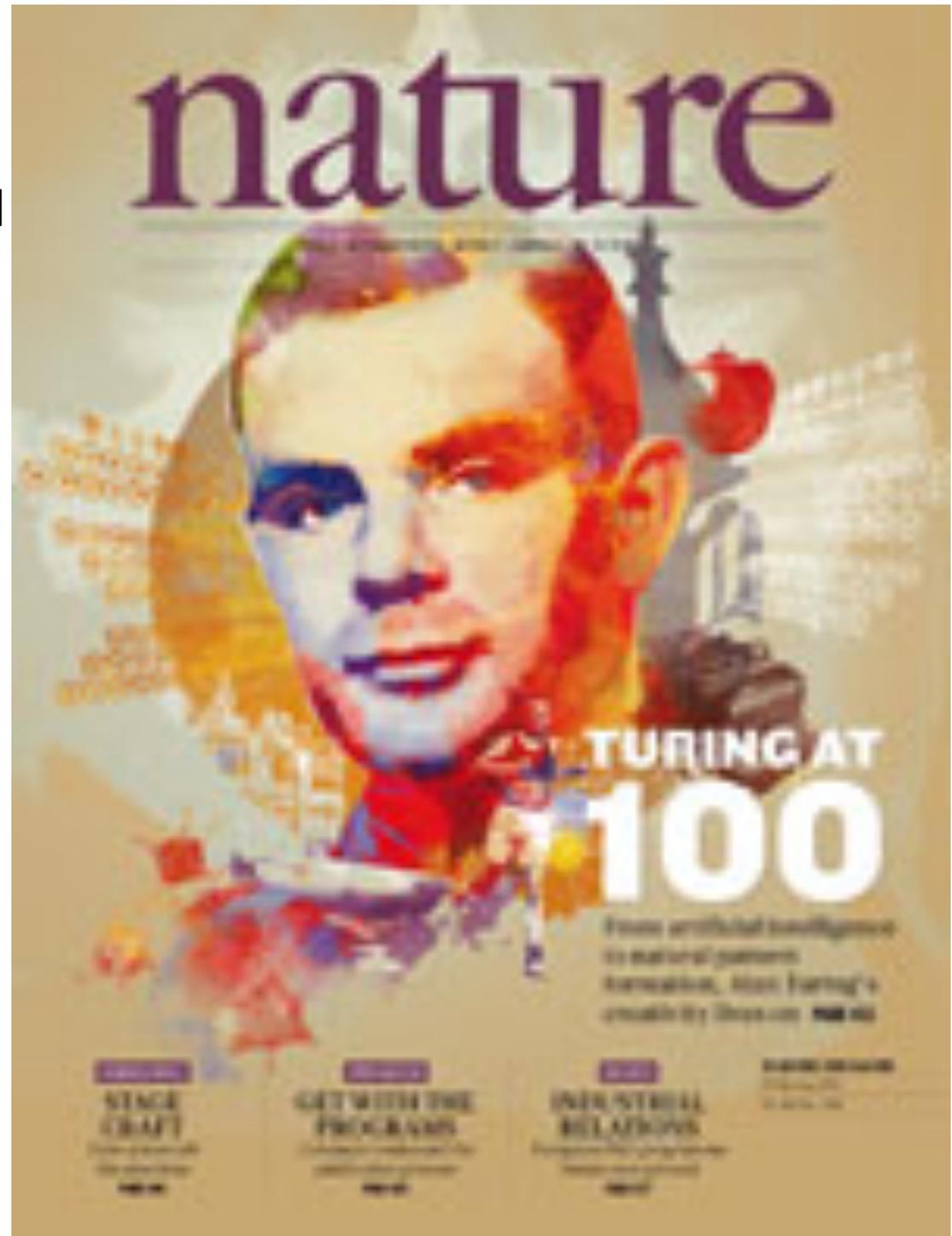


Turing at 100:

