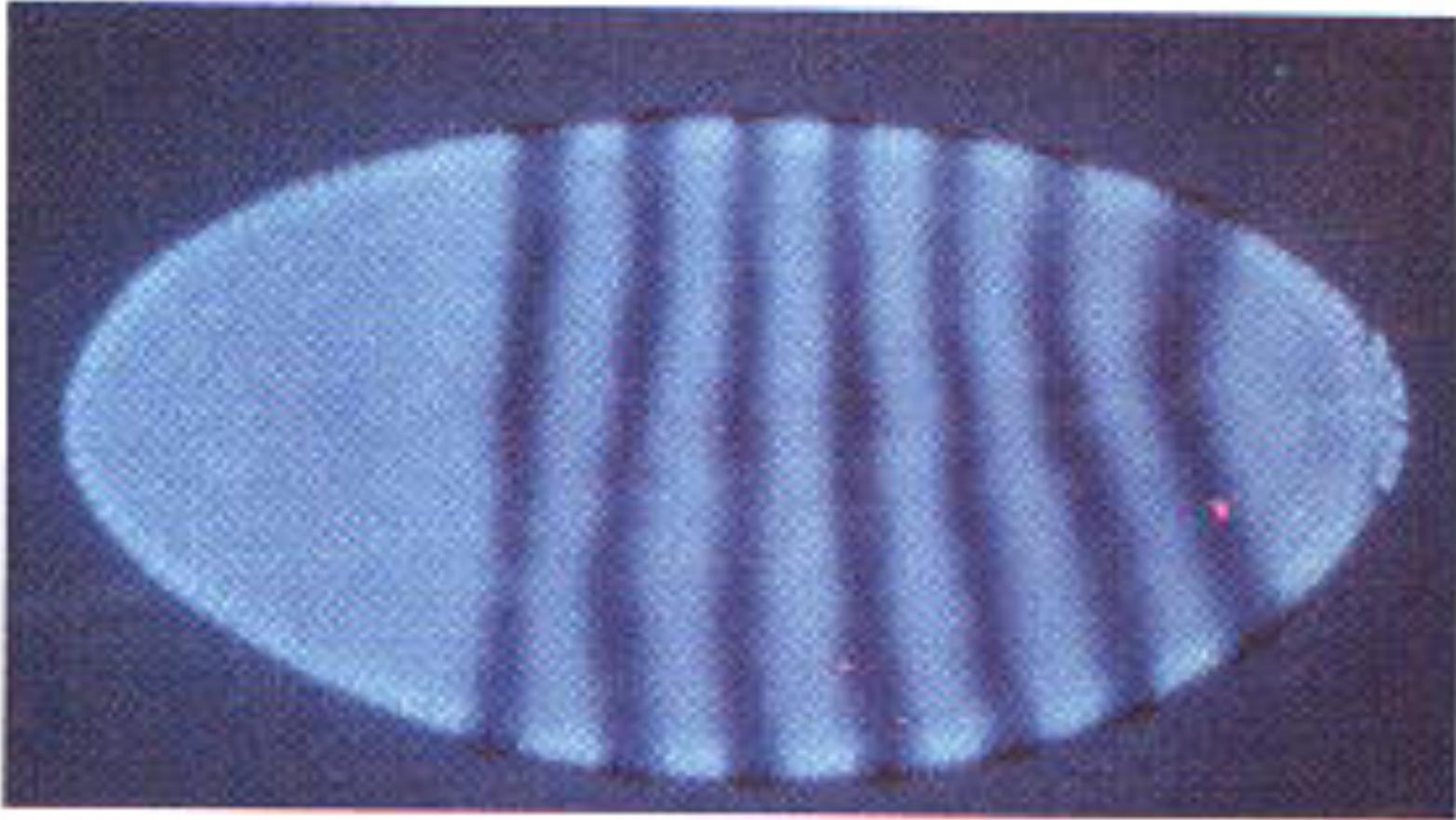
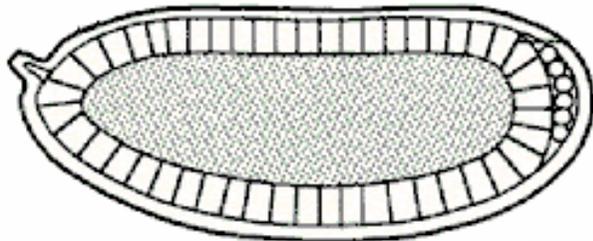
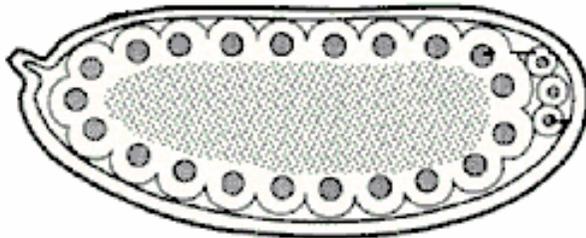
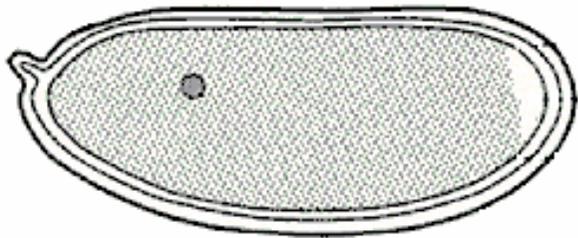


# Drosophila embryo



# The early development of the *drosophila* embryo occurs in a syncytium



## Early syncytium :

- . cycle-1 to cycle-8 (~ 70 mn)
- . No transcription

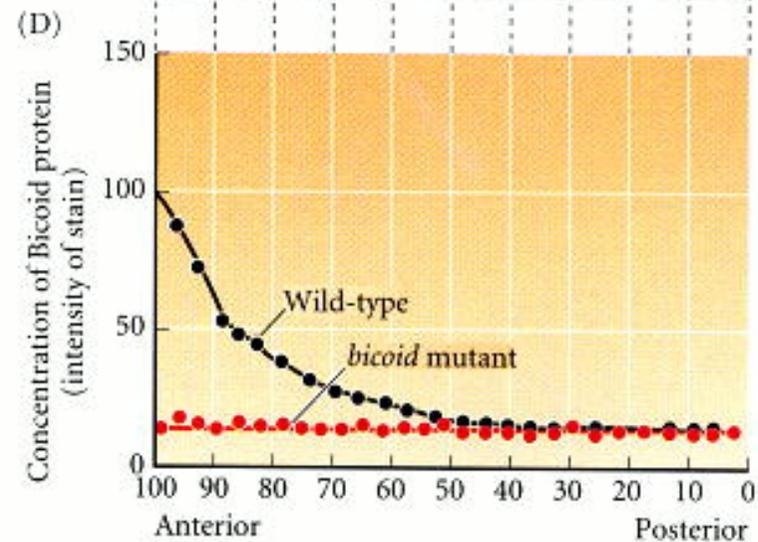
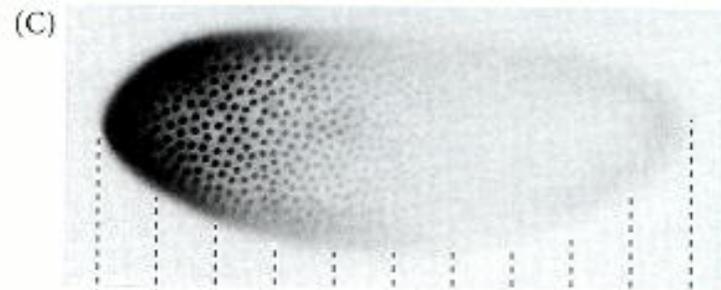
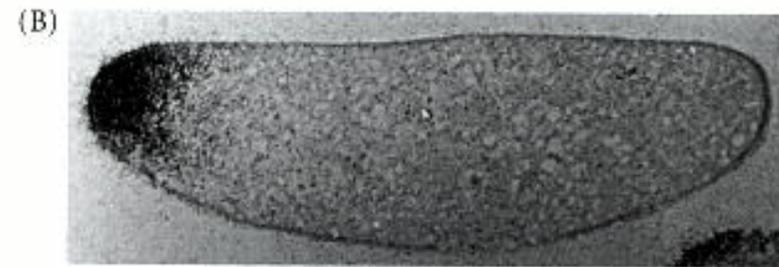
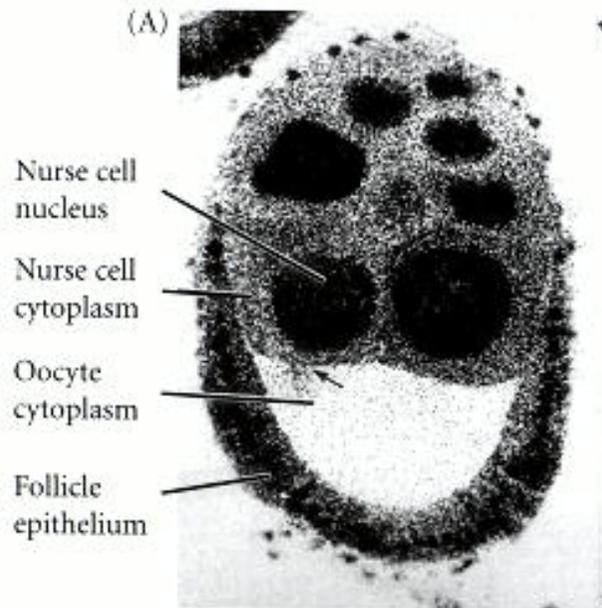
## Syncytial blastoderm :

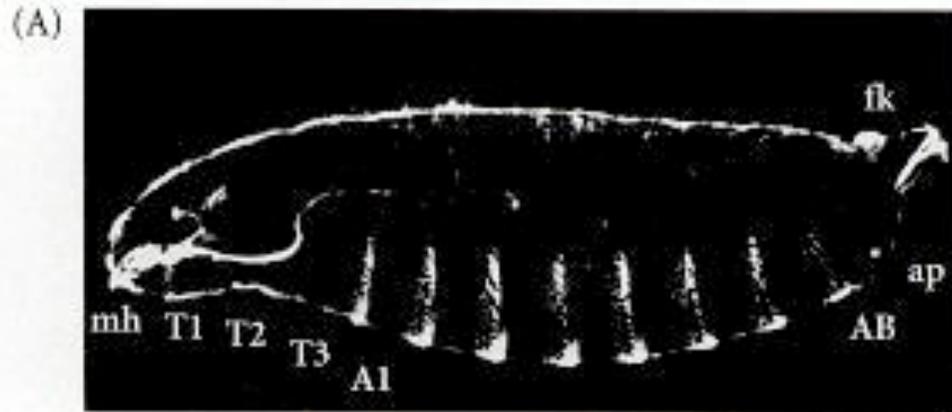
- . cycle-9 to cycle-13 (~ 70 mn)
- . Transcription of the zygotic genome

