

MAR05-2004-000991

Abstract for an Invited Paper
for the MAR05 Meeting of
the American Physical Society

Axis definition during Hydra regeneration

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Hydra may recover even from dissociation into single cells. During such a reformation process, Hydra cells first form a hollow ball made of a cell-bilayer, subsequently the developmental isotropy is broken and an axis is established. The animal then reforms according to this axis. We show that a temperature gradient of about 1 ° C across the embryo determines the axis but not the orientation of the developing animal. A change in morphogenetic inflation-contraction cycles of the Hydra cell ball coincides with irreversible axis establishment, accompanied by a change in tissue elasticity and WNT expression. We suggest that a modulation of cell adhesion or internal pressure lock the axis during development, therefore corroborating the recently advanced hypothesis of a link between cell-adhesion regulation and the WNT cascade. Quantitative analysis of the early, Hydra specific gene *ks1* reveals scaling of the expression-pattern size distribution. A plausible interpretation is, that transient collective cell-differentiation-fluctuations with increasing magnitude break the symmetry of the Hydra cell-ball; they establish the axis irreversibly upon short-range WNT cascade activation. Our interpretation suggests why Hydra regeneration starts with a hollow cell ball and how only five to ten organizer cells may convey their existence to the 10000 others.

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