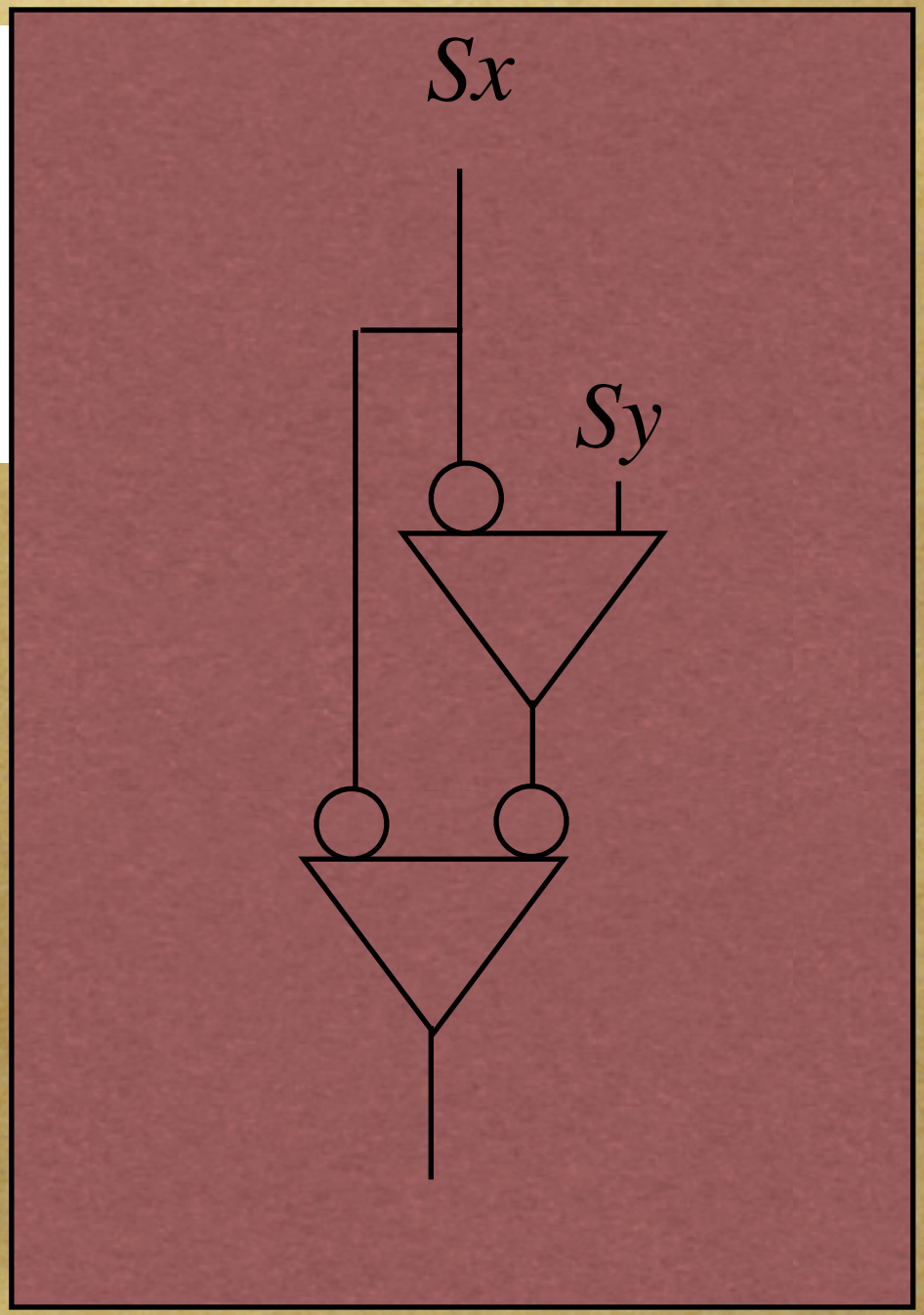
Sx
Sy

&	Sx	!Sx
Sy	1	0
!Sy	1	0

Species	Incoherent type 1		Incoherent type 2		Incoherent type 3		Incoherent type 4	
	Structure	Abundance	Structure	Abundance	Structure	Abundance	Structure	Abundance
E. coli		5		0		1		1
S. cerevisiae		21		3		1		0