## Cellular blastoderm :

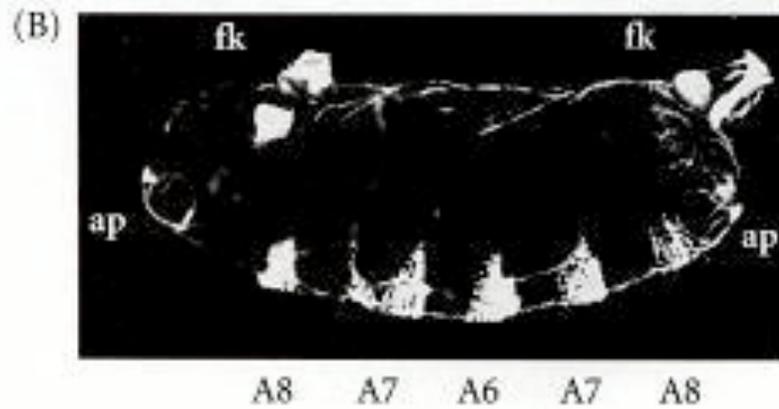
- . cycle-14 (> 60 mn)
- . Cellularisation

# The bicoid gradient





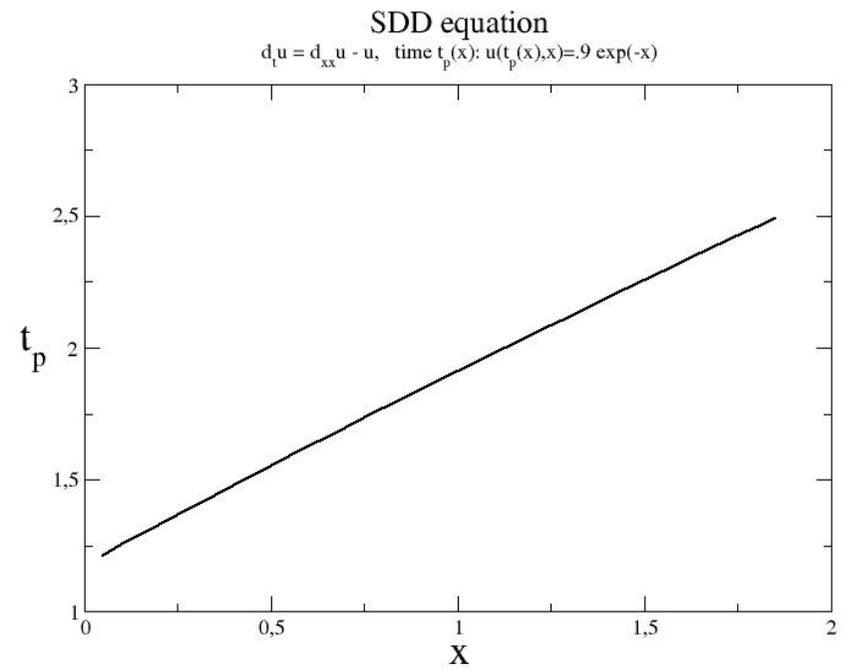
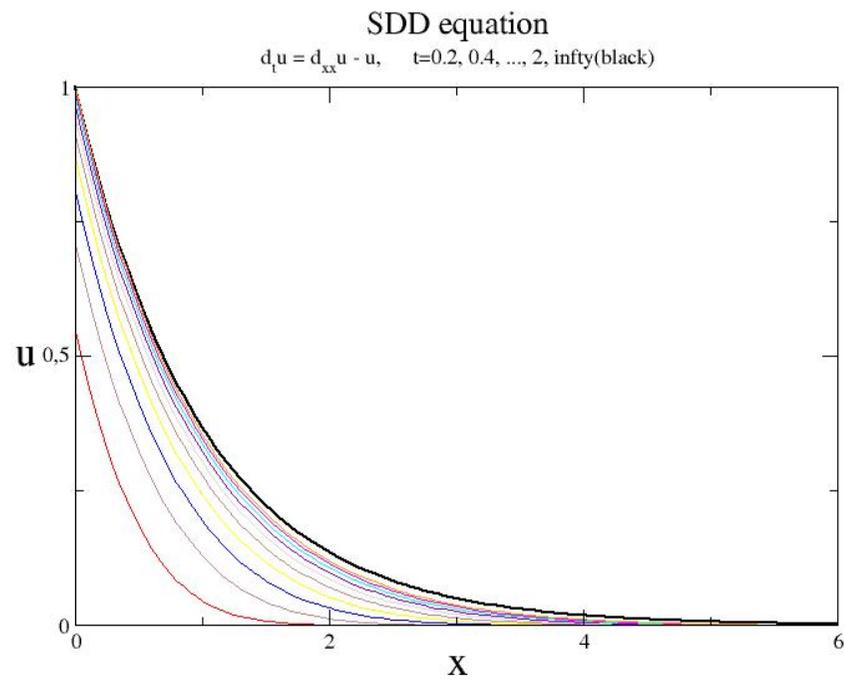
Wild-type cuticle patterns



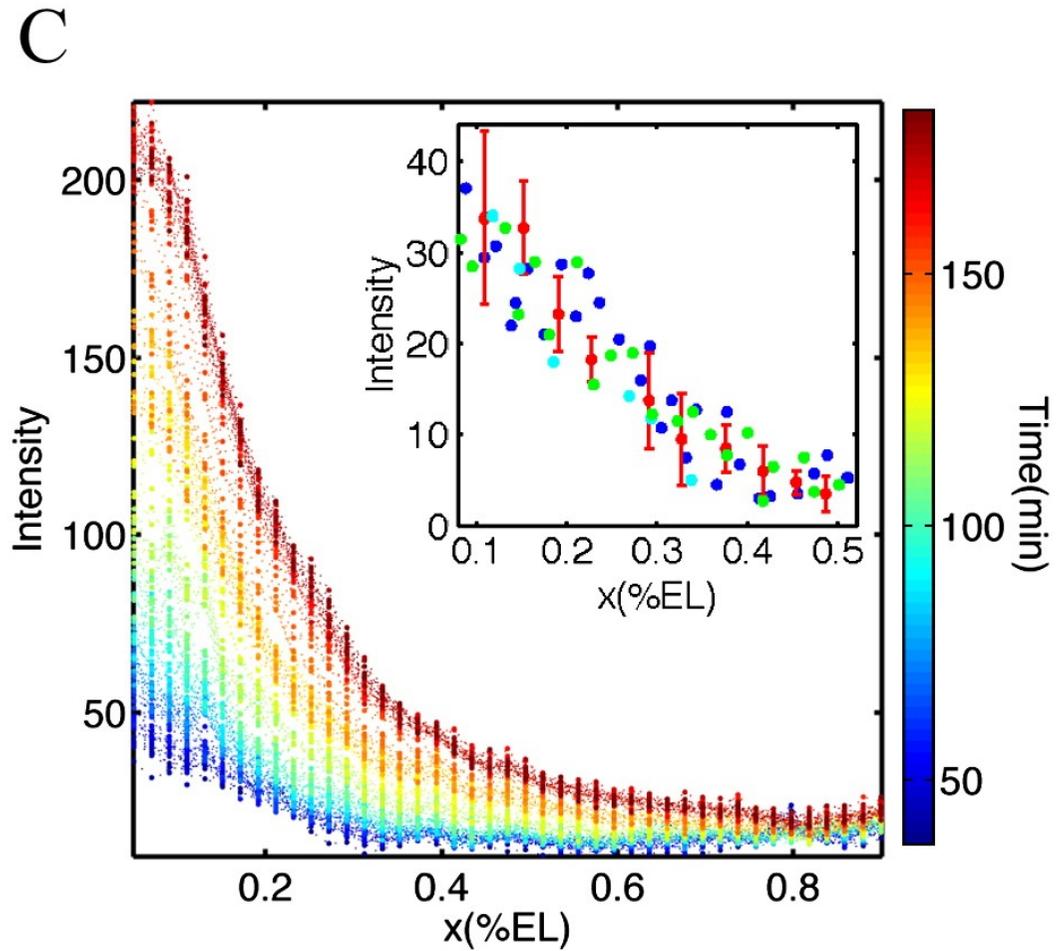
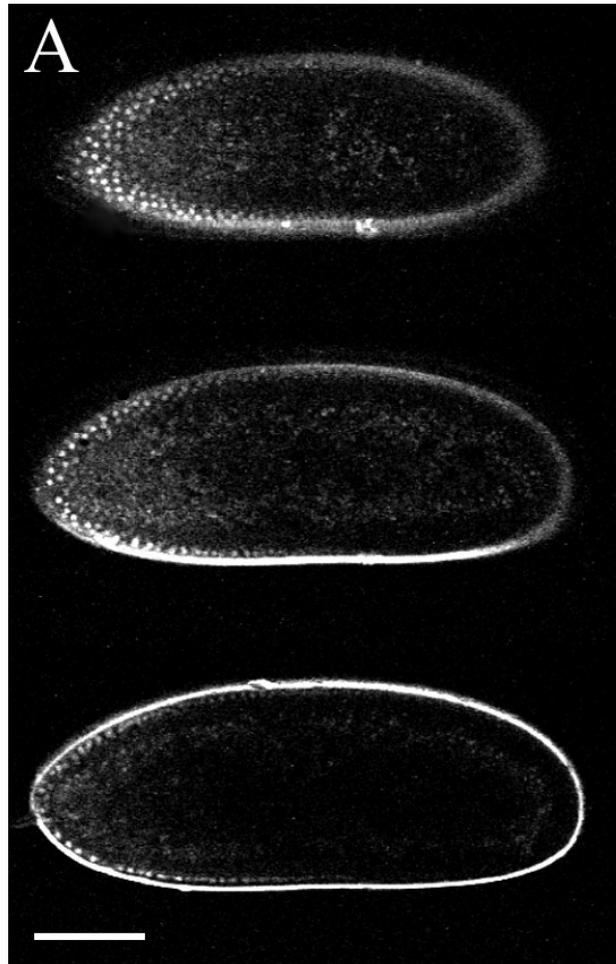
Bicoid mutant

Driever, Nusslein-Vollhardt, Cell (1988)

