#### GAP-FREE NEURAL CIRCUITS - CLASS #5: C. elegans pharyngeal pumping

# **OUTLINE:**

- Background on behavior and anatomy
- Nervous system control of pumping
- Light-induced behavior and circuit

## C. elegans pharyngeal pumping and neural anatomy

- SLIDES: video of pharyngeal pumping and animation of pumping
- DRAW: Pharynx with each piece labeled (corpus, anterior bulb, isthmus, posterior bulb)
- Pharynx sub-behaviors
  - 1. Contraction stroke
    - Corpus opens (negative pressure) and sucks in liquid
    - Grinder moves posterior
  - 2. Relaxation stroke
    - Corpus closes and liquid pushed out -> filter feeding
    - Grinder moves anterior
  - 3. Isthmus peristalsis moves bacteria into posterior bulb
- SLIDES: Muscles and cells of the pharynx
- WEB: wormweb.org with PM at center
- Some numbers
  - 1. Neurons = 20 individuals in 14 classes (some bilaterally paired) (bilateral redundancy)
  - 2. Muscles = 34 nuclei in 8 classes (PM1-PM8, with 3-fold symmetry)
    - Muscles and marginal cells connected by gap junctions
- Nervous system connectivity
  - 2 islands
    - Pharyngeal nervous system (20 neurons)
    - Main nervous system (282 neurons)
    - I1 (pharynx) o----o RIP (main)
- NOTES:
  - Pharynx is a bit like the heart rhythmic pumper

### Nervous system modulation of pumping

- Pumping is modulated by bacteria (food):
  - o Bacteria -> 4-5 Hz and rhythmic
  - No bacteria -> 1 Hz and erratic
- Where is the CPG for pumping?
  - Only 20 neurons, so systematically laser kill
  - MC: ½ Hz, erratic -> grow to adult but starved
  - M4: stuffed corpus, no ingestion -> larvae don't grow to adult
  - M3: delayed relaxation (minor)

- o All others individually: no effect
- All but MC and M4 together: ½ Hz, erratic
- o All 14 classes: pumping continues, stuffed corpus
- "Sufficiency"
  - Def #1: activation of neuron -> behavior or affects another neuron
  - Def #2: behavior persists in absence of other neurons
    - All but M4: slow pumping, but isthmus peristalsis is intact
- SLIDES: Pharyngeal electrophysiology
  - o MC: initiates pump with pre-E excitatory spike
  - o M3: encourages repolarization with P inhibitory spikes
- DRAW: MC, M3 and M4 on pharyngeal muscle [KEEP]
- Some mysteries:
  - O How does food promote the activity of MC? -> food sensor, in pharynx or out?
  - O How does contraction promote the activity of M3? -> proprioceptor?
  - O How does food modulate peristalsis rate?
  - o How does the pumping signal conduct through the muscle without initiating peristalsis?

#### **Light-induced locomotion**

- Behavior:
  - Light on head -> reversal
  - Light on tail -> forward acceleration
  - Most sensitive to lower wavelength light (<400 nm)</li>
- No eyes and transparent, so light sensors unclear
- Previous work found that
  - ASJ and ASK are redundantly required for light-induced reversals
  - ASJ and ASK respond by depolarizing to light
  - o tax-2 and lite-1 act in ASJ and elsewhere for depolarization and light-induced reversals