Legacy of a universal mind

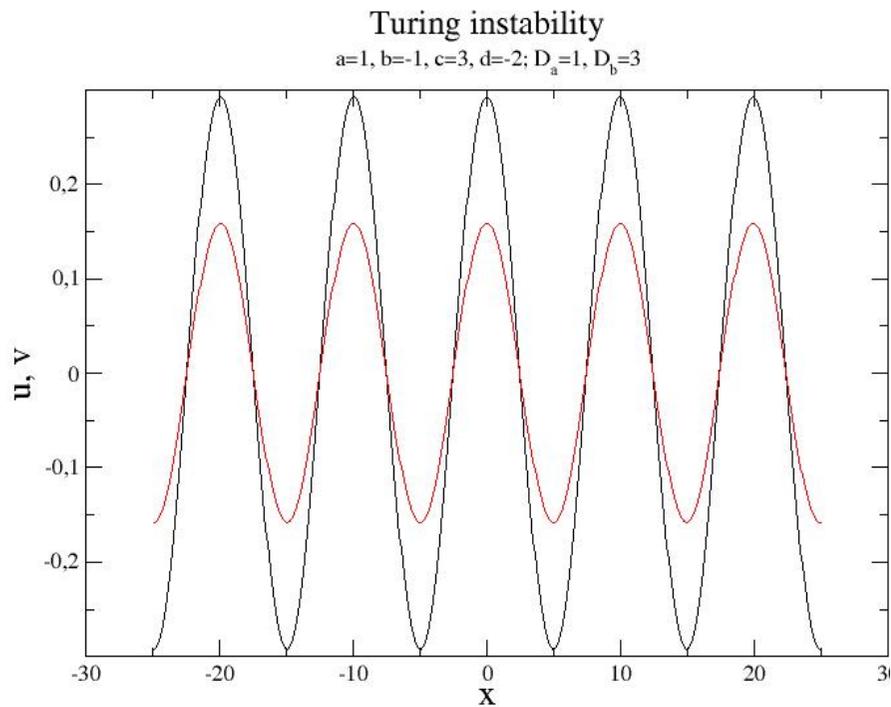
Nature

23 february 2012

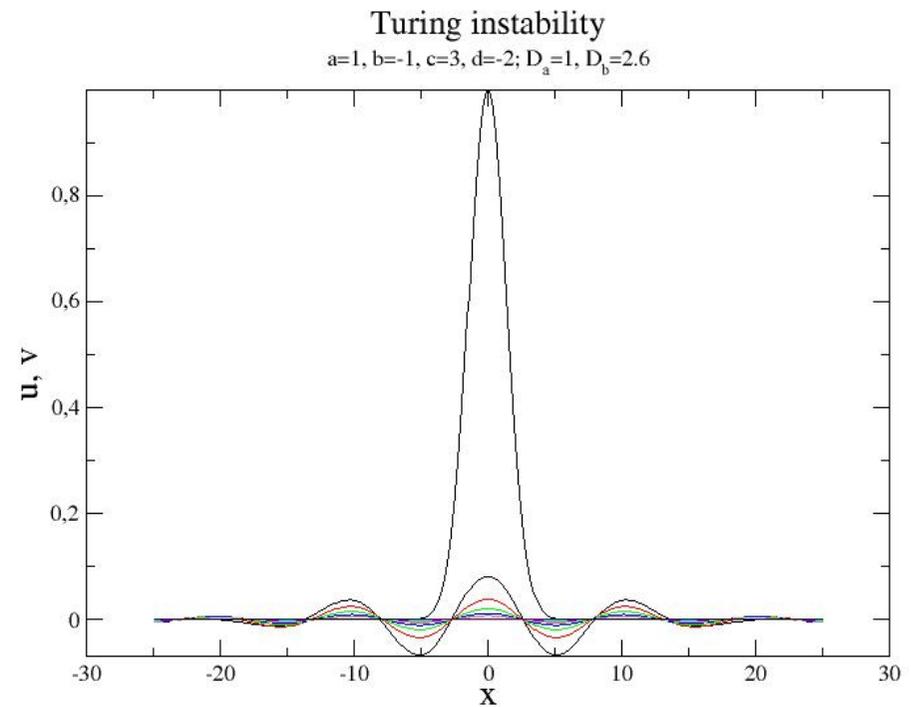


Turing instability

$$\begin{aligned}\frac{\partial u}{\partial t} &= a u + b v + D_u \partial_{xx} u - u^3 \\ \frac{\partial v}{\partial t} &= c u + d v + D_v \partial_{xx} v\end{aligned}$$



Above threshold



Below threshold

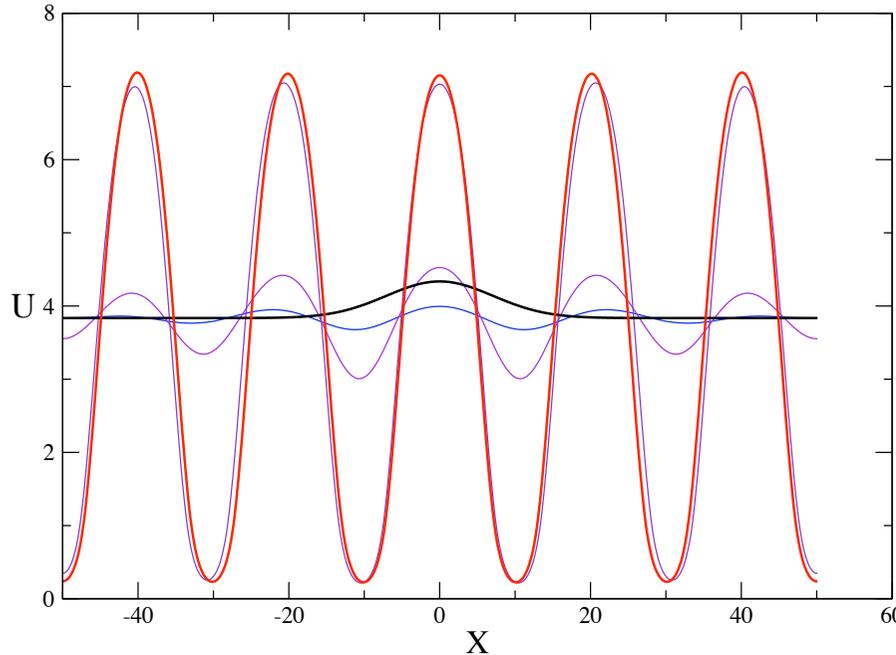
Turing instability : a simple non linear example

