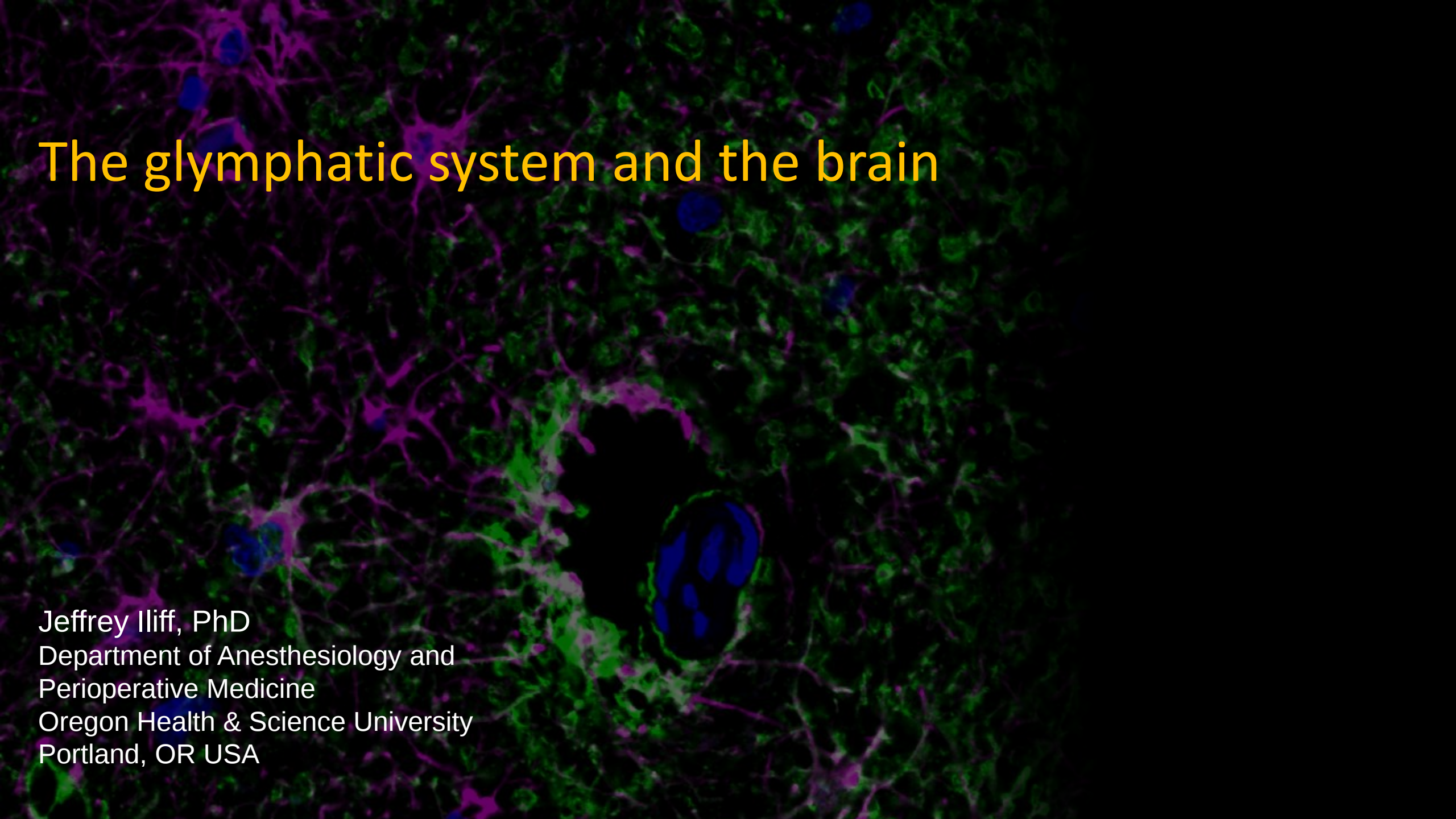




The glymphatic system and the brain

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Galen of Pergamon
AD 150



Galen of Pergamon
AD 150



Leo Errera
AD 1887

“All work, muscular or cerebral, produces waste products. These accumulate, make work more and more difficult: this is fatigue. As the process continues, the waste-products, notably the *leucomaines*, intoxicate the higher nerve-centers, and render them incapable of action: that is sleep...From here on, the *leucomaines* are gradually eliminated and destroyed...In short, fatigue is a poison for which sleep is the normal antidote.”

