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Ghostly Glia

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Ghostly glia: The less famous brain cells

Is your brain filled with cobwebs? Nah. But the ghostly-looking cells in the image below (Figure 1) do weave around all of the neurons in your brain and actually outnumber them. Recognizing one role that they play in surrounding neurons and holding them in place, early scientists coined these brain cells as glia – meaning glue.

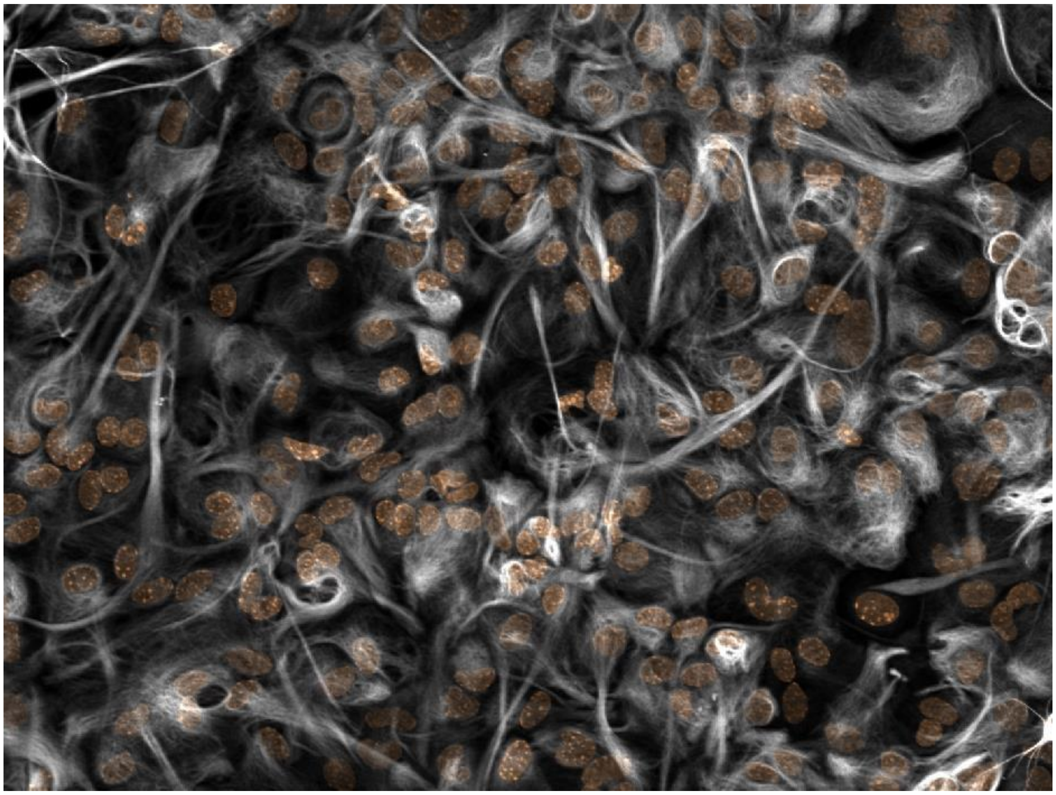

Figure 1: Neurons and glial cells grown together ex vivo, or outside of an organism's brain. Growing cells in this way allows me to tightly control the cells' environment and test the effects of different treatments. I have stained these astrocyte glial cells to display the characteristic molecular markers of these specific cell types.

Glial cells and their better known neuron neighbors are both created from the same parent progenitor cells during brain development. When these early progenitor cells started dividing to produce both glia and neurons, your brain was not yet the beautifully organized structure with folded gyri and sulci and a flowery cerebellum all gathered together at the brainstem. At that time, early in your development, your entire nervous system consisted of a simple tube-like structure. It was your glial cells that acted as the scaffold for building your brain, allowing your neurons to climb along the glial scaffolding and organize into the layers of your cortex (a review article depicting some nice diagrams of this process can be found here).