a
Sx
X
Sy
Y
Z
b
Sx
X
Sy
Y
Z





	y	!y
x		
!x		

2 entrées

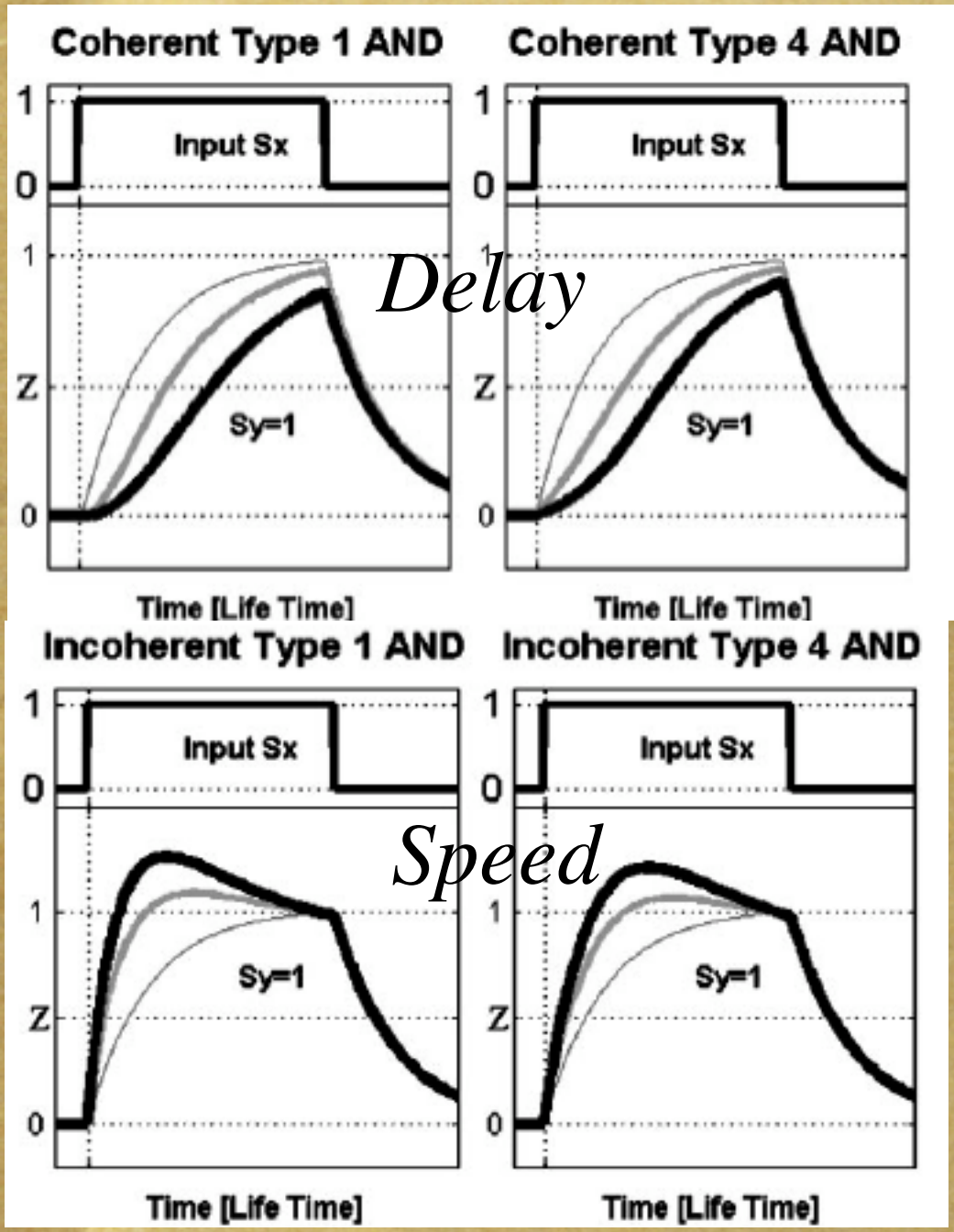
8 cablages

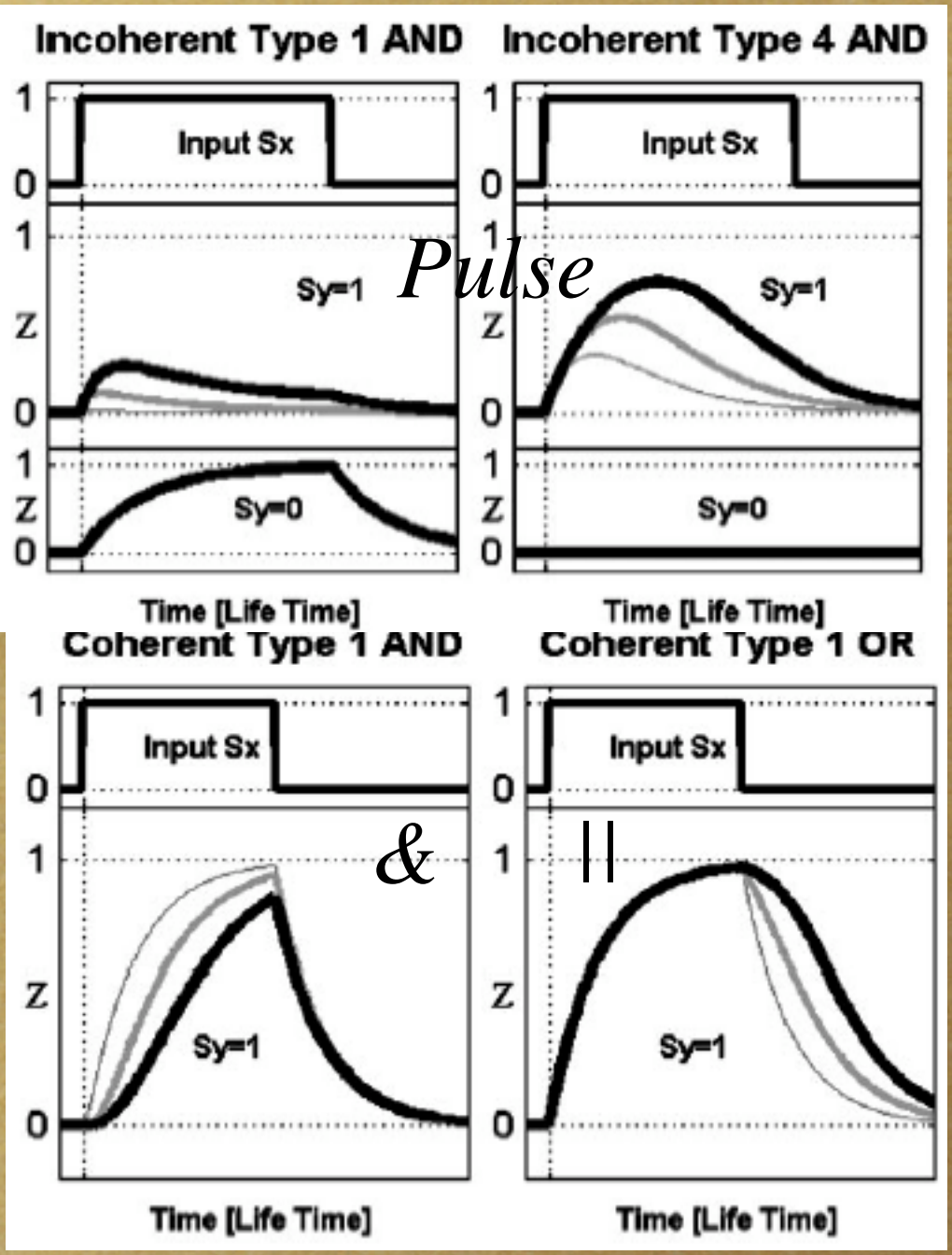
4 transitions pour

chaque cablage

= 32 ‘résultats’

1 Sortie


Coherent Type 1 AND
Coherent Type 4 AND
Input Sx
Sy=1
Delay
Time [Life Time]
Incoherent Type 1 AND
Incoherent Type 4 AND
Speed


Incoherent Type 1 AND
Incoherent Type 4 AND
Input Sx
Sy=1
Sy=0
Pulse
Time [Life Time]
Coherent Type 1 AND
Coherent Type 1 OR
&
||

