38. New Faculty Showcase: Mitochondrial organization
1 unit, Christina Gladkova, April 22, 2026

We will consider the principles that govern the shape, distribution and movement of mitochondria. These are essential, because defects in organelle maintenance cause neurodegeneration, and altered organelle architecture is a hallmark of many diseases including cancer. The ultimate goal of current research in the field is to understand how mitochondrial architecture supports proper cellular function. We will cover:

1. The mechanisms that organize mitochondria in a cell.
2. The contexts in which proper mitochondrial architecture matters (neurological and metabolic disease).
3. Does "mitochondrial architecture" make a good drug target?
4. Paper discussion (see below).
5. The case for reducing cellular complexity to understand the signals that link cell function and organelle organization.

Suggested reading:

Mitochondrial heterogeneity and homeostasis through the lens of a neuron. Pekkurnaz G, Wang X. *Nature Metabolism* (2022). https://doi.org/10.1038/s42255-022-00594-w .

Selective motor activation in organelle transport along axons. Cason SE, Holzbaur ELF. *Nature Reviews Molecular Cell Biology* (2022). https://doi.org/10.1038/s41580-022-00491-w .

Paper discussion:

We will cover two papers that study the microtubule-based transport of mitochondria using different approaches. The class will be divided into two groups that will read one paper each (students are welcome to read both if the topic is of interest). We will establish a common background, and then compare and contrast the approaches taken by the two studies. Please find questions that will be covered during our discussion below.

Required reading:

TRAK adaptors regulate the recruitment and activation of dynein and kinesin in mitochondrial transport. Canty JT, et al. *Nature Communications* (2023). https://doi.org/10.1038/s41467-023-36945-8 .

Loss of Miro1-directed mitochondrial movement results in a novel murine model for neuron disease. Nguyen TT, et al. *PNAS* (2014). https://doi.org/10.1073/pnas.1402449111 .

Discussion questions:

Background:

What is the function of dynein and kinesin molecular motor proteins?

What are the roles of the adaptor proteins Miro and TRAK in attaching mitochondria to dynein and kinesin?

What experimental approach does the paper take?

- How is dynein- and kinesin- mediated transport measured?
- What perturbations do the authors make to test their hypothesis?

Does the work address the following questions? What are the key experiments?

What components of the motor-adaptor complex are necessary for anterograde (kinesin-driven) or retrograde (dynein-driven) transport?

Can the opposing motor protein hitch a ride on moving complexes to "get back to the beginning" of its microtubule track?

Is increased Ca^{2+} concentration sensed by Miro to halt mitochondrial transport?

What is the next experiment to figure out the Ca^{2+} transport sensor?

Groups:

Group 1

Afroz, Jalwa

Ahmed, Nibras

Cherkas, Shelby

Hanselman, Olivia

Illouz, Sylvia

Lange, Matthew

Levin, Bailey

Li, Ruofei

Magnus, Karina

McIlhenny, Lauren

Nadler, Rebecca

Group 2:

Beattie, Kai

Mutaher, Mohammed

Pavletich, Tatiana

Perea del Angel, Ana

Pope, Eleanor

Prabakaran, Adithya

Styers, Hannah

Sussman, Carleigh

Ta, Christina

Tarrab, Stephanie

Volpe, Christina

Xiao, Michael