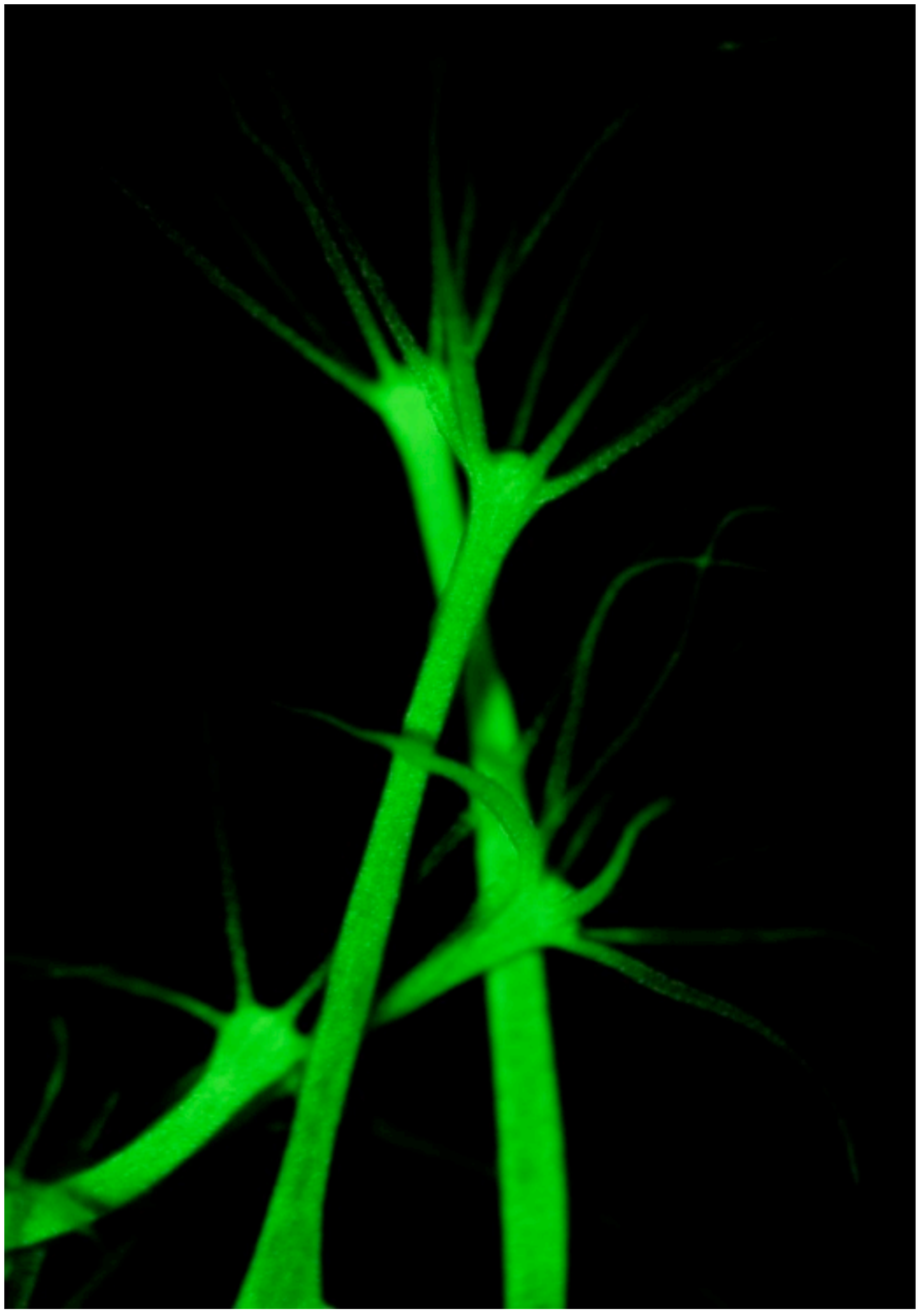

Exploring *Hydra* growth and morphogenesis with genomics, transgenics, and chemical genetics

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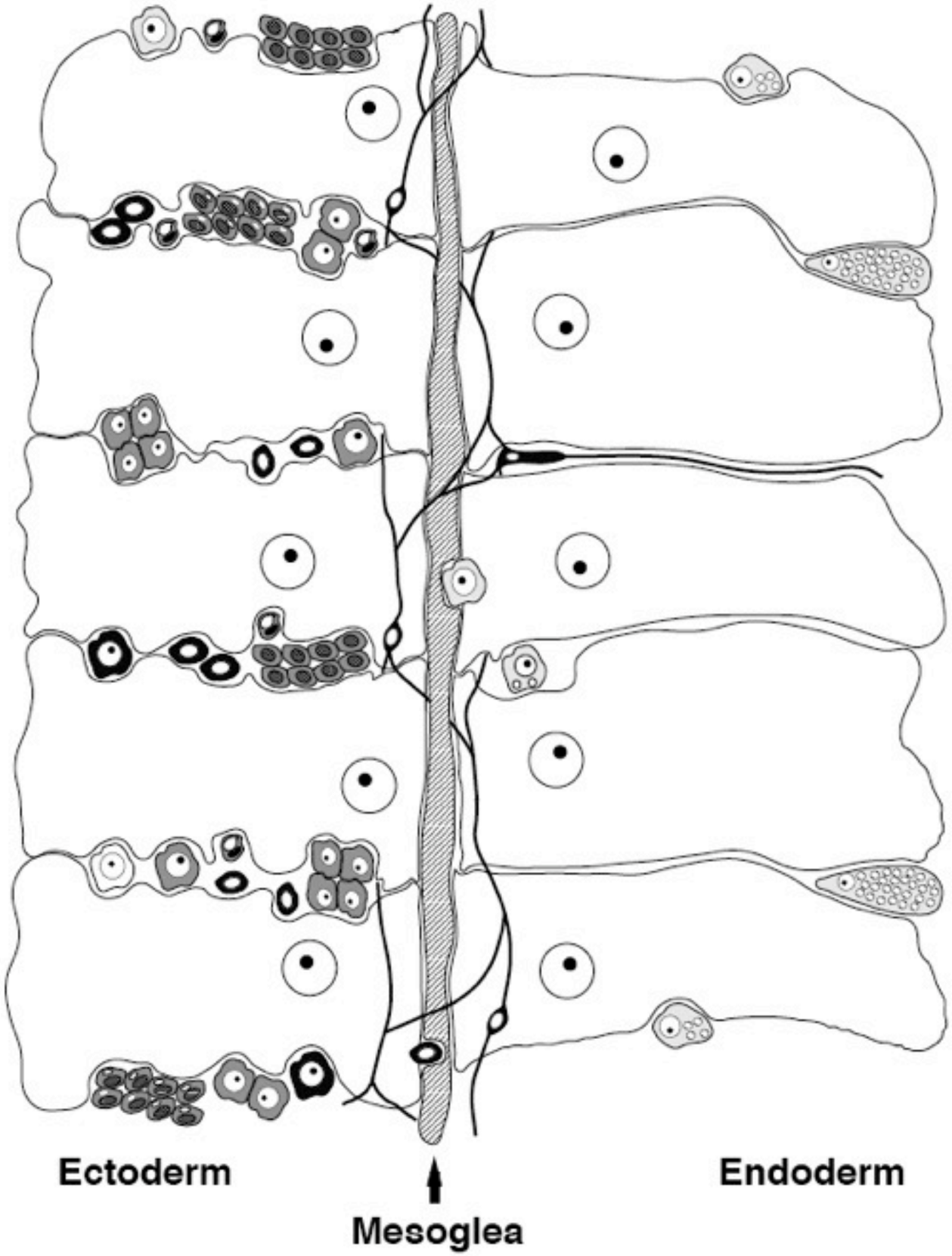
Department of Biological Chemistry and
the Developmental Biology Center
UC Irvine

Photo by Peter Bryant

Hydra is a member of the phylum Cnidaria, which includes sea anemones, jellyfish, and corals

