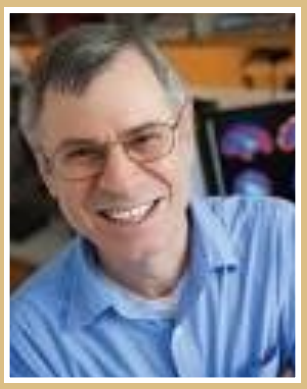
UNIVERSITY *of* DELAWARE

BIOMEDICAL ENGINEERING SEMINAR



MAY 2, 2016

Larry A. Taber, Ph.D.

DENNIS AND BARBARA KESSLER PROFESSOR

BIOMEDICAL ENGINEERING

WASHINGTON UNIVERSITY, ST. LOUIS

"Mechanical Aspects of Early Heart and Eye Development"

Although the molecular and genetic aspects of embryonic development are becoming clear, the physical mechanisms that create tissues and organs remain poorly understood. This talk focuses on two problems in the mechanics of organogenesis: (1) cardiac looping, which transforms the initially straight heart tube (HT) into a curved tube to lay out the basic plan of the mature heart; and (2) transformation of the optic vesicle (OV) into the optic cup (primitive retina).

Abnormal looping is thought to underlie many of the congenital heart defects that threaten the health of the developing embryo. Recently, we have proposed a new hypothesis for the first phase of looping (c-looping), as the HT bends and twists into a c-shaped tube. According to our hypothesis, differential hypertrophic growth causes the heart tube to bend, while a combination of growth, contraction, and external compression drives rightward torsion. The physical plausibility of this hypothesis was examined using a computational model based on realistic heart geometry. The behavior of the model is in reasonable agreement with experimental results from control and perturbed chick embryos, offering support for our hypothesis.

The eyes form initially as a pair of relatively spherical OVs that protrude from of the brain tube. Each OV grows until it contacts and adheres to the overlying surface ectoderm (SE) via an extracellular matrix (ECM). The OV and SE then thicken and bend inward (invaginate) to create the optic cup and lens vesicle, respectively. We speculate that invagination is driven by OV growth that is constrained by the ECM. By disrupting the ECM in chick embryos at various stages of development, we found that the matrix is required for the early stages but not the late stages of invagination. Finite-element model consisting of a growing spherical OV attached to a relatively stiff layer of ECM reproduced the observed behavior, as well as measured changes in OV curvature, wall thickness, and invagination depth reasonably well. These results support our hypothesis.

Our results provide new insights into the forces that drive early heart and eye development. Understanding the mechanics of morphogenesis could one day lead to new strategies for tissue engineering, tissue regeneration, and the prevention and treatment of congenital malformations.

10:30am in 322 ISE Lab. ***Refreshments served at 10:15am.***

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Dare to be first.

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