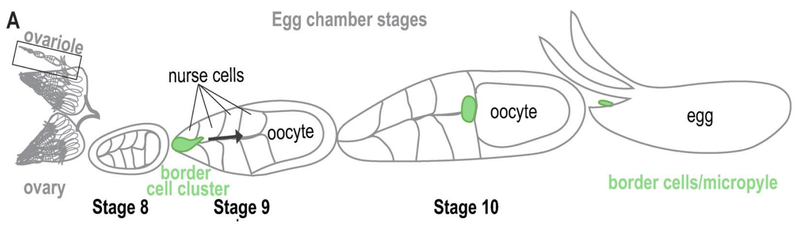
Computational analysis of border cell cluster texture to elucidate the cell mechanics of collective migration

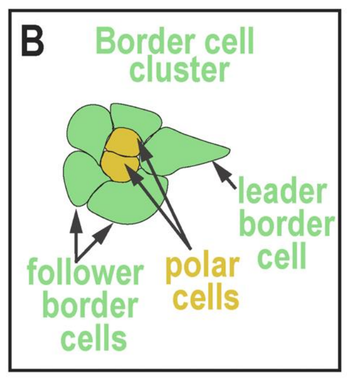
Kevin Chang[1]; Emily G. Gemmill[2]; Joseph P. Campanale, PhD[3]; Allison M. Gabbert, PhD[4]; Noah P. Mitchell, PhD[5]; Denise J. Montell, PhD[2,3]

[1]**Department of Mathematics, University of California, Santa Barbara;** [2]Interdisciplinary Program in Quantitative Biology, University of California, Santa Barbara; [3]Molecular, Cellular, and Developmental Biology, University of California, Santa Barbara; [4]Division of Cardiovascular Medicine and Division of Hemostasis and Thrombosis; Beth Israel Deaconess Medical Center and Harvard Medical School; [5]Molecular Genetics and Cell Biology, University of Chicago