# Source-Diffusion-Decay



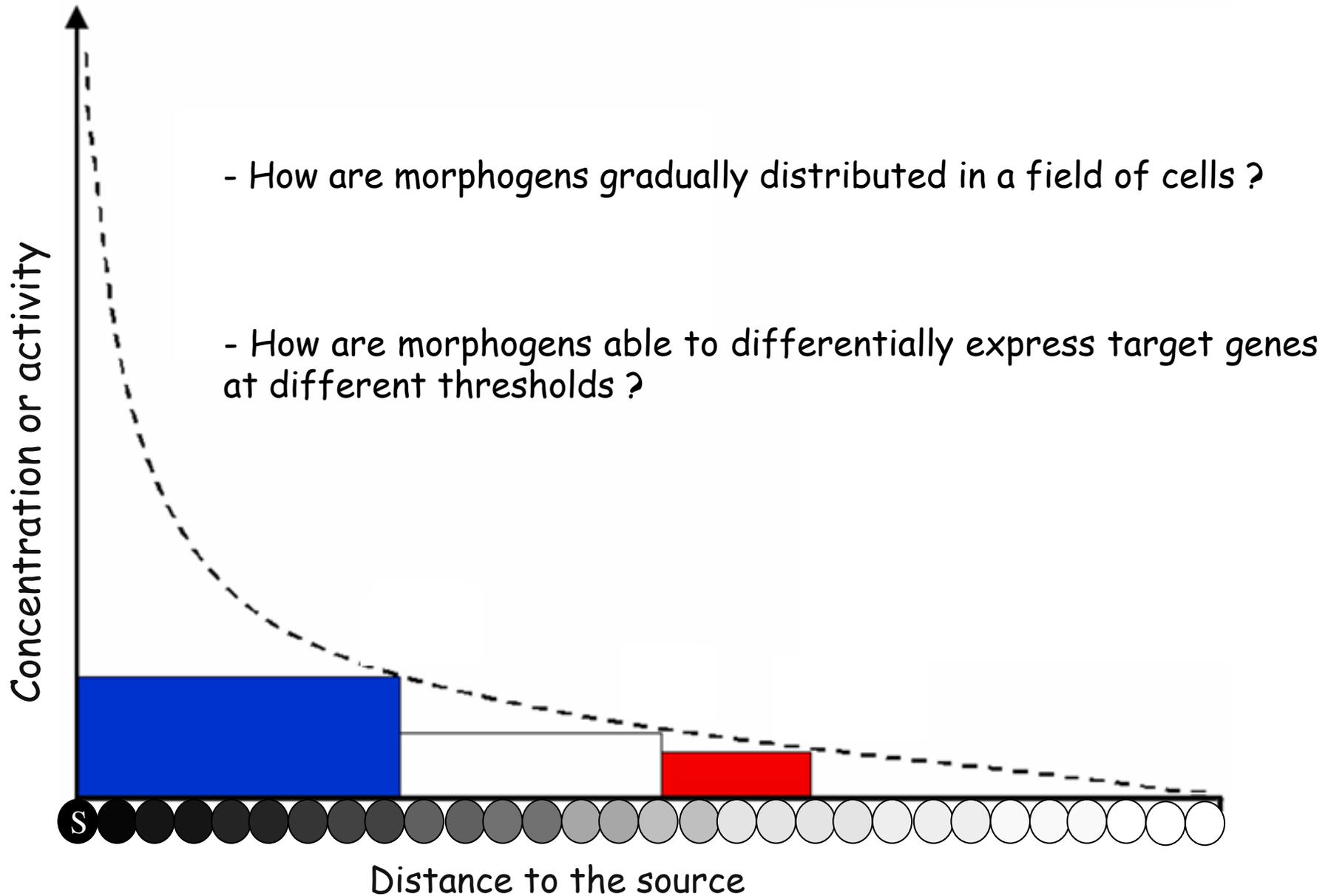
# Precision measurements of the bicoid gradient dynamics



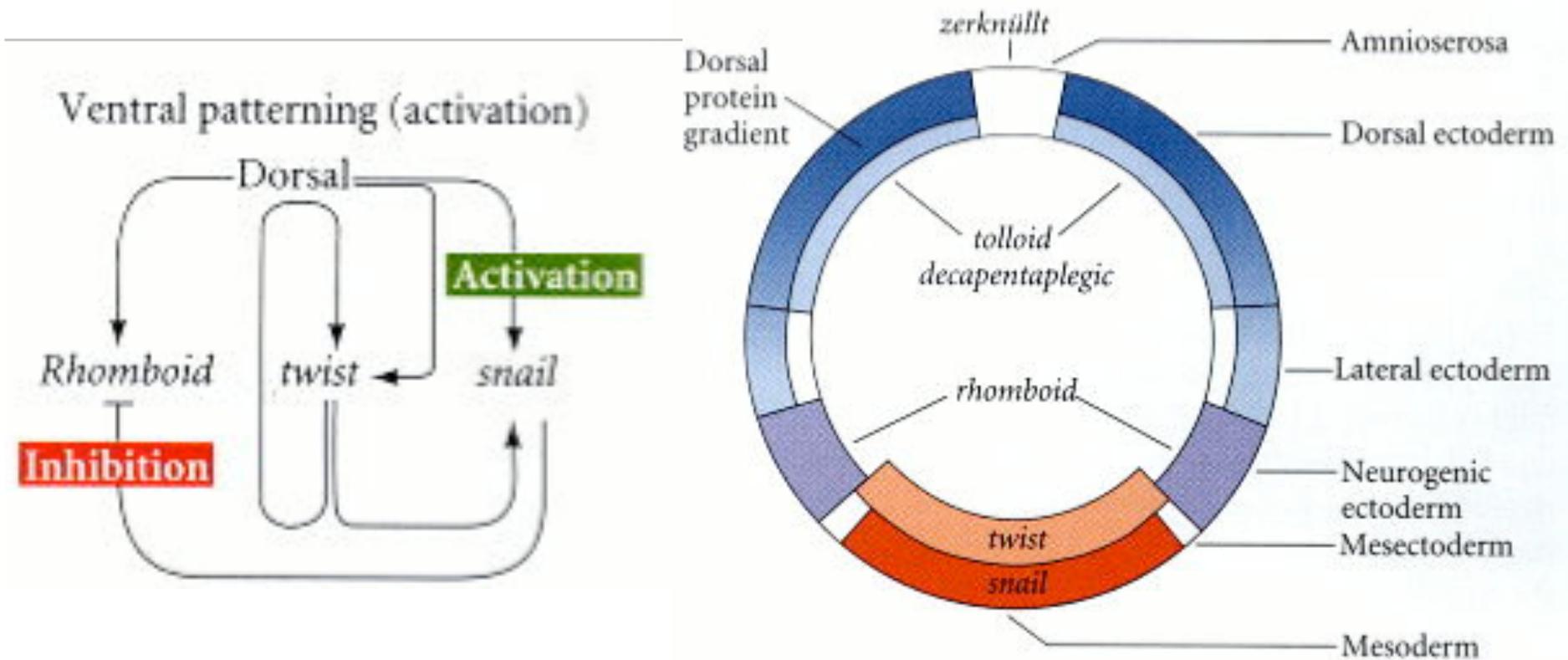
T. Gregor et al, Cell 130 (2007)

