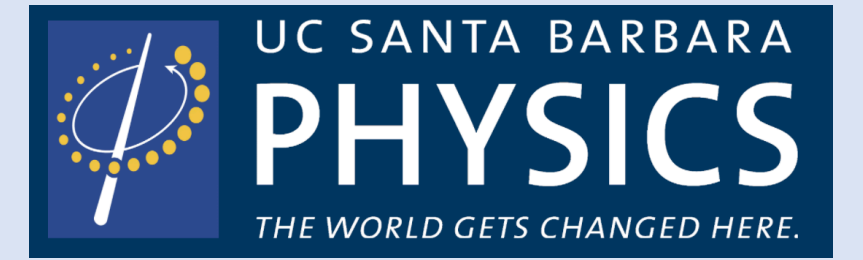


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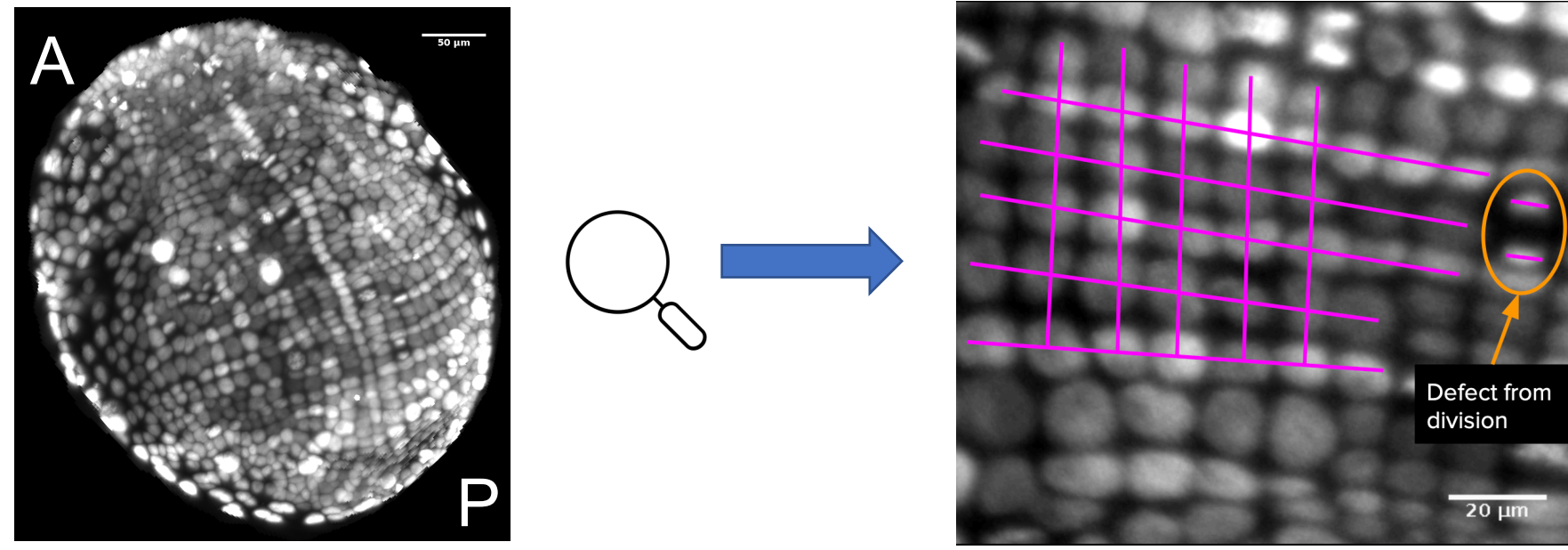
4-FOLD ORDER FORMATION IN *PARHYALE HAWAIENSIS* EMBRYO