‘Why do we sleep,’ *Science* 1887

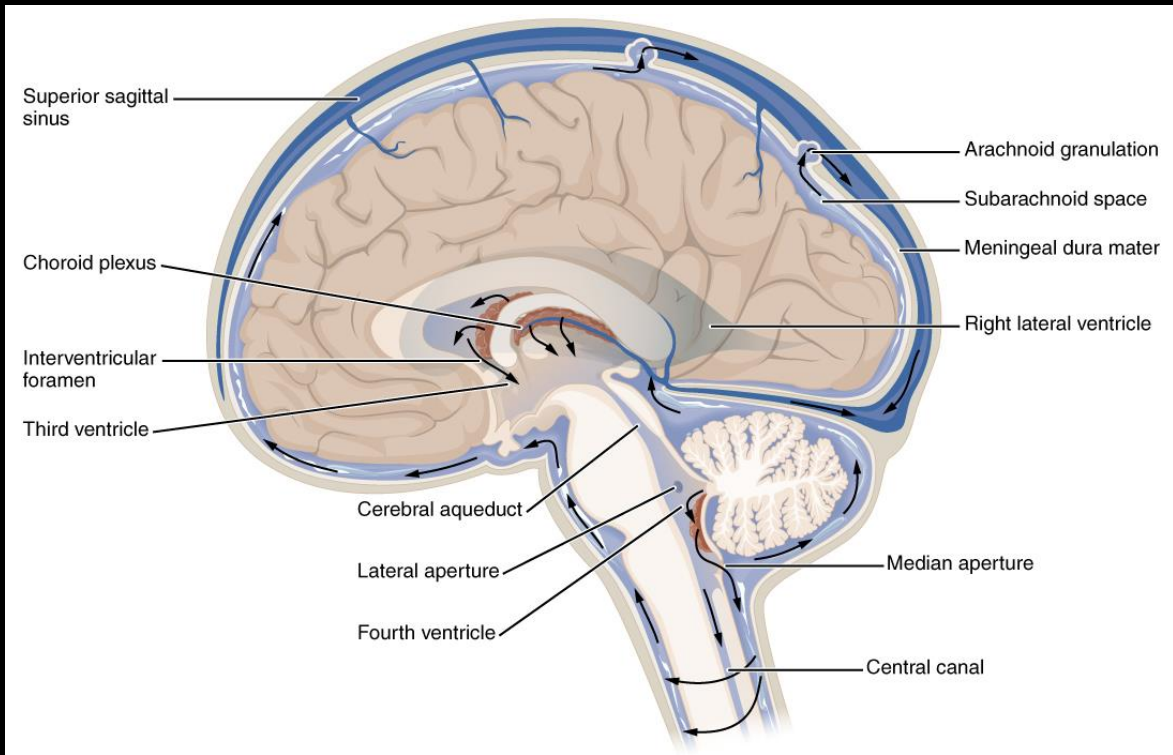


Leo Errera
AD 1887

waste clearance



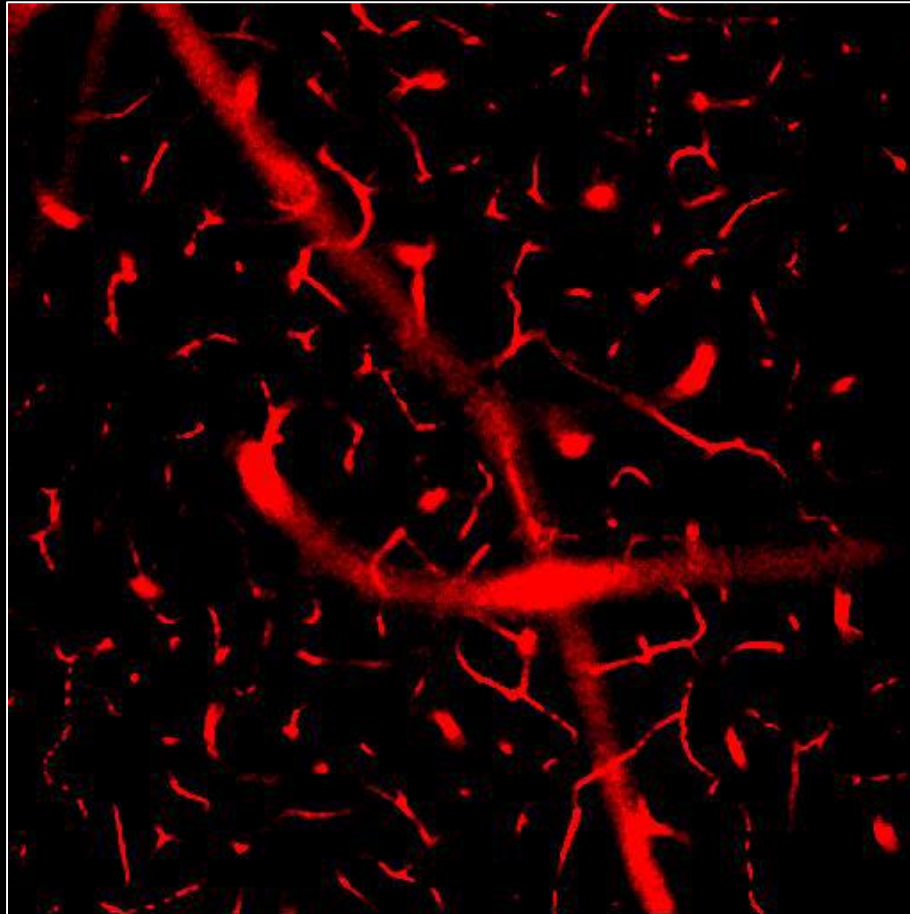
cerebrospinal fluid (CSF) circulation

