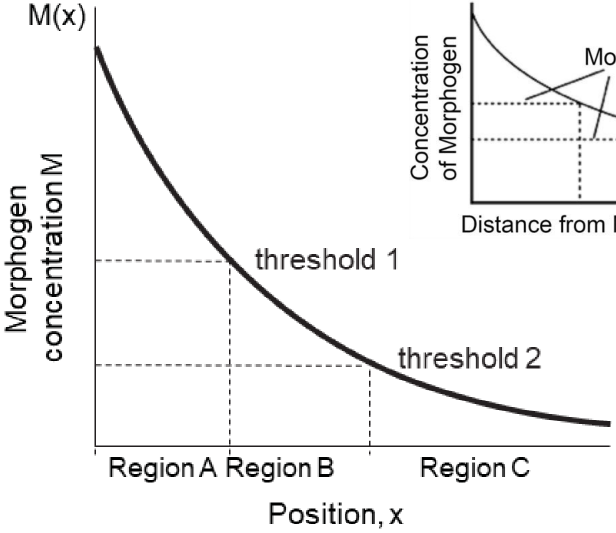
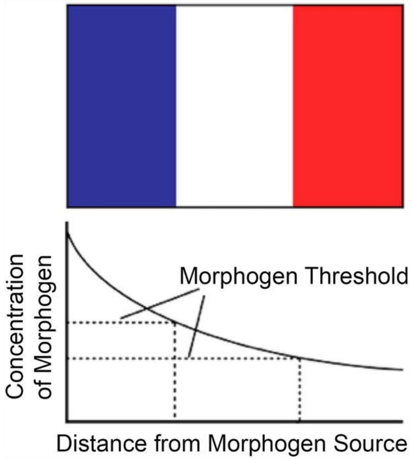
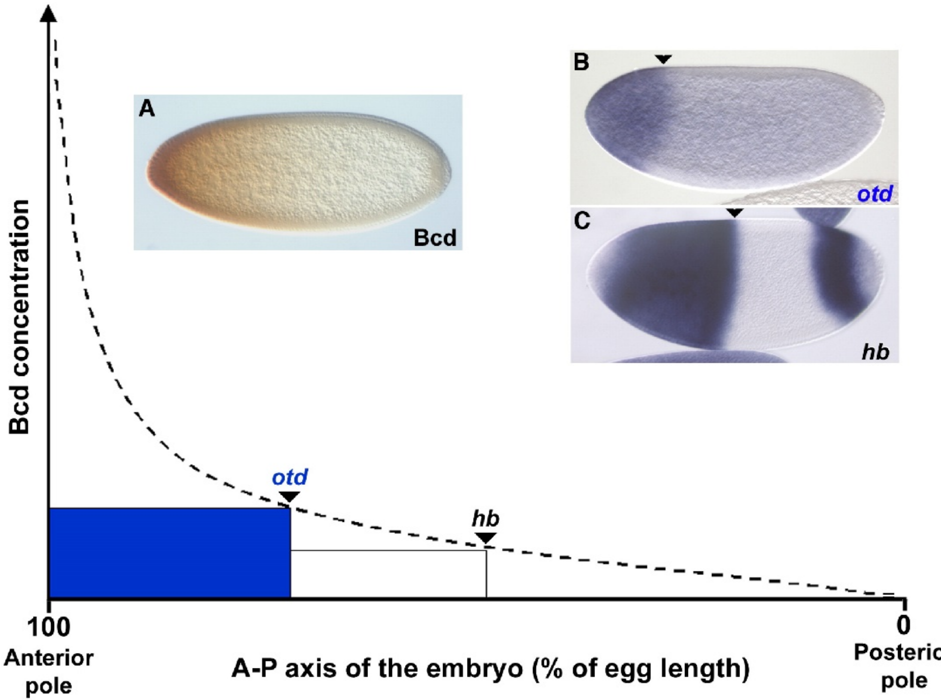
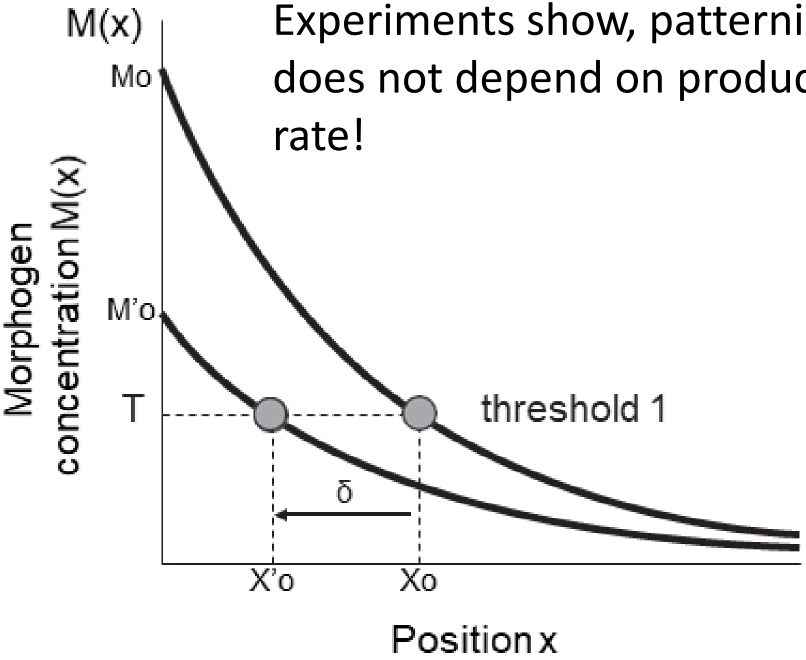
Robust Patterning in Development