Richard Yang, Dillon Cislo, Haodong Qin, Mark J. Bowick, Sebastian J. Streichan



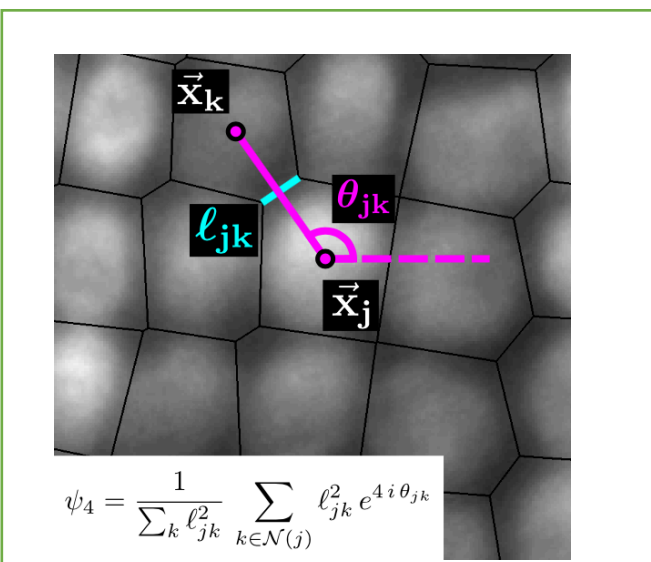
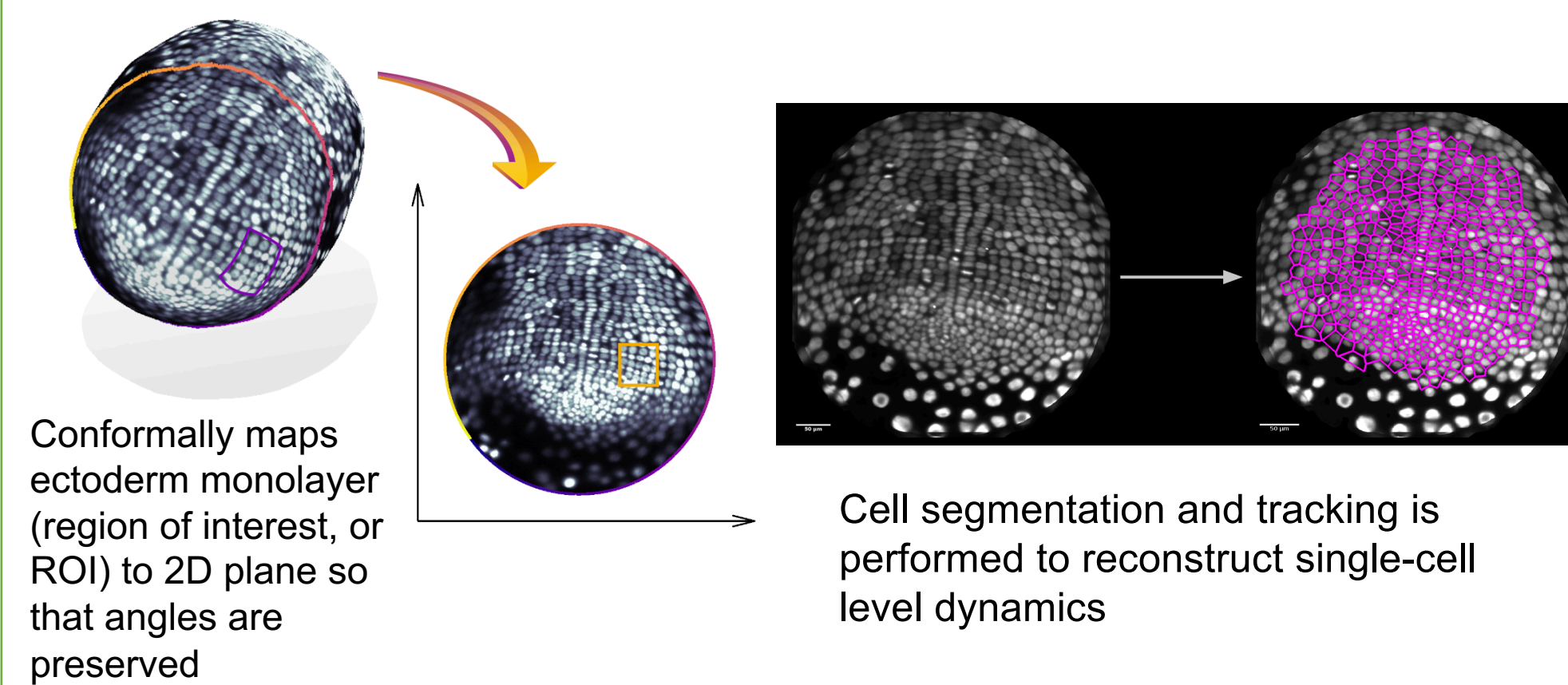
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INTRODUCTION

