The eyes have it

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Our bodies, with all their different features and variations, are the result of well-orchestrated processes that dictate what and how cells develop into the organs and tissues that comprise our anatomy. Much of the information is genetic—the result of DNA—and biochemical signals also play a role. Yet another, and still somewhat mysterious, mechanism for embryonic development exists in the tiny mechanical forces that cells exert on each other in the process.

"The growth of the embryo and organs inside it is a carefully controlled process. Cells that make up the embryo must divide and move in very specific ways and with correct timing to change the shape of the tissues," said Georgina Stooke-Vaughan, a developmental biologist in the lab of UC Santa Barbara mechanical engineering professor Otger Campàs. "Developmental biologists already know a lot about what genes are required for normal embryonic growth, but we don't fully understand how cells inside the embryo are interacting with their mechanical environment to shape organs correctly during growth."

Take, for example, the eye. How do embryonic cells know how to divide, move and position themselves to form one of the most interesting, important and complex organs an animal can possess? The eye's structures, adaptations and capabilities help the organism feed, mate and escape from danger. Therefore, proper eye formation can make the difference between strength and weakness, life and death.

The mechanical formation of the eye will be the focus of Stooke-Vaughan's research in the Campàs lab. Thanks to an Otis Williams

Postdoctoral Fellowship from UCSB, she has received funds for two years of study to investigate coordination of growth and the mechanical environment during organogenesis using zebrafish.

"For me, the big advantage of the zebrafish is that the embryos develop quickly, growing from an egg to larval fish in three days," said Stooke-Vaughan, who received her doctoral degree from the University of Sheffield and was a research associate at the University of Manchester before coming to UCSB. "Another big advantage is that they are completely transparent during the first day of development, allowing me to observe the living embryo and its organs using a microscope. I also think that the embryos are very beautiful."

Stooke-Vaughan, who studied ear development in zebrafish in her Ph.D. research, will be using Campàs' groundbreaking method to investigate minute forces involved in embryonic development. This method uses tiny droplets of oil-based or ferromagnetic fluid to measure or exert pressure on embryonic cells inside the developing tissues and organs.

"The eye is one of the most impressive organs, both in terms of functionality and structure," said Campàs. "Understanding how the eye is physically sculpted during embryogenesis would be a major advance in our understanding of how organs are formed, and would suggest new ways to prevent developmental defects leading to eye malformations."

Studying how cells sculpt themselves into tissue is essential to understand the mechanics behind abnormal development.

"This work is important because if tissue growth isn't carefully controlled during development, it can cause birth defects," Stooke-Vaughan said. "Also, changes to the mechanical environment around the tumor have been noticed in some cancers, and these mechanical changes may be involved in the uncontrolled cell proliferation associated with the disease.

"I am very fortunate to be working in Professor Campàs' lab," she continued. "The lab brings together biologists like myself with physicists and engineers, allowing us to tackle questions that can't be answered by just one discipline."

Provided by University of California - Santa Barbara

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