SCIENTIST TO WATCH

Thomas Gregor: Biological Quantifier

Assistant Professor, Physics, Princeton University. Age: 39

BY ANNA AZVOLINSKY

Those who want to study living systems generally major in biology. But Thomas Gregor's path first took him through math and physics. Only after completing a master's degree in theoretical physics at the University of Geneva did Gregor return to his core interest: understanding the fundamentals of how life works.

"Thomas started as a theorist, but has transformed into a scientist who pushes our ability to measure the biological system he studies farther than anyone," says one of Gregor's graduate advisors, Princeton University theoretical physicist William Bialek.

METHODS: That biological system is the *Drosophila* embryo, introduced to Gregor by another of his PhD advisors at Princeton, Eric Wieschaus, a developmental biologist. Gregor recognized that the biology of early fly embryos was qualitatively well understood, but was ripe for a thorough investigation from a physical perspective. Under the guidance of three advisors spanning theoretical physics, developmental biology, and neuroscience, Gregor used the fly embryo to understand the physics of how flies develop at the molecular level. He demonstrated that, contrary to previous studies, the concentration of bicoid, a transcription factor that sets up the initial fly body plan, is precisely regulated and reproducible from embryo to embryo.[1,2] (See "Precision in fly patterning," *The Scientist*, July, 2007.) The research was among the first attempts to produce accurate molecular measurements in a multicellular organism.

RESULTS: After an HHMI fellowship at Princeton, Gregor went to the University of Tokyo to continue his postdoctoral work. There, he and Satoshi Sawai developed a sensor to measure intracellular levels of cyclic adenosine monophosphate (cAMP) in individual living cells of the slime mold *Dictyostelium*. Gregor found that the chemical signal created by individual *Dictyostelium* cells links the behavior of a single cell to the coordinated behavior of a group of cells.[3]

DISCUSSION: Gregor has since returned to Princeton to run his own biophysics laboratory, mentoring both biology and physics students. The productivity of his lab stems from Gregor's passion for science, which is contagious, says Mariela Petkova, a biophysics graduate student who worked with Gregor for four years as an undergraduate and deferred starting graduate school at Harvard for one year to complete a project with Gregor. "Thomas taught me that any scientific approach needs to be flexible because there will always be surprises," says Petkova.

Most recently, Gregor's lab discovered that *Drosophila* development appears to be precise at the level of mRNA, despite random pulses of transcriptional activity in individual nuclei, a feature that may be common to all organisms. Gregor observed that mRNAs diffuse evenly throughout the cytoplasm shared by all of the cell nuclei during the early development of a fly embryo, when nuclear division occurs without cell division.[4]

While theorists may dabble in experiments, they don't typically become leaders in precise and sensitive measurements, says Bialek. "Thomas is doing this on several levels in both *Drosophila* and *Dictyostelium*."

"Thomas's unique view, and what distinguishes him from a lot of biologists, is his belief that quantitative data from accurate measurements can lead to biological truth," says Wieschaus.

LITERATURE CITED:

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2. T. Gregor et al., "Stability and nuclear dynamics of the bicoid morphogen gradient," *Cell,* 130:141-52, 2007. (Cited 226 times)
3. T. Gregor et al., "The onset of collective behavior in social amoebae," *Science,* 328:1021-25, 2010. (Cited 79 times)
4. S.C. Little et al., "Precise developmental gene expression arises from globally stochastic transcriptional activity," *Cell,* 154:789-800, August 15, 2013.