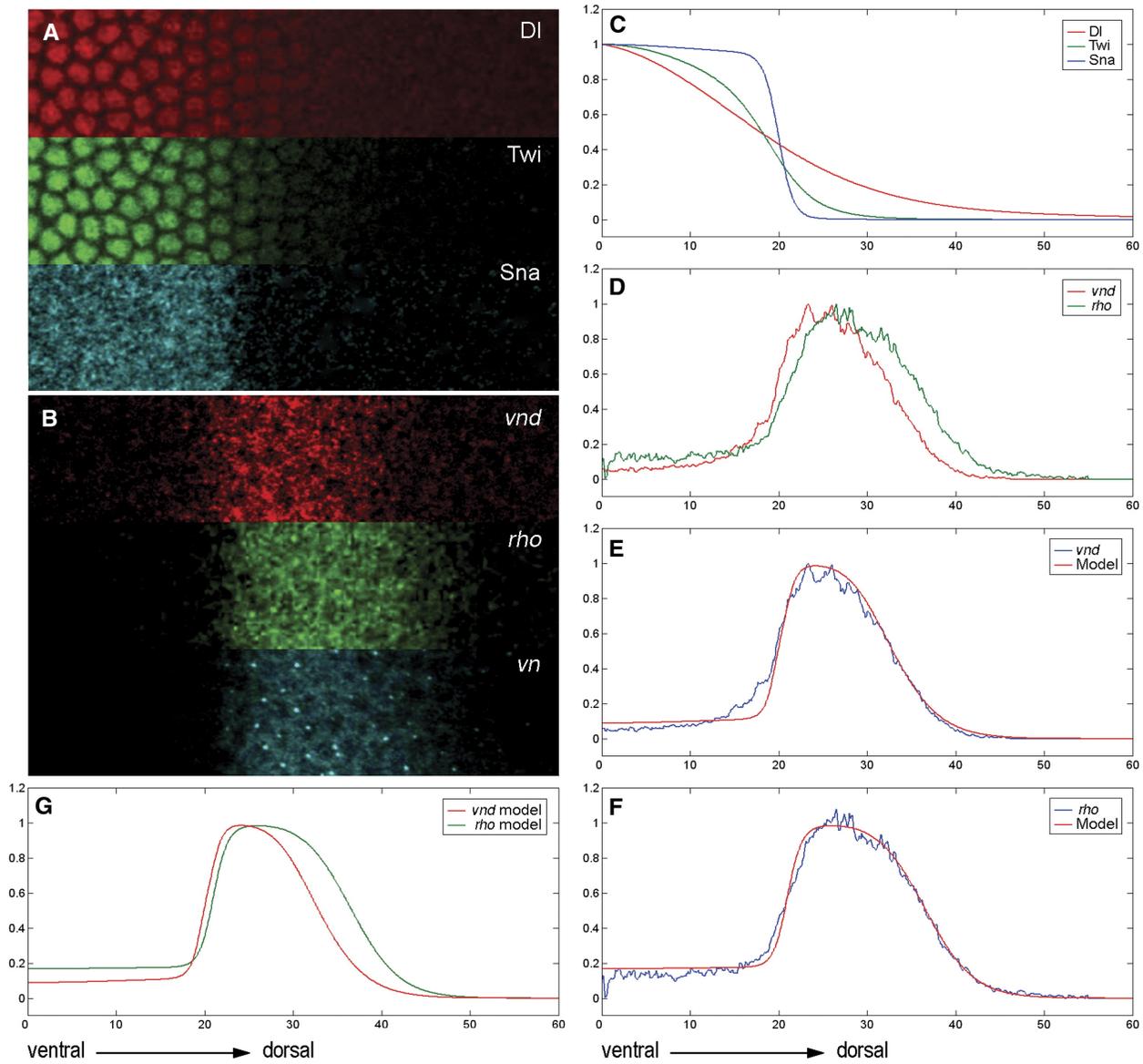
# Gradients and the french flag model

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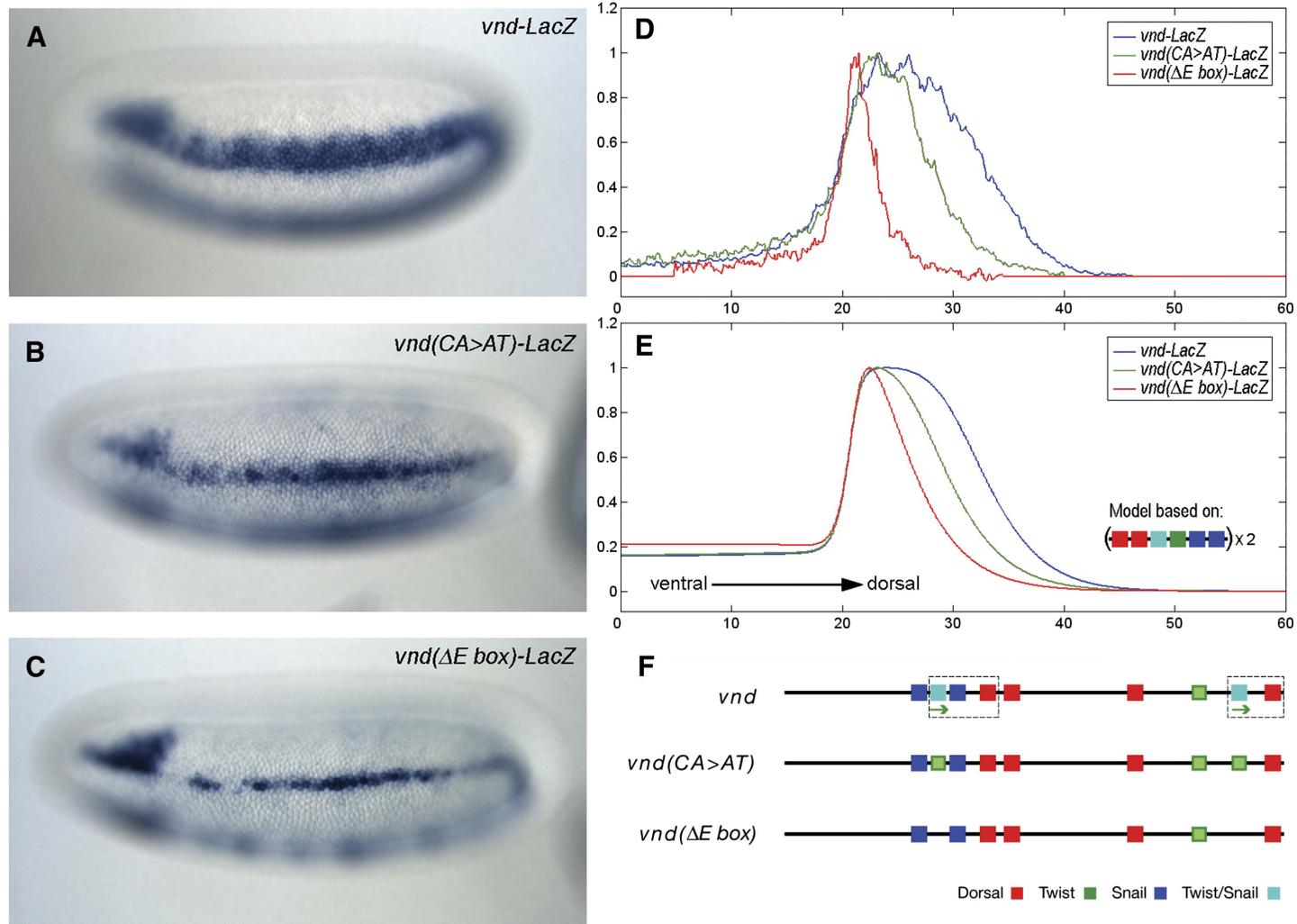


# Drosophila : embryonic dorso-ventral patterning



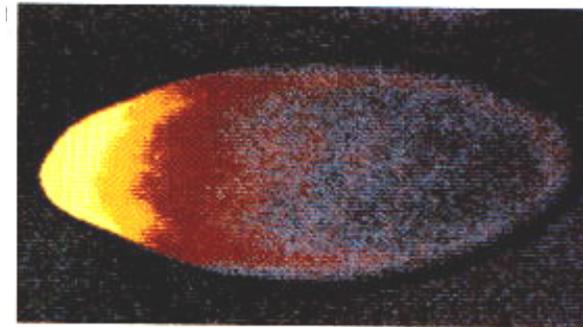
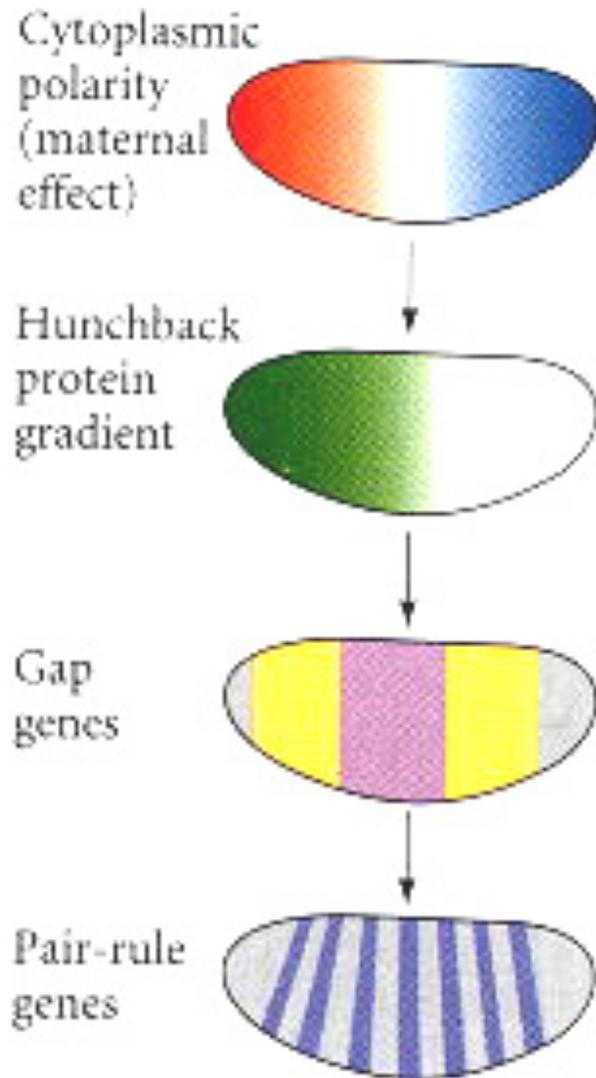


R Zinzen, K Senger, M Levine and D Papatsenko, *Curr. Biol.* 16, 1358 (2006)

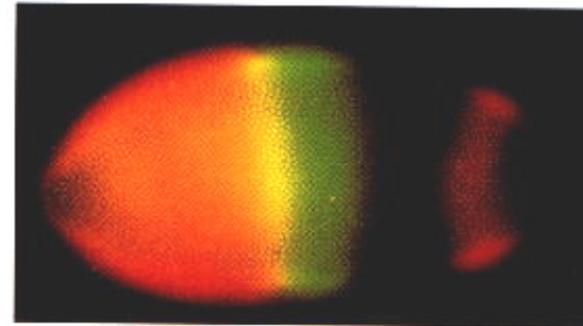


R Zinzen, K Senger, M Levine and D Papatsenko, *Curr. Biol.* 16, 1358 (2006)