Border cells as a model for collective migration to study the cytoskeleton

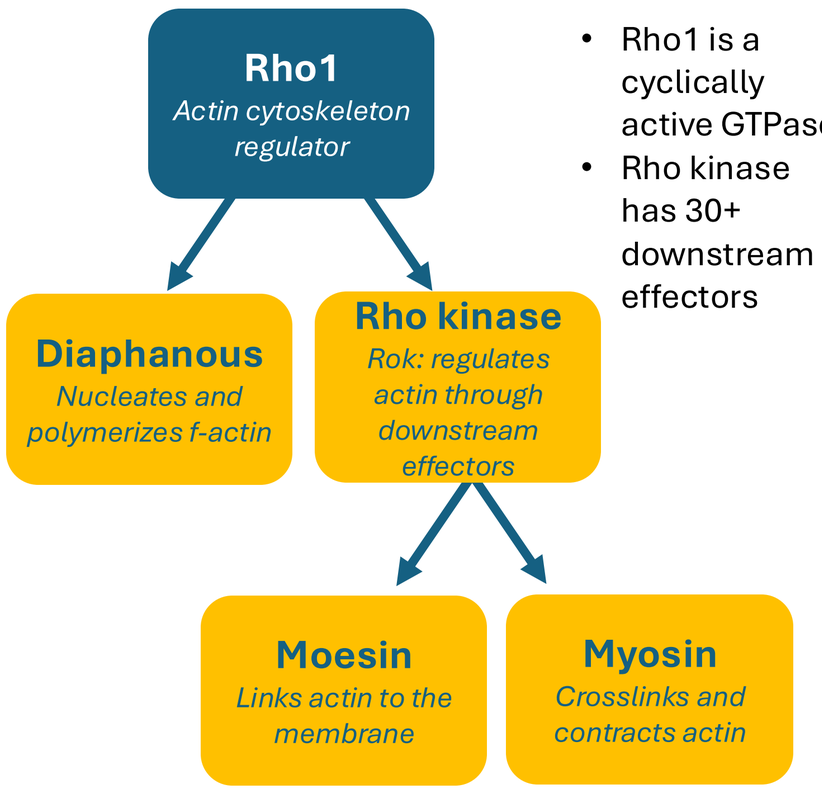
Border Cell Migration





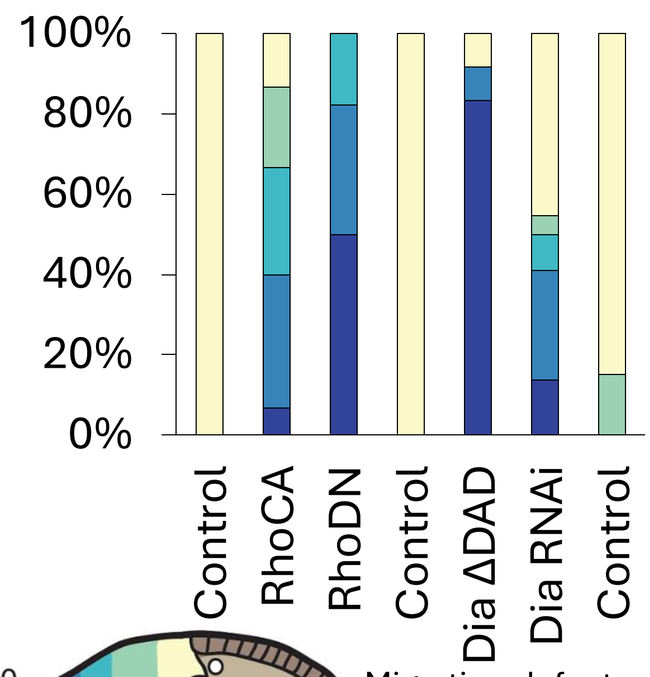
Border cells from Drosophila model collective cell migration, a process important for wound healing, metastasis, and development[1]

Rho1 regulatory pathway



- Rho1 is a cyclically active GTPase
- Rho kinase has 30+ downstream effectors

Migration defects

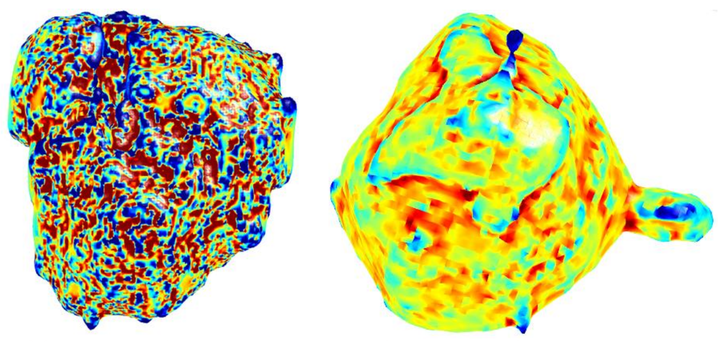


Migration defects are quantified by border cell location at stage ten[2]

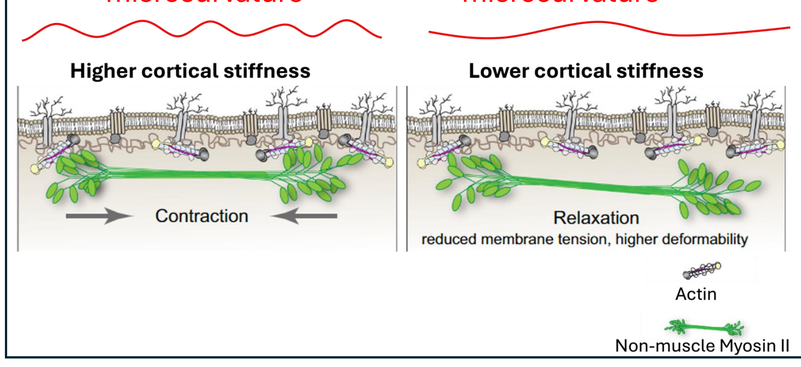
Texture model/system

Texture is a proxy for tension[3]

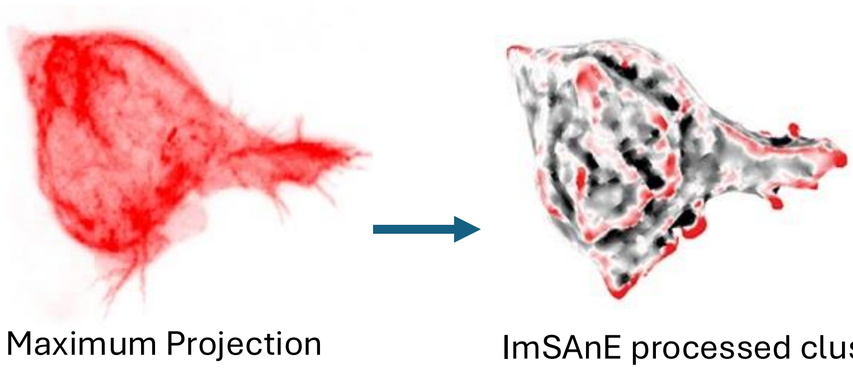
Rougher cluster **Smoother cluster**



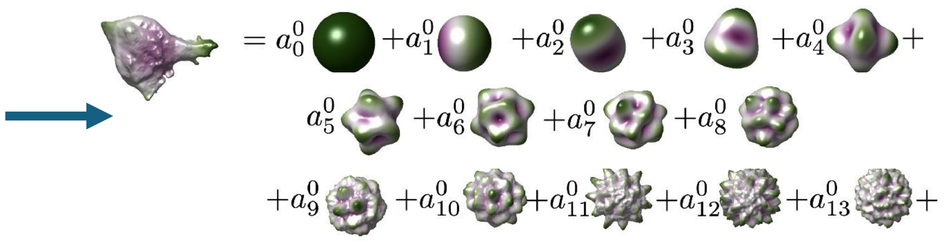
More membrane microcurvature — Less membrane microcurvature