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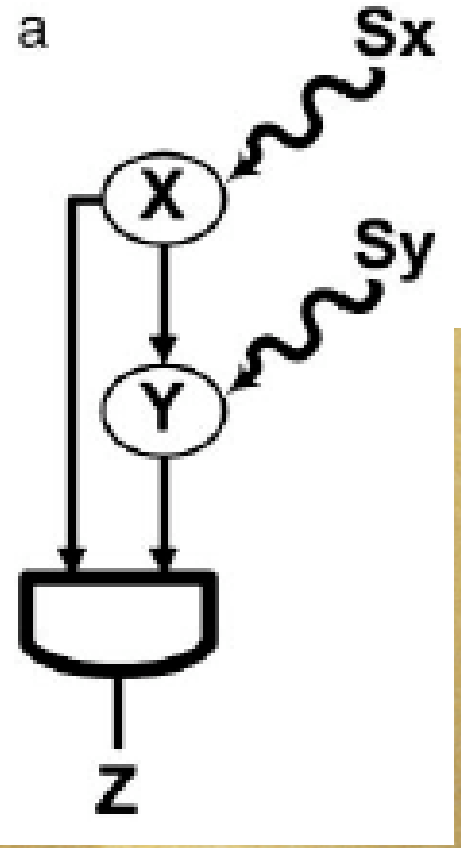


$$dY/dt = B_y + \beta_1 f(X, K_{xy}) - \alpha_1 Y,$$

$$dZ/dt = \beta_2 f(X, K_{xz}) f(Y, K_{yz}) - \alpha_2 Z$$

Activateur $f(u, K) = u^H/(K^H + u^H)$

Inhibiteur $f(u, K) = 1/(1 + (u/K)^H)$

AND

$$G_z = f(X^*, K_{xz}) f(Y^*, K_{yz})$$

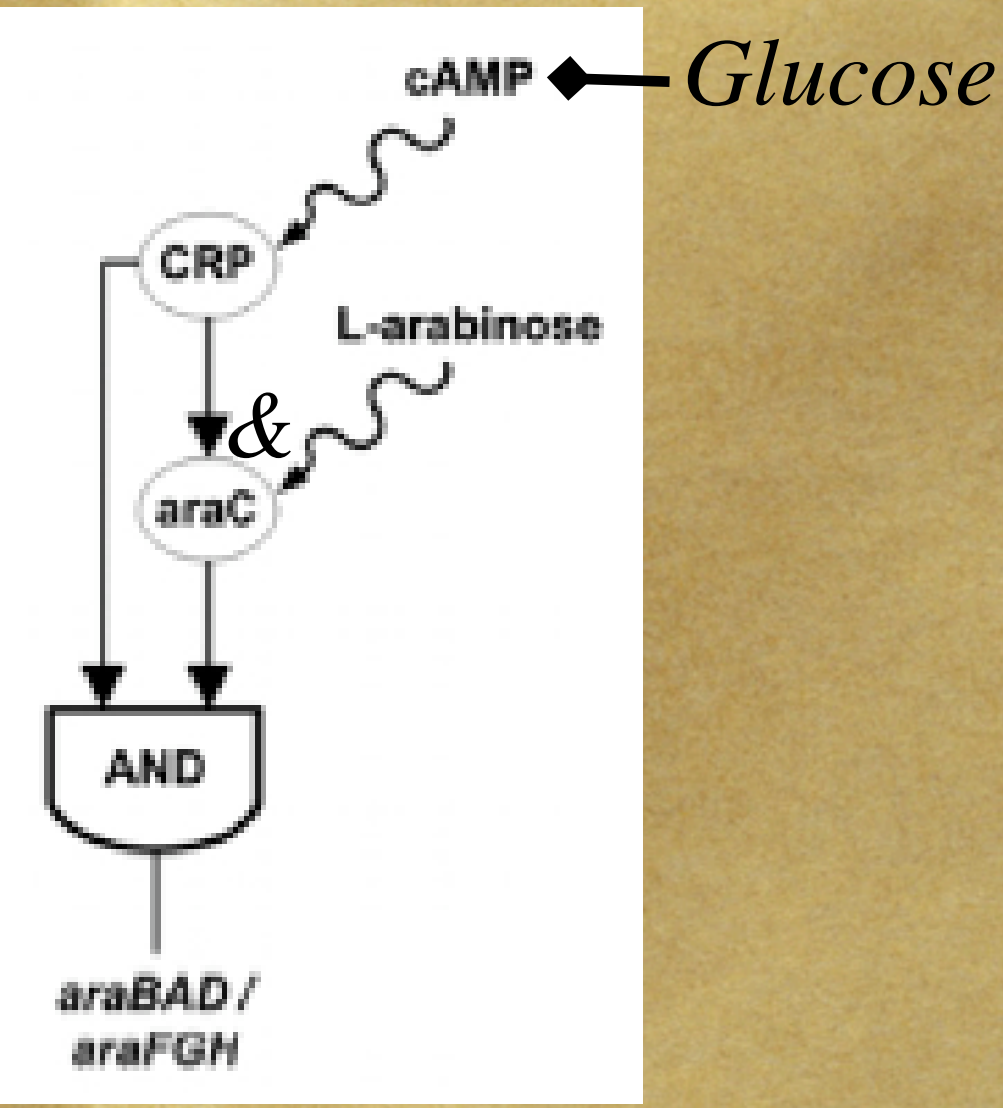
OR (competitif)