$$\frac{\partial U}{\partial t} = \rho(U) - \delta_u U - \kappa UV + D_u \partial_{xx} U$$

$$\frac{dV}{dt} = cU - \delta_v V + D_v \partial_{xx} V$$

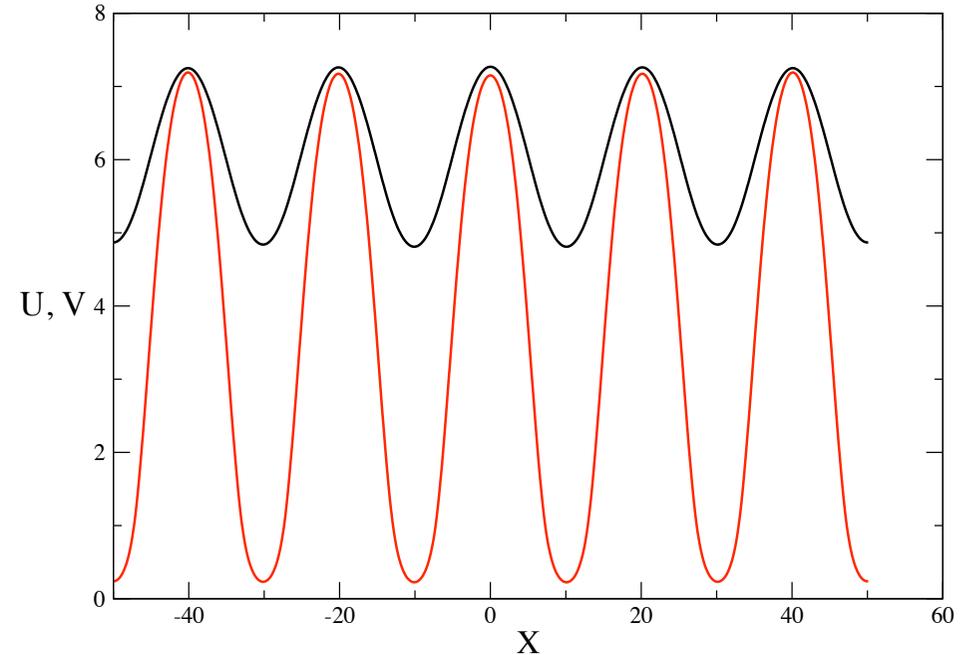
Turing instability : a nonlinear case

$U_0=1, \alpha=1, \kappa=1, \delta_u=1, \delta_v=1.2, c=2, D_u=1, D_v=7$

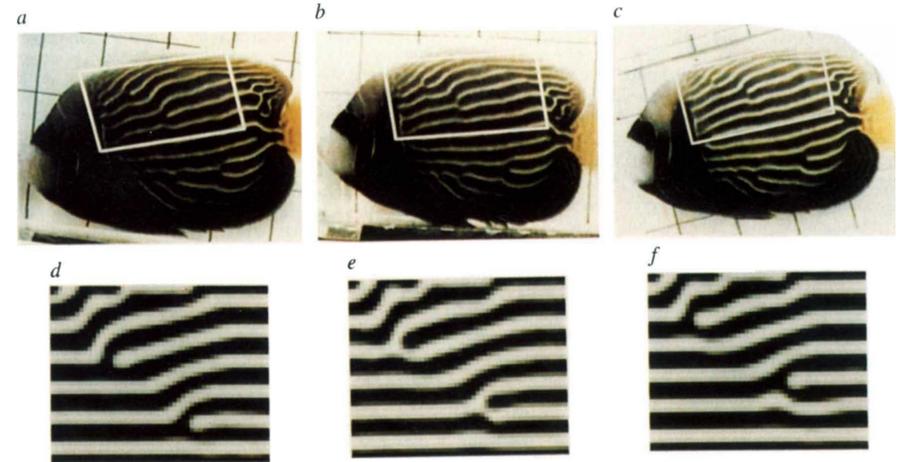
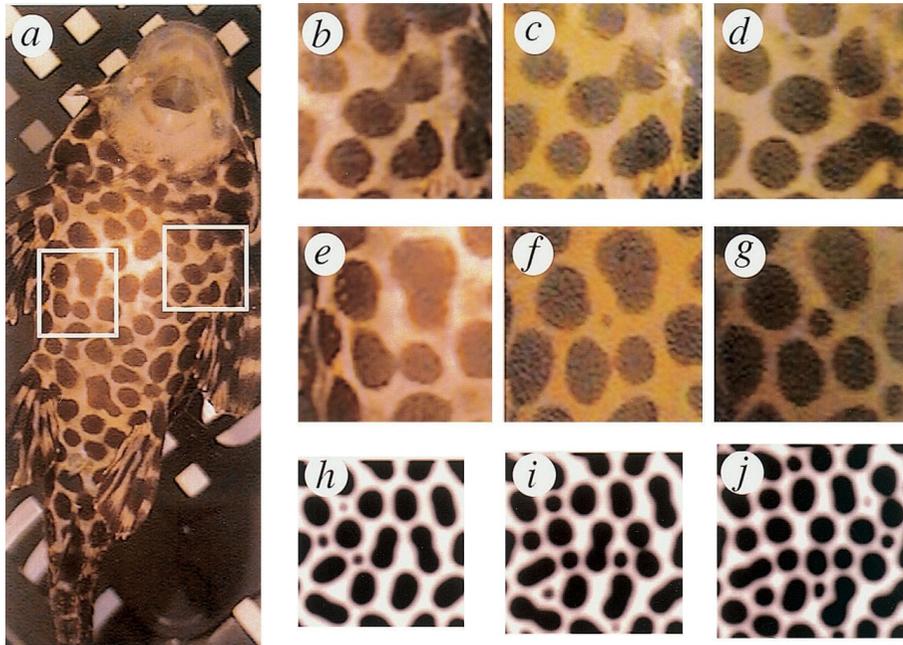