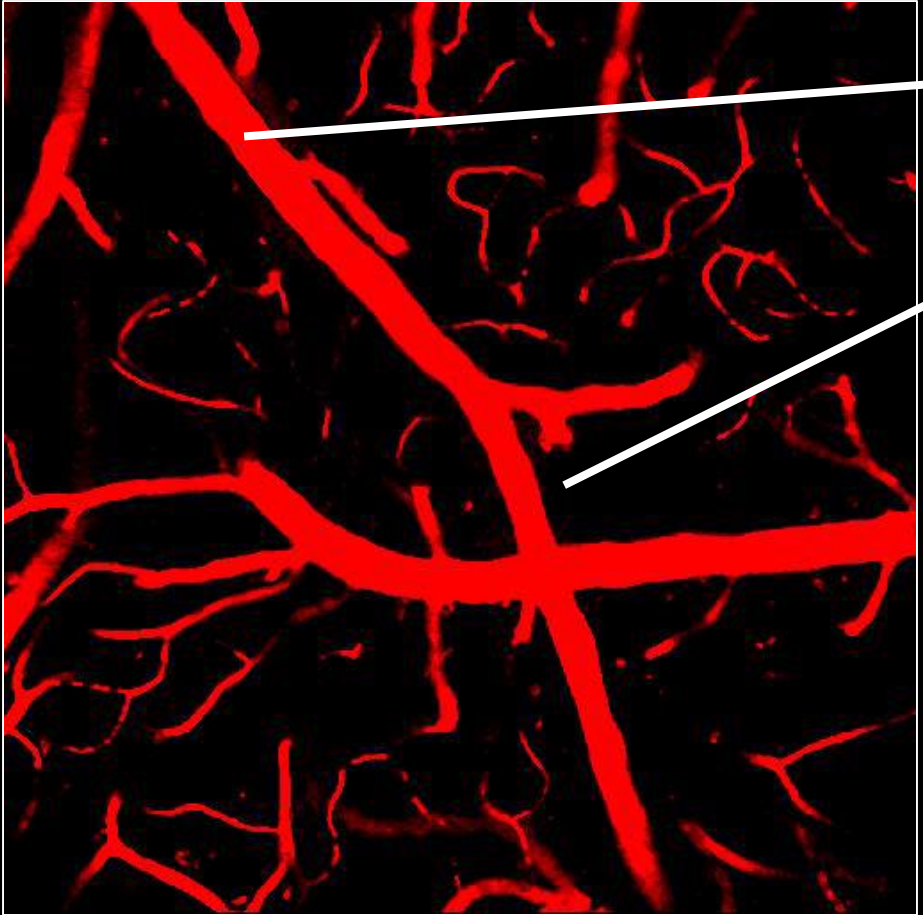


Blood Vessels

... and inside the brain

Imaging at the brain surface





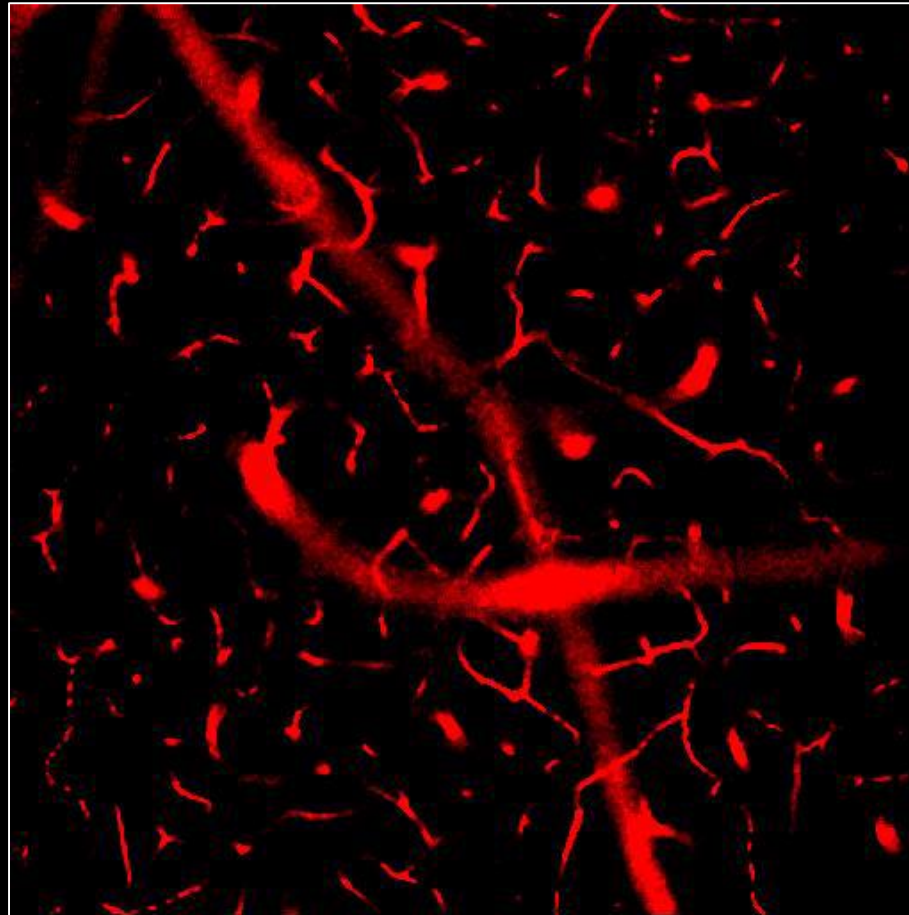
Blood Vessels

This fluorescence micrograph shows a dense network of red-stained blood vessels at the brain surface. Two white lines originate from the text labels 'Blood Vessels' and 'Cerebrospinal Fluid (CSF)' and point to specific vessels and the surrounding space, respectively.

