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During development, cells must arrange into particular tissue patterns in order to become functional organs. Shyer studies the emergence of biological form, or morphogenesis, using the chicken embryo as a model system. By focusing on physical dynamics, the lab is able to gain insight into critical symmetry-breaking events that control how tissues and organs take shape.

As an organism develops, homogenous tissues gradually give rise to complex morphological features. Understanding this process is crucial to enhancing fundamental knowledge about development. In recent decades, the prominence of genetic models has led to an assumption that patterns of gene expression, more than any other factor, govern tissue formation. Taking an alternative course, the Shyer lab focuses on the mechanical forces that influence morphogenesis. Her team takes an integrative approach to developmental biology, melding physical and molecular perspectives.

To better understand the dynamics of morphogenesis, the lab measures and perturbs physical aspects of cells in chicken embryos. The group conducts experiments in eggs, whole tissue explants, and primary cells extracted from embryos. Using these techniques, Shyer seeks to determine whether, given the appropriate physical and chemical contexts, researchers can reconstitute tissue dynamics from cellular components.

The emergence of feather follicles in birds is analogous to that of hair follicles in mammals. The Shyer lab therefore uses avian skin as a model for investigating questions about pattern formation that may be relevant in human skin. An applied goal of the lab is to uncover tactics for generating lab-grown tissues that more faithfully mimic their natural counterparts. Though scientists can already generate tissue from cultured cells, these products have limited clinical usefulness because they often fail to develop important morphological features. For example, skin grafts made from cultured cells using existing techniques do not form hair follicles or sweat glands—a shortcoming that may cause health issues if used to replace damaged skin. A lack of sweat glands, for instance, can lead to problems with thermoregulation.

Previously, Shyer and co-author Alan Rodrigues showed that avian follicle morphology and gene expression patterns depend on contractility-driven cellular mechanics. These findings corroborate the scientists' view that mechanical processes can precede and trigger gene-expression changes that are cell fate-determining. Shyer and Rodrigues ultimately aim to build unified models that integrate mechanical and molecular perspectives of morphogenesis. To test the generality of these mechanisms, they hope to explore whether other tissue types demonstrate patterning dynamics similar to those observed in skin.

EDUCATION

B.A. in psychobiology, 2005
University of California, Los Angeles

Ph.D. in cell and developmental biology, 2013
Harvard University

POSTDOC

University of California, Berkeley, 2013–2018

POSITIONS

Research Associate, 2005–2008
University of California, San Francisco

Assistant Professor, 2018–2024
Associate Professor, 2024–
The Rockefeller University

AWARDS

Miller Research Fellowship, 2013

UC Berkeley MCB Outstanding Postdoctoral Fellow Award, 2017

Burroughs Wellcome Career Award at the Scientific Interface, 2017

Searle Scholar, 2020

NIH Director's New Innovator Award, 2023

SELECTED PUBLICATIONS

Palmquist, K.H. et al. Reciprocal cell-ECM dynamics generate supracellular fluidity underlying spontaneous follicle patterning. *Cell* 185, 1960–1973 (2022).

Shyer A.E. et al. Emergent cellular self-organization and mechanosensation initiate follicle pattern in the avian skin. *Science* 357, 811–815 (2017).

Shyer A.E. et al. Bending gradients: how the intestinal stem cell gets its home. *Cell* 161, 569–580 (2015).

Shyer A.E. et al. Villification: how the gut gets its villi. *Science* 342, 212–218 (2013).

Savin T. et al. On the growth and form of the gut. *Nature* 476, 57–62 (2011).