Turing instability, a nonlinear case : the final state

U (red), V (black)

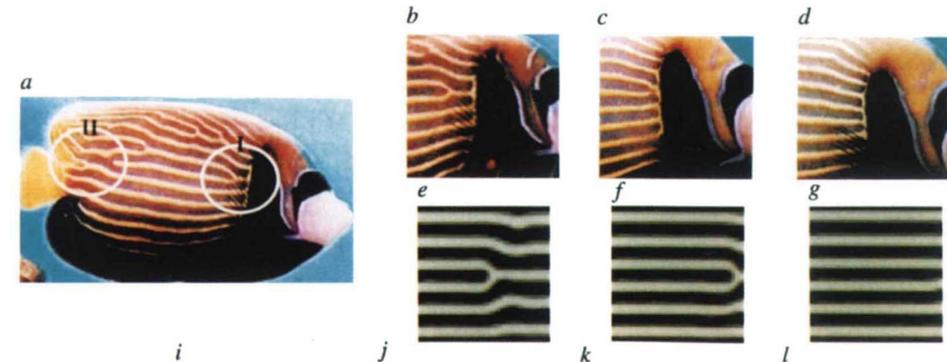


Skin patterns



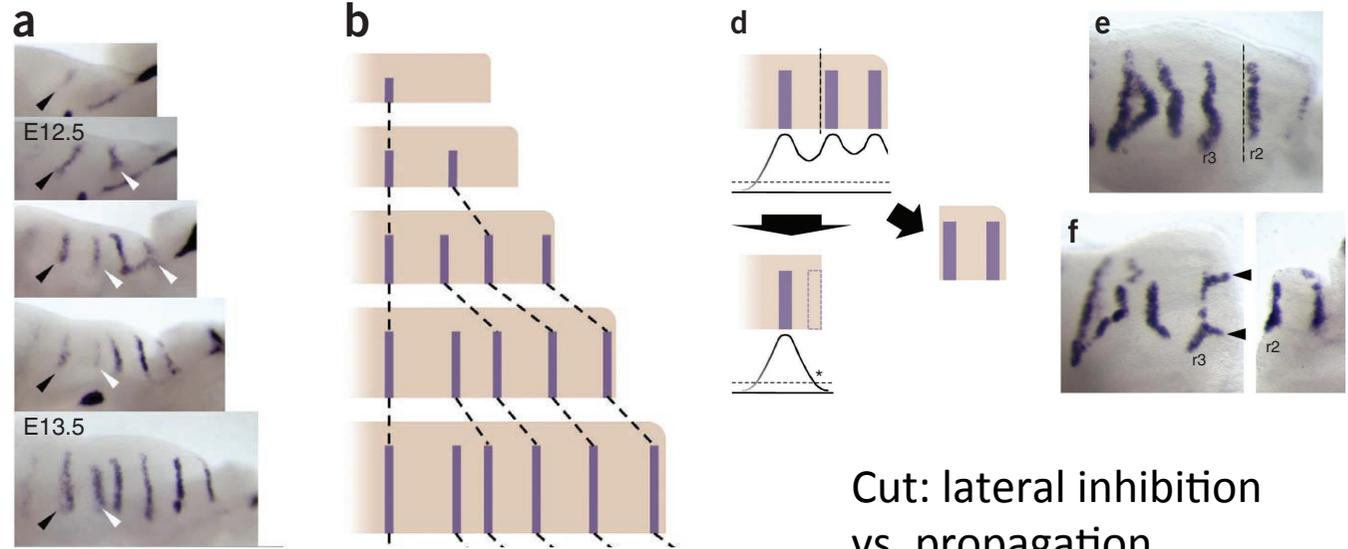
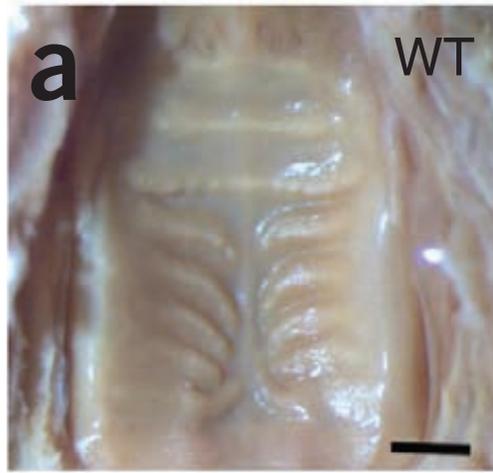
S Kondo, R Asai, Nature 376 (1995)