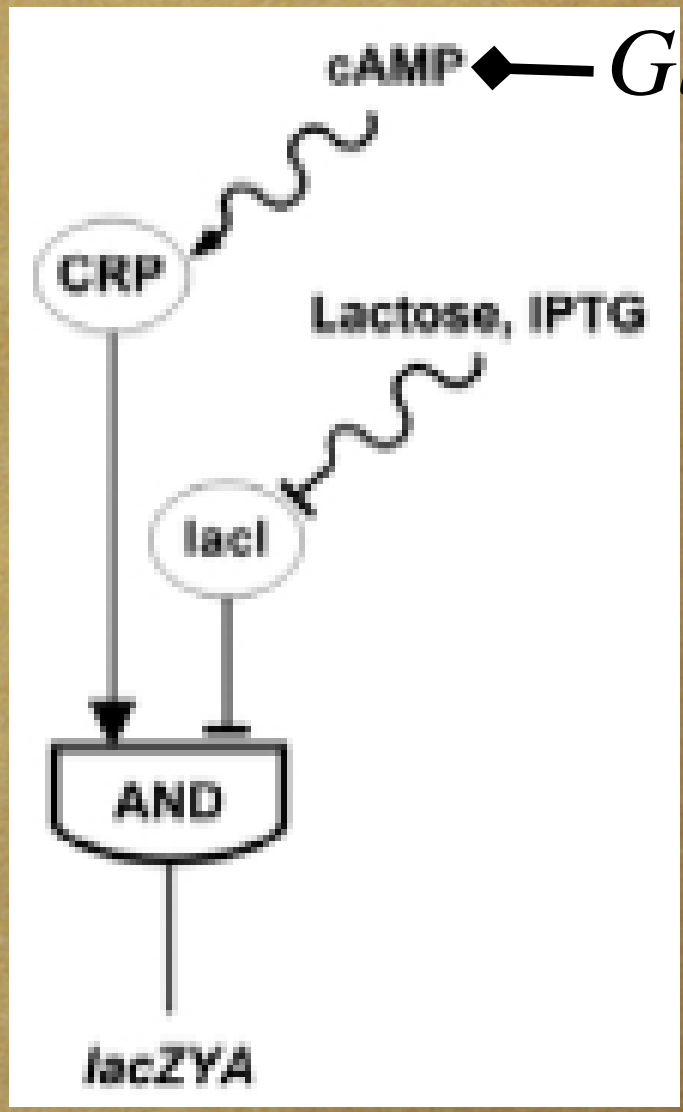
$$G_z = fc(X^*; K_{xz}, K_{yz}, Y^*) + fc(Y^*; K_{yz}, K_{xz}, X^*)$$

Activateur $= (u/K_u)^H/(1 + (u/K_u)^H + (v/K_v)^H)$

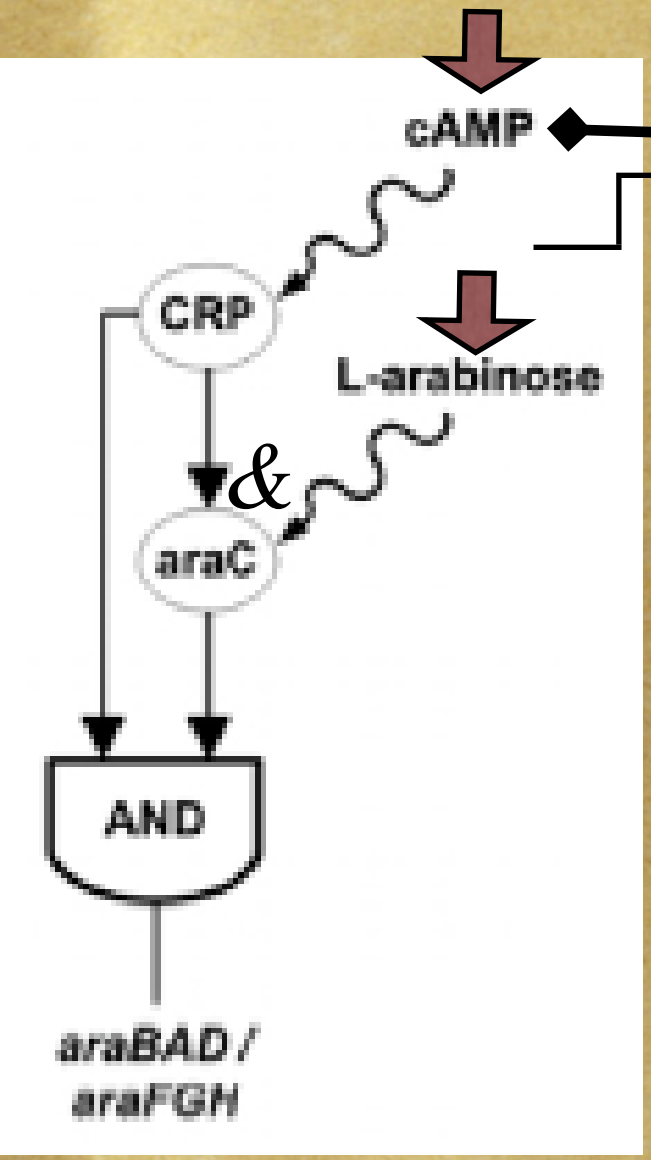
Inhibiteur $= 1/(1 + (u/K_u)^H + (v/K_v)^H)$

