Clockwise, from bottom left: Kwantae Kim (PhD-BIOL), Sydney Popsuj (PhD-BIOL), Christopher Johnson (PhD-BIOL), Tanner Shearer (undergrad), Alex Gurgis (undergrad), Leslie Cohen (undergrad), Florian Razy-Krajka (postdoc), Susanne Gibboney (lab manager), unaffiliated person, Elijah K. Lowe (postdoc), Alberto Stolfi (PI), Jameson Orvis (undergrad)

Tune in to Tunicates

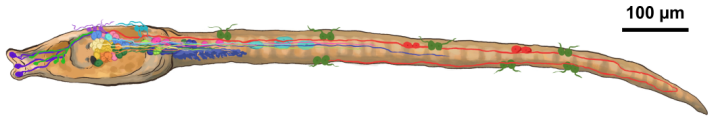


Figure 1. The larval nervous system of Ciona Tunicates are marine chordates that alternate between a motile larval phase and a sessile filter-feeding adult phase. The simple nervous system of the short-lived larva is geared entirely for swimming in search of a spot on which to settle and undergo metamorphosis. After the larva finds a suitable substrate for attachment, a wave of programmed cell death eliminates all larval neurons, and dedicated set-aside stem cells regenerate the adult nervous system. In spite of this biphasic lifestyle, both larval and adult nervous systems derive from the same typical chordate nervous system as our own.

Summary:
How does your brain form? Our lab seeks to answer how animal behavior is set up by the collective behaviors of individual cells over the entire course of brain development. More specifically, we investigate how gene activity can instruct how each developing brain cell will move around, change shape, and connect to other cells.

To do this, we study the simple larval nervous system of our closest invertebrate relatives, the tunicates. Tunicates, like us, belong to the Chordate phylum, but have very simple embryos and extremely compact genomes. The laboratory model tunicate Ciona has only 231 neurons and is the only chordate with a fully mapped "connectome". We take advantage of this simplicity to probe molecular mechanisms that may underlie human neurodevelopment.

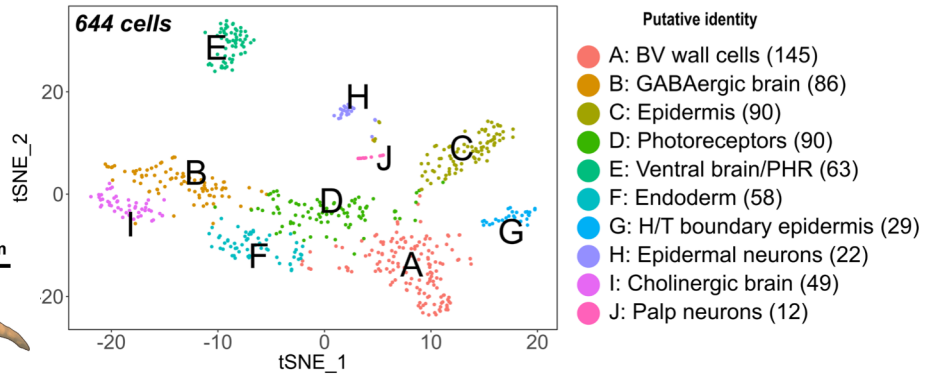
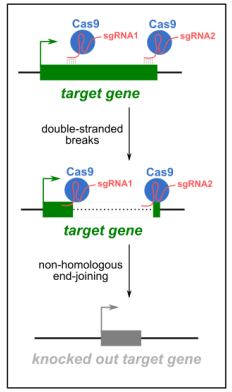


Figure 2. Single-cell RNA sequencing. We use this new technology to quantify the expression of all 15,000 genes in the Ciona genome in each individual cell isolated from the larval brain. This allows us to identify novel cell types and find key genes controlling their functions.



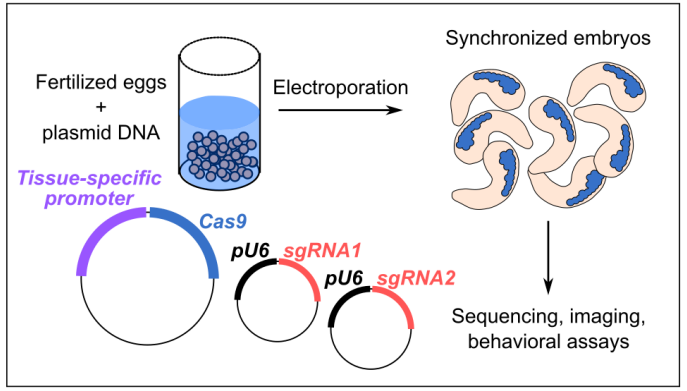


Figure 3. CRISPR/Cas9 genome editing. We use this versatile technique to delete genes in very specific neurons, and then measure the resulting effect on cell differentiation and behavior to identify novel genes that are crucial for neural development.

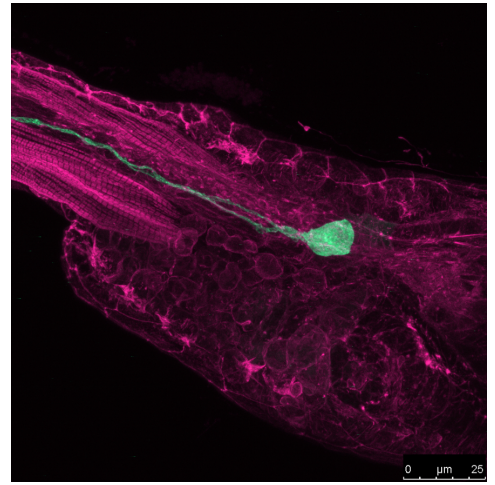


Figure 4. Confocal microscope image of descending decussating neurons (ddNs). These neurons are the Ciona homolog of vertebrate Mauthner cells and project their axons across the midline and down the tail to control escape behaviors shared between these simple larvae and their larger vertebrate relatives.