Asai, R.,..., Kondo, S. (1999).
Mech. Dev. 89: 87-92.

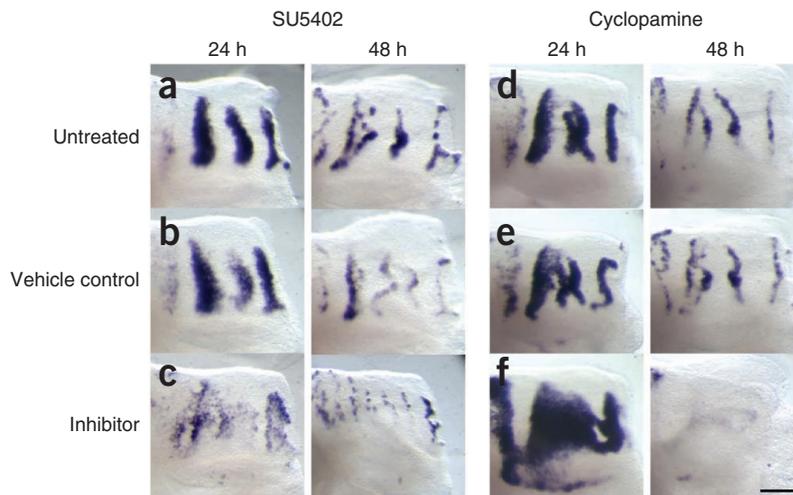


Mammalian palate (rugae formation)

A D Economou et al, Nature Genetics 44, 348 (2012)