Thursday, September 24, 2009

Hydra is simple in composition and organization



From Bode, *J. Cell Sci.* 109, 1155-1164, 1996

Two concentric epithelial layers

Approximately 20 cell types

Three cell lineages

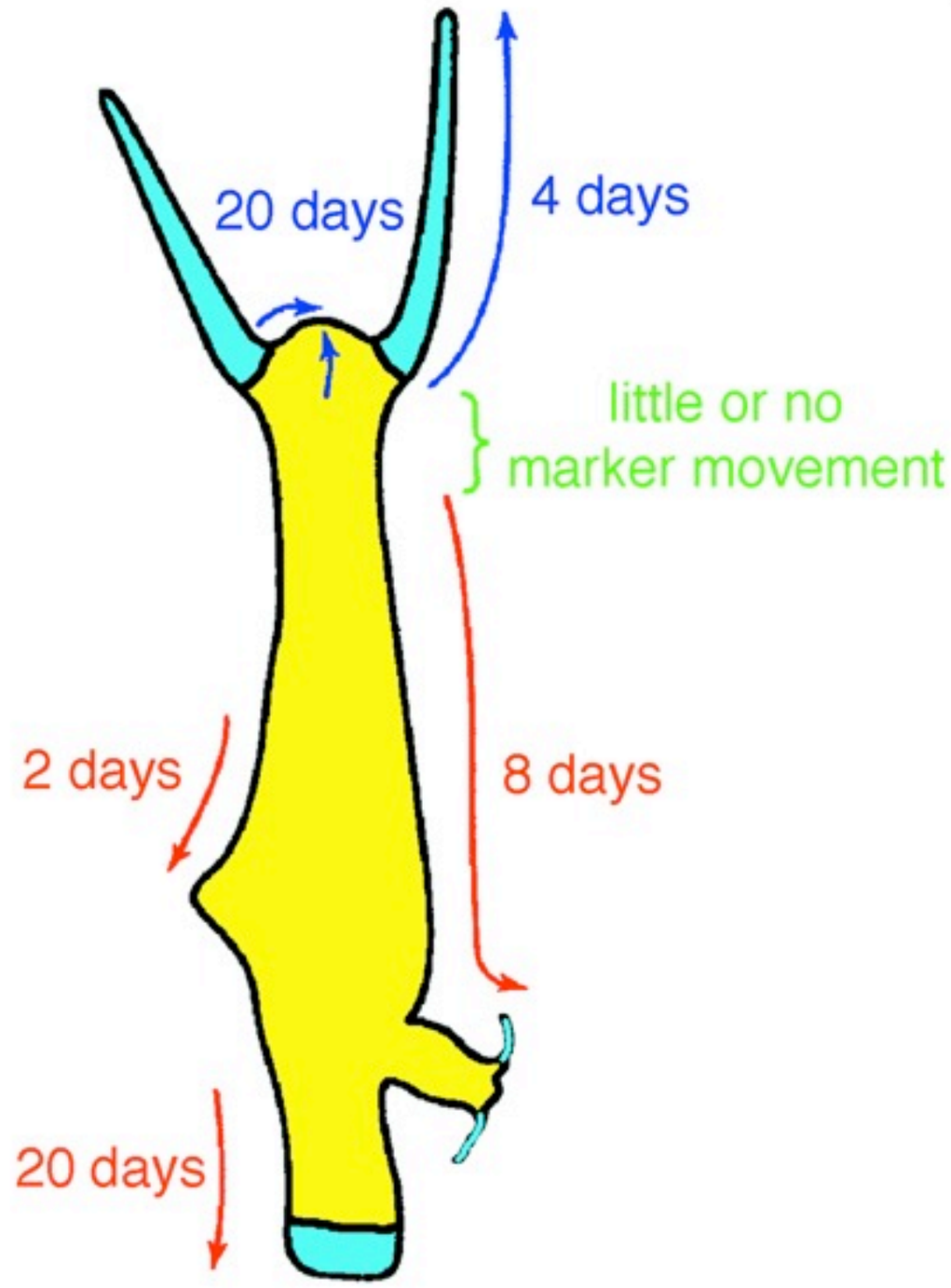
~100,000 cells

Hydra is an infinitely looping developmental system

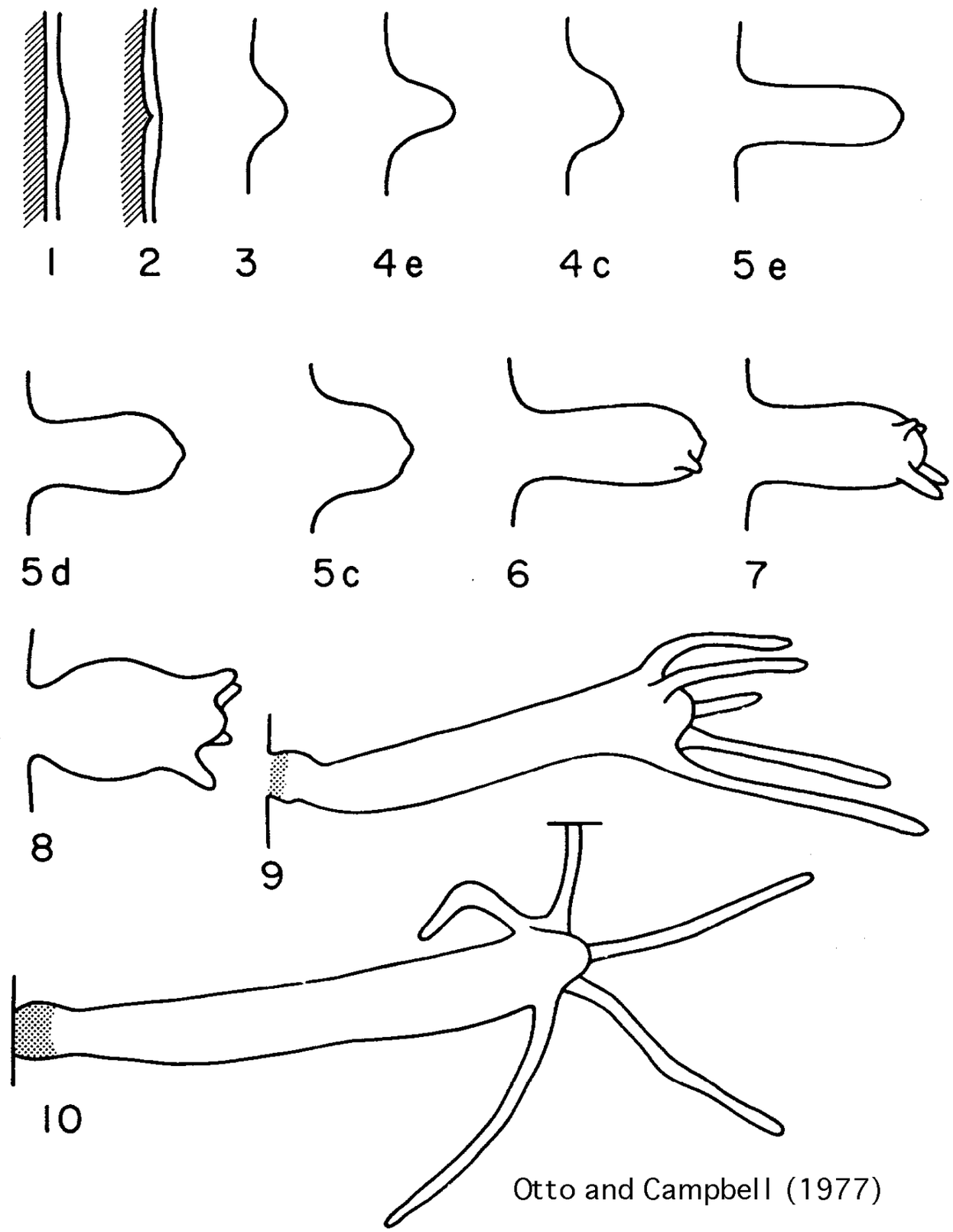
- Yellow indicates tissue in which the cells are dividing.

- Blue indicates tissue in which cells are arrested in G2 of the cell cycle.

- Arrows indicate courses followed by marked cells and how long they take to move

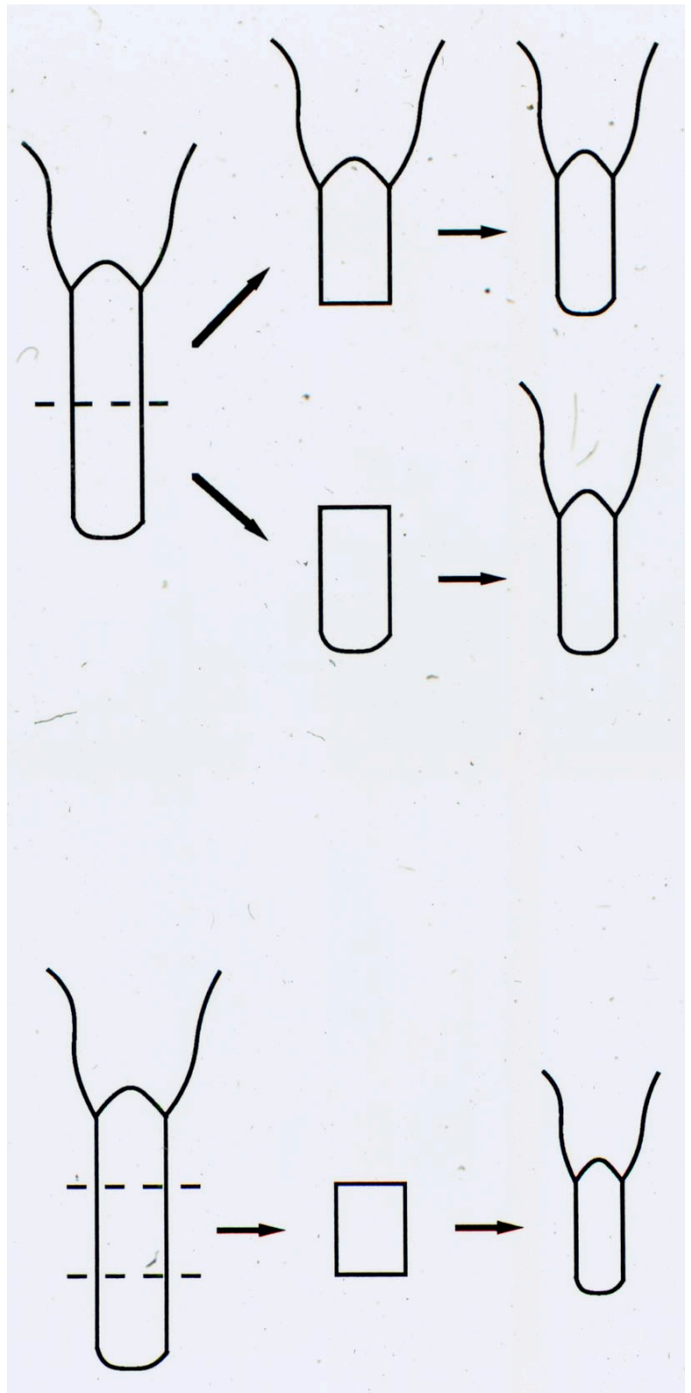


Modified from Campbell, 1967

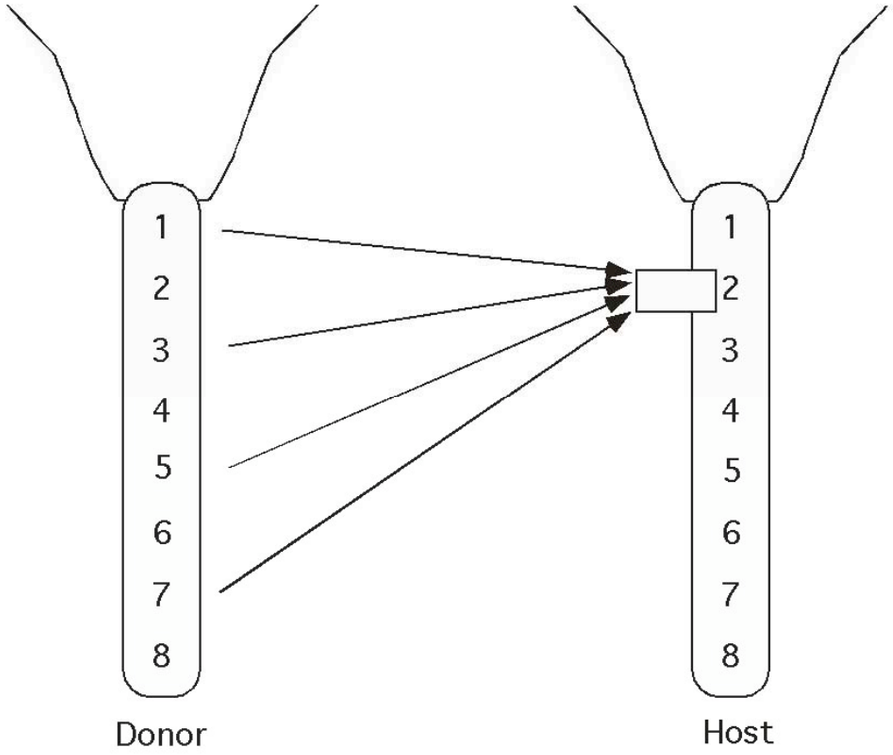


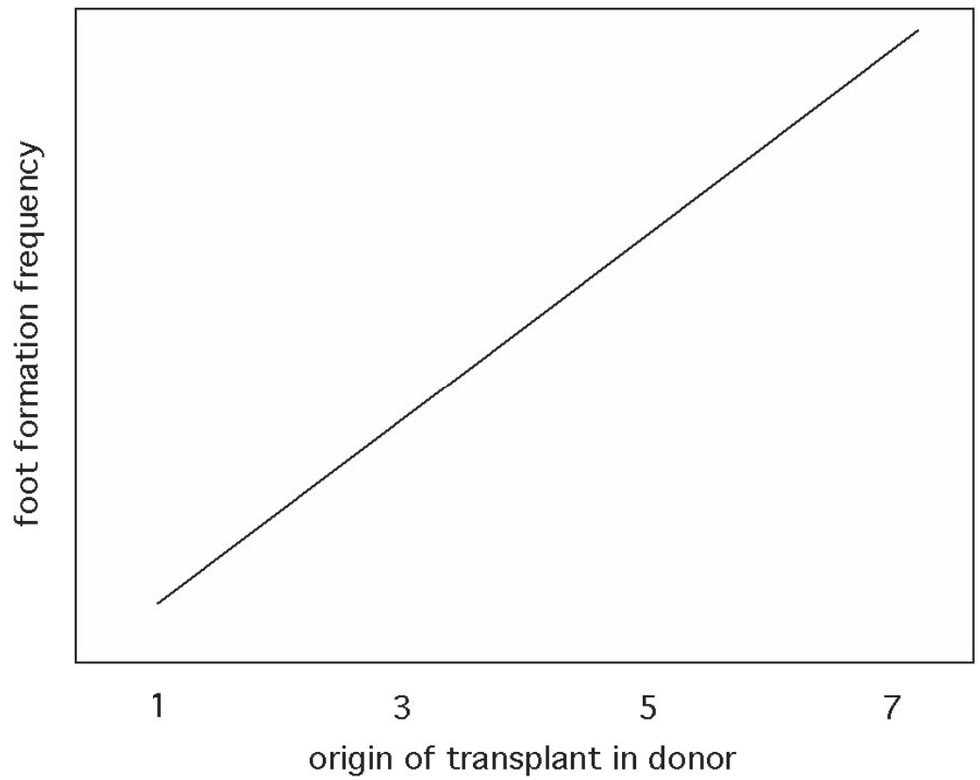
Otto and Campbell (1977)

