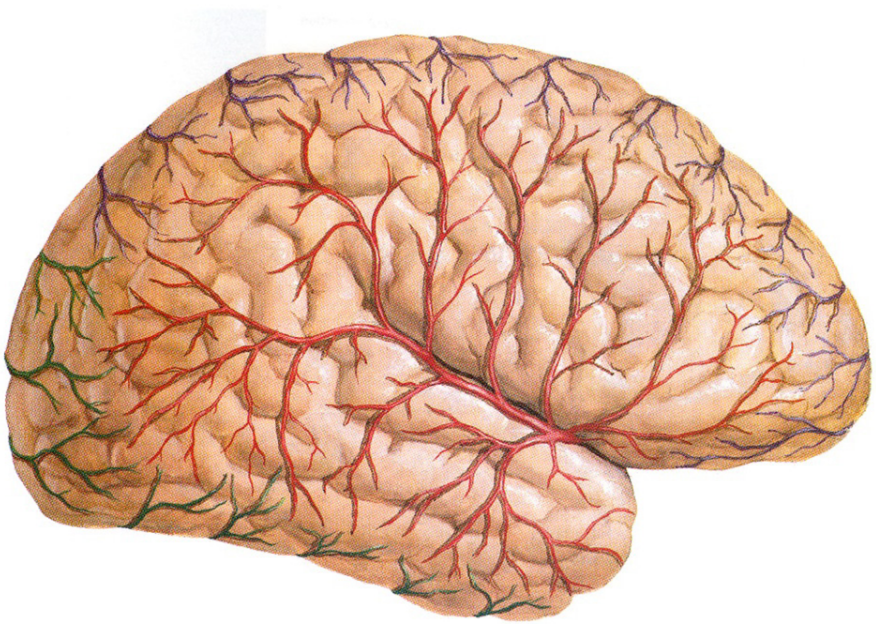
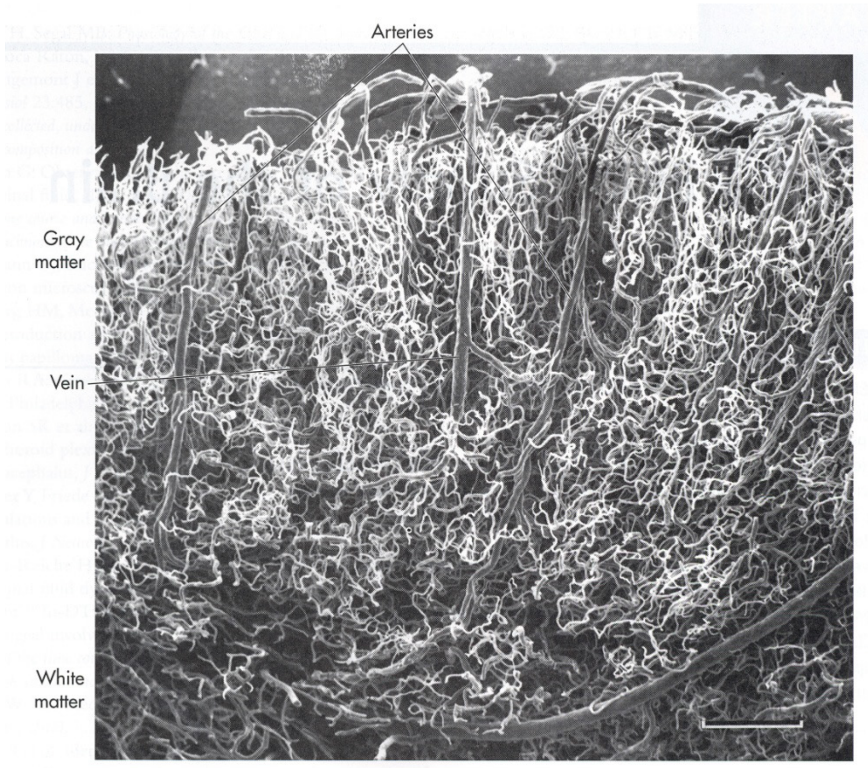
Circulation and Stroke