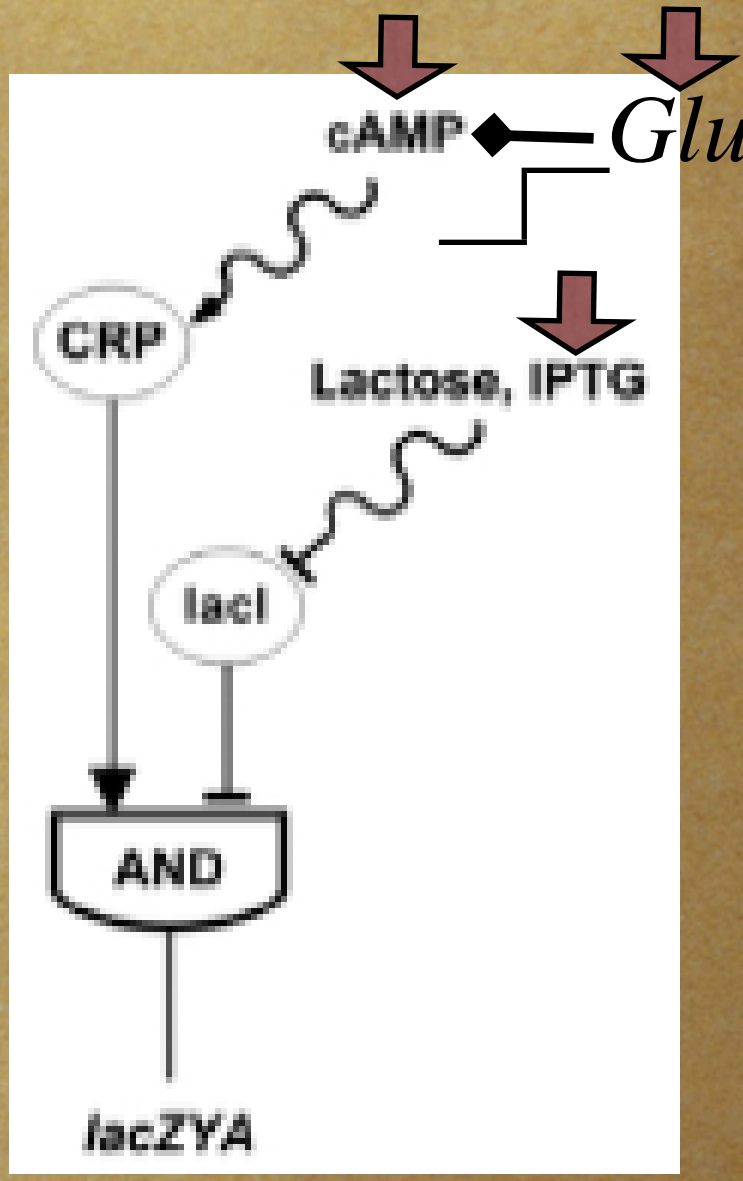
FFL,L-arabinose vs Test



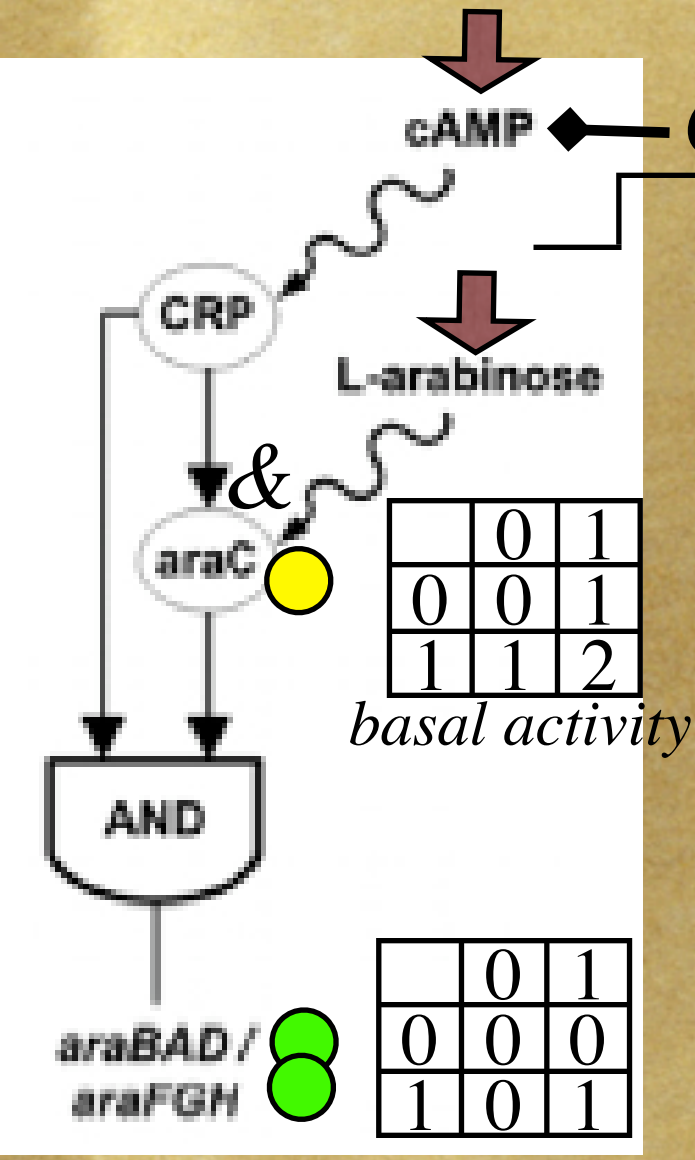


FFL,L-arabinose vs Test





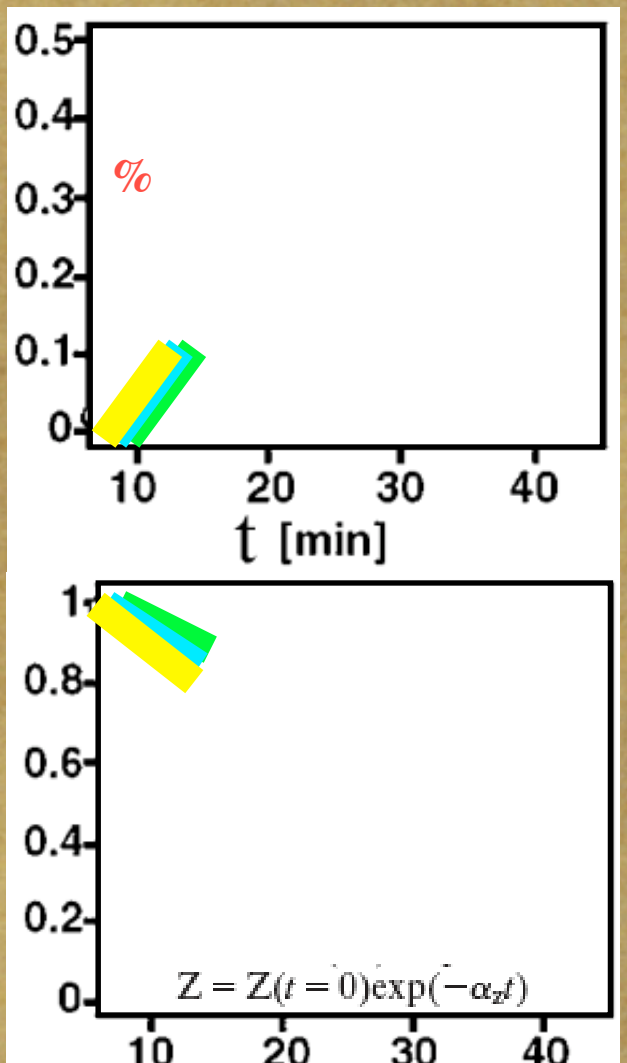
FFL,L-arabinose vs Test