Cut: lateral inhibition vs. propagation



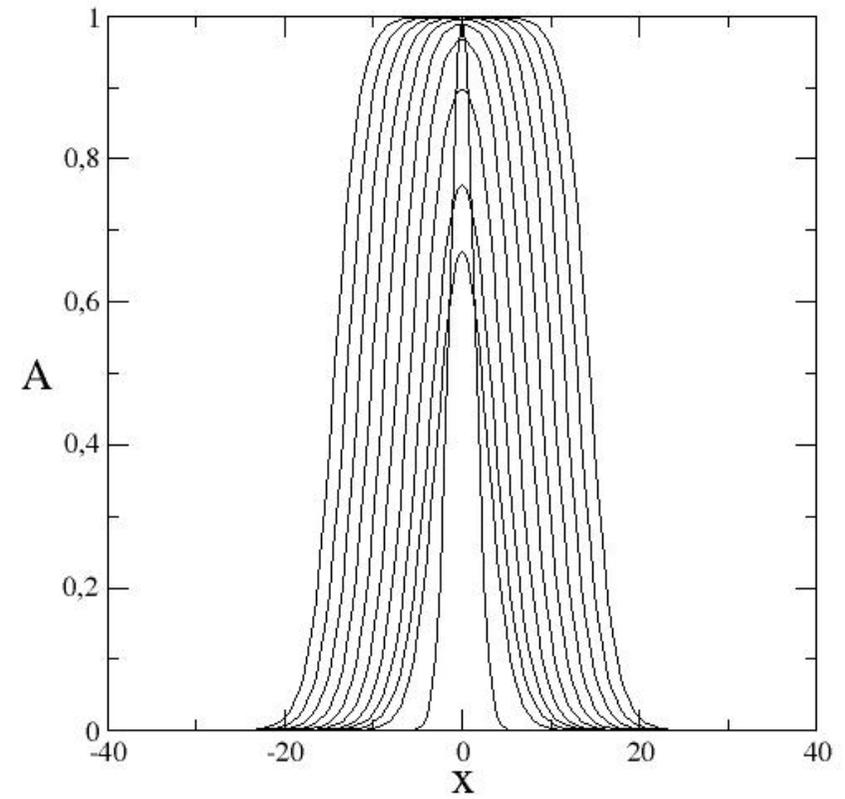
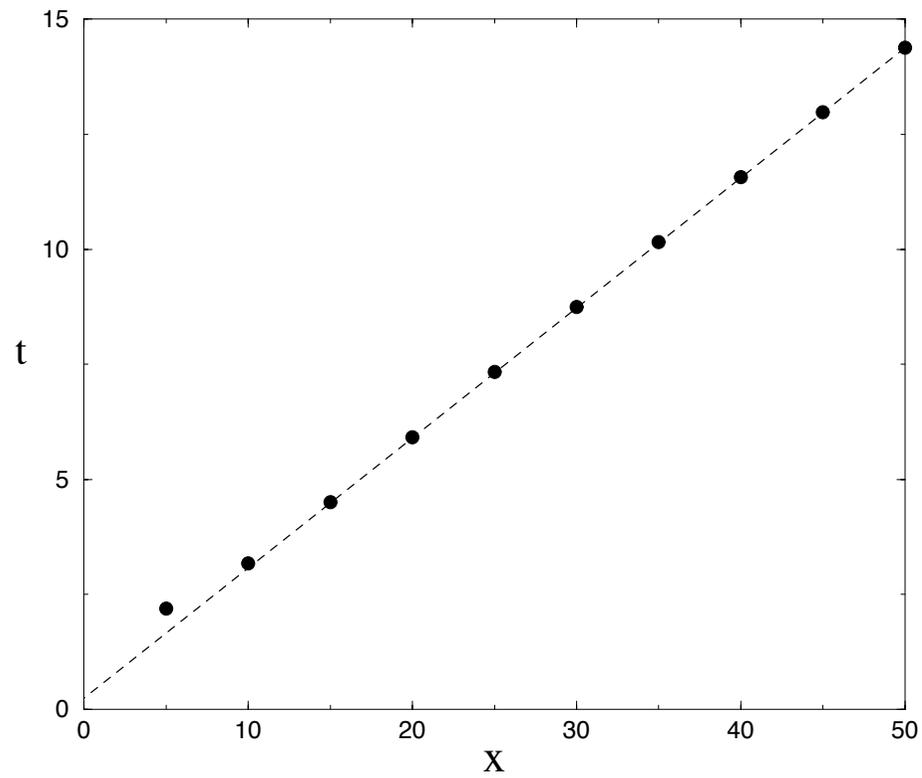
SU5402 chemical inhibitor of FGF
 -> FGF suggested Turing activator