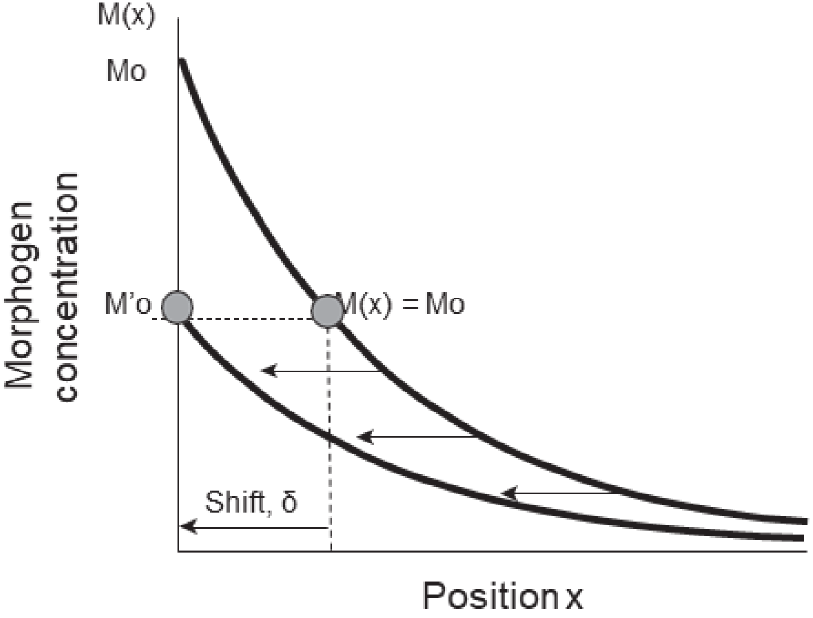
Question how can the position be independent of protein production?



Experiments show, patterning does not depend on production rate!

Why the diffusion does not explain this!

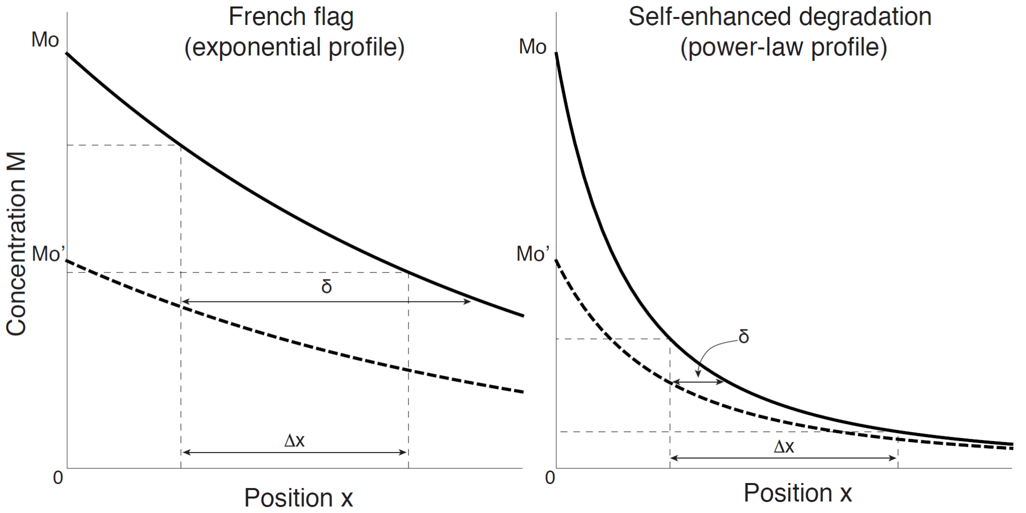
General feature: Shift is always the same!!! Independent of position