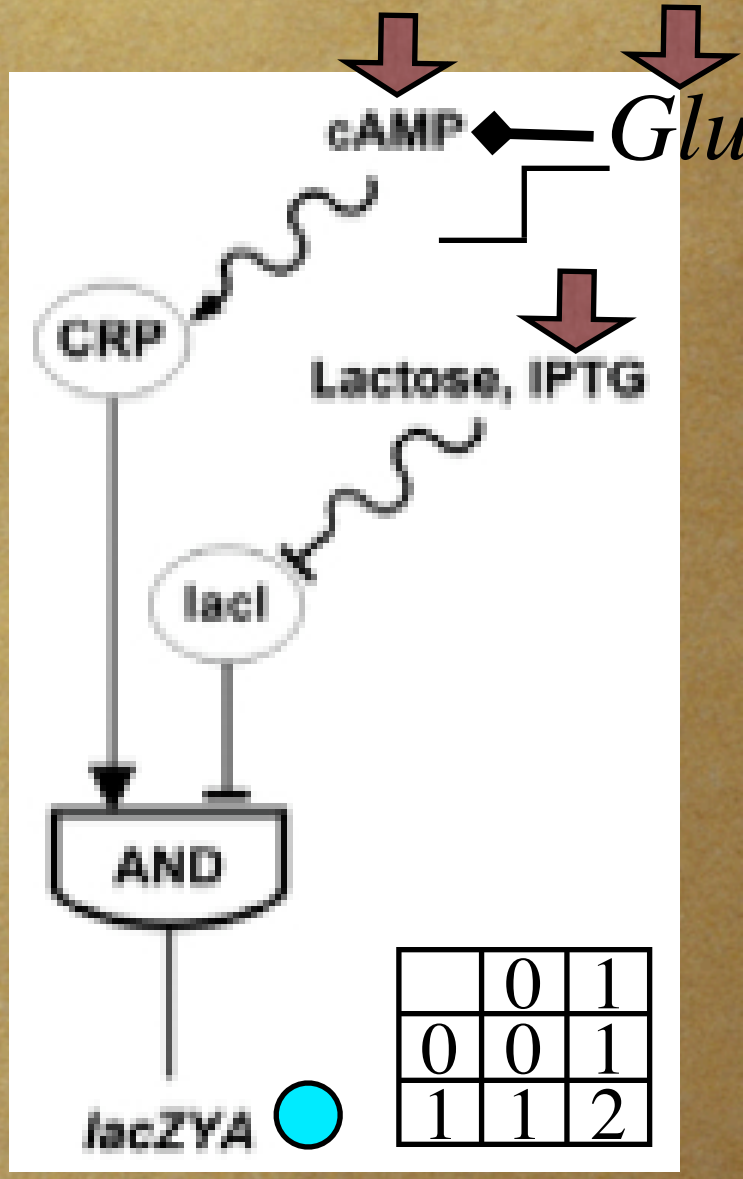


	0	1
0	0	1
1	1	2

basal activity

	0	1
0	0	0
1	0	1

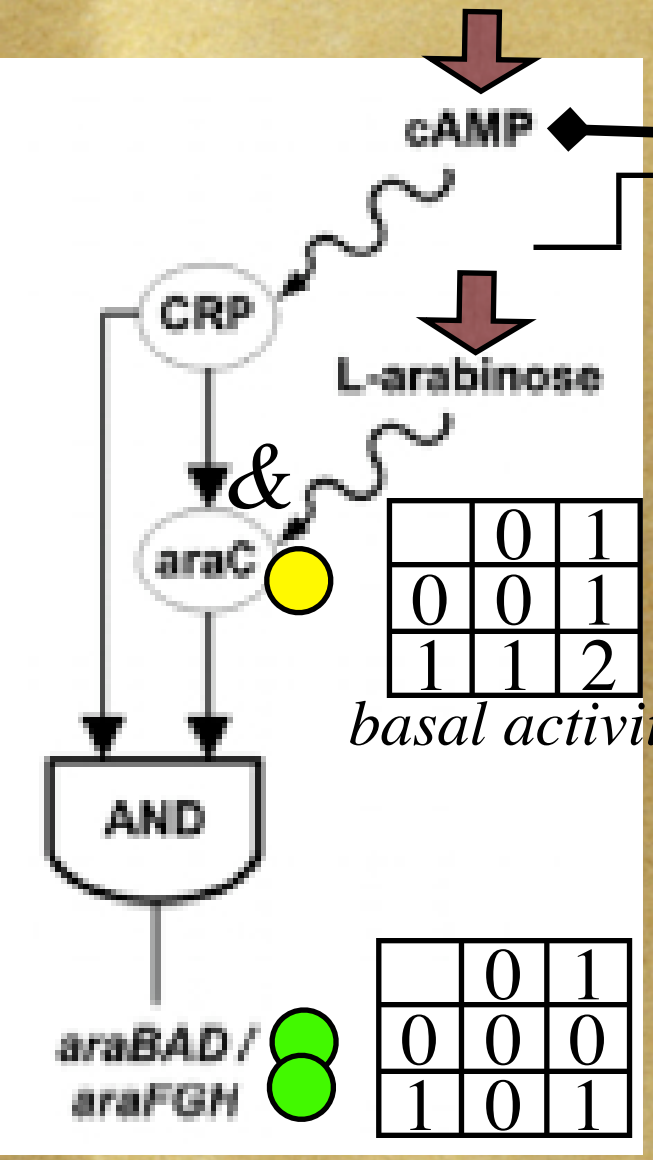


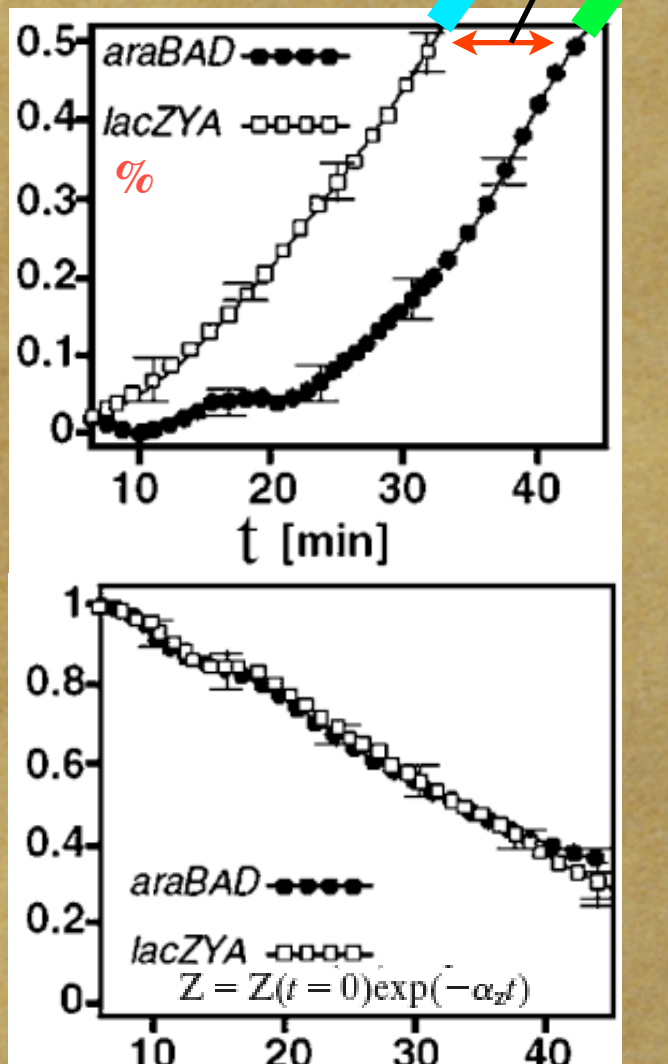