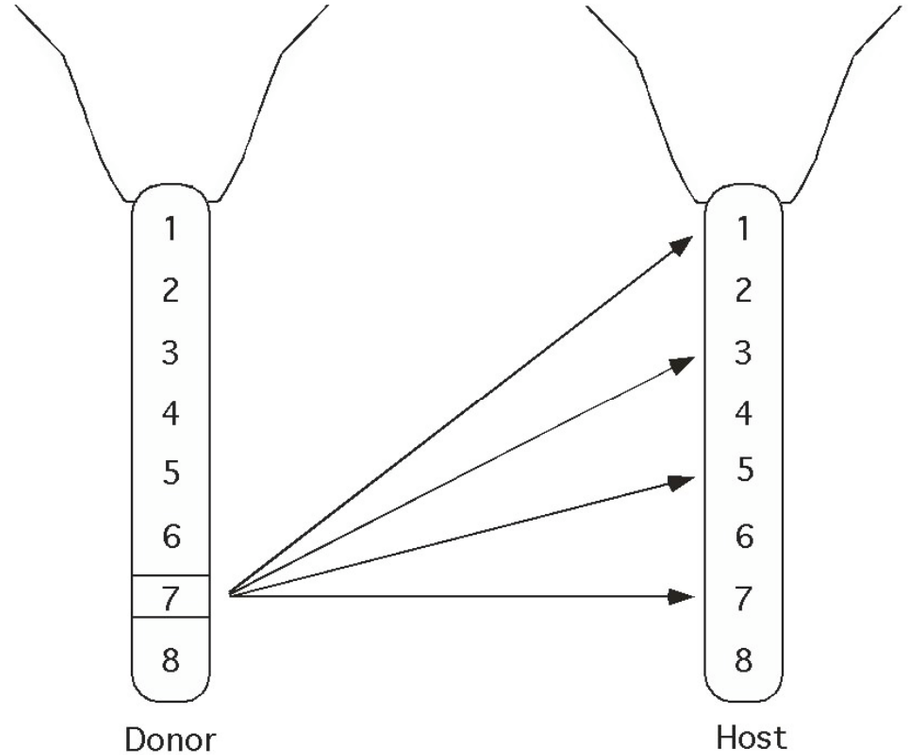
Hydra can regenerate, and regeneration shows polarity