Blood and the Brain

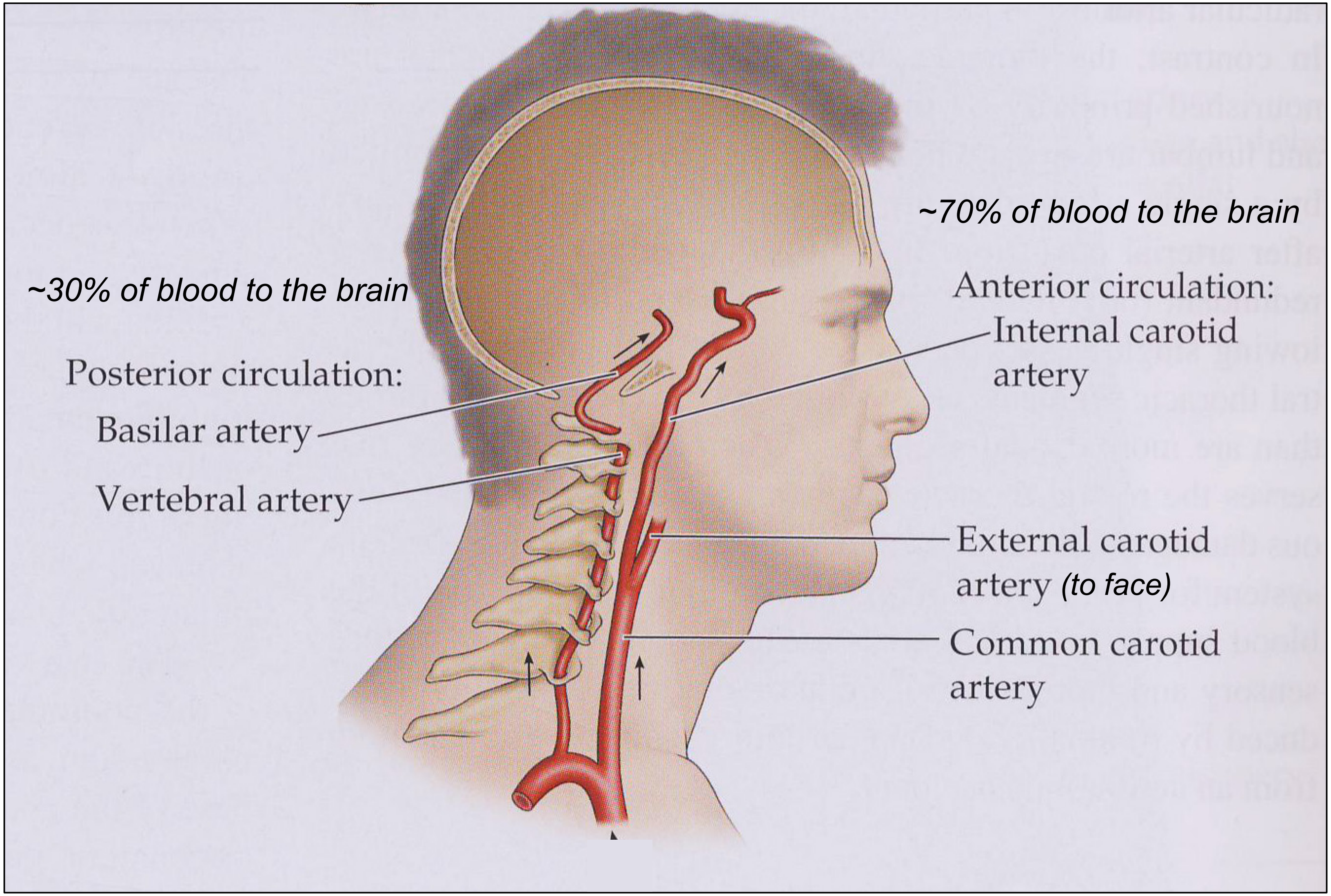
The brain is only **2%** of body weight; however, it receives **15%** of the cardiac output.

Gray matter requires **~4** times as much blood flow as white matter.