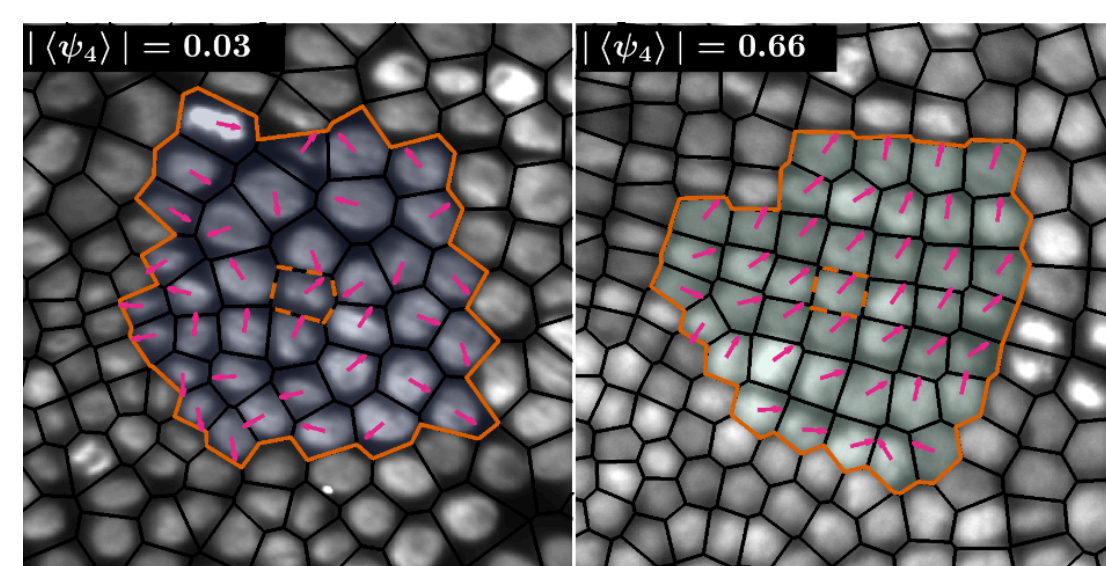


- 4-fold orientational order emerges from a disorganized state in ectoderm layer of a growing *Parhyale hawaiiensis* embryo
- Embryo highly dynamic due to cell division, which introduces defects in 4-fold order
- Emergence of order despite noisy and far-from-thermal-equilibrium