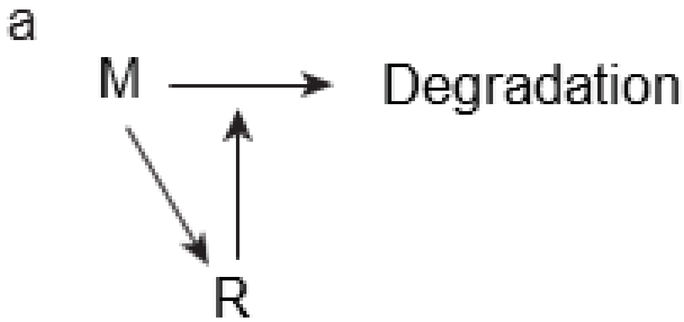
Problem: Patter with long range AND high robustness!
Needs two properties:
1) Fast decay at x=0 (robustness against M0)
2) Slow decay at large x, to increase effect of M

Exponential decay does not work, maybe nonlinear decay function?

$$M = A\,(x + \varepsilon)^{-2} \qquad \varepsilon = (\alpha\, M_o/6\,D)^{-1/2} \qquad A = 6\,D/\alpha$$

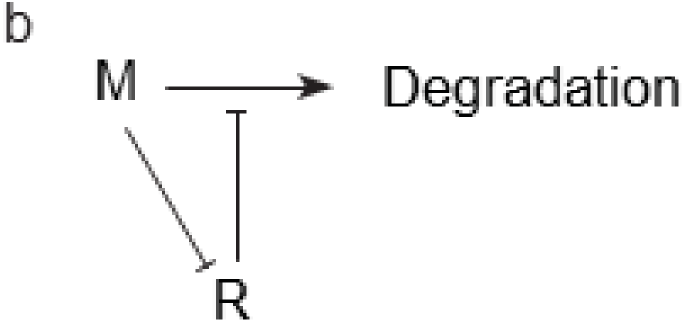


Self enhanced degradation is possible mechanism that solves the puzzle



Receptor stimulates degradation (endocytosis)

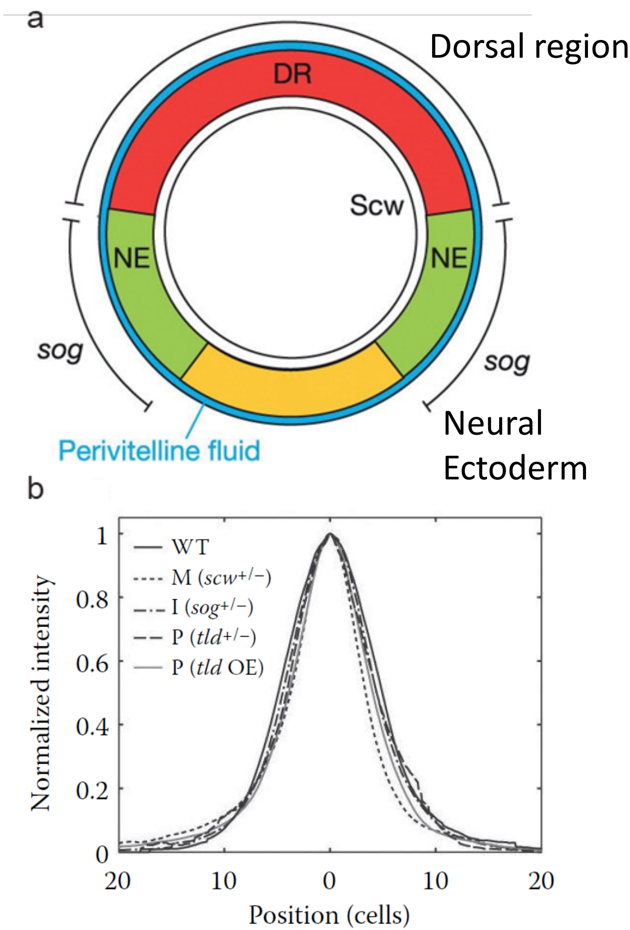
Example: Hedgehog (M) and Patched (R)