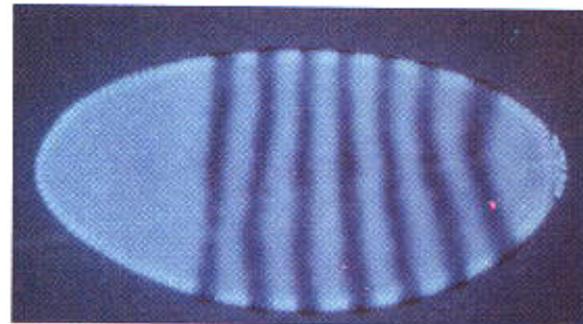
# Drosophila embryonic A-P segmentation



Bicoid gradient

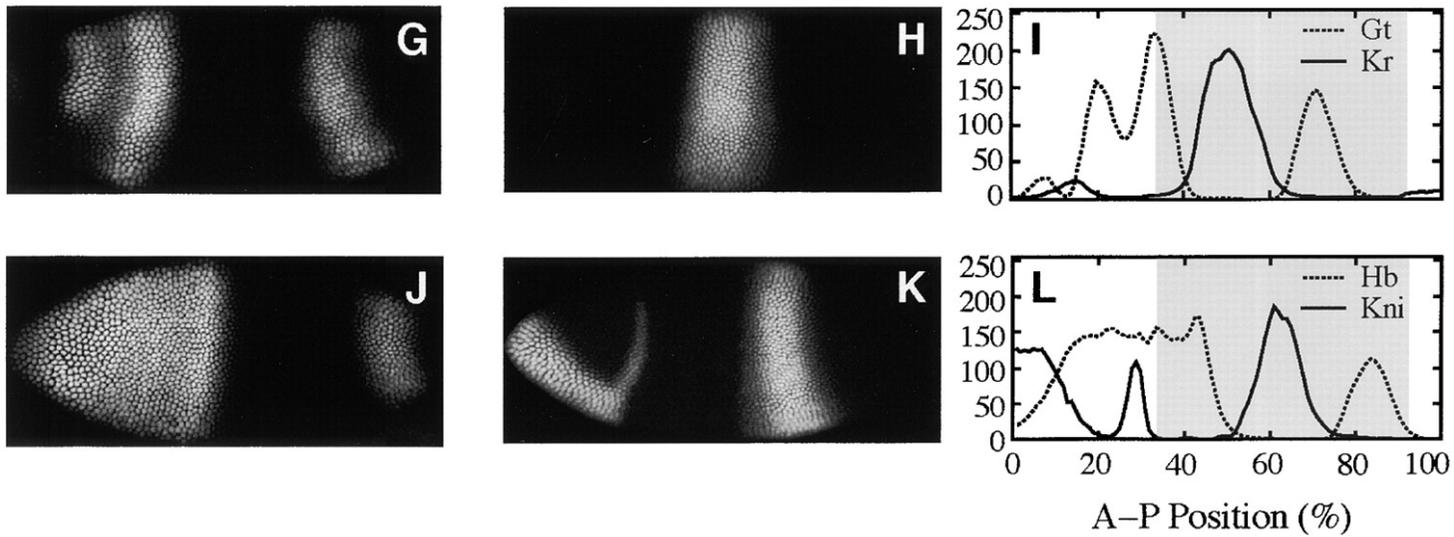


Gap genes

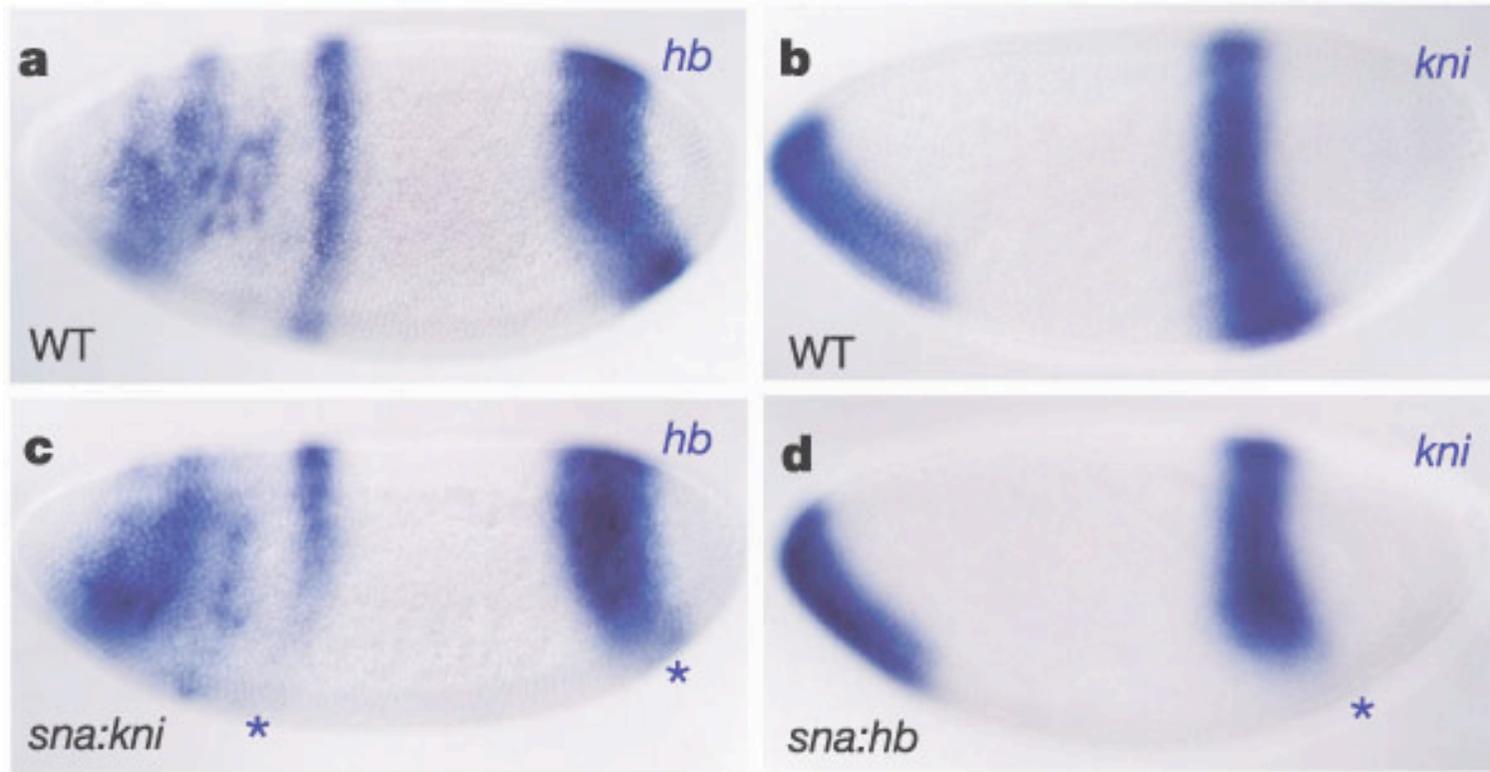


## Gap gene **functional** interactions in the embryo central region

Jaeger J et al. *Genetics* 2004;167:1721-1737



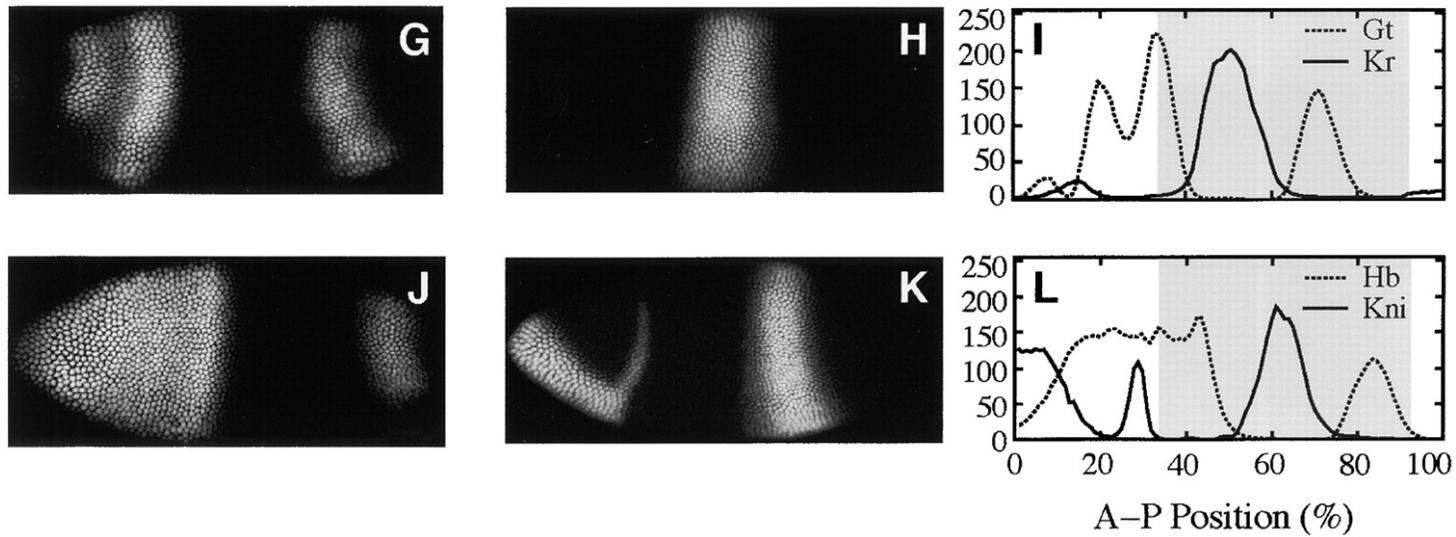
## Mutual repression between Hb and Kni.



D. E. Clyde, ..., S. Small Nature 426, 849-853 (2003)

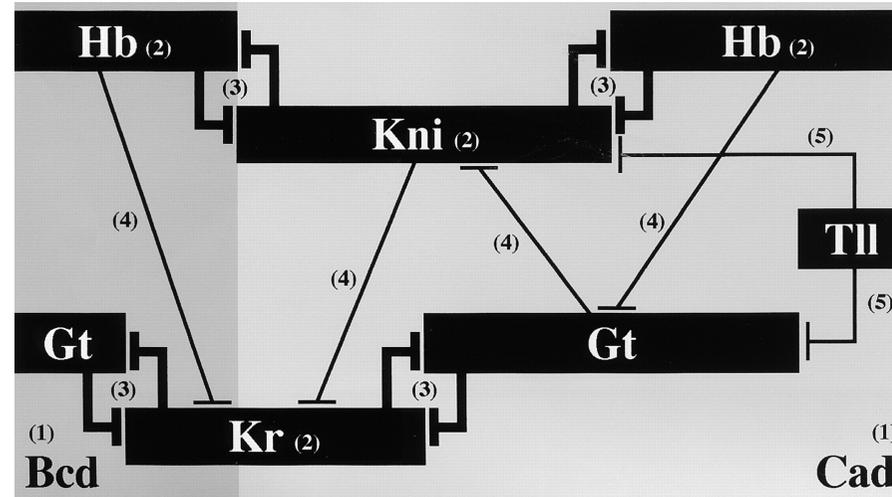
## Gap gene **functional** interactions in the embryo central region

Jaeger J et al. Genetics 2004;167:1721-1737



General features:

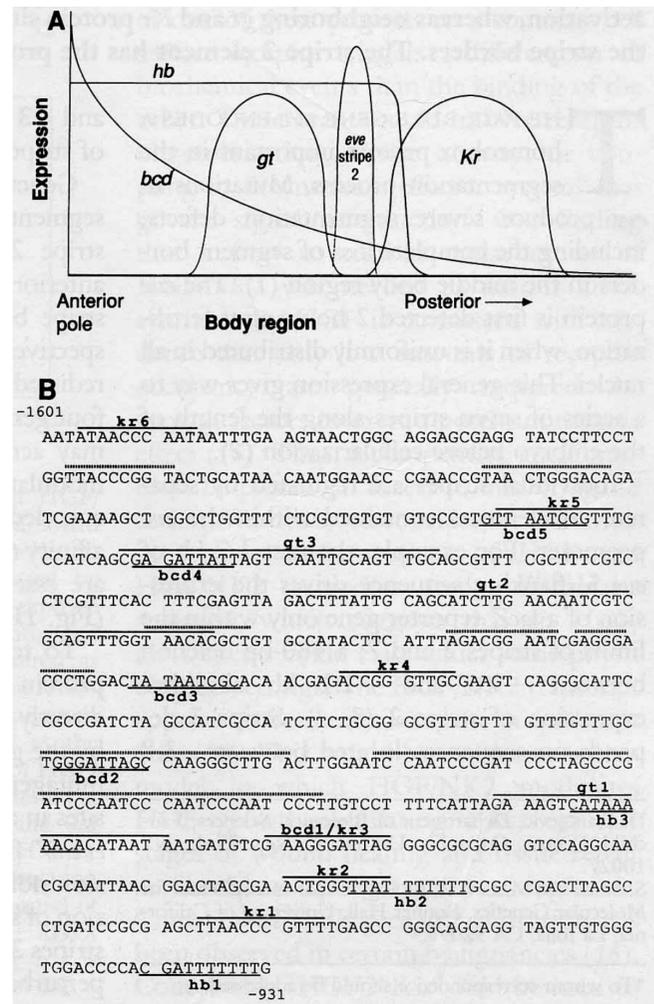
- activation by bcd and cad (gradients)
- auto-activation
- strong mutual repression of Hb/Kni and Gt/Kr



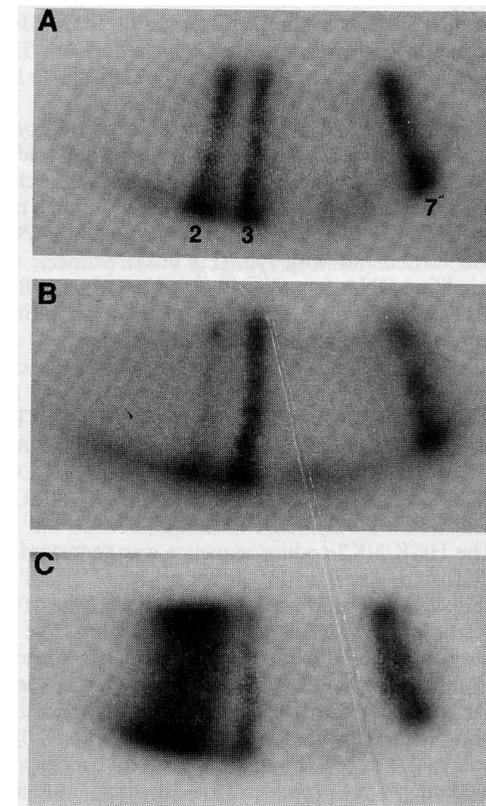
# Pair-rule gene stripes are specified one by one : the *eve* case.

