Sleep and the Glymphatic System

Ken Saladin

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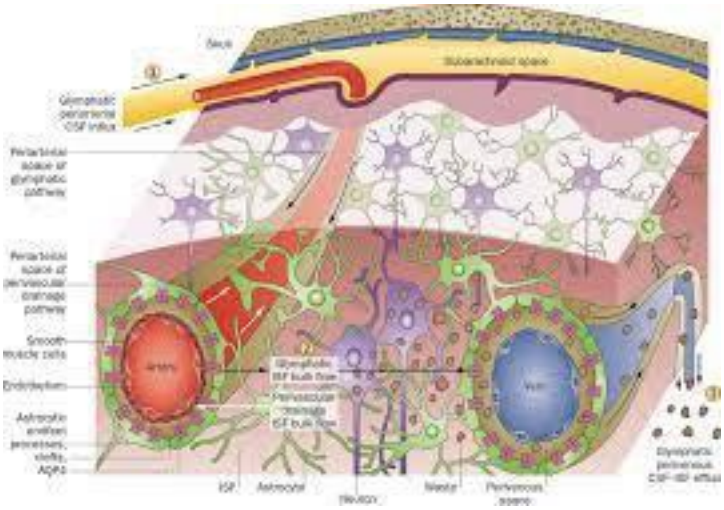
Who plays the role of lymph in central nervous system?

This is an interesting question because until recently, the brain was thought to be devoid of a lymphatic system. In recent literature (well, a decade or so, but just now getting around to the textbooks), it's been shown that surprisingly, it does have a modified system that combines aspects of the neuroglia (or glial cells) and lymphatics. It's therefore now called by a portmanteau word, the **glymphatic system.**[1][2][3][4][5] The 10th edition of my main textbook is now in press and I think it's going to be the first anatomy and physiology textbook to illustrate this.

As arteries from the meninges (particularly from the subarachnoid space) penetrate into the brain tissue, they're surrounded by fluid-filled tunnels called perivascular (or periarterial) spaces. The fluid is a combination of cerebrospinal fluid (CSF) and brain tissue (interstitial) fluid filtered through glial cells called astrocytes. Pulsations of the arteries drive this fluid along in the spaces surrounding them.

As this fluid leaves the periarterial space and washes through the brain tissue, it rinses away metabolic wastes and possibly exogenous toxins or microbes. This waste-laden fluid enters perivascular spaces around the veins that are carrying blood out of the brain and back to the subarachnoid space. From the subrachnoid space, the fluid exits by two routes—some filters into the bloodstream (via the *arachnoid granulations*that some readers here will know) and via lymphatic vessels that lead to deep lymph nodes in the neck.

Here is another author team's illustration of this system from their 2018 research article in the journal, *Magnetic Resonance in Medical Sciences.*[6] My illustrators are still working from my color drawings to render the art in digital textbook form.



The glymphatic system has two very intriguing implications.

1. The arterial pulsations that drive this fluid flow occur mainly when one is asleep. This suggests (or lends further support to) the idea that the brain clears itself of waste mostly when we're sleeping—a nocturnal "brainwashing," you might say.[7]Researchers have found that when the glymphatic system is inactivated in experimental animals (mice I think), wastes accumulate and brain function deteriorates. This is an important contribution to research on the functions of sleep.
2. Drainage of glymphatic fluid to the lymph nodes of the neck establishes an anatomical brain–immune system link, whereby the body's immune system can be kept apprised of conditions in the brain and respond effectively to anything going wrong there, like cerebral infections. Thus, discovery and elucidation of the glymphatic system is also an important contribution to the field of neuroimmunology.

Further developments along these lines will be interesting to watch. This is science at the level of the highest scientific awards. I will not be surprised to see a Nobel Prize in Physiology or Medicine for this sometime soon, but there are other equally prestigious, if not more so, scientific prizes that most people have never heard of, at least one of which already recognizes the importance of this finding.

This year's Eric K. Fernström foundation Grand Nordic Prize - one of the largest awards for medicine in Scandinavia - goes to neurology researcher Maiken Nedergaard, who works at the University of Copenhagen and the University of Rochester. She has discovered and investigated how the brain gets rid of harmful products using its own purification system, the glymphatic system- knowledge that is significant in the context of neurodegenerative diseases, among other conditions.

Footnotes

[1] The role of brain barriers in fluid movement in the CNS: is there a 'glymphatic' system? - Acta Neuropathologica

[2] https://www.iahe.com/docs/articles/brain-toxins-be-gone--the-role-of-the-glymphatic-system-revealed.pdf

[3] https://journals.sagepub.com/doi/pdf/10.1177/1073858418775027

[4] Brain's Drain: Neuroscientists Discover Cranial Cleansing System

[5] Scientists Discover Previously Unknown Cleansing System in Brain

[6] (PDF) Gadolinium-based Contrast Media, Cerebrospinal Fluid and the Glymphatic System: Possible Mechanisms for the Deposition of Gadolinium in the Brain

[7] Deep Sleep Gives Your Brain a Deep Clean