After young neurons reach their destination in the brain, they reach out distances as long as from your spine to the tip of your toes and form connections for electrical communication. Just like wires running through your house, neuron signals move faster and more efficiently when their long axons are insulated. And guess what kind of cells act as your neurons' insulators? More glia! Specialized glial cells wrap their own fat-rich cell membranes around neurons' axons to increase the resistance against loss of electrical signal—a process called myelination.

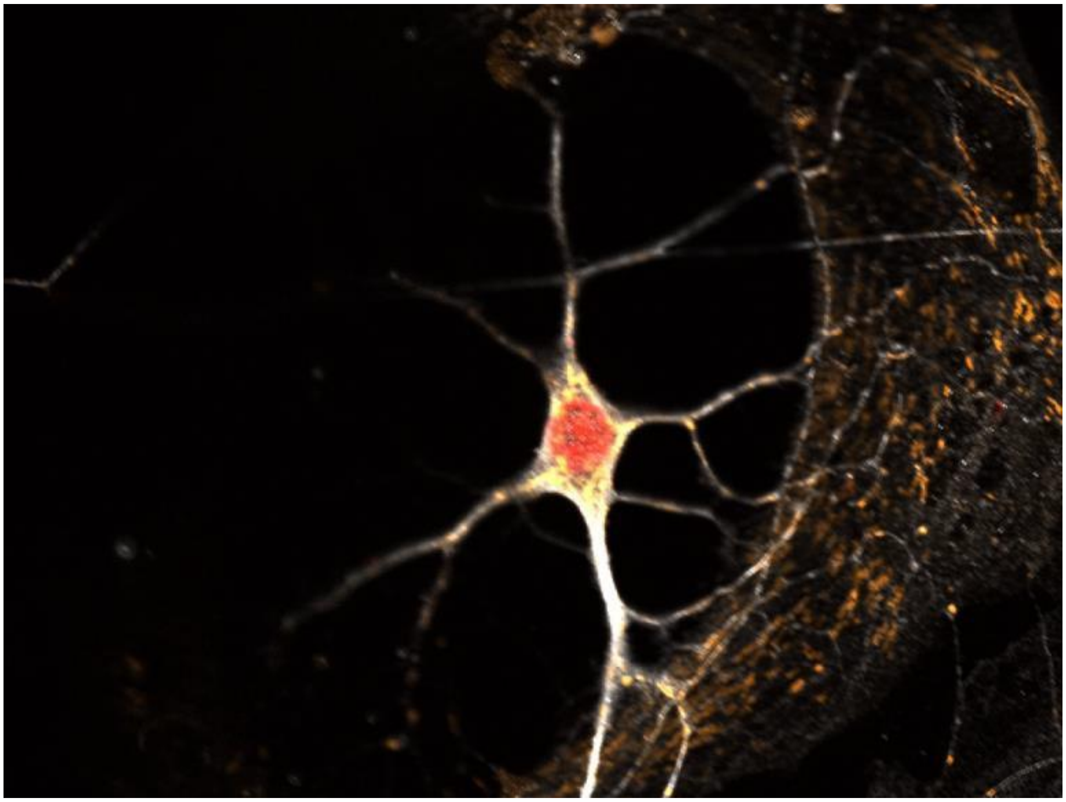

Figure 2: The first researchers to see astrocytes under a microscope named them after stars. The processes that form the astrocytes' delicate, radiating shape participate in the tripartite synapse with communicating neurons.

Even your fully-developed and completely-myelinated brain continues to depend on activity of glial cells. Our carefully regulated brain environment is closed off from the rest of the body by the blood-brain barrier. Closing the brain off from the rest of the body does protect it from outside toxins and bacteria, but this precaution also prevents our body's immune cells from protecting the brain. Not to worry, there are glial cells for that. Microglia within the brain help remove dead cells, waste, and potentially infectious agents.