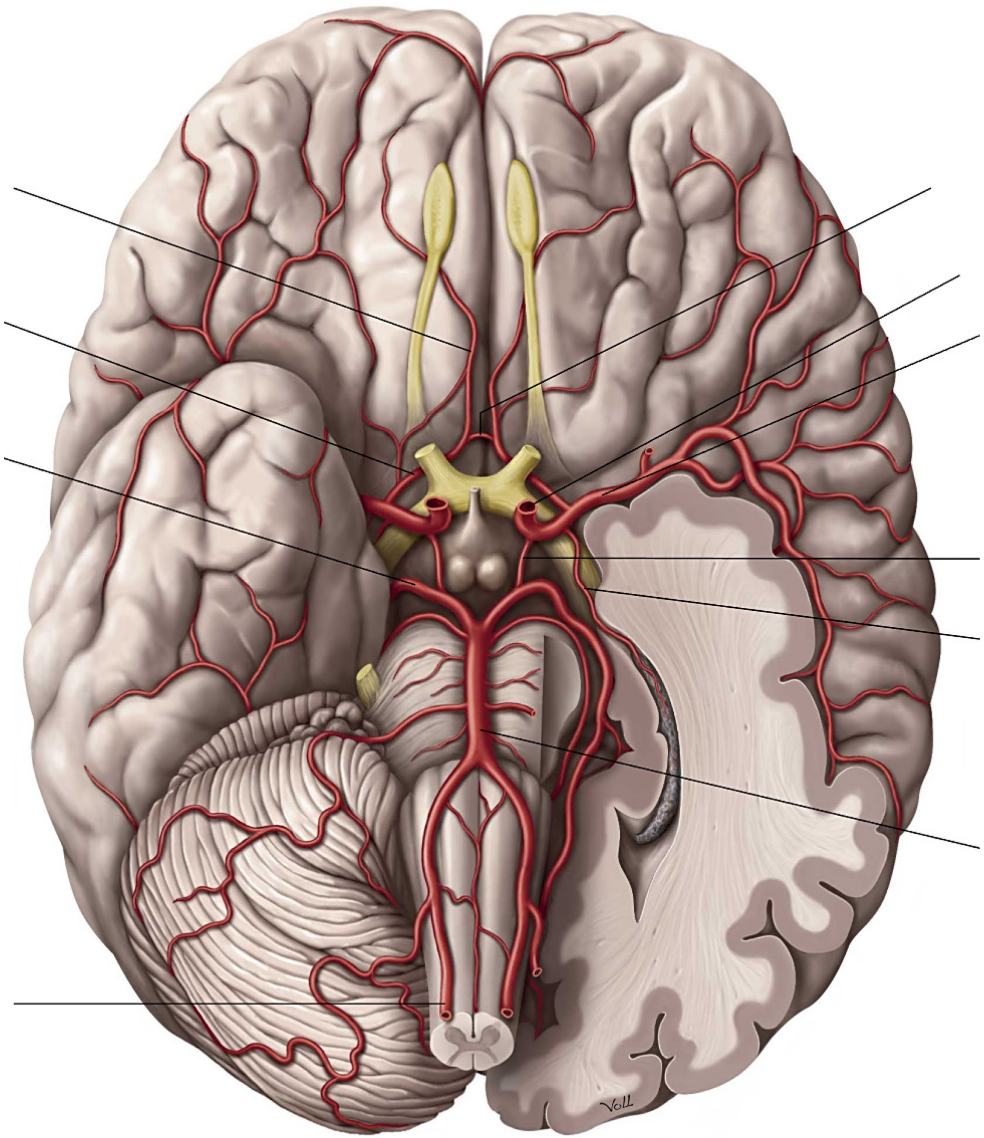


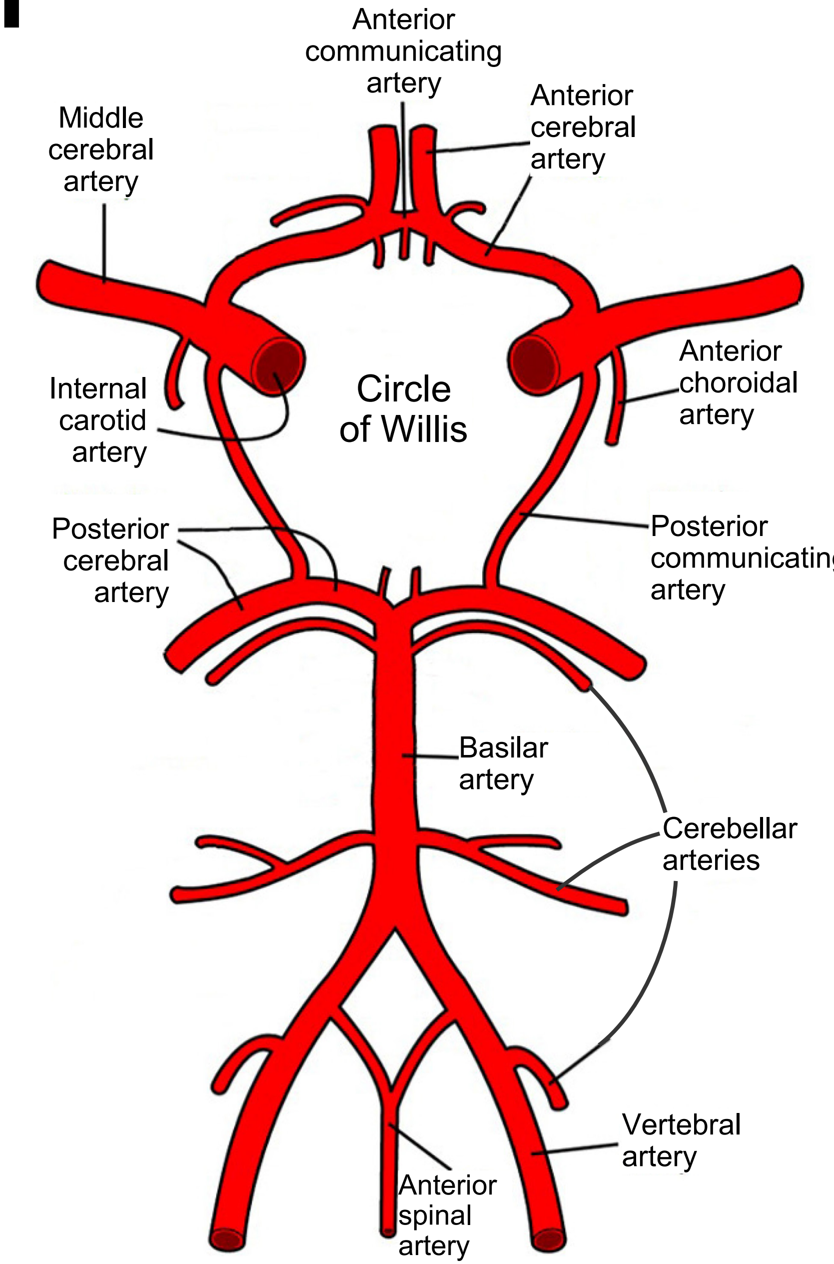
Two Routes to the Cranium