METHOD



ψ_4 quantifies 4-fold orientational order using edge-length l_{jk} as weight

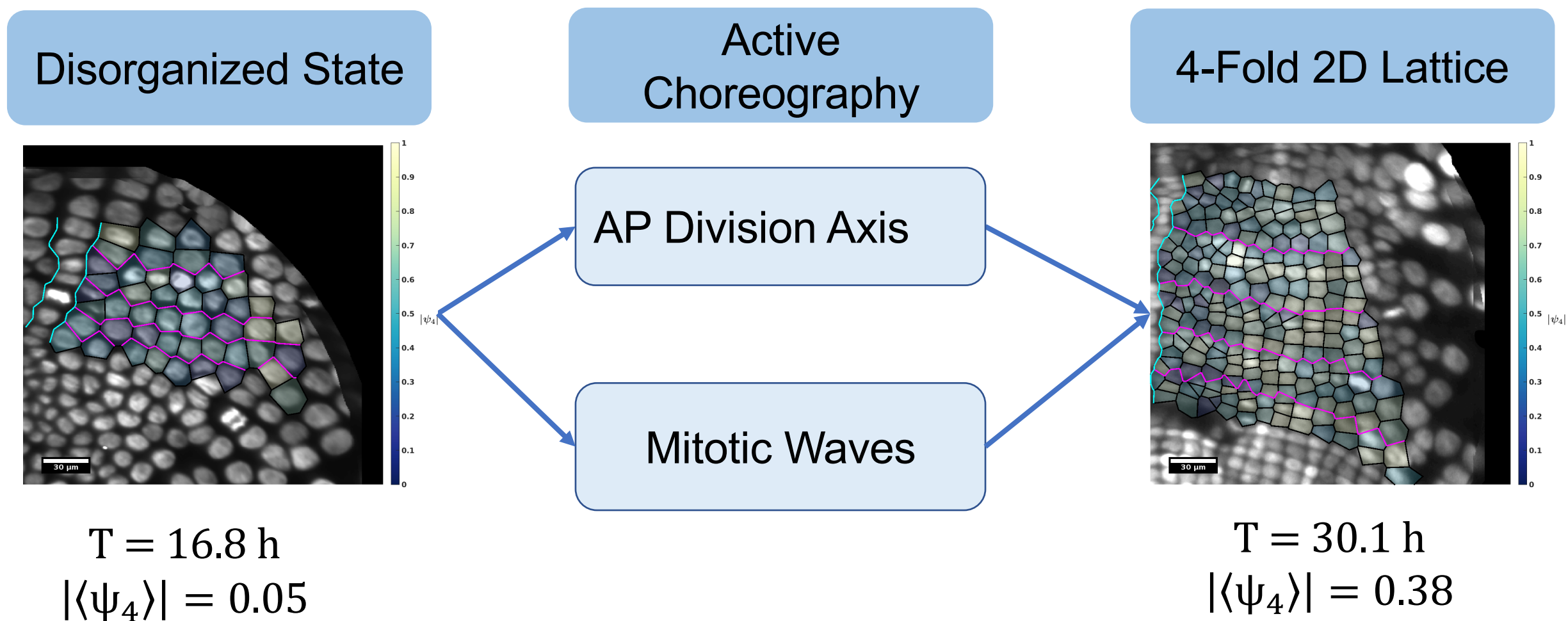


Average of ψ_4 over tissue describes the strength of 4-fold orientational order in the region

Conclusion:

Actively choreographed cell divisions generate and maintain 4-fold orientational order in living tissue