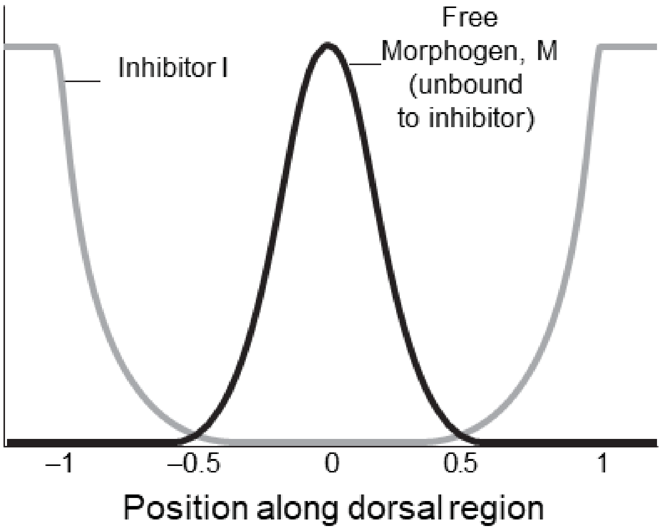
Receptor suppresses degradation (suppression of protease)

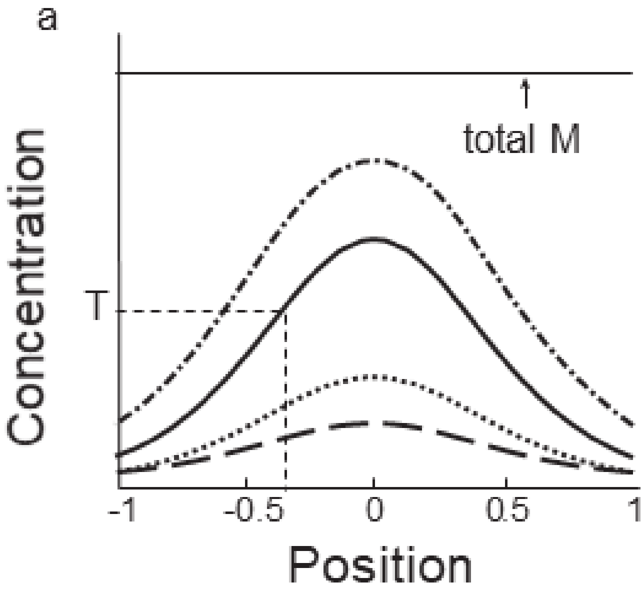
Example: Wingless (M) and Frizzled (R)

Robust patterning as principle to find right mechanism



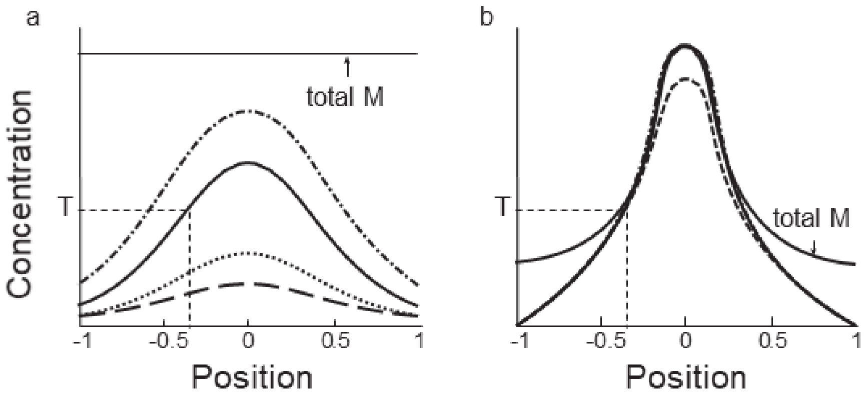
Simplest approach: I degrades M everywhere but not in the DR





Problem: Not robust against changes in M, I and P

Hmm, self enhanced degradation does not work (I is degraded, not M!)



Only numerical model for full Deq, but of these 97% non-robust

0.5% of solution highly robust with powerlaw!

Single calls where:

- M could not diffuse freely, only in the complex (Dc>>Dm)
- I is not degraded by P unless in complex. (alpha_c >> alpha_i)