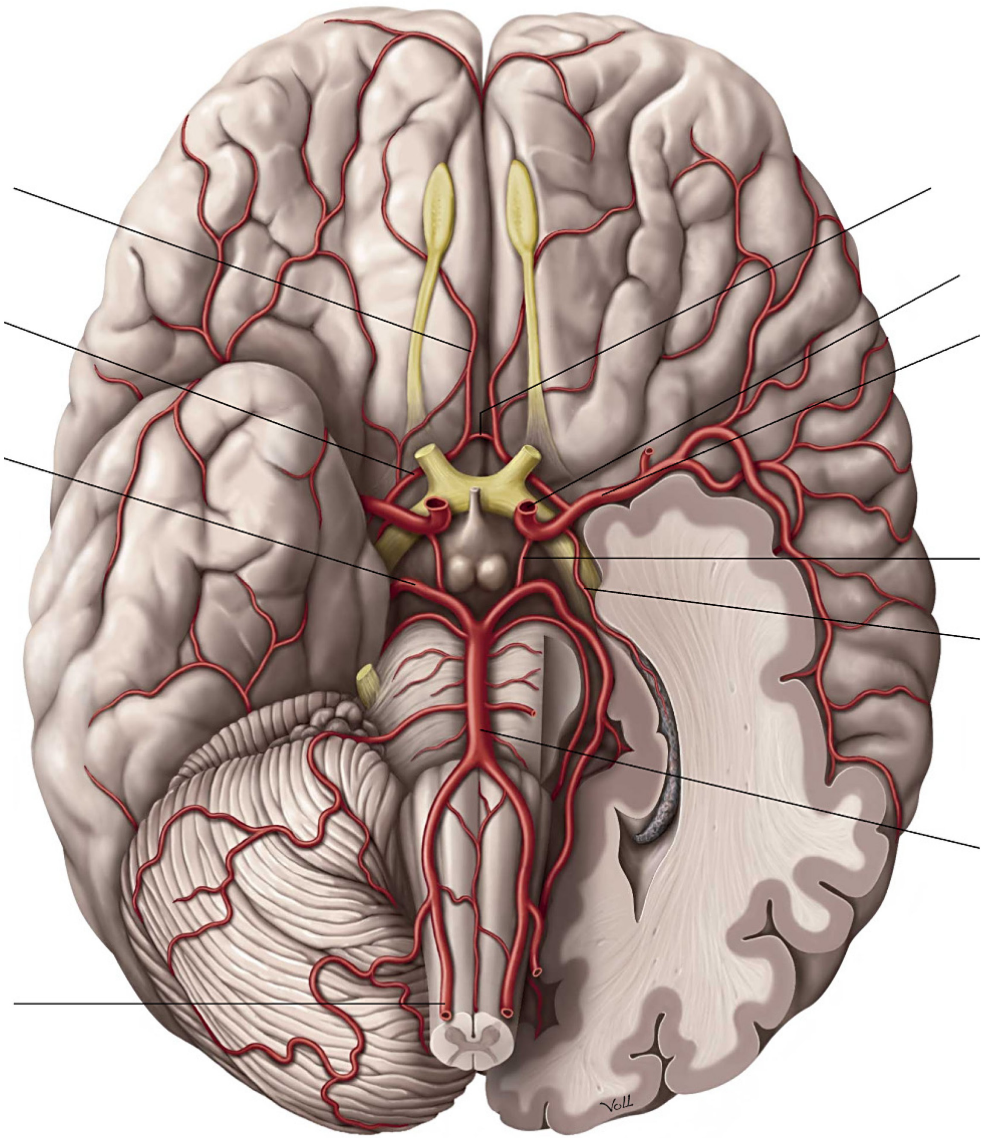
Both routes bring blood to the Circle of Willis at the base of the brain