3 enhancers for single stripes 1, 2, 5

2 enhancers for pairs of stripe 3+7, 4+6



*eve2*  
enhancer



Mutations :

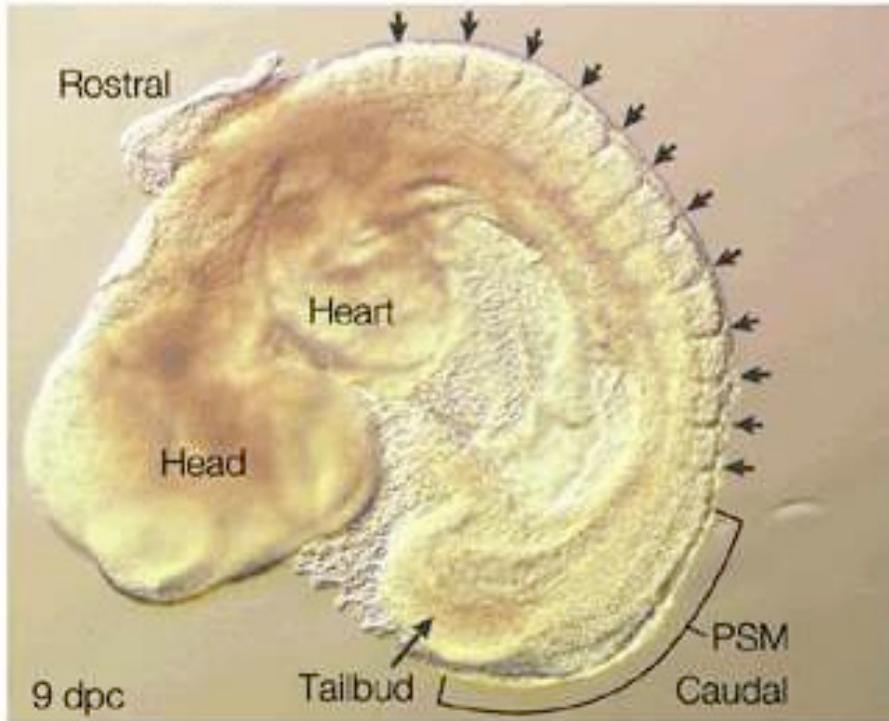
*bcd1-kr* +  
*bcd2* sites

*gt1+gt2+*  
*gt3* sites

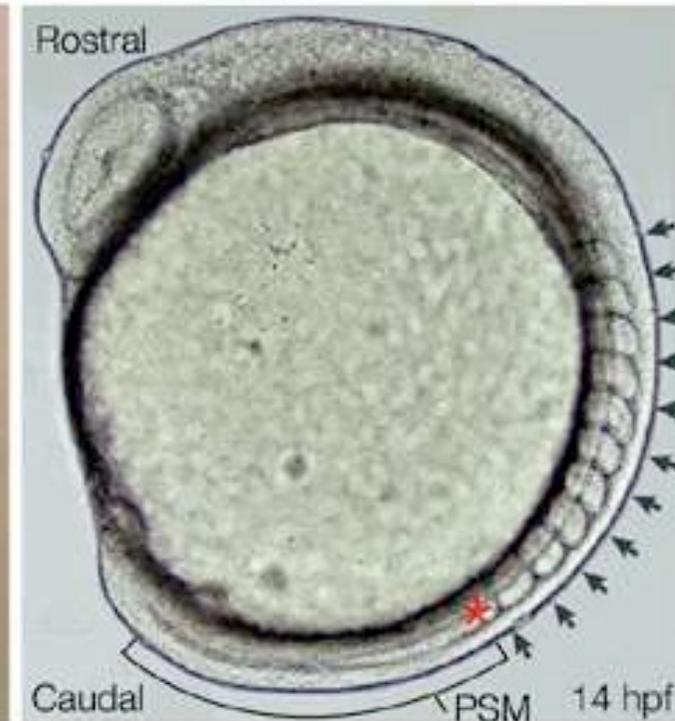
D Stajonevic, S. Small, M Levine, Science (1991)

# Segmentation in a dynamic gradient : somite formation in vertebrates

Mouse embryo



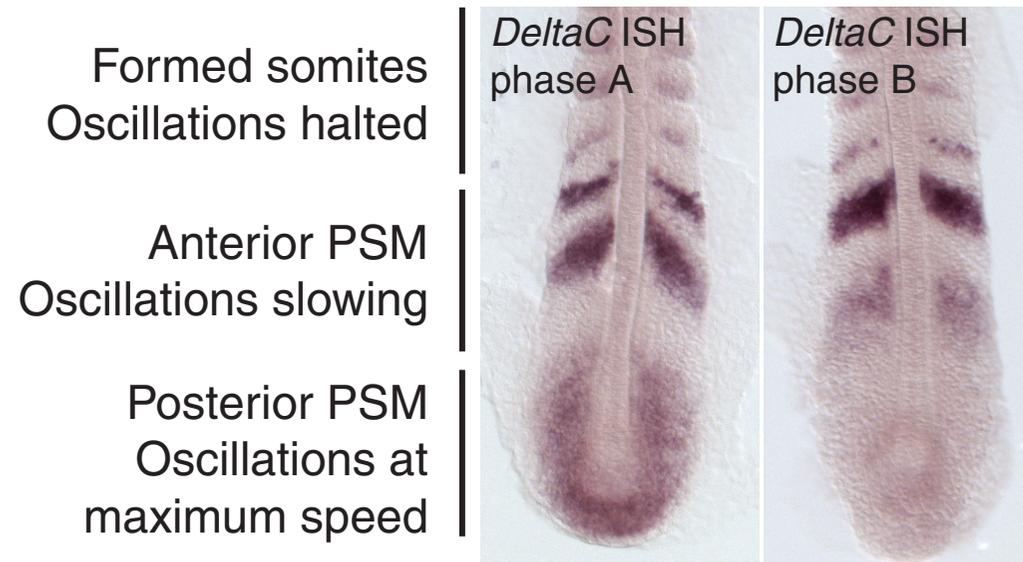
Zebrafish embryo



Y Saga, Nat Rev Gen (2001)

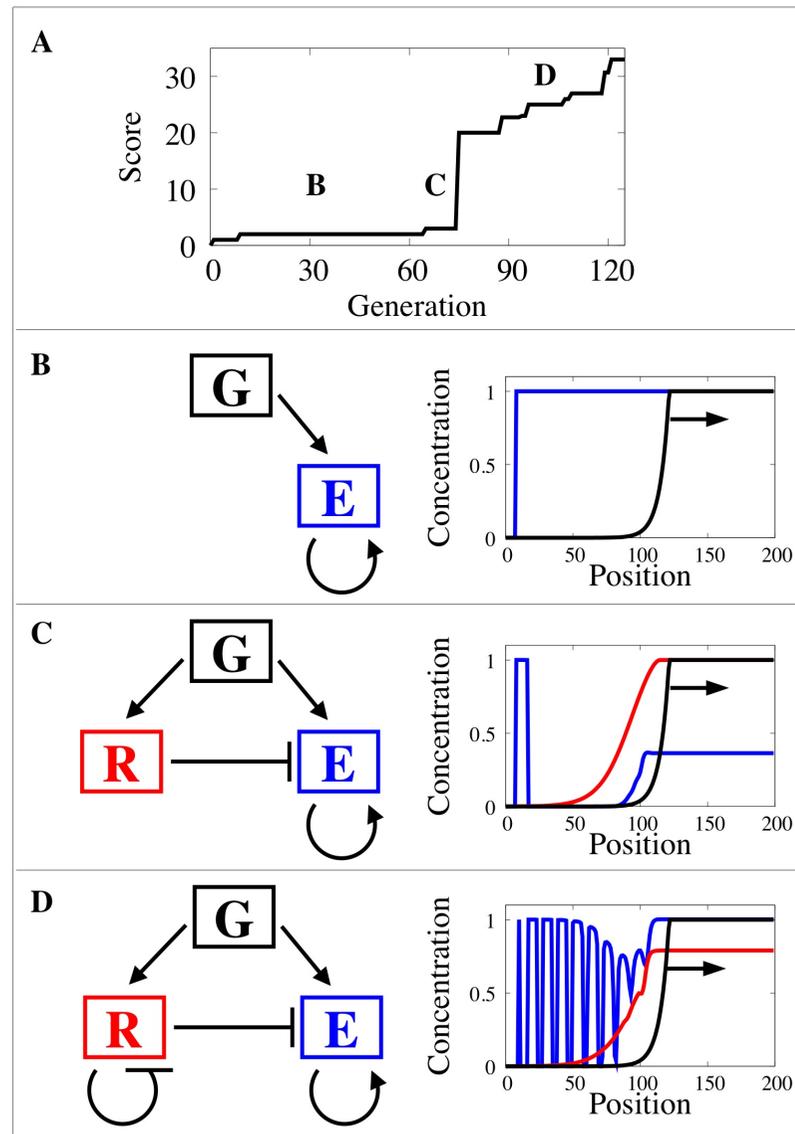
# Somitogenesis and oscillations

Cooke & Zeeman (1976) -> Palmeirim et al (1997)



J Lewis, J Biology (2009)

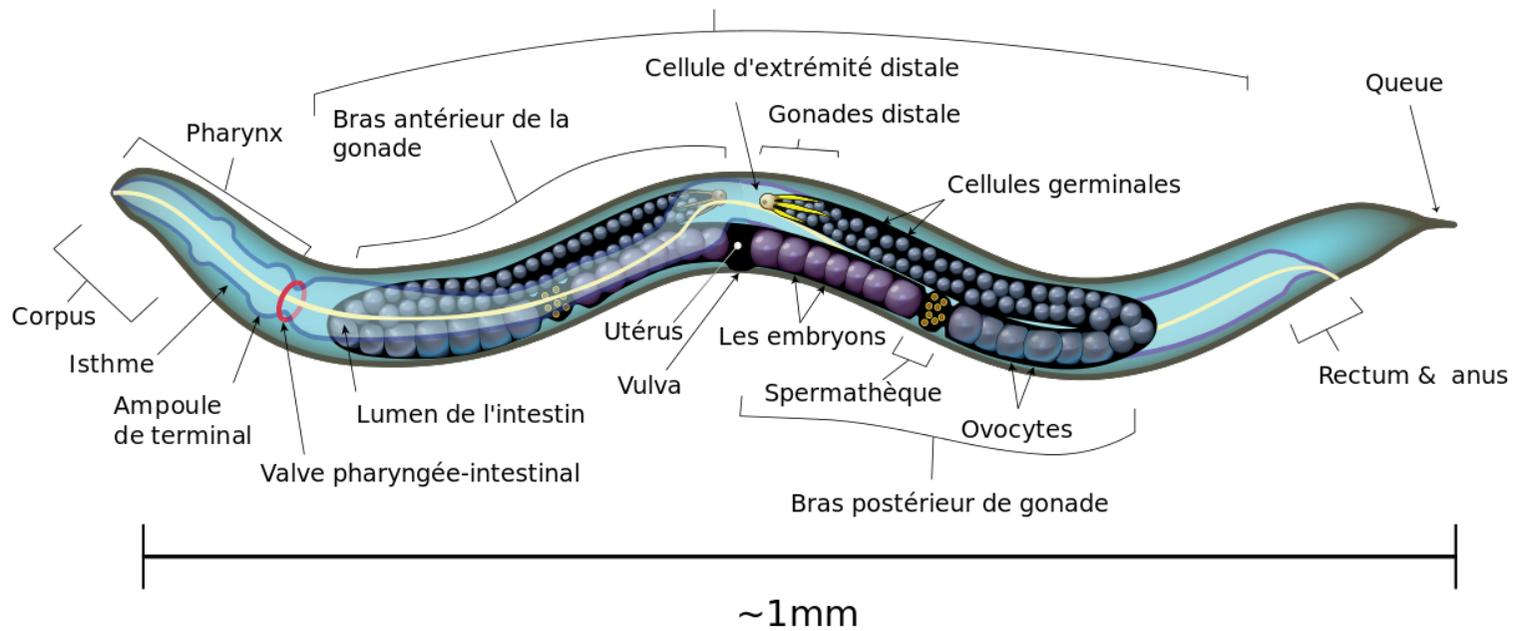
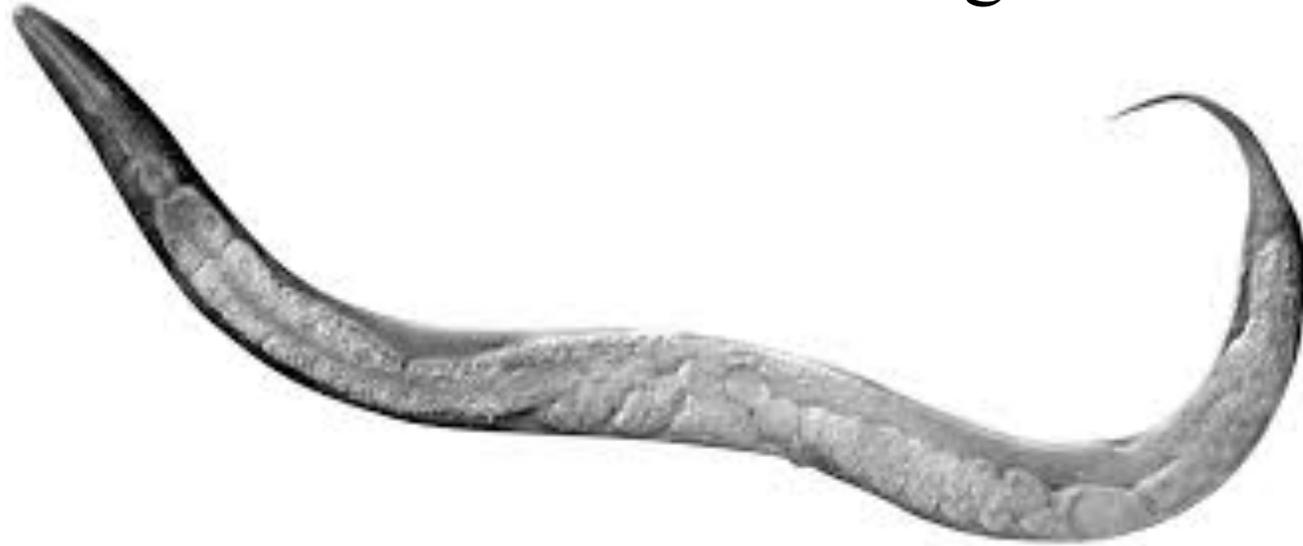
# Somitogenesis : a transition from oscillation to bistability ?



