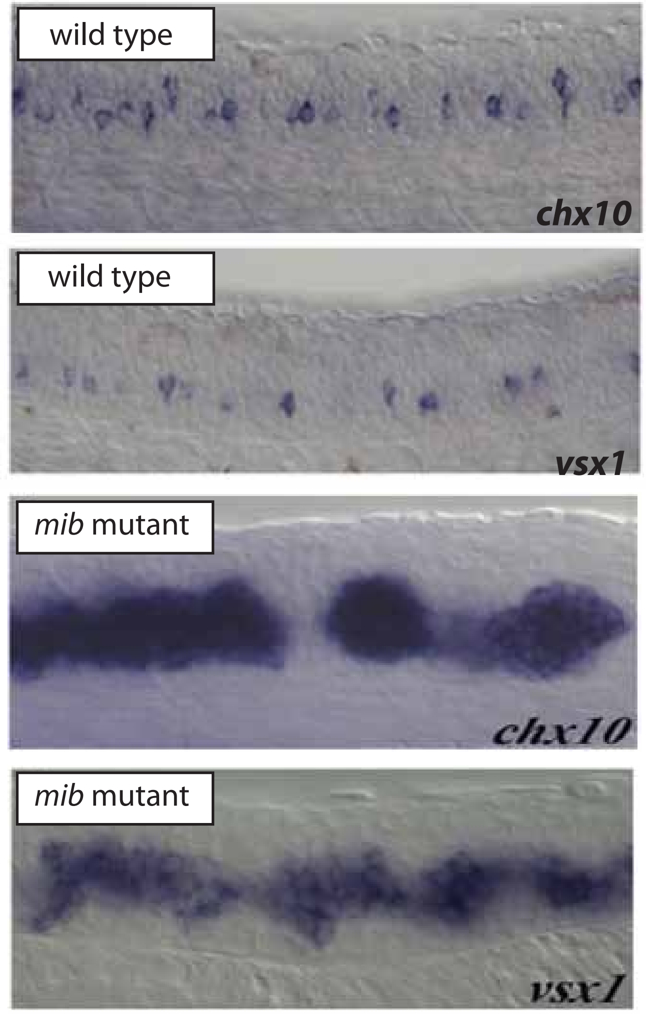
Interplay between tissue mechanics and biochemical signaling during spinal cord development

In normal wild-type zebrafish embryos (and in all other vertebrates), the spinal cord contains distinct classes of neuronal cells that form at precise locations and express specific combinations of transcription factors. In zebrafish, the temporal pattern of differentiation is also important; normal neuronal cells form slowly over time as the surrounding tissue grows, divides, and changes its morphology, and develop a robust "salt and pepper" pattern (Top two panels on the right).

In contrast, "*mindbomb*" (*mib*) mutants have neuronal cells that differentiate early and all at the same time. These embryos lack an important signaling pathway which is conserved across many vertebrates, the Notch signaling pathway. In these mutants, the neuronal cells do not end up in the right pattern (Bottom two panels). An interesting question is whether the difference in differentiation timescales means that the cells experience different mechanical environments, which in turn influences neuronal cell patterning.

In this project, graduate students will work as part of an interdisiplinary team to quantify the spatio-temporal expression patterns of transcription factors, analyze images to quantify cell and tissue shapes, and develop a mechanical and biochemical model that makes predictions about cell patterning. Students can choose to work mostly on experiments, mostly on mathematical modeling, or some comination of the two.

SOFT INTERFACES IGERT @ SYRACUSE UNIVERSITY



Pattern and morphologies of neuronal cells in developing spinal cords in zebrafish. Staining indicates expression of two different types of transcription factors found in neuronal cells. Top two panels: wildtype embryos show a "salt and pepper" pattern of neuronal cells. Bottom two panels: *mib* mutants have a thick band of neuronal cells.

Goal:
Develop quantitative model based on experimental data to explain how neuronal cell patterning depends on mechanical interactions and signaling

Techniques used by our team:
- zebrafish husbandry
- in situ hybridisation and immunohistochemistry
- image analysis
- computer simulations
- mathematical modeling

Project Leaders:

Prof. Kate Lewis
(biology.syr.edu/faculty/lewis/lewis.htm)
Department of Biology, Syracuse University

Prof. Lisa Manning (www.phy.syr.edu/~mmanning)
Department of Physics, Syracuse University