Getting nutrients to highly active brain cells is another challenge resulting from isolating the brain from the rest of the body's fluctuations. Our busy brains consume about 20% of our body's energy and require large amounts of nutrients from the blood supply—which is inaccessible to neurons because of the protective blood brain barrier. Glial cells called astrocytes help bridge this barrier by regulating regional blood flow to direct nutrient-rich blood to more active brain regions and to control the number of nutrient transporters in the blood brain barrier.

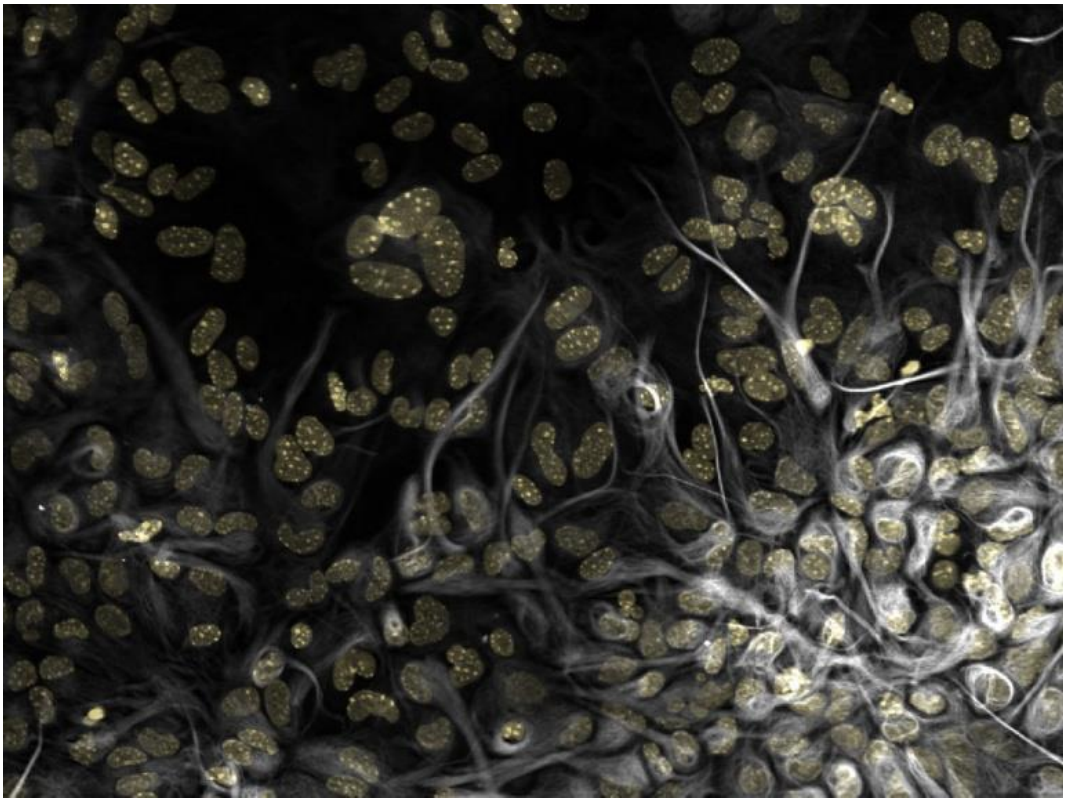

Figure 3: While neurons in the brain are unable to replenish and regenerate, these astrocytes in white are growing and spreading towards other cells, which appear as yellow ovals.

Researchers often overlook glial cells, thinking of them only as helper cells, second in importance to neurons (we are neuro-scientists, after all). More recent research places glia at an active role in neuron-to-neuron signaling where the end of one neuron reaches the beginning of another. These two neurons plus an interacting astrocyte glial cell form the three-part synapse. A ménage à trois relationship, as a giggling mentor once told me. Within the tripartate synapse, astrocytes help to form, maintain, and remove connections between neurons, helping us learn, remember, and be cognitively flexible. And just like neurons, they are beautiful!