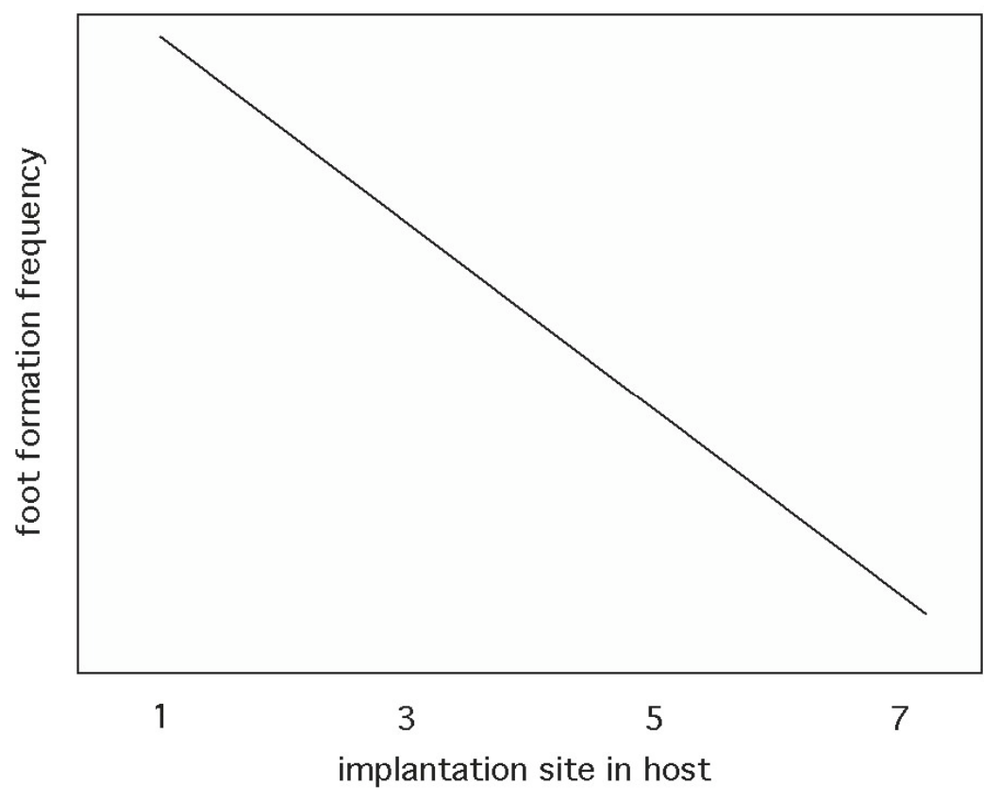


Axial patterning in *Hydra* involves graded properties

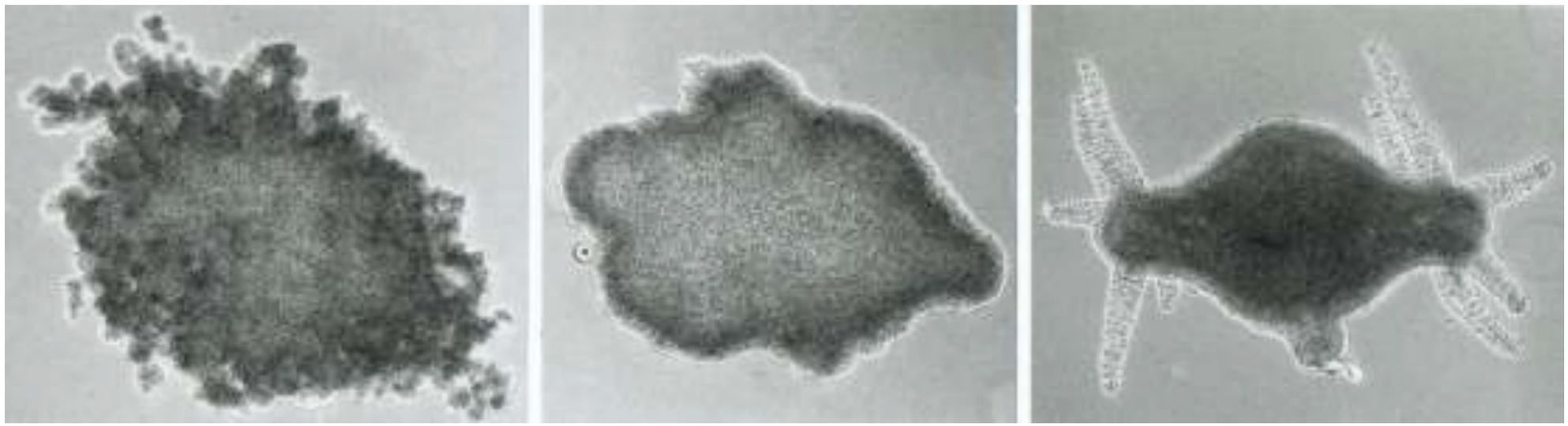




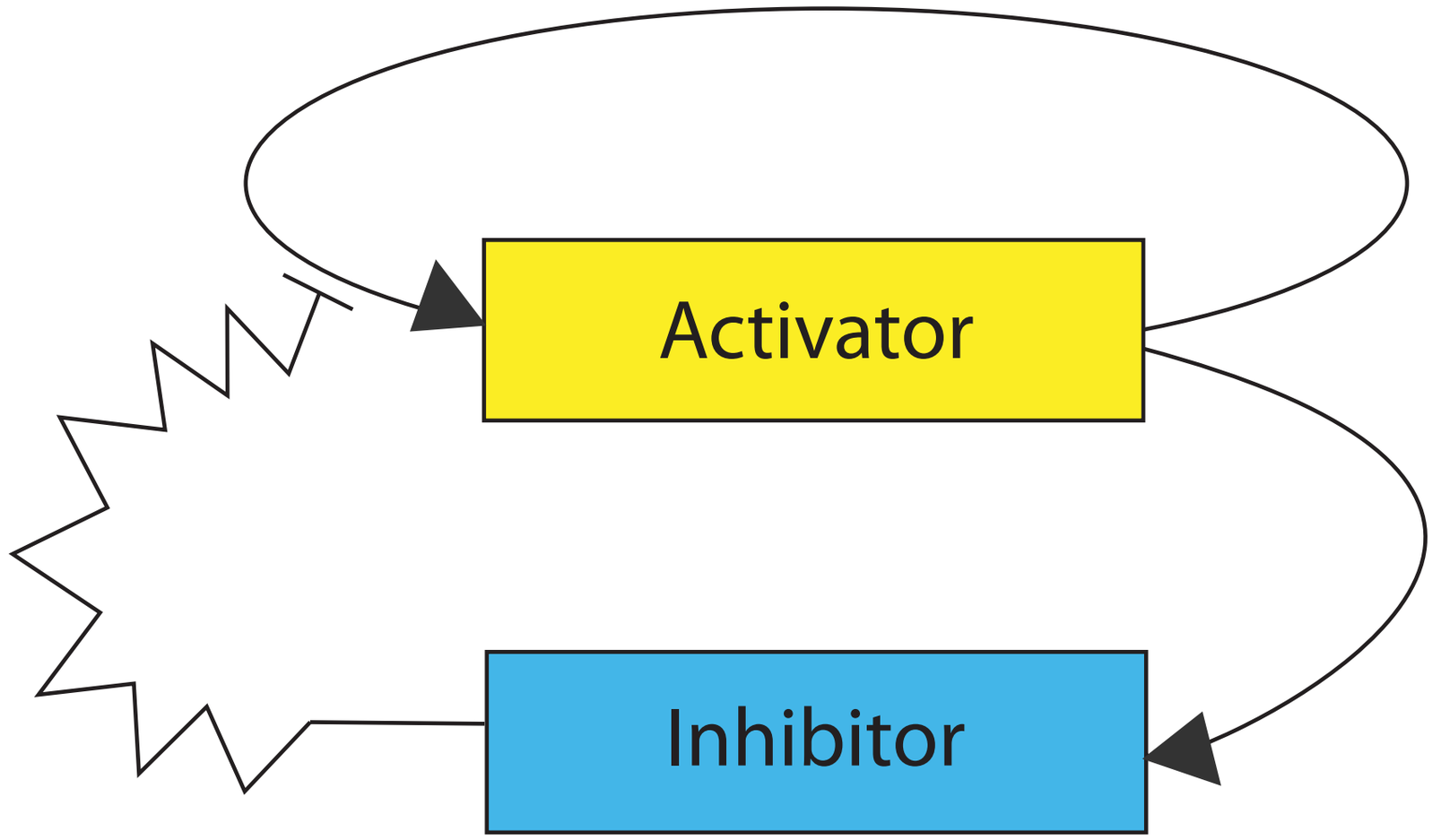




Hydra can regenerate after dissociation into a suspension of cells



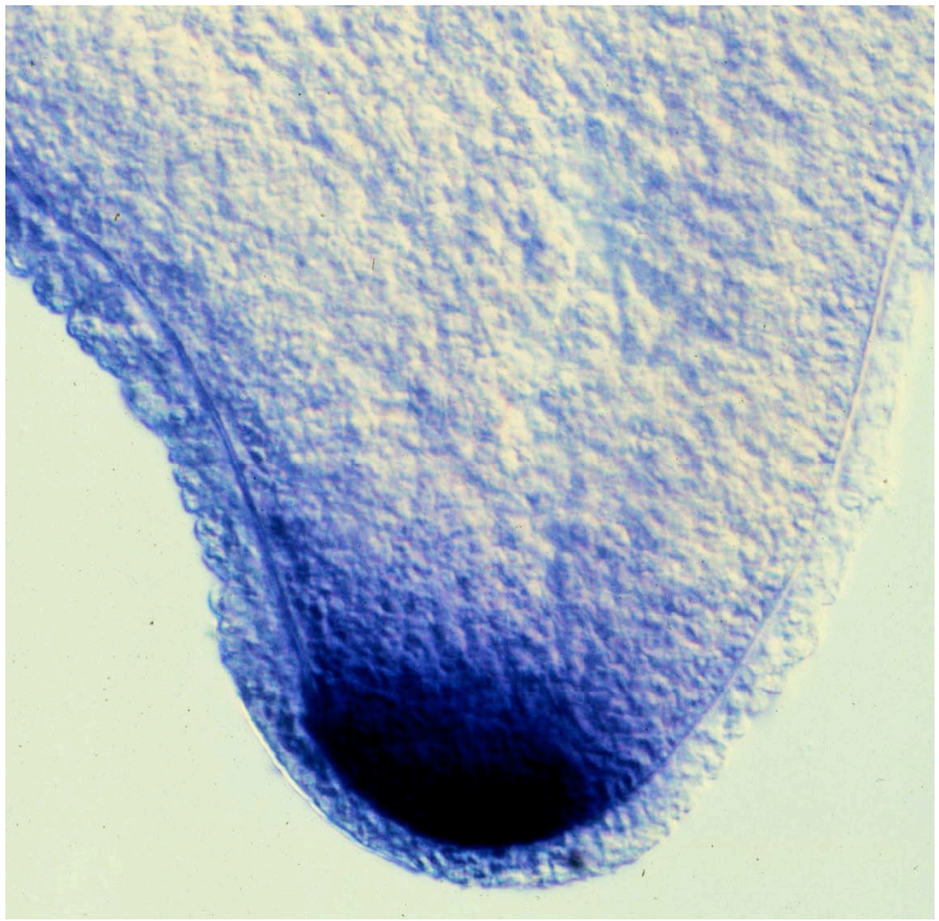
Hydra developmental biology has been dominated by the reaction-diffusion model of Gierer and Meinhardt (1972)



