Bumps, Ridges, and no Flows in Vein

By Nicholas Battista & Laura Miller

The research story

In a developing vertebrate heart, the heart does not simply beat just to transport blood, nutrients, and oxygen, but it beats to aid in the formation of the heart itself! Our hearts begin as a straight, valveless tube and morph into a multi-chambered valvular pumping system during development. A well-choreographed dance takes place between the shape of the heart and the blood being pumped through it. As the blood is driven against the chamber walls, little cellular hair-like sensors along the heart walls feel the force of the blood, take that signal, and delegate a list of orders to spark other cellular processes to transform the heart through various geometrical changes. During this whole operation, the composition of heart walls themselves undergo complex morphological changes themselves, where small bumps and ridges, called trabeculae, push out and form. It's been suggested that these trabeculae coordinate how much force the heart walls feel from the blood [1].

The image

This image depicts a computational model of a developing heart, highlighting the interplay between these trabeculae, found along the edge of the ventricle, and blood cells as they are pushed through. The dark and light regions illustrate areas where the blood forms vortices as the blood is driven up into the ventricle from the atrium. If any of these processes are slightly off, the heart will not develop correctly and a congenital heart defect arises.

Reference

[1] Battista NA, Lane AN, Liu J, Miller LA, Fluid dynamics in heart development: effects of trabeculae and hematocrit, Math. Med. and Biol. 35(4): 493–516, 2018.

F. Matthäus et al. (eds.), *The Art of Theoretical Biology*, https://doi.org/10.1007/978-3-030-33471-0_53