SUMMARY

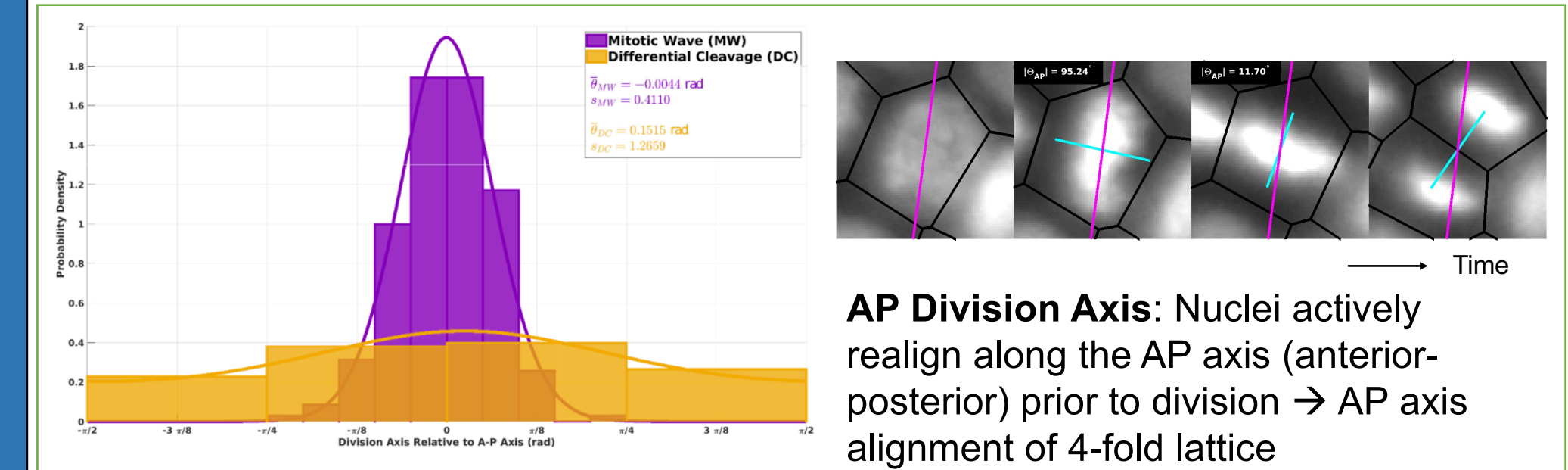


ACKNOWLEDGEMENT

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RESULTS

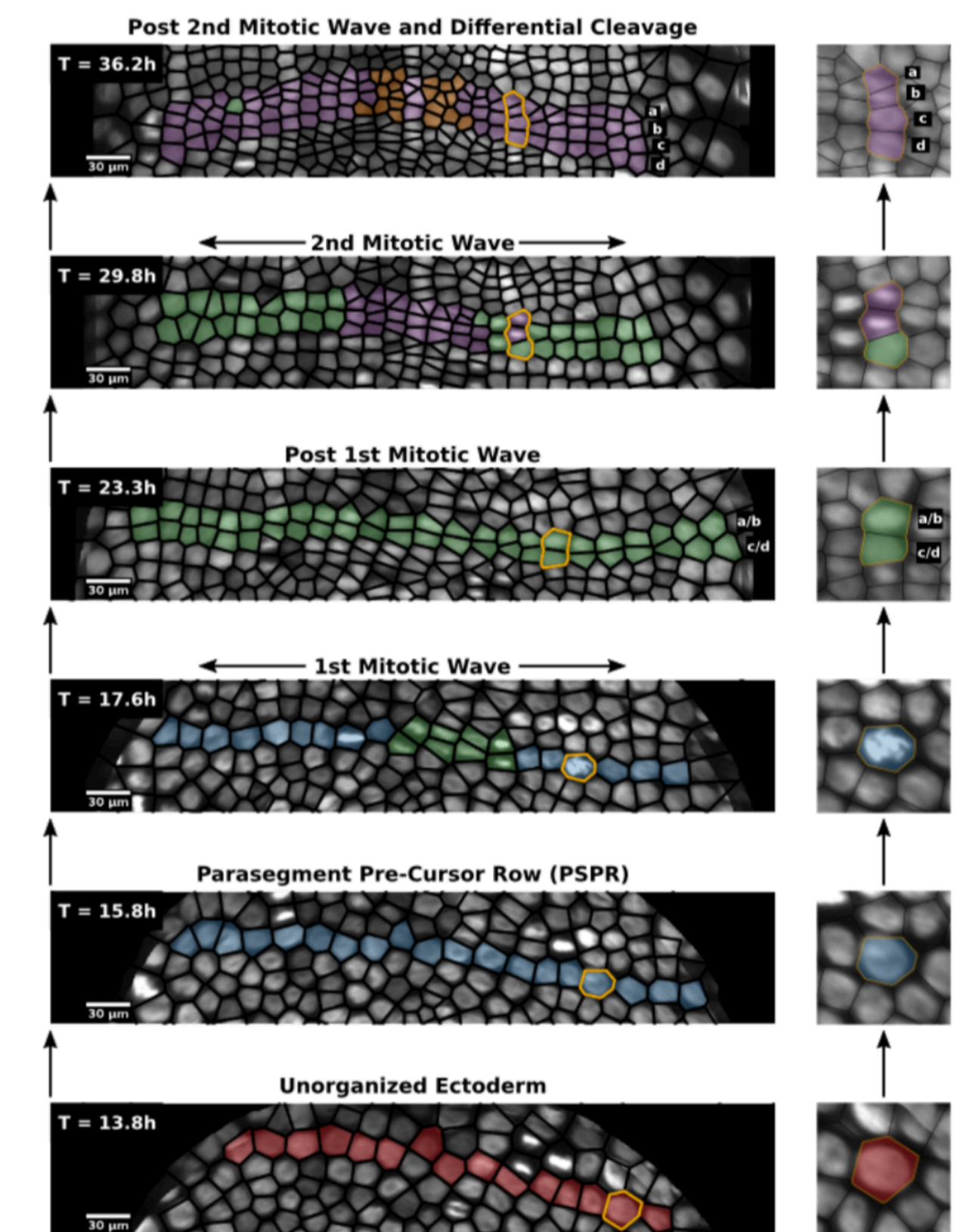
Cells Actively Choreograph Division Patterns



- The 4-fold lattice is formed with distinct *parasegments*, which is a group of rows of cells that descend from a single row.

- **Mitotic Waves:** Division spreads within the tissue surface like waves
 - Division spreads laterally *within* a parasegment
 - Division spreads along AP axis *across* a parasegment

Division's action captured on the scale of parasegment → Natural emergence of 4-fold order through division



Active Choreography Generates and Maintains ψ_4

- ψ_4 increases globally for $16 \text{ h} < T < 30 \text{ h}$
- Tissue growth incompressible during the time
- Breakdown of ψ_4 at later time corresponds to a new phase of development
- Morphogen field may be involved in setting up the choreography