Cyclopamine Shh signalling inhibitor
 -> Shh suggested Turing inhibitor

Other pathways (Wnt, BMP) involved

Domain growth and front velocity

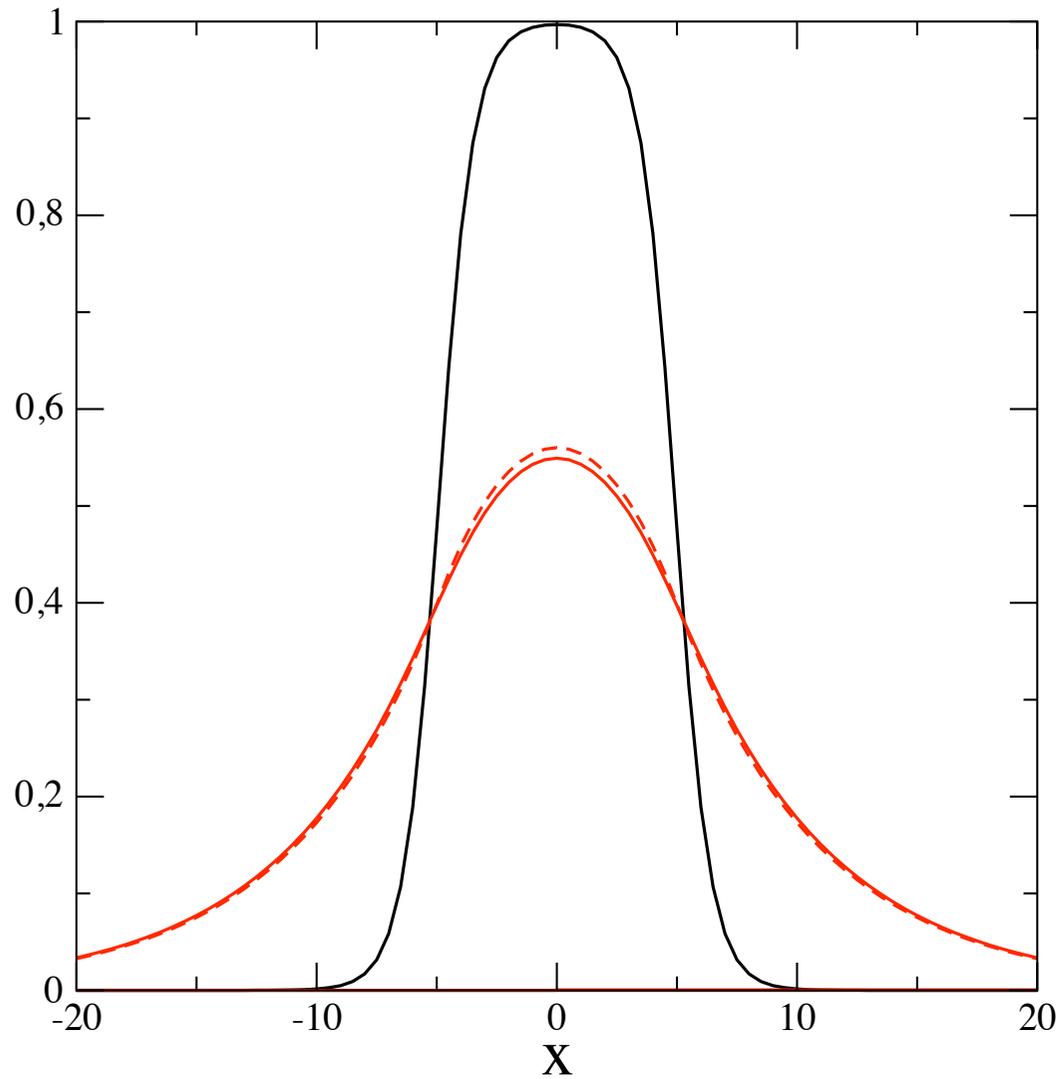
Front velocity

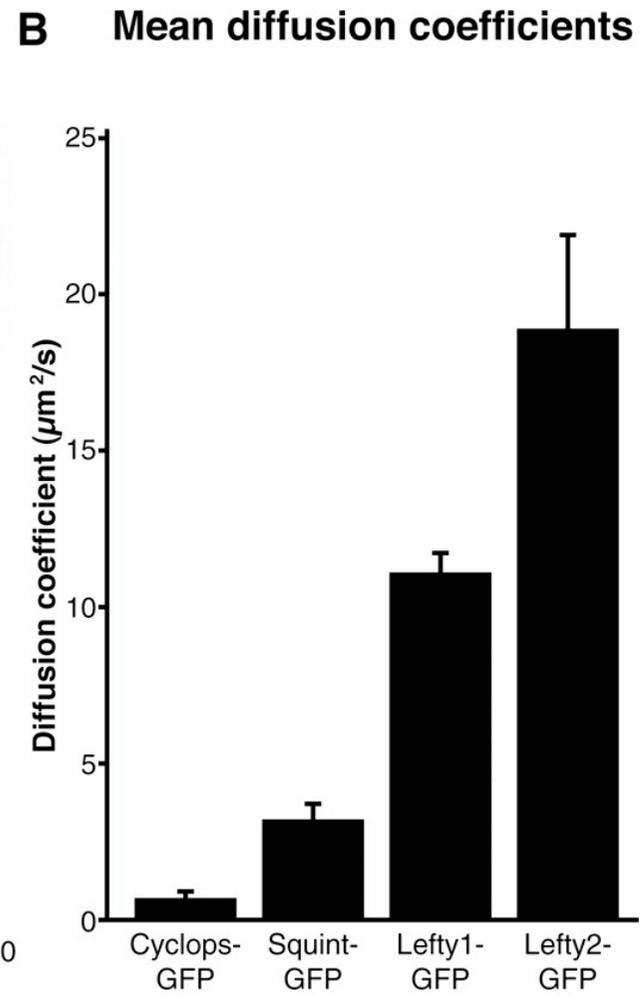
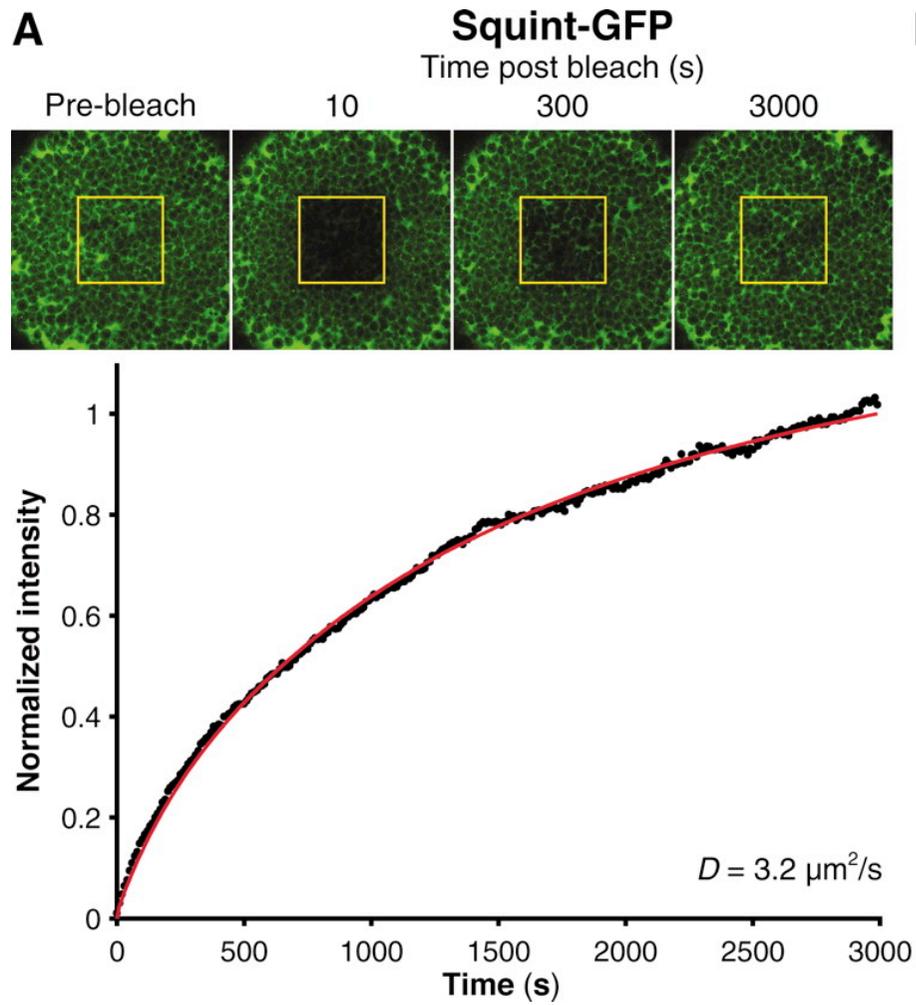