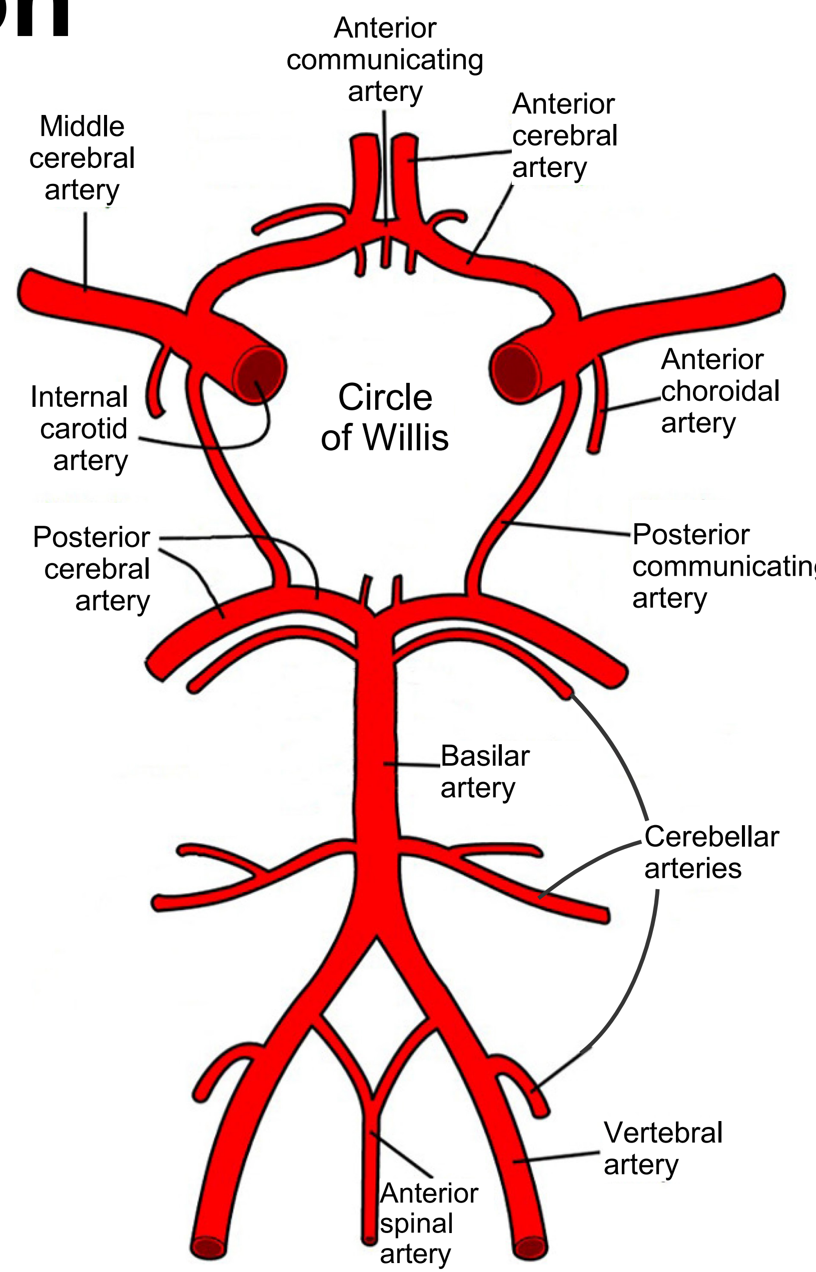
Anterior Circulation





Posterior Circulation





Major Cerebral Arteries

Anterior Cerebral Artery (ACA)

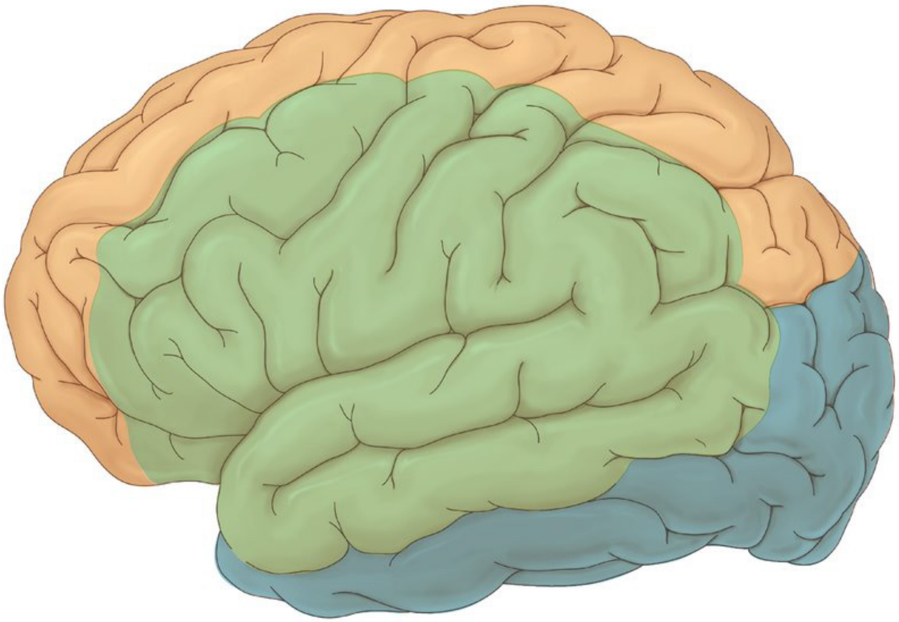
- Medial frontal and parietal lobes
- Inferior frontal lobe
- Most of the corpus callosum