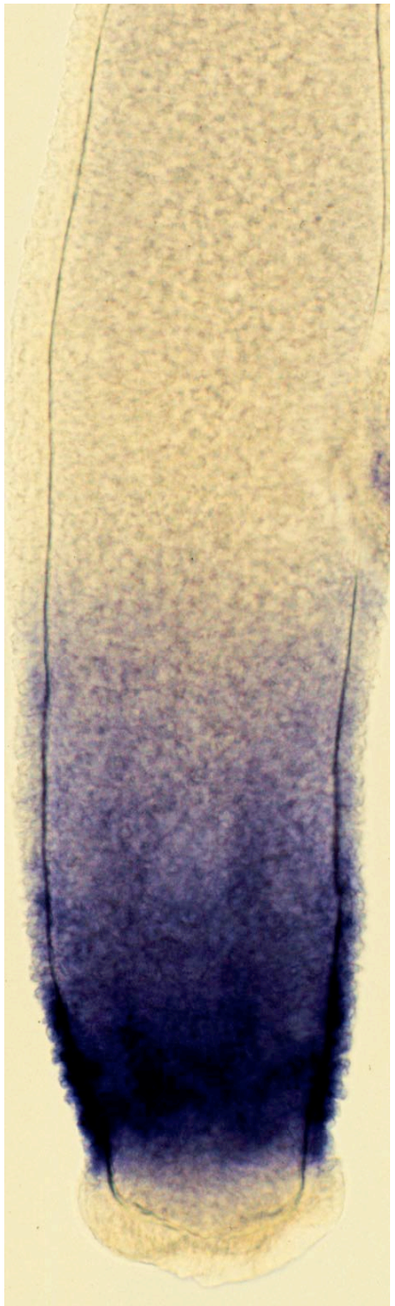
The *Hydra* genome has been sequenced

Gene expression patterns in *Hydra* come in a variety of types

Gradients



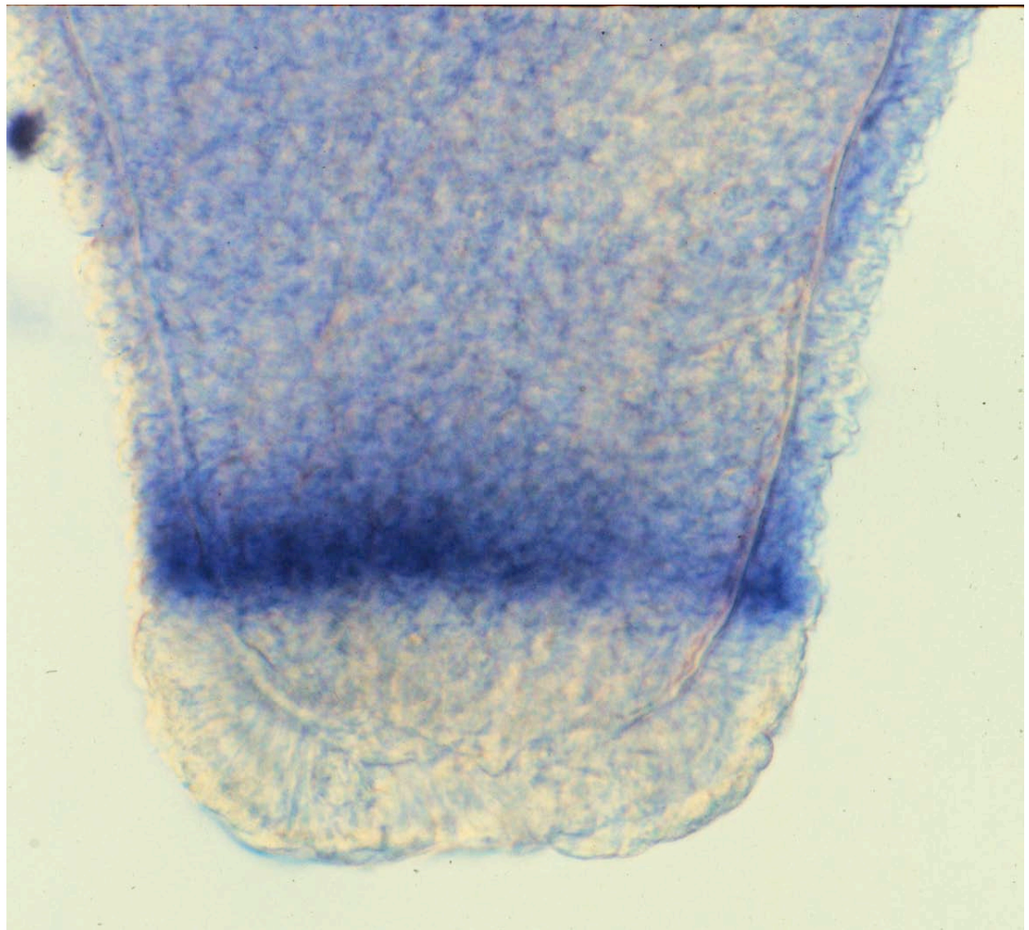
protein kinase C



receptor tyrosine kinase

NK homeobox transcription factor

Rings



insulin receptor

paired-like homeobox transcription factor

Spots

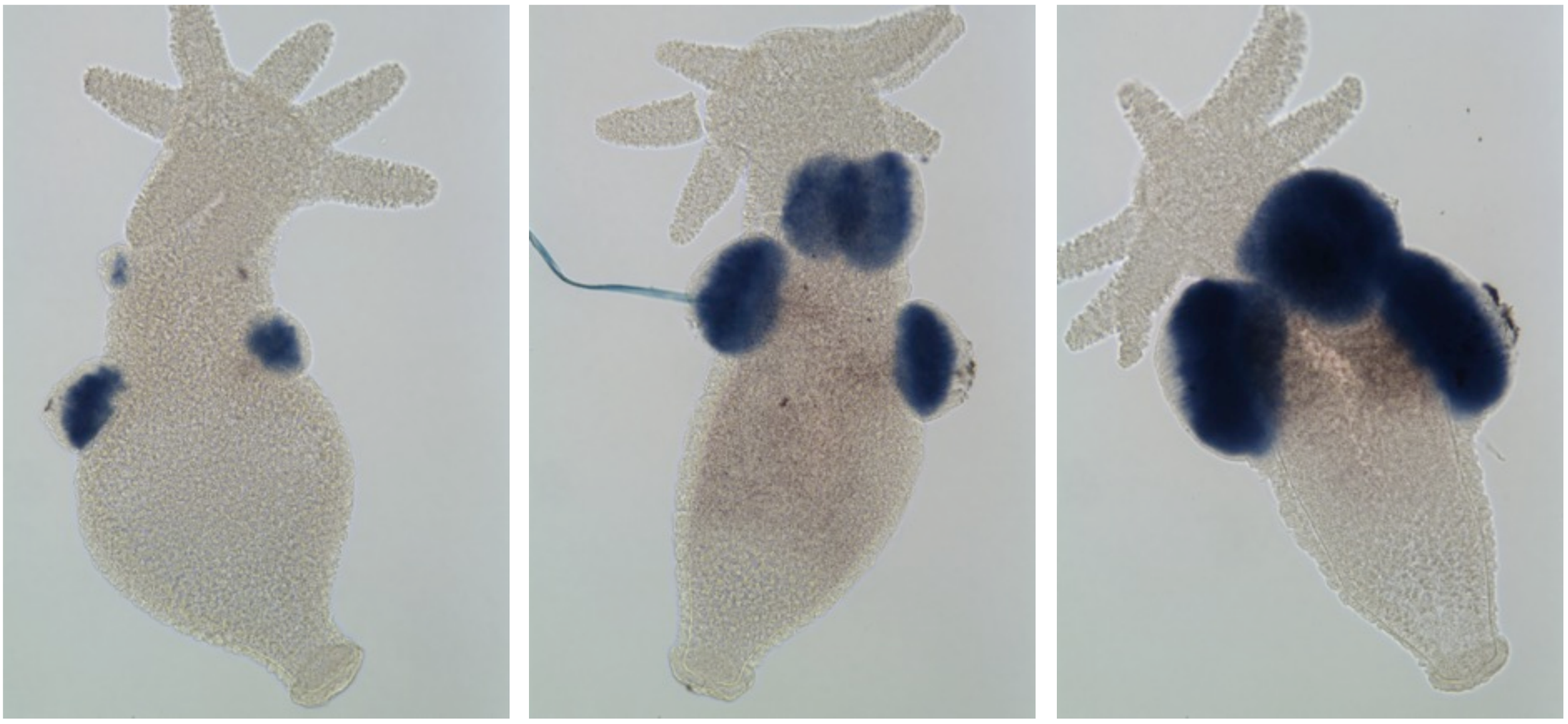
Regions

VEGF

pyruvate-
formate lyase

Hym 301

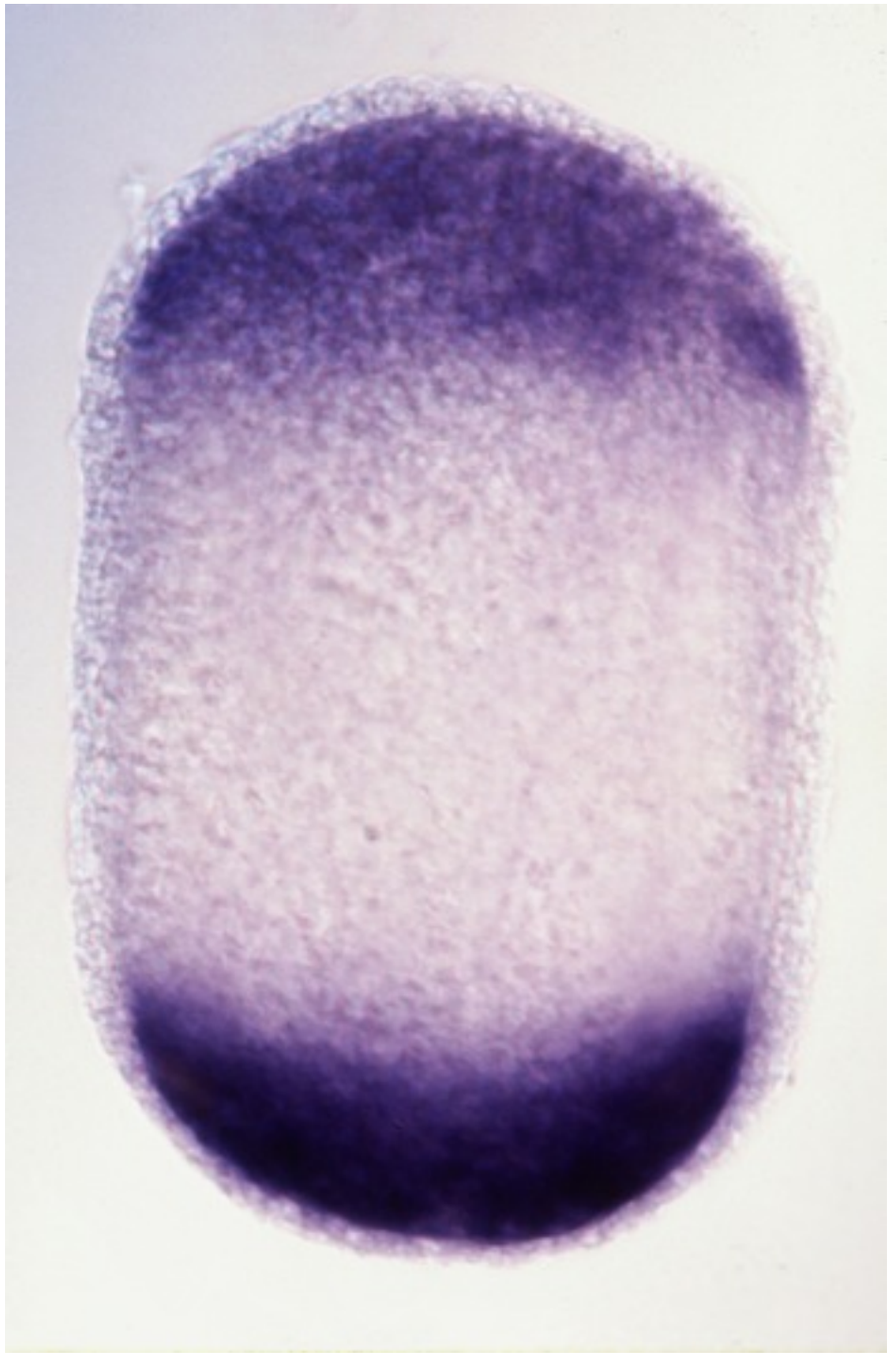
Specialized structures (e.g. testes in sexual animals)