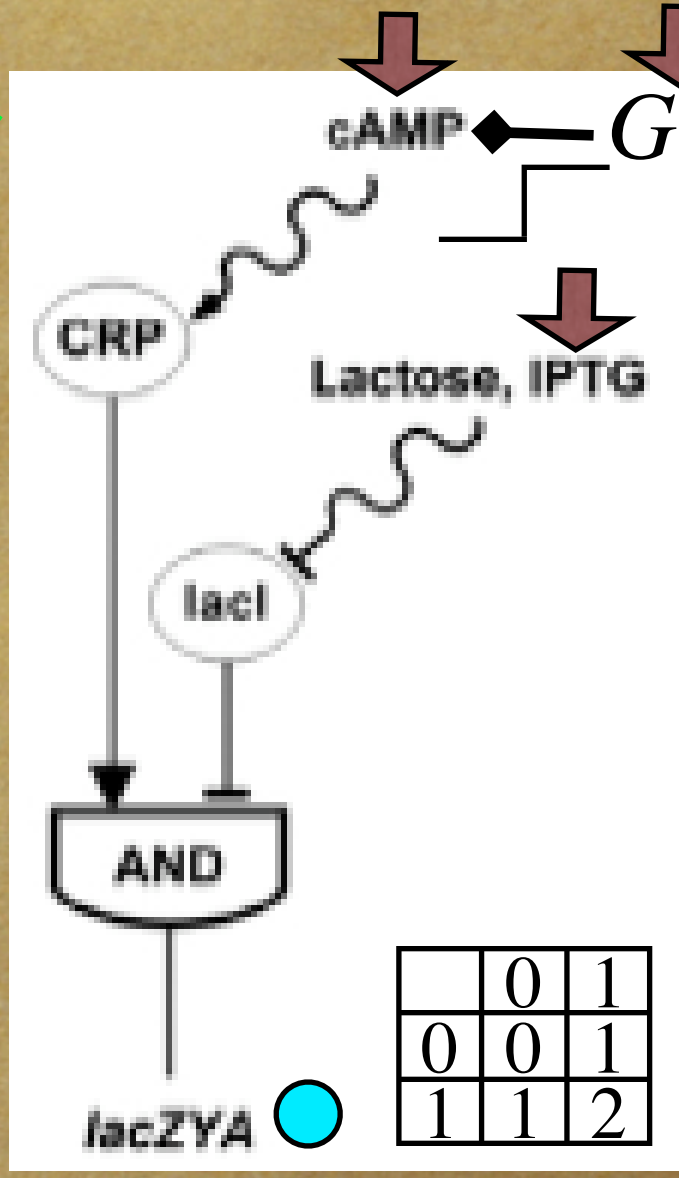
	0	1
0	0	1
1	1	2

FFL,L-arabinose vs Test

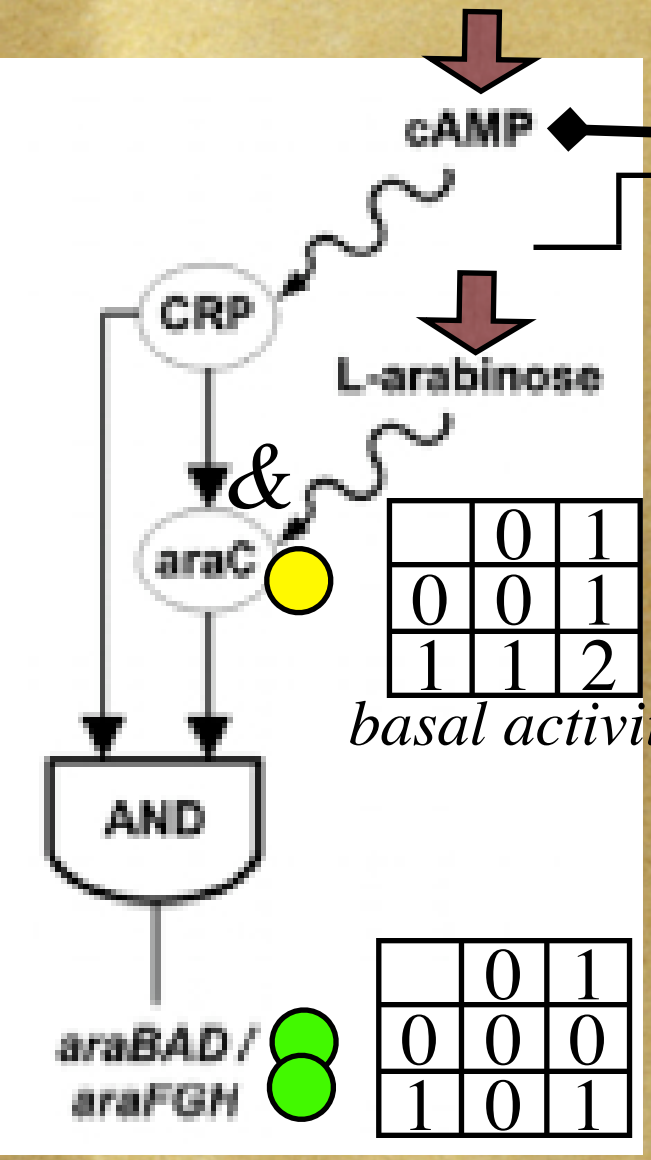
$$t_D = \alpha_y^{-1}\log[(Y_{max} - Y_{min})/(Y_{max} - K_{yz})].$$