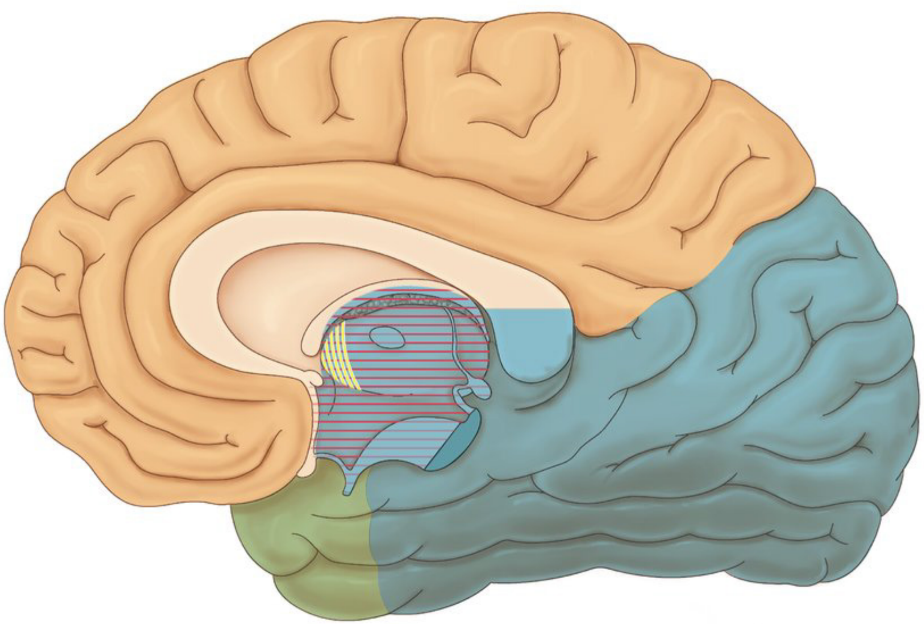
Middle Cerebral Artery (MCA)

- Lateral frontal, parietal, and temporal lobes ("convexity" of the cortex)
- Insula

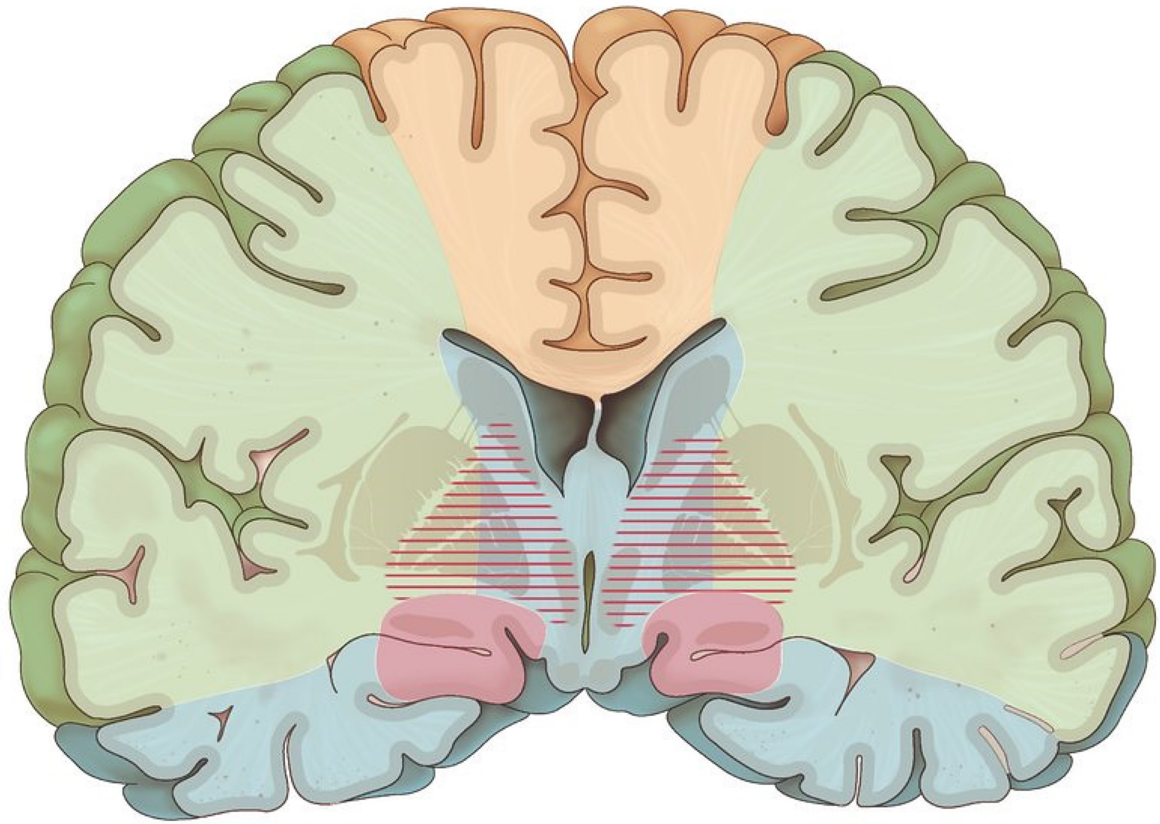
Posterior Cerebral Artery (PCA)