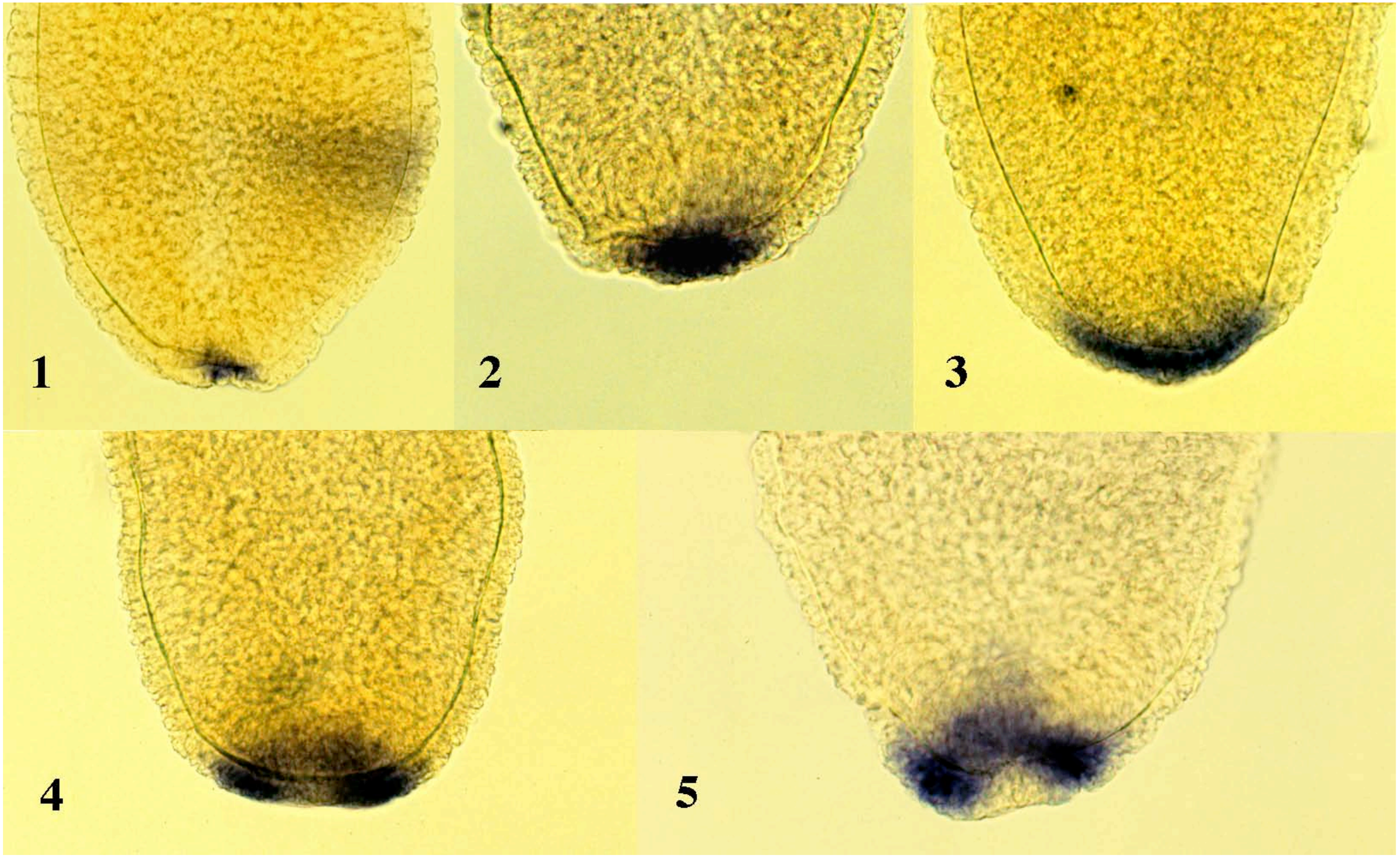
HAP2


A


B

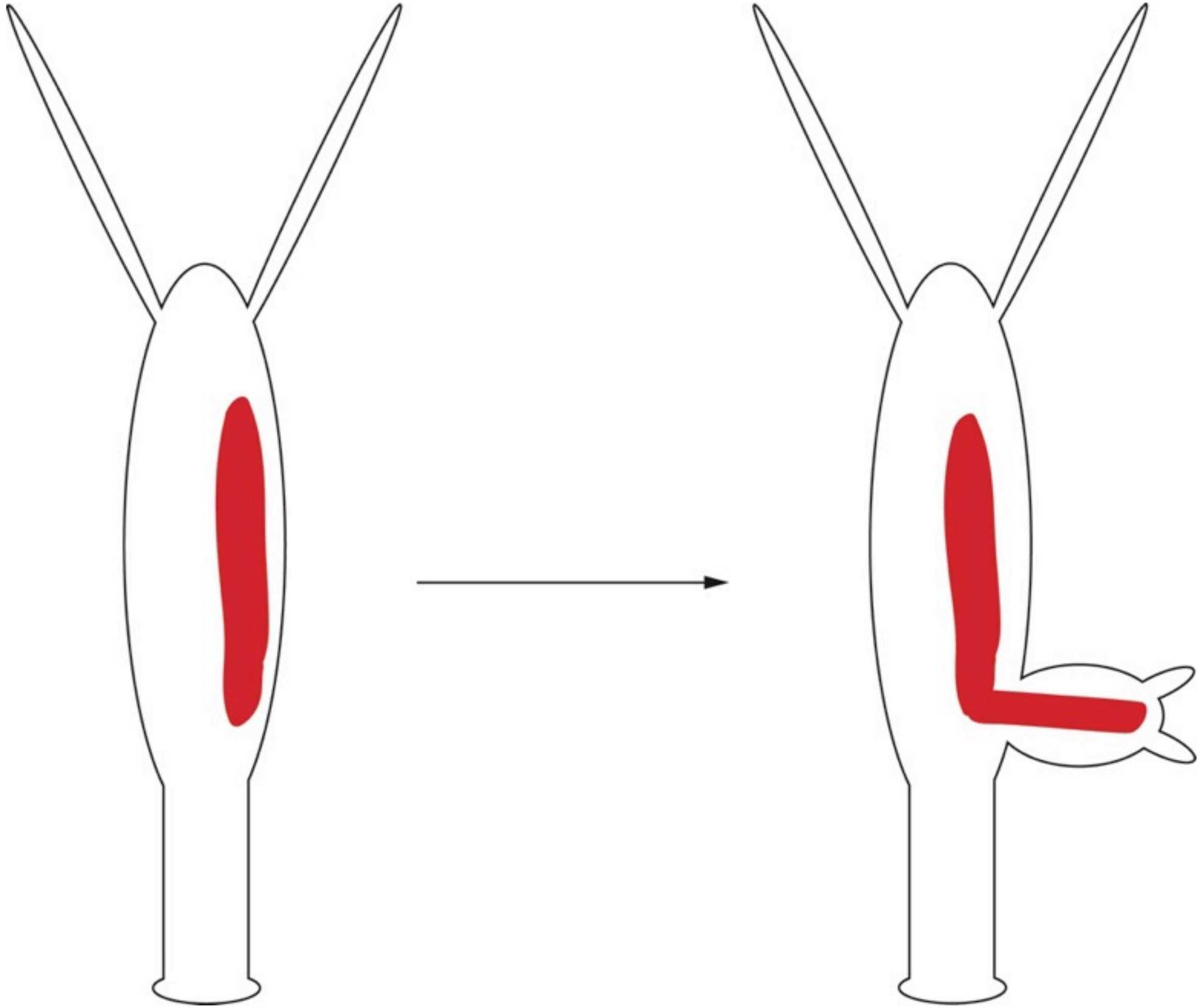


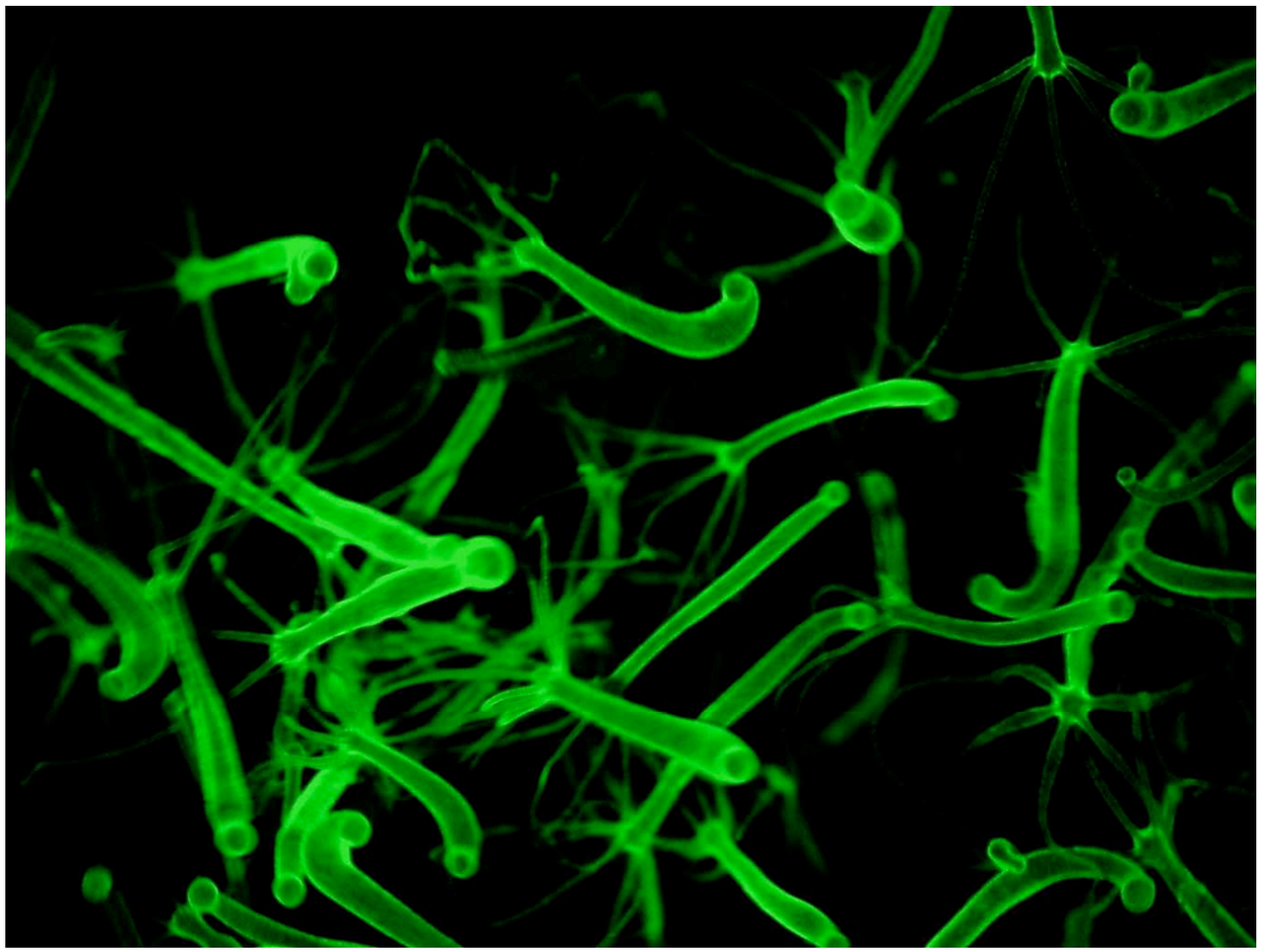
PKC2 expression in a regenerating animal

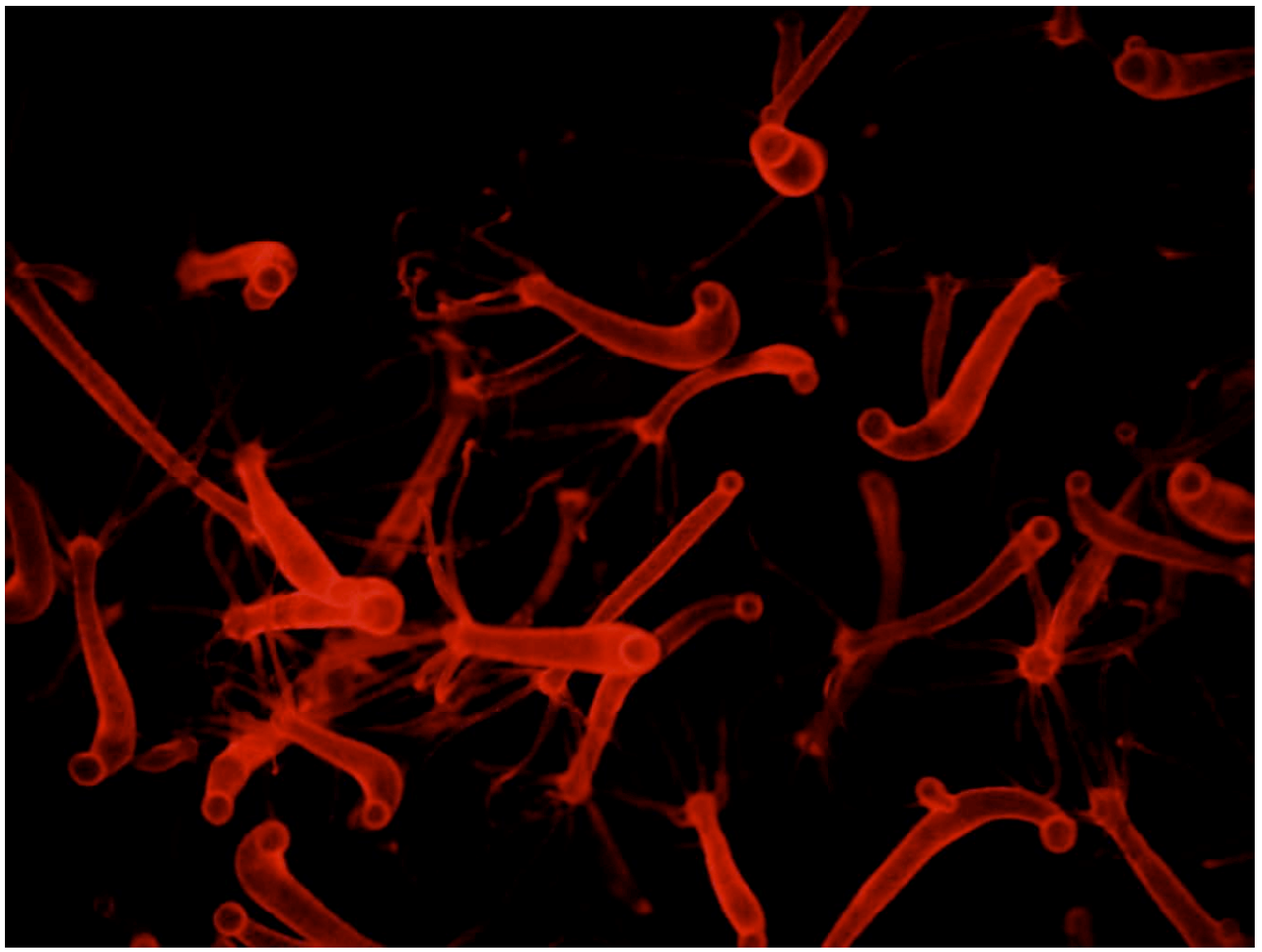


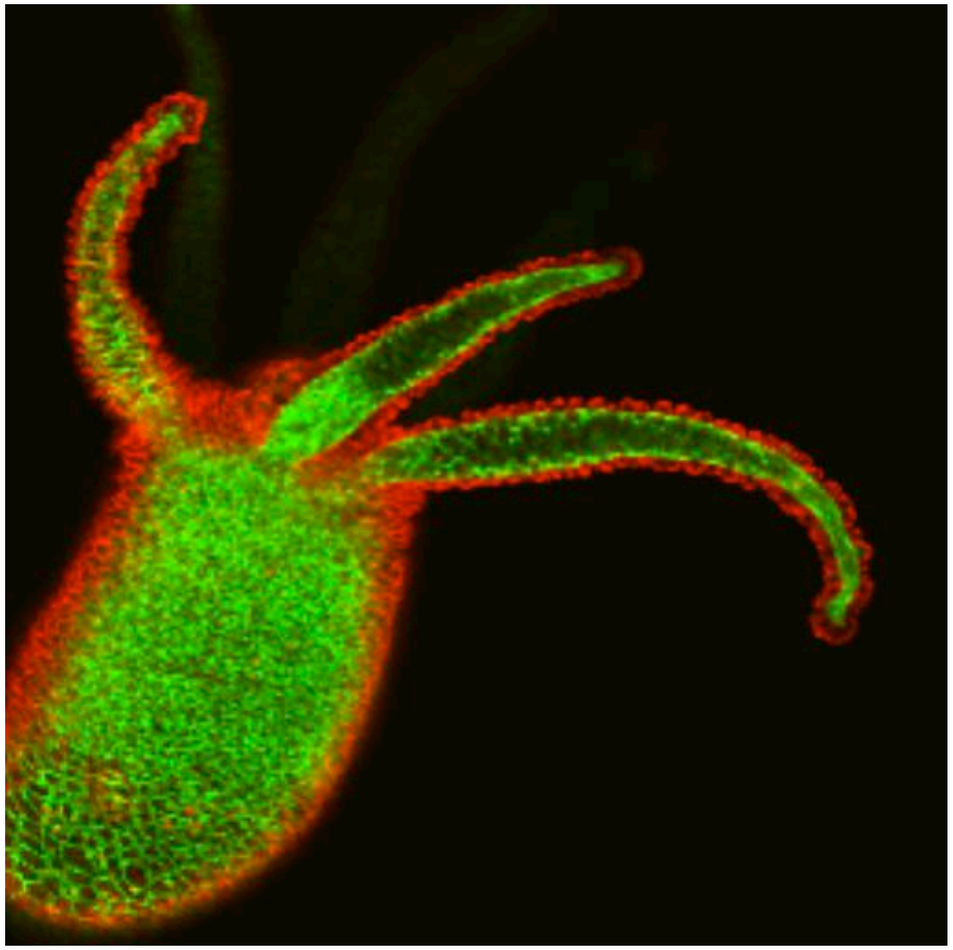
Expression of the manacle gene during foot regeneration

