

Tutorial 4: Shapes and Roles of Glial Cells

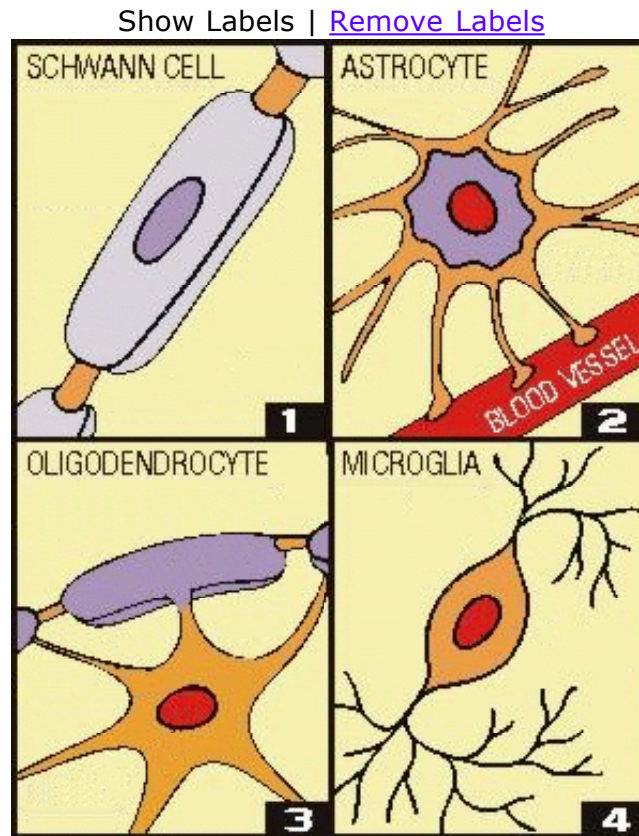


Figure 4: Shapes and Roles of Glial Cells

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In addition to neurons, the nervous system is populated with a category of cells that support the functions of neurons. These support cells are called *glial cells* in the central nervous system and *satellite cells* in the peripheral nervous system. Glial cells are approximately 10 times more plentiful than neurons in the CNS. However, since they are approximately one-tenth the size of neurons, glial cells take up equal space. Glia is a Greek term meaning glue. Researchers originally believed that glial (and satellite) cells served as the binder that held the neurons together. Recent research indicates that these cells provide very important contributions that extend well beyond the realm of physical support.

Oligodendrocytes and Schwann cells form the myelin sheaths that insulate axons in the central and peripheral nervous systems, respectively. The myelination of axons not only speeds the rate of signal transmission, but also prevents cross talk between neurons. The tiny microglia and the star-shaped astrocytes remove waste materials that are created primarily when neurons die. Both glial types release chemicals in the vicinity of dying neurons (e.g., following a stroke) and promote the growth of dendrites and axons of healthy neurons in the same area, perhaps stimulating

recovery of function. Nitric oxide speeds up the dying process when released close to weakened neurons. *Radial glial* cells (a type of astrocyte) guide the migration of neurons and the path of sprouting and growing dendrites and axons during embryonic development of the nervous system. Astrocytes also exchange K⁺ and other chemicals with neurons, and act as an intermediary by transporting substances between neurons and the bloodstream.

Advanced

The complete classification scheme for glial cells in the nervous system provides additional detail (Parent, 1996). Astrocytes are technically divided into two types: fibrous astrocytes are associated with white matter or collections of axons and protoplasmic astrocytes are associated with gray matter or collections of neuronal cell bodies. Astrocytes are the largest of glial cells with an average diameter of 40-50 microns. Each contains numerous podia (or feet-like extensions) that make intimate contact with both blood vessels and neurons.

Astrocytes communicate with each other via gap junctions called syncytium. Probable physiological roles served by astrocytes include:

1. the maintenance of ions and buffering of potassium and pH in extracellular fluid,
2. recycling of neurotransmitters, the production and secretion of neurotrophic factors (e.g., neural growth factor) that stimulate the growth and maintenance of neurons, and
3. calcium signaling (the use of slowly changing gradients of calcium as a means of cross-glial communication).

Receptor sites for neurotransmitters such as glutamate and GABA have been identified on both astrocytes and Schwann cells. The functional significance of these receptors remains a mystery, but there is some speculation that these receptors allow for identification of neighboring neurons. This identification would allow for the production of appropriate signaling and membrane proteins by the glial cell.

Another type of glial cell, the ependymal cell, form the linings of the brain's internal cavities (the ventricular system). Ependymal cells play a role in the blood-brain barrier. This barrier prevents the entry of certain (usually large) molecules into the central nervous system.

Glial cells are capable of reproduction, and when control over this capacity is lost primary brain tumors result. So called astrocytomas and glioblastomas are amongst the most deadly or malignant forms of cancer. Other neurological conditions are associated with abnormal glial function.

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Suggestions for further study

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