Cerebrospinal Fluid
(CSF)

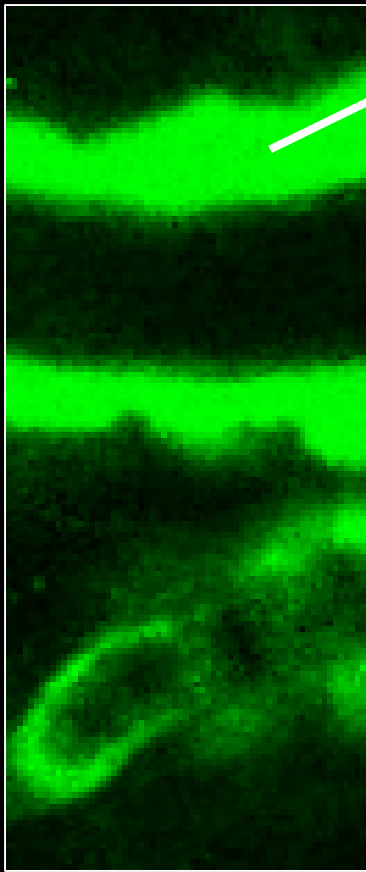
... and inside the brain

Imaging at the brain surface





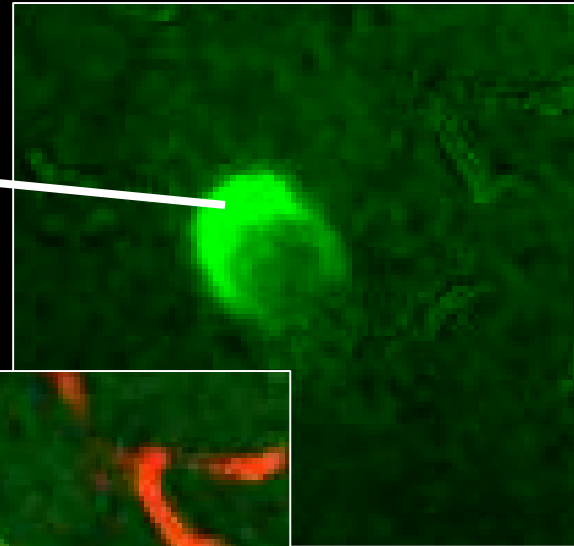
Blood Vessels