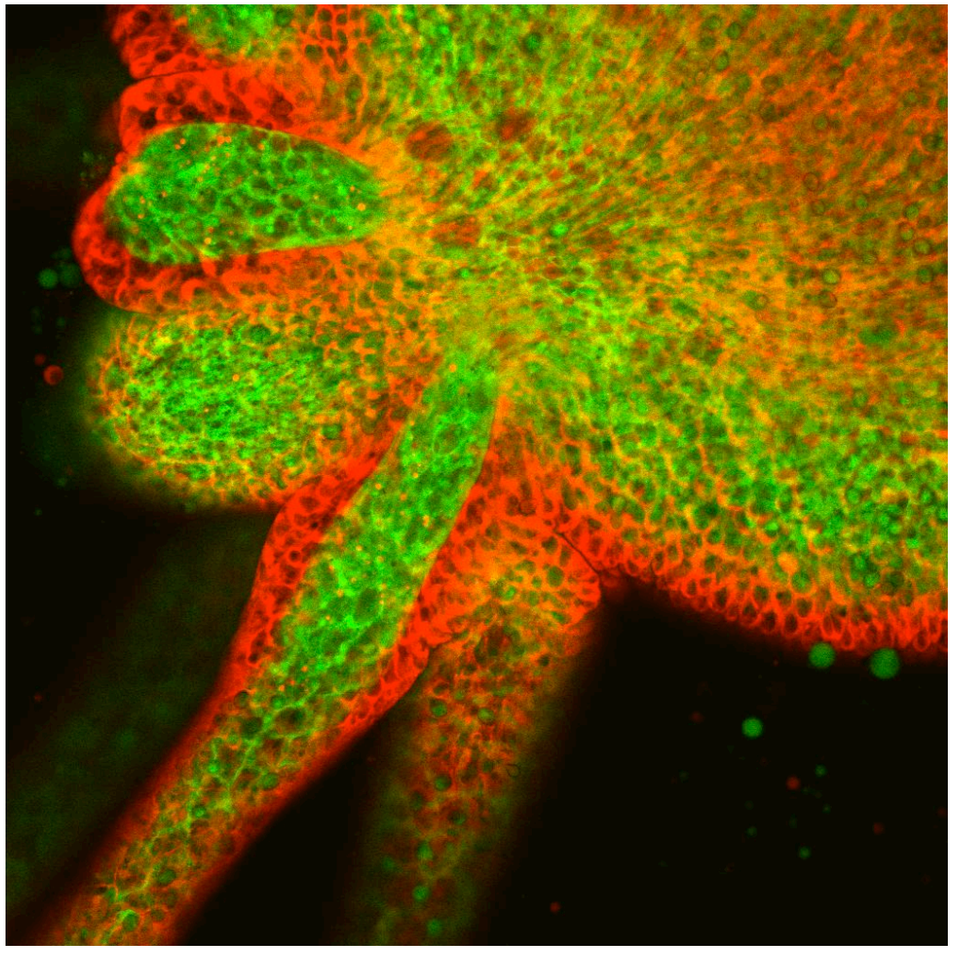
Making stably transgenic *Hydra* is easy

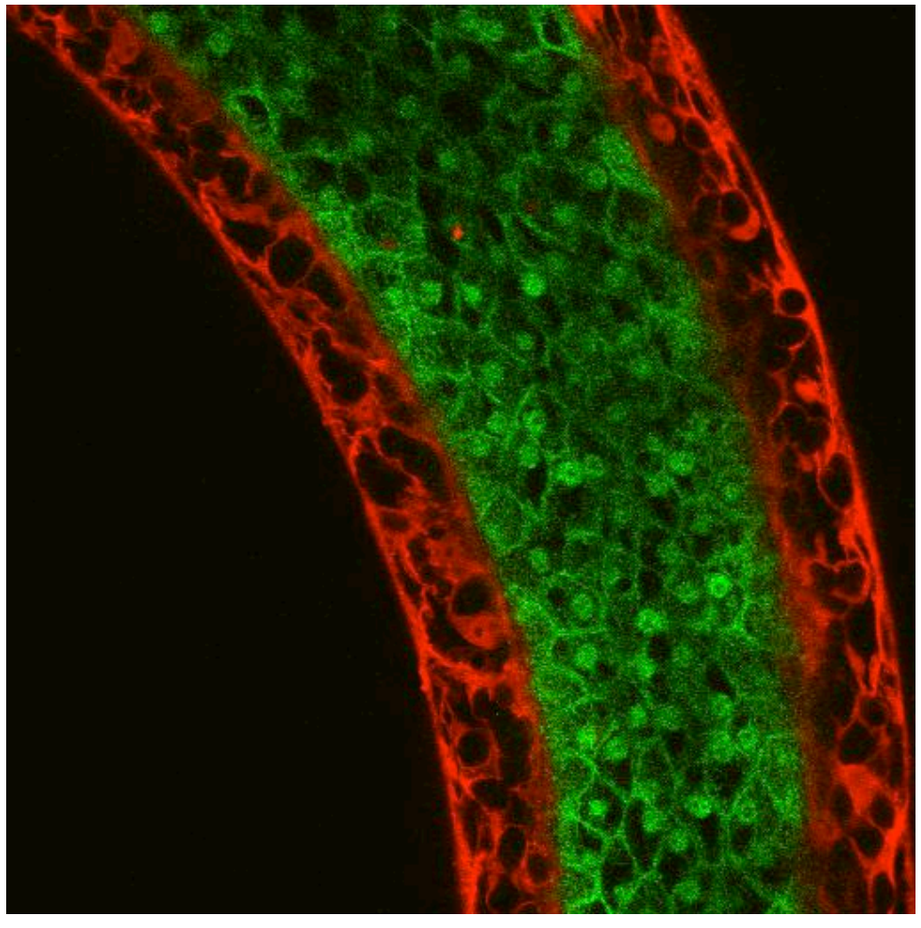












Forward Genetics

Mutagenesis ⟶ Phenotype ⟶ Gene

Reverse Genetics

Gene ⟶ Mutagenesis ⟶ Phenotype

Chemical Genetics

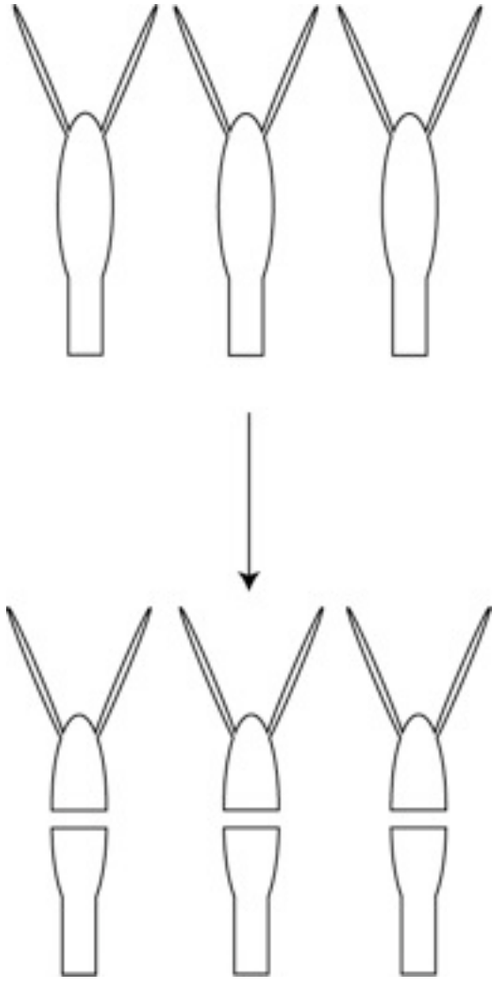
Chemical ⟶ Phenotype ⟶ Gene

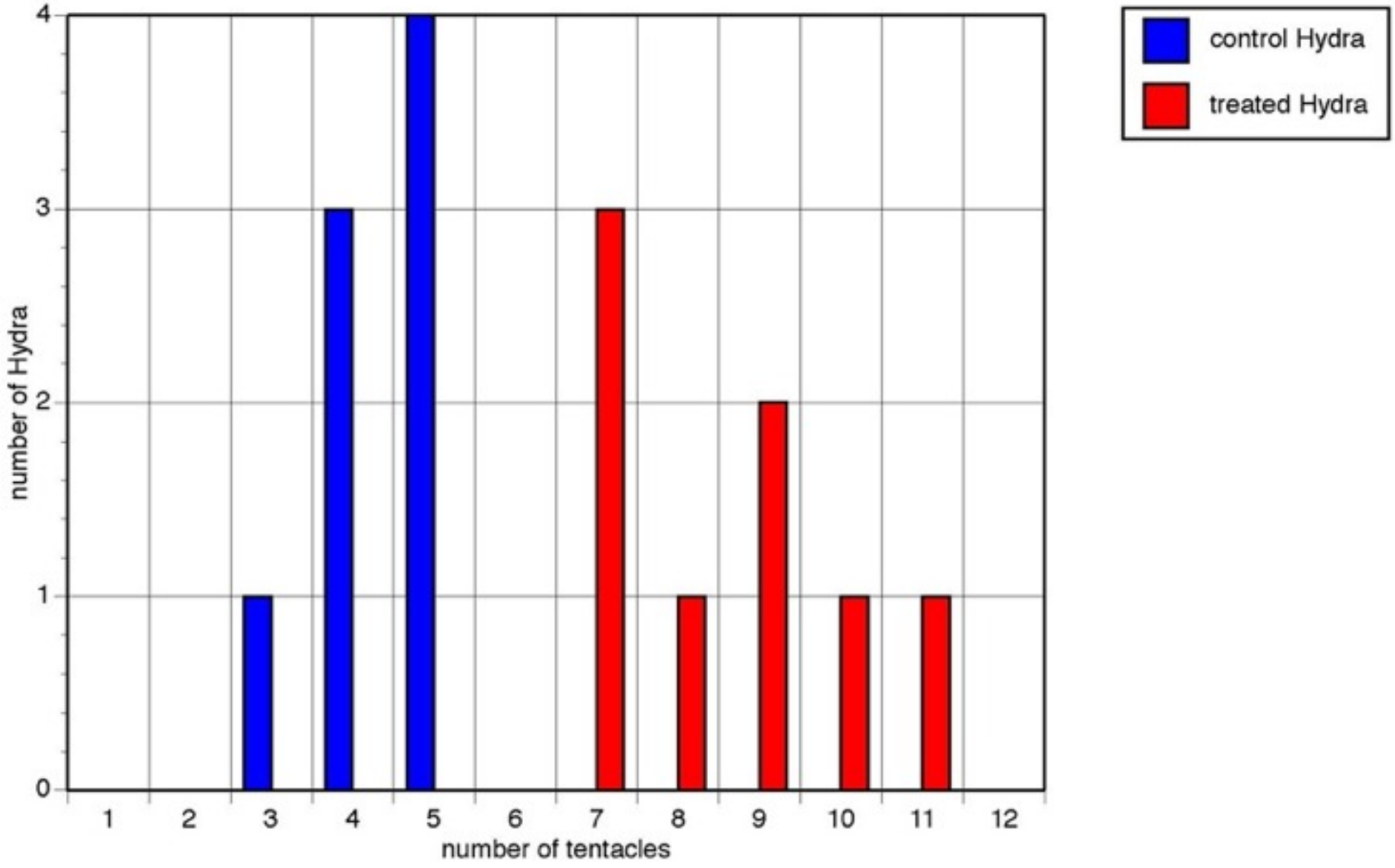
Advantages of *Hydra* for chemical screening