- Occipital lobe
- Inferior temporal lobe
- Posterior corpus callosum





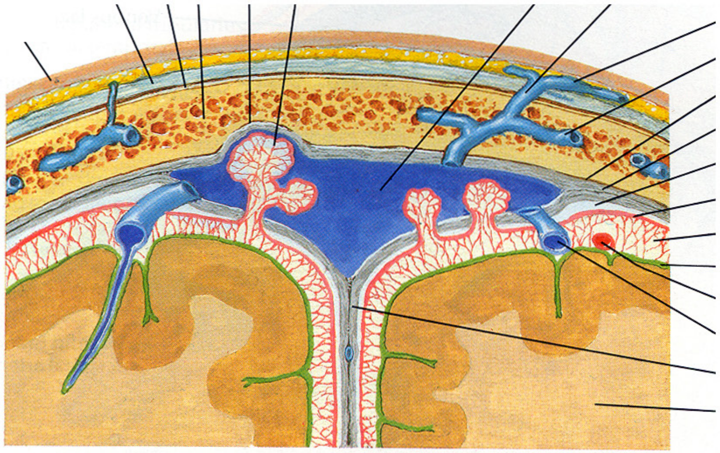
Major Cerebral Arteries

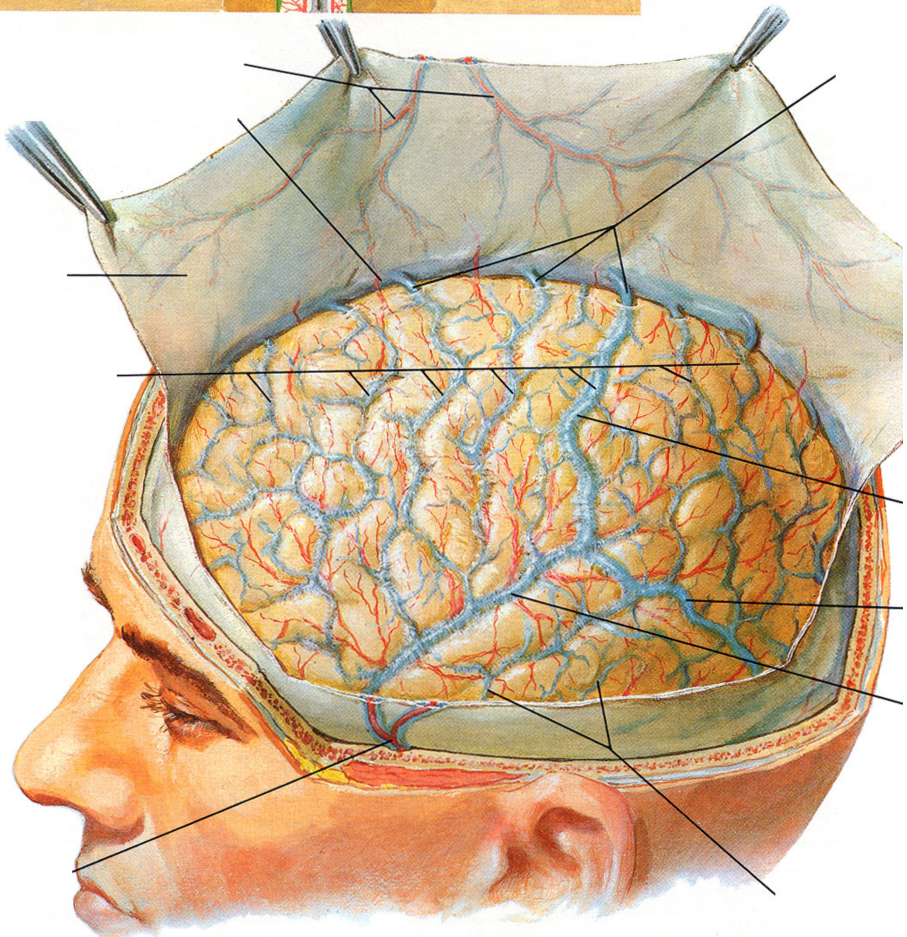


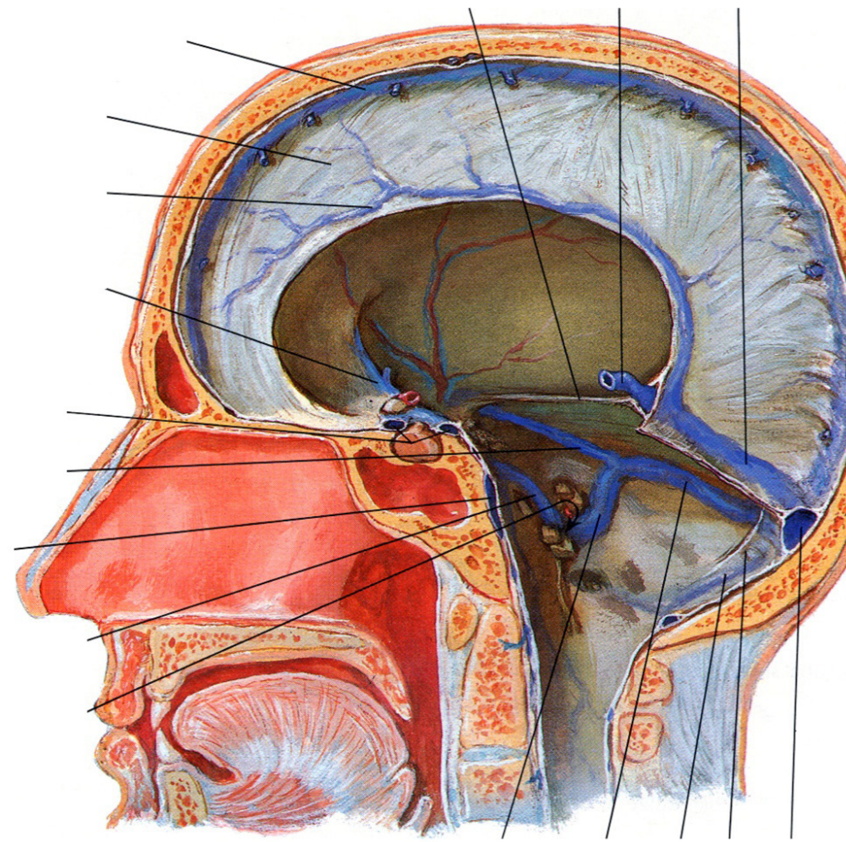
- Anterior cerebral artery
- Middle cerebral artery
- Posterior cerebral artery
- Anterior choroidal artery
  - Anterior choroidal artery Partially supplied