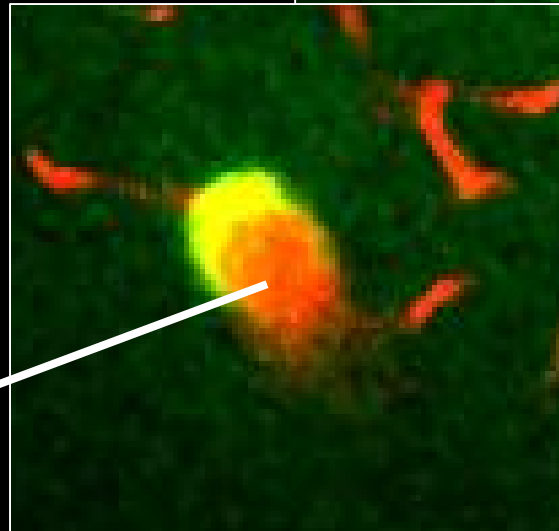
CSF

Imaging at the brain surface

... and inside the brain

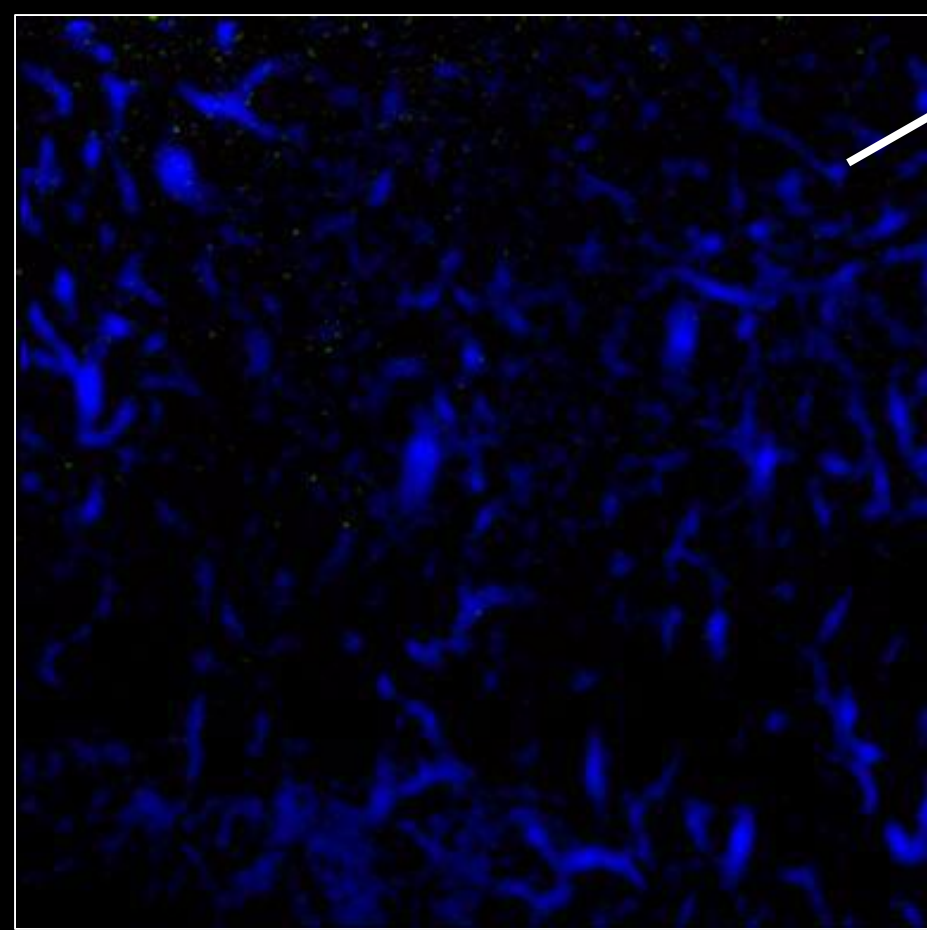


CSF



Blood Vessels

Blood Vessels



Imaging the waking brain

Blood Vessels

