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Research Interest: Avi Adler

The biological sciences particularly excite me because of the complexity and relevance to life. This is especially true of the nervous system. Within this system, each neuron transmits electrical pulses, and therefore needs large amounts of energy. To accomplish this, neurons contain an abundance of mitochondria, the energy producers of the cell. The health and function of these organelle is critical for cellular function and longevity. However, as they age, they also become a danger to cellular health by releasing harmful byproducts of energy synthesis. To avoid this, mitochondria are regularly re-generated. Even though much is known about this process in cell cultures, little is known about how these processes occur in-vivo.

Neuronal mitochondria degradation (mitophagy) is thought to be regulated by factors such as PINK1 and parkin proteins. Current work in the Barnhart lab is using the model organism Drosophila to investigate this relationship. Specifically, the visual system of Drosophila is used because it is highly organized and structured. The visual system operates in a way that relays information from particular regions in the visual field to specific and identifiable optical units.

I propose to overexpress and knock-out PINK1 and parkin factors then examine how it effects mitophagy, neuronal health, and function in-vivo. Knocking out these factors (which are responsible for mitochondria turnover) should lead to decreased mitophagy rates, and consequently a decrease in cellular health. As cell health declines because of the accumulating and aging mitochondria, function of the cell, determined by mitochondrial volume (which increases as mitophagy decreases), might increase. In contrast, over-expression of PINK1 and parkin should lead to increased mitophagy, increased health and decreased function.

To accomplish this, I plan to perturb PINK1 and parkin expression, then use genetically coated optical indicators to analyze the effects. Specifically, I plan to use a technique known as mito-QC imaging. This technique fluorescently labels mitochondria and allows for distinguishing between healthy and degrading mitochondria. Doing so allows for analyses of mitophagy between controlled and perturbed samples. In addition, I plan to use Mitotimer fluorescent reporters, a proxy for mitochondrial health, to analyze controlled and perturbed samples.

Understanding the regulation of mitophagy by PINK1 and parkin factors is important for its implication on neuronal function. The Drosophila visual cortex is a perfect model system in this regard because specific neurons can be expressed with controlled visual stimuli. Exposing Drosophila to these stimuli combined with in-vivo imaging will help in determining the connection between mitophagy and neuronal function.