# Segmentation is an ancient invention

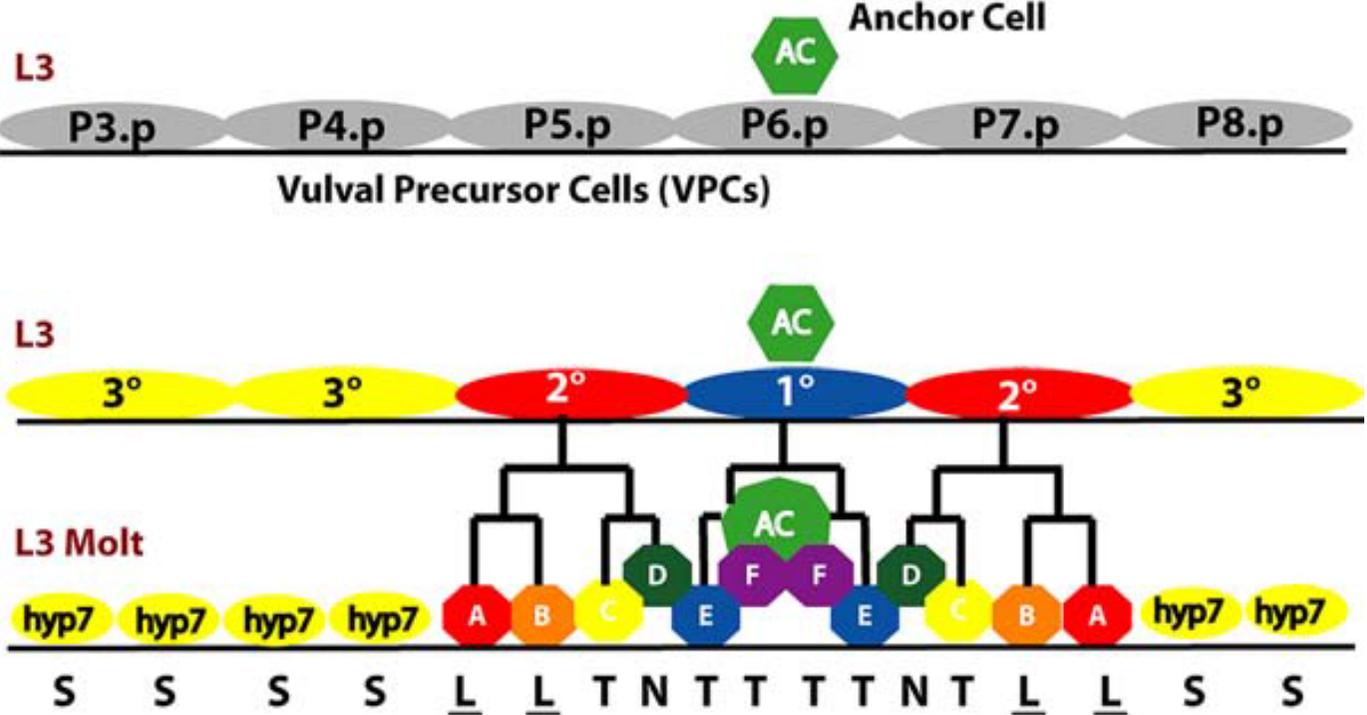
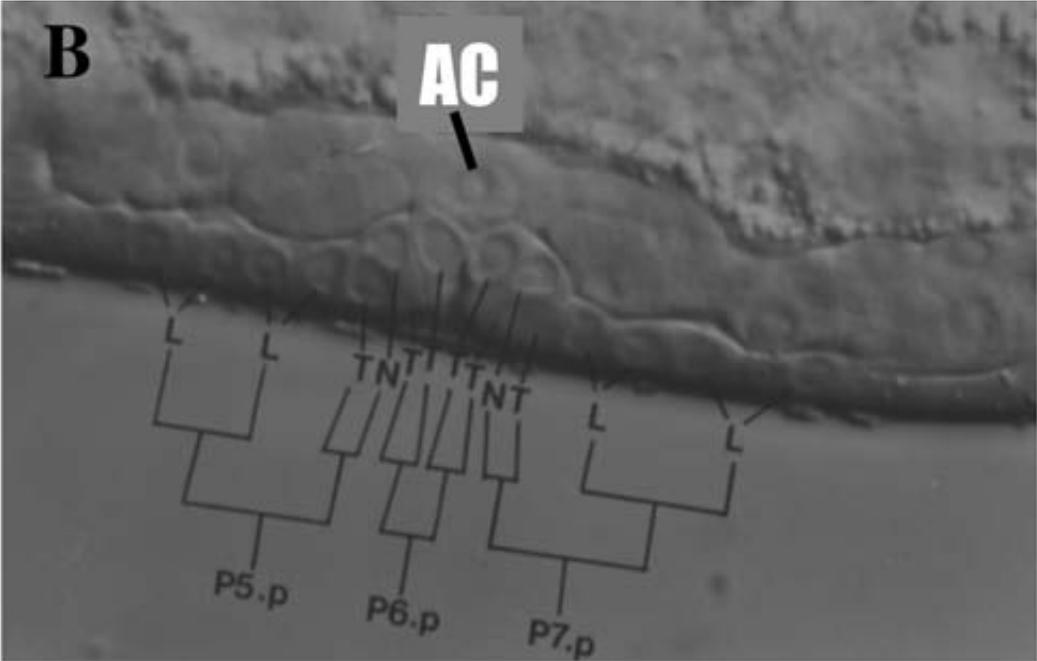