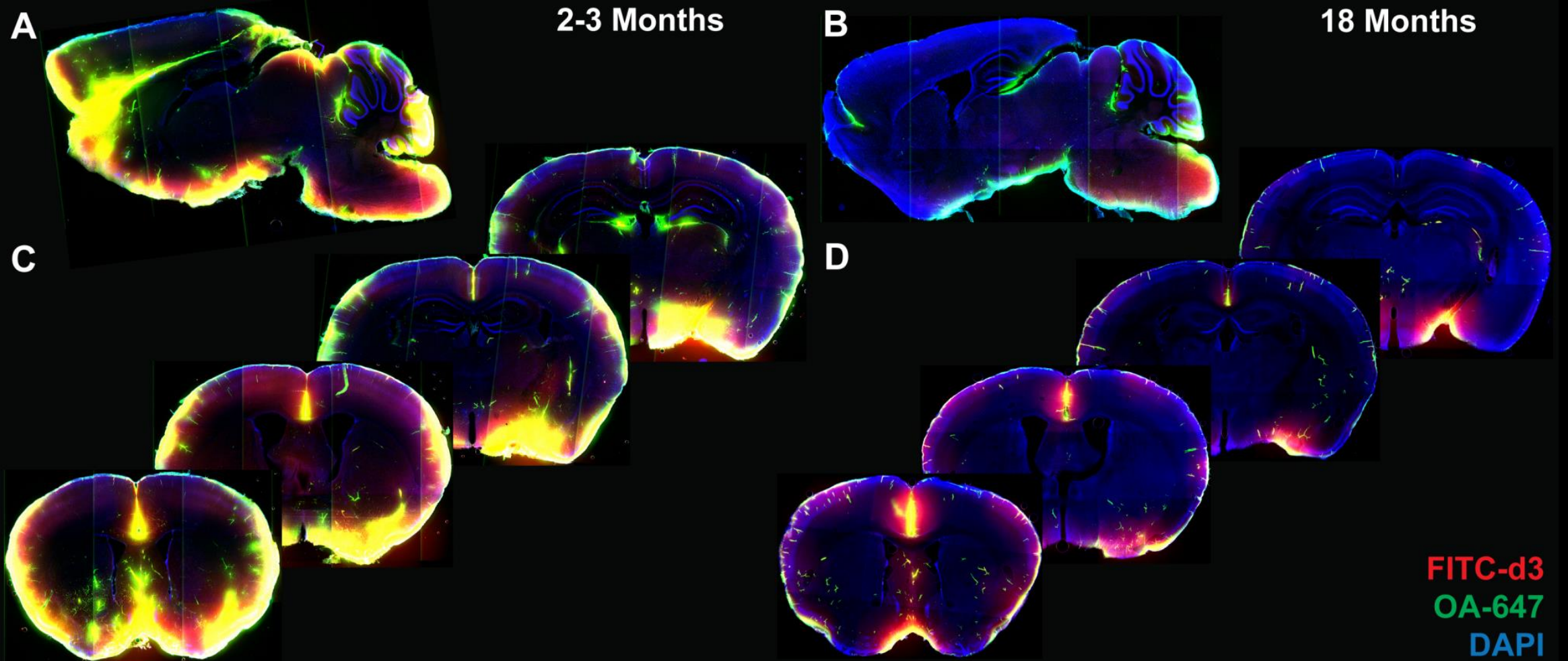
... and after it falls asleep

Imaging the waking brain

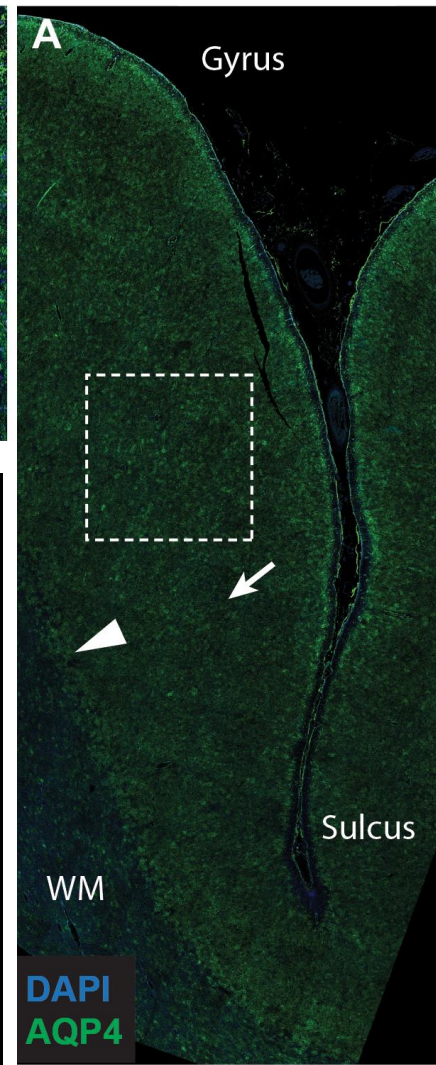
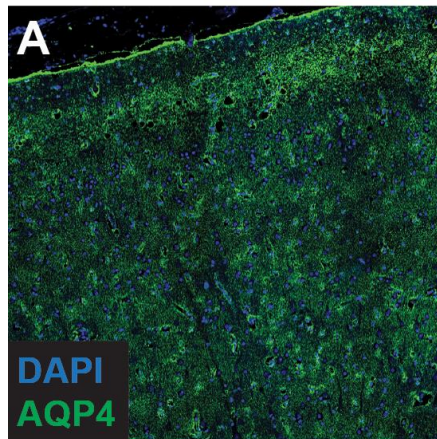
Blood Vessels