(hippocampus, amygdala, internal capsule, globus pallidus, choroid plexus)

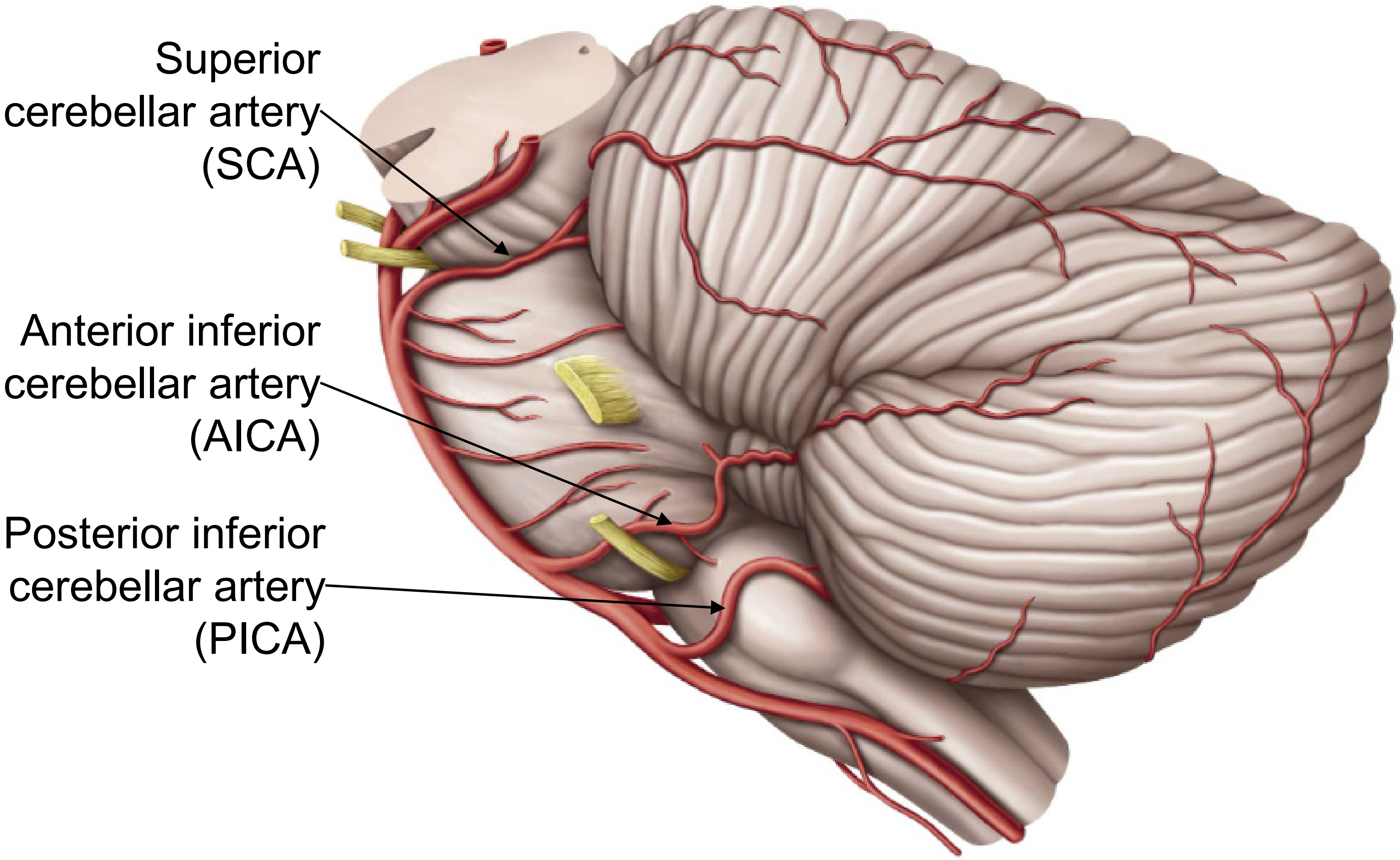
Venous Drainage of the Brain