Short-range activation, long-range inhibition :

Localized state

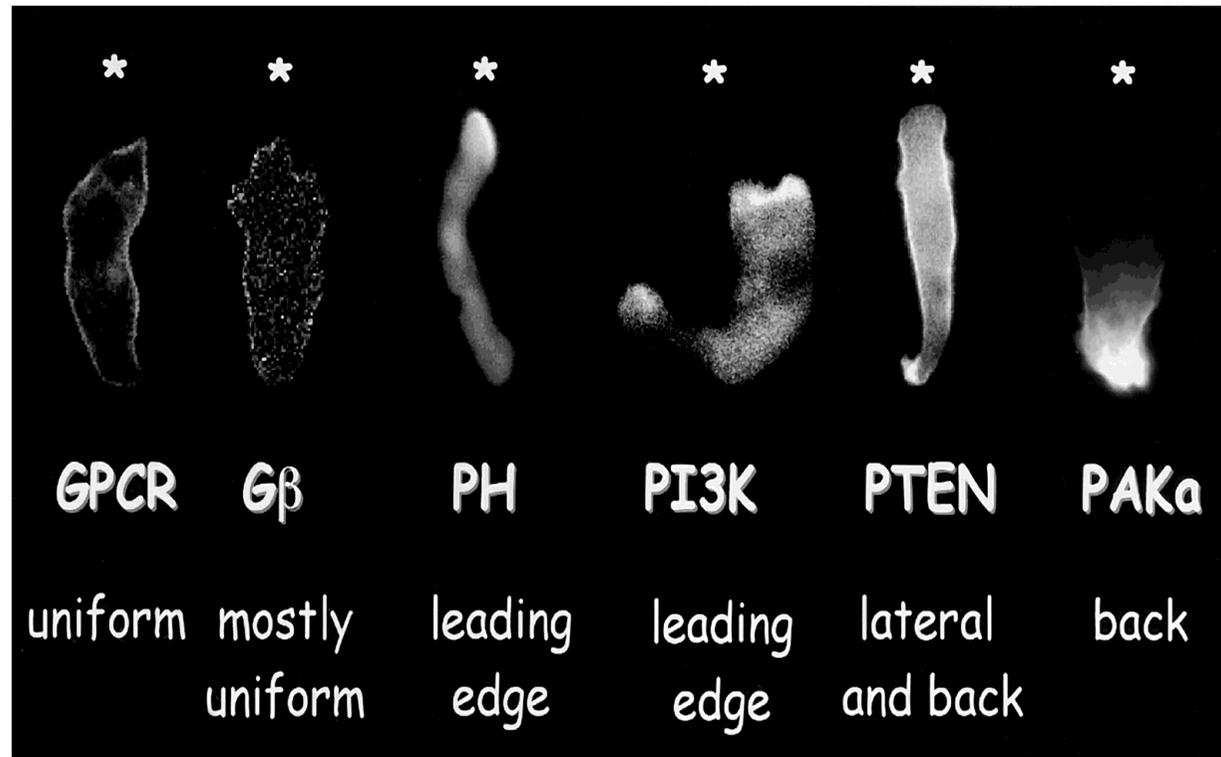
(potential $a=.3; l_A=.5, l_B=6, t_A=t_B=1$)





Mueller et al, Science 2012

Cell polarity as a localized Turing-like state ?



F. I. Comer and C. A. Parent, Cell 109, 541 (2002)