CSF

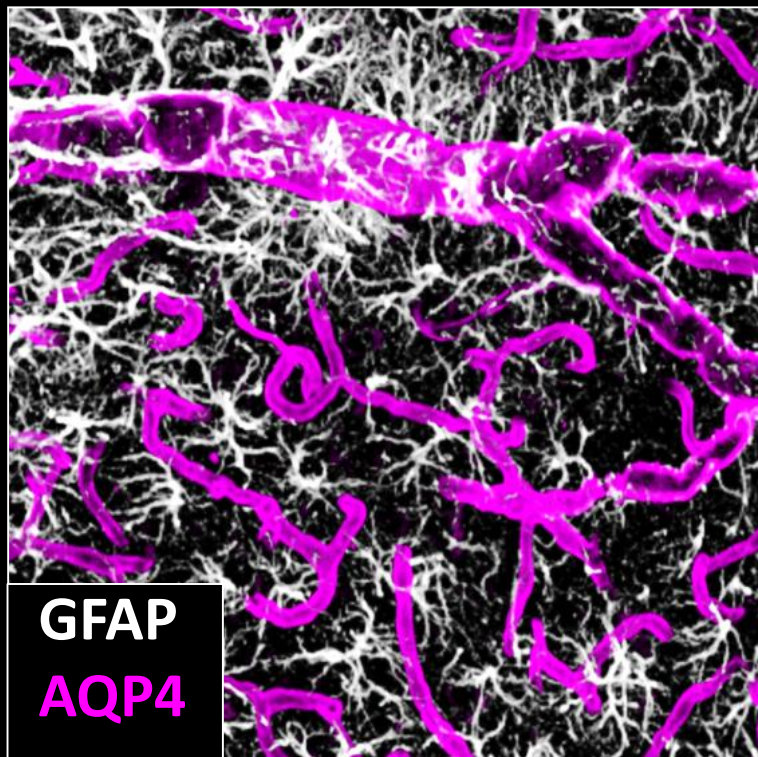
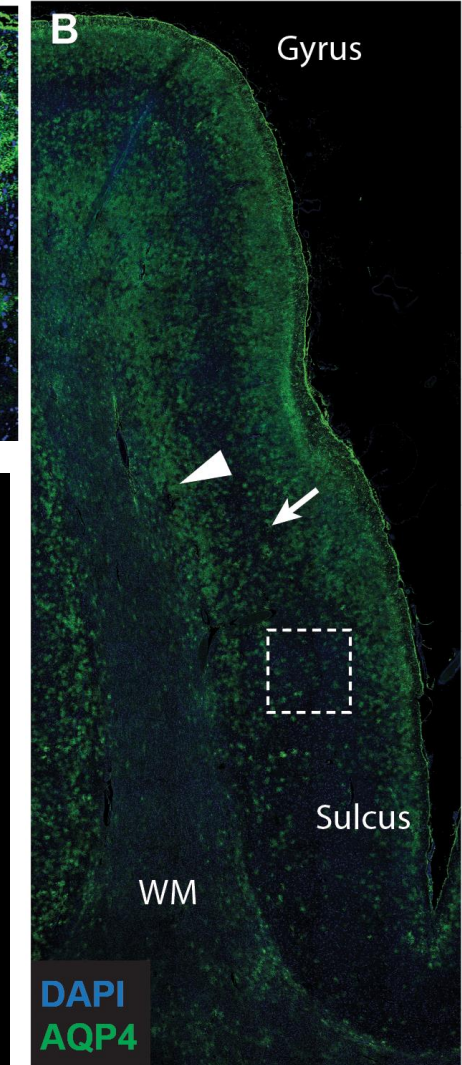
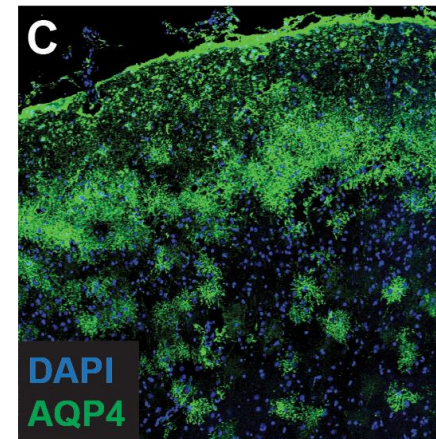




Young (25-45yrs)



Aged (60-85yrs)



Zeppenfeld et al.
JAMA Neurol 2016

Adapted from Simard et al. *J Neurosci* 2003



>7hrs 6-7hrs <6hrs