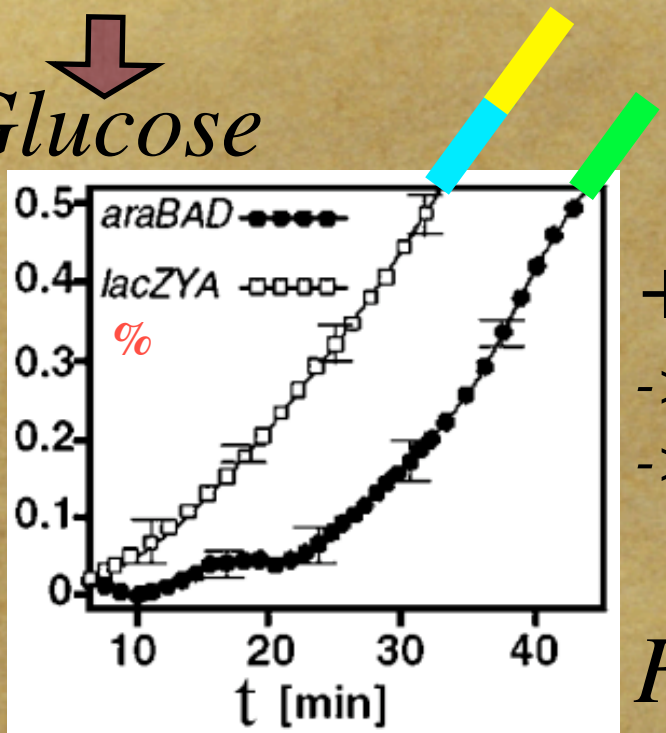
FFL,L-arabinose

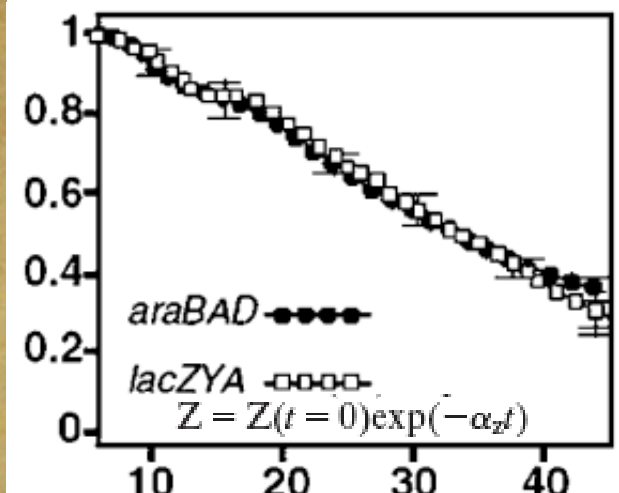


	0	1
0	0	1
1	1	2

basal activity

	0	1
0	0	0
1	0	1





1)Dans intestin
L-arabinose(++)
+pulse de Glucose

->Stop rapide ~
-> réenclanchement lent
mais stock de ara

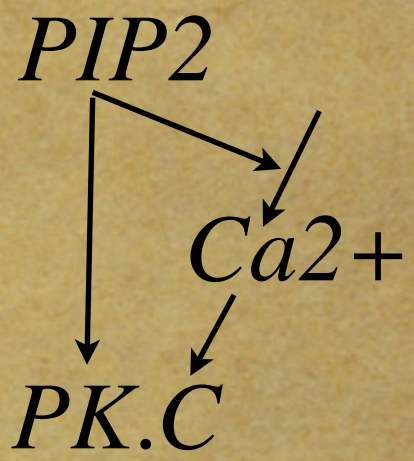
Fructose(++)(FFL)
Maltose(++)(FFL)
Lactose(--)

Filtre signal de glucose bruité

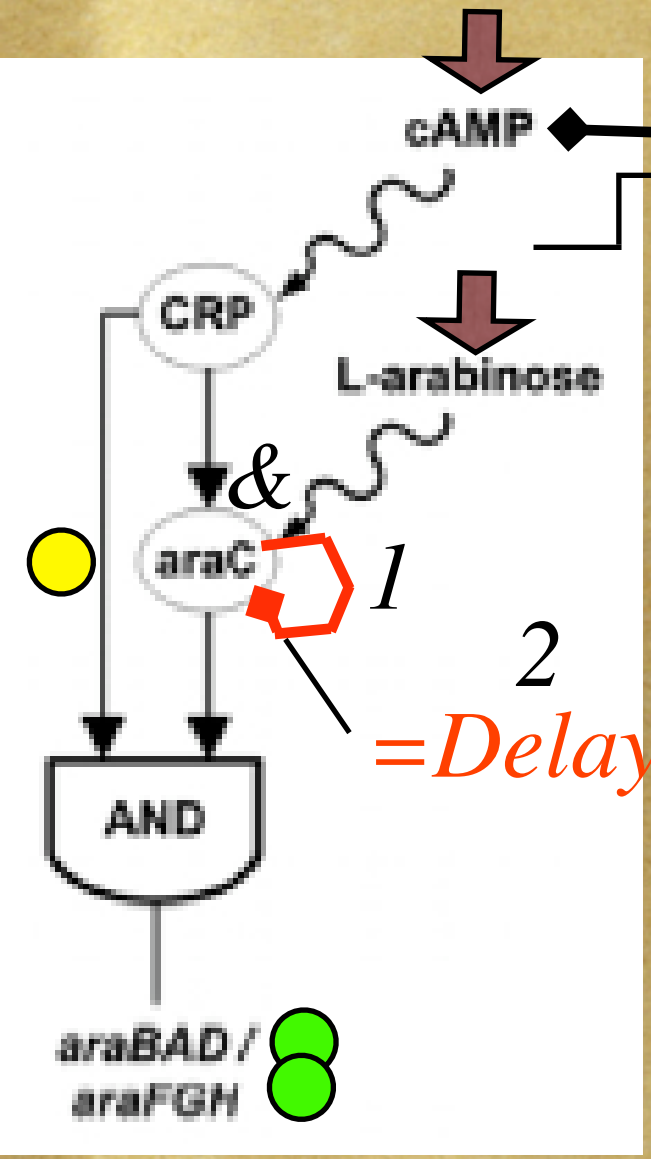
2)?

Ou sont les FFL ?

- *FFL E.coli: Arabinose, Fructose, Maltose, Azote, drugs.*
- *FFL S.cerevisiae: Même module, (même fonction), mais protéines différentes.*
- *C.elegans, Oursin, développement, neurones, Homme...*
- *PPI net:*



Autres informations connues



3

T.M. Dunn, S. Hahn, S. Ogden and R.F. Schleif, An operator at -280 base pairs that is required for repression of araBAD operon promoter: addition of DNA helical turns between the operator and promoter cyclically hinders repression. *Proc. Natl Acad. Sci. USA* **81** (1984),