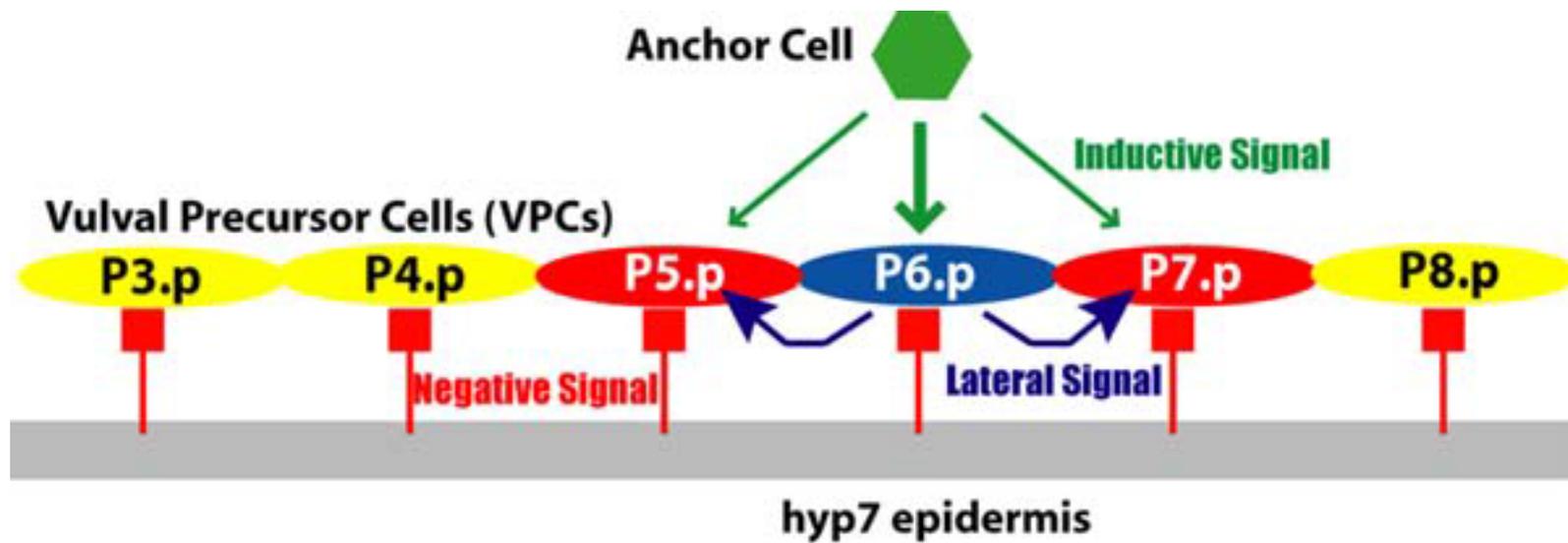
# The nematode *C. elegans*



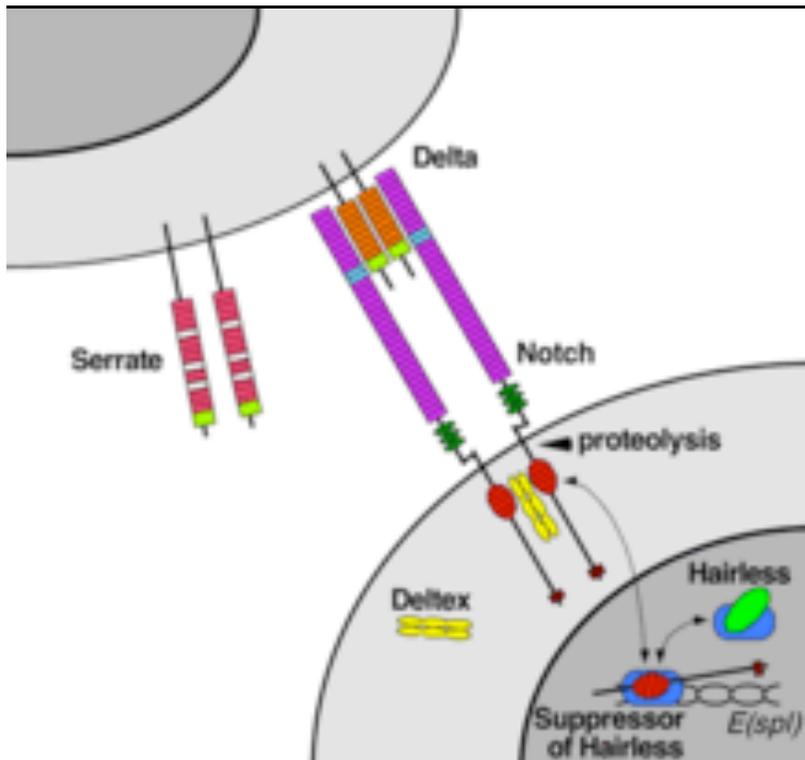
# Gradient and cell-interaction : the development of the Celegans vulva.

P Sternberg, Wormbook

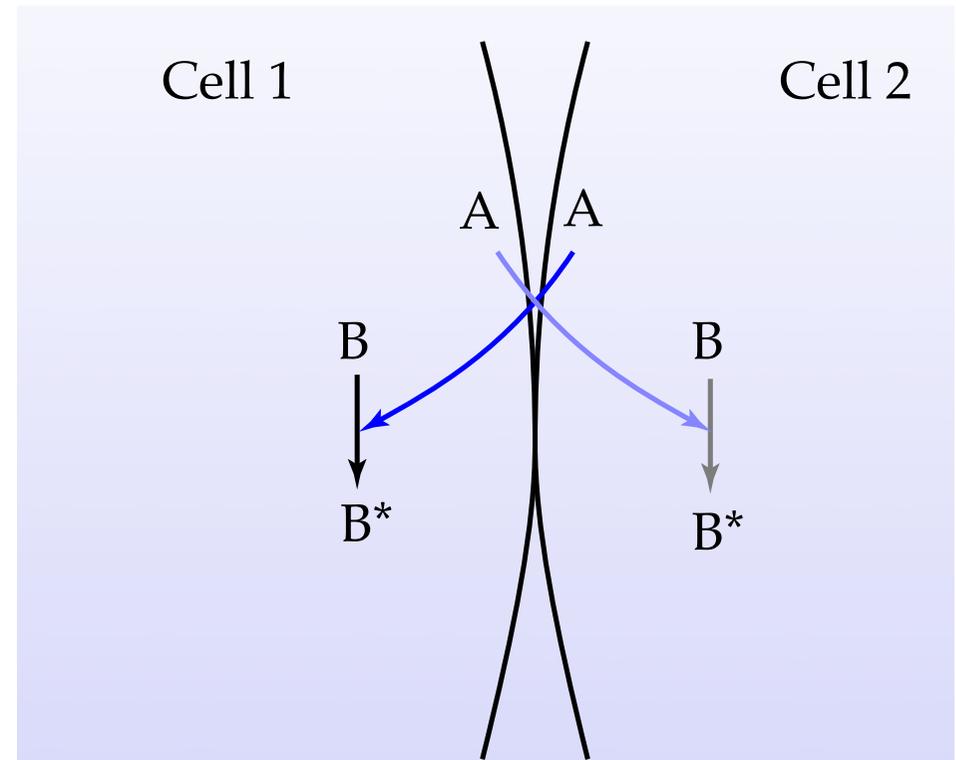




# Interactions between cells

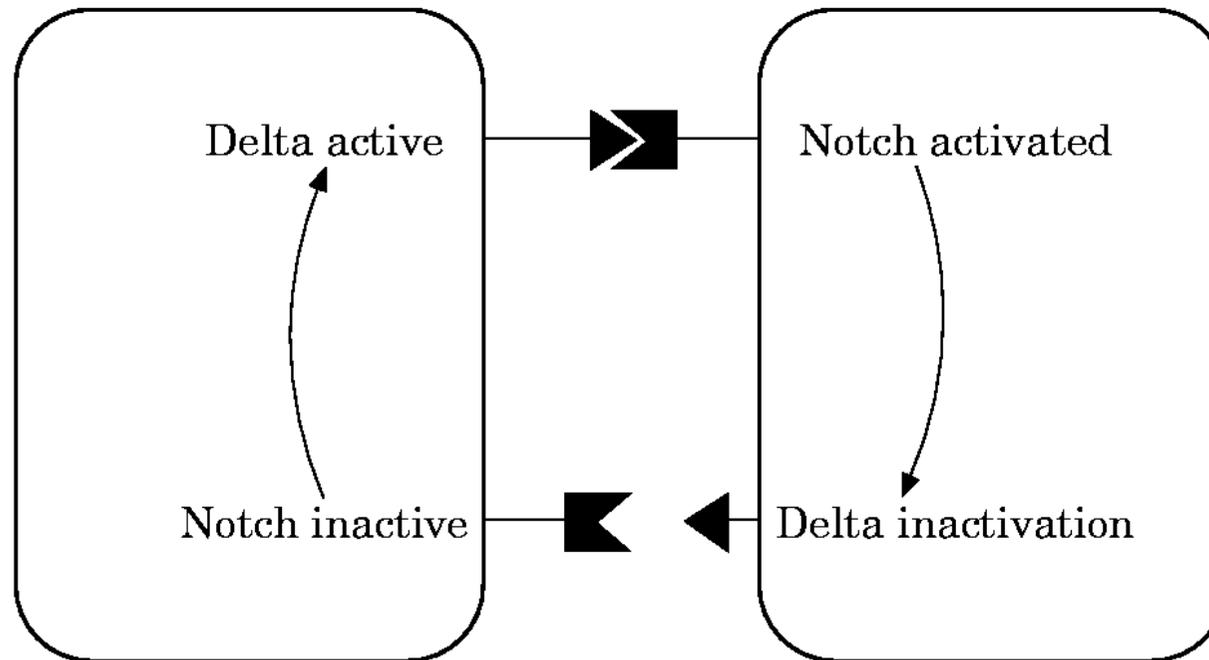


The Notch-Delta pathway  
(a wikipedia view)



$$dB_2^*/dt = \gamma A_1 B_2 + \dots$$

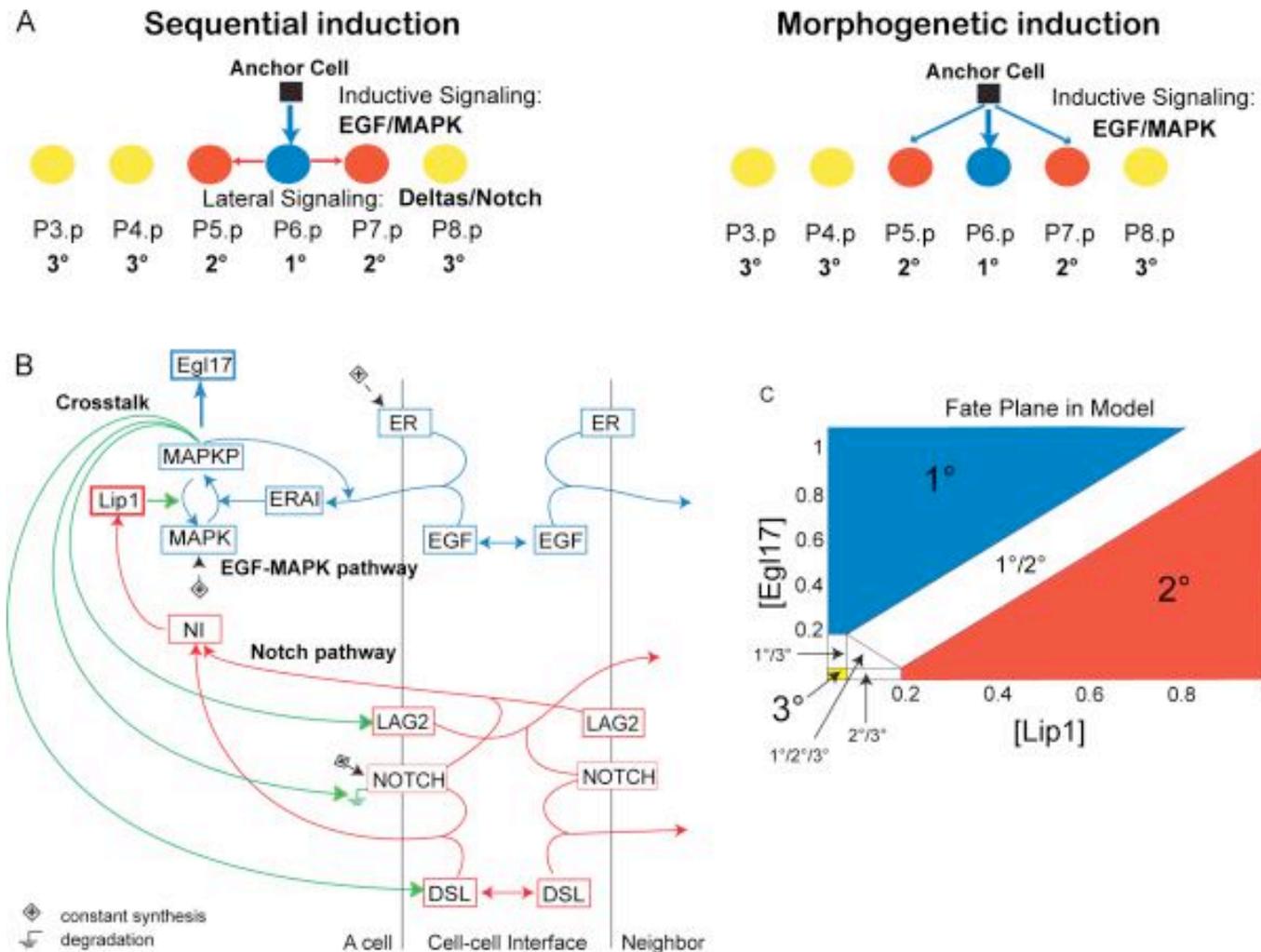
# Lateral inhibition and symmetry-breaking



$$\frac{dN_1}{dt} = A(D_2) - \delta_N N_1$$

$$\frac{dD_1}{dt} = R(N_1) - \delta_D D_1$$

# A detailed model



E Hoyos, J Milloz, ..., MA Felix, Curr. Biol. (2011)

**The End**