- All cell types can be exposed readily
- Cultured in simple, non-sterile medium
- Tolerates DMSO at typical concentrations
- Can be cultured in microtiter plates
- Large quantities can be obtained for biochemical studies
- All animals are genetically identical
- Genome has been sequenced
- Ability to produce transgenics
- Screen can potentially be automated

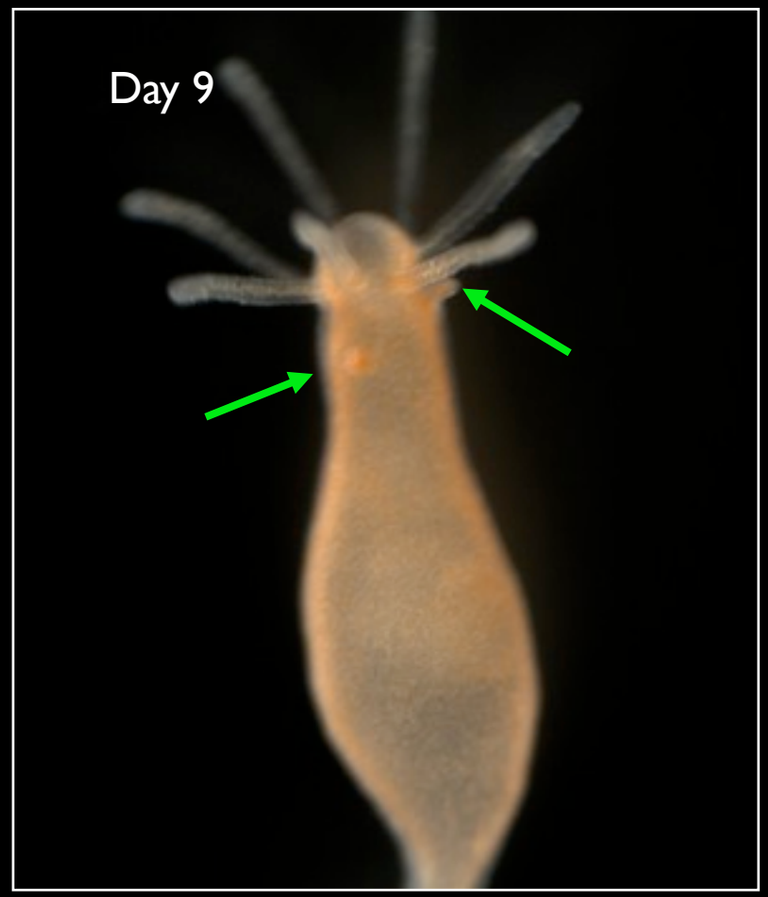
The Chemical Library

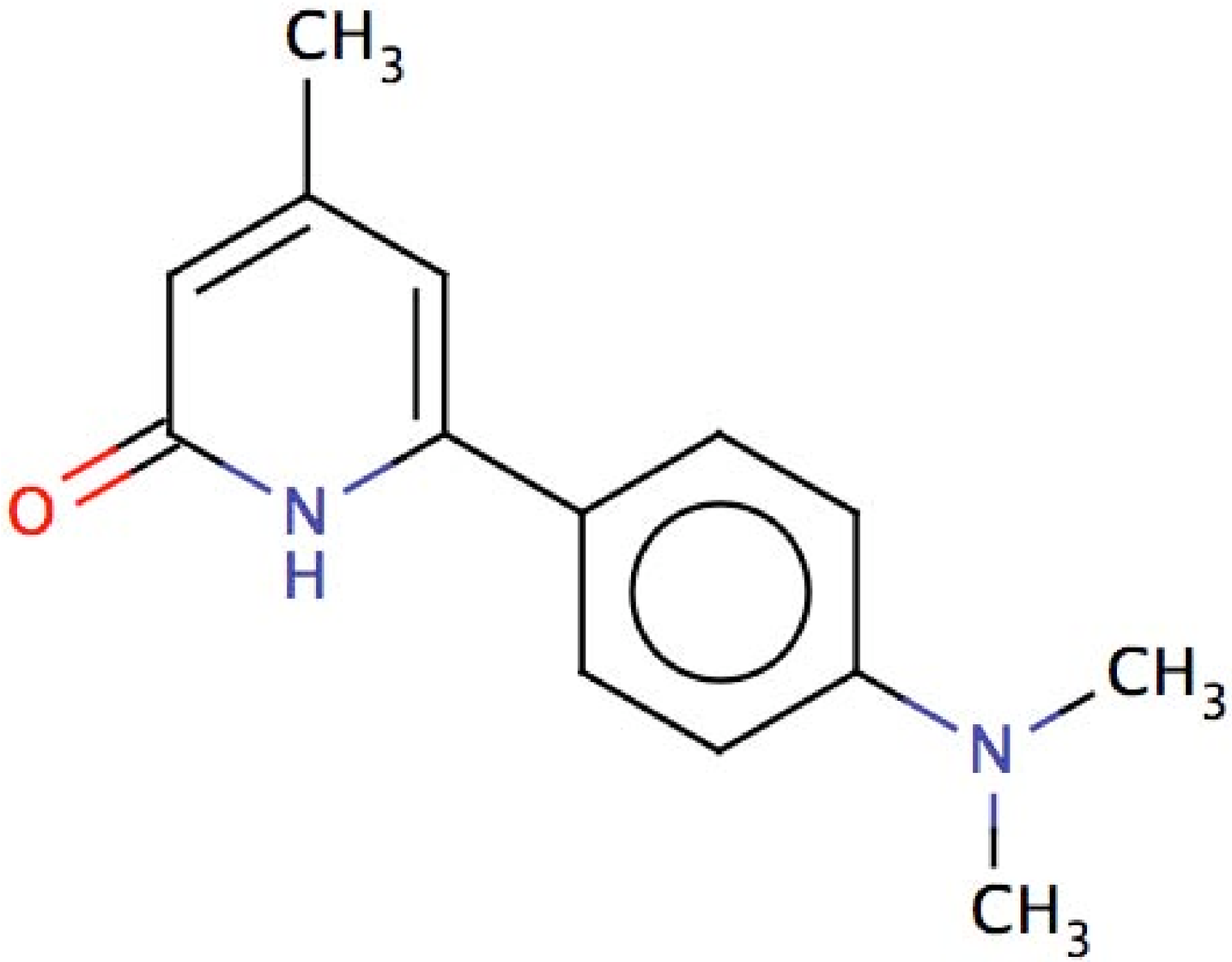
- ~1500 compounds
- Structurally diverse
- Produced by various labs in the UCI Department of Chemistry and assembled by Dr. Dick Chamberlin
- Free to UCI researchers!

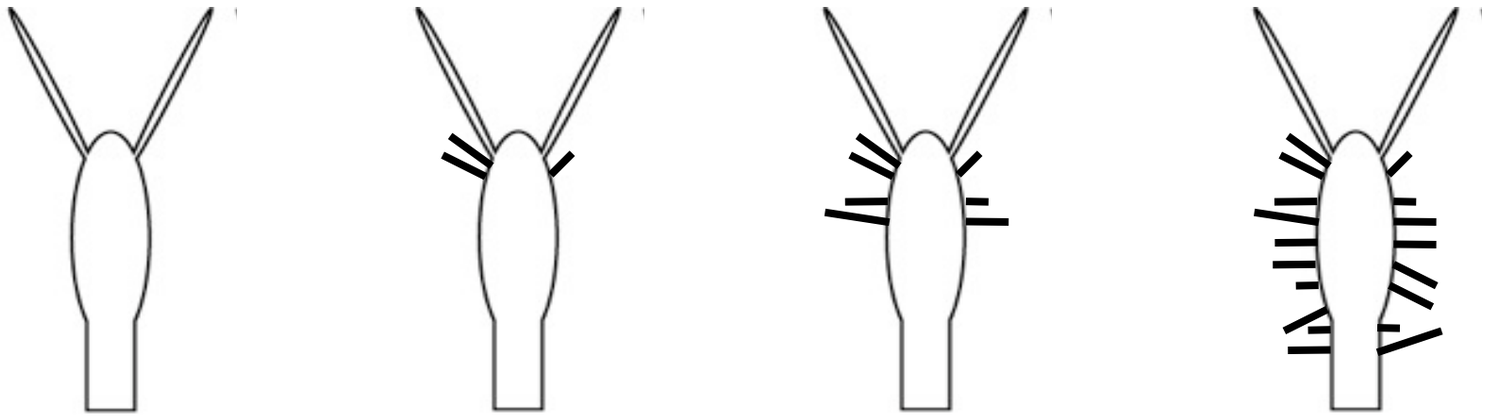



4
3
2
1
0
number of Hydra
1
2
3
4
5
6
7
8
9
10
11
12
number of tentacles
control Hydra
treated Hydra

Chronic Treatment with DAC-2-25

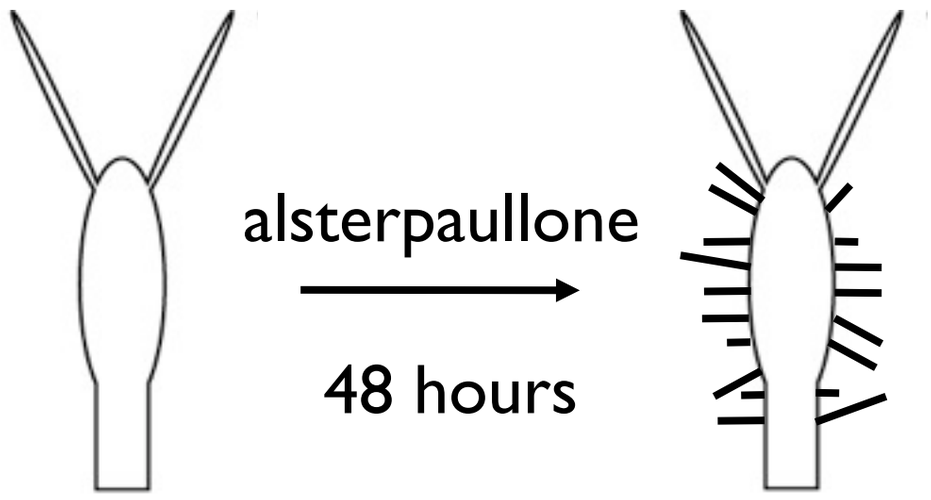



CH3
O
N
H
N
CH3
CH3



DAC-2-25

2-3 weeks



What do we need to carry out morphodynamic studies with *Hydra*?

- Ways to carry out real-time, quantitative fluorescent imaging on moving animals

- Numbers

- Information on the routes signaling molecules take through the animal

Who pays the bills?