ImSAnE & spectral decomposition analysis[4]

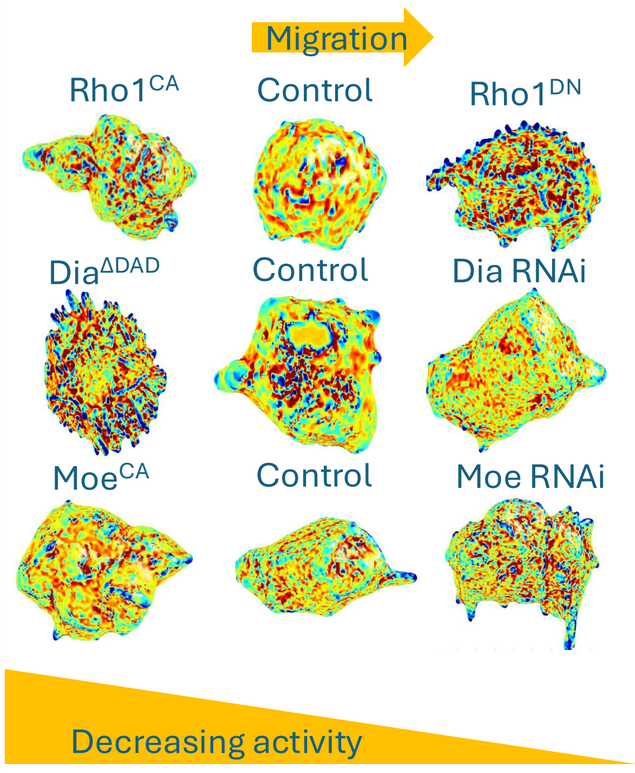


Maximum Projection — ImSAnE processed cluster



Spectral Decomposition

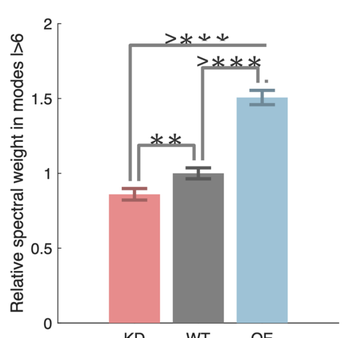
Representative processed clusters



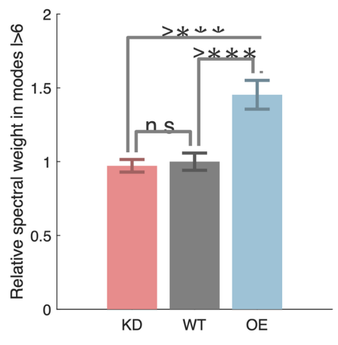
Results & Conclusion

Results

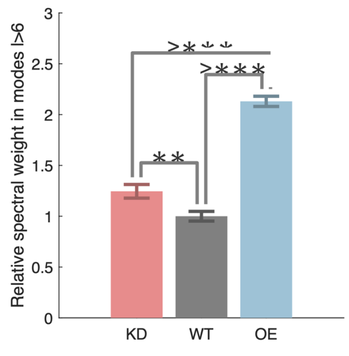
Rho1



Moesin



Diaphanous



Interpretation

Rho1 expression is positively correlated with microcurvature, increased Rho1 expression leads to more fine-scale texture.

Modulating Diaphanous expression up or down causes increase in fine-scale texture.

Moesin KD does not change the microcurvature, but Moesin CA exhibited significantly more fine-scale texture.

Conclusion: Rho1, Diaphanous, and Moesin all uniquely modulate surface texture.

Next steps

- Shape analysis using spheres and ellipsoids
- Expanding the existing spectral decomposition protocol
- Doing a mode-by-mode comparison for the eigenmodes during the decomposition

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[1]Penfield L., Montell D.K. , *J Cell Biol*(2023); [2]Smith A.S., Nowak R.B., Zhou S., Giannetto M., et al. *Proc Natl Academy Sci U S A* (2018).; [3]Gabbert A.M. et al. *Dev Cell*(2023); Smith A.S. et al. *Pnas*(2018); Gabbert A.M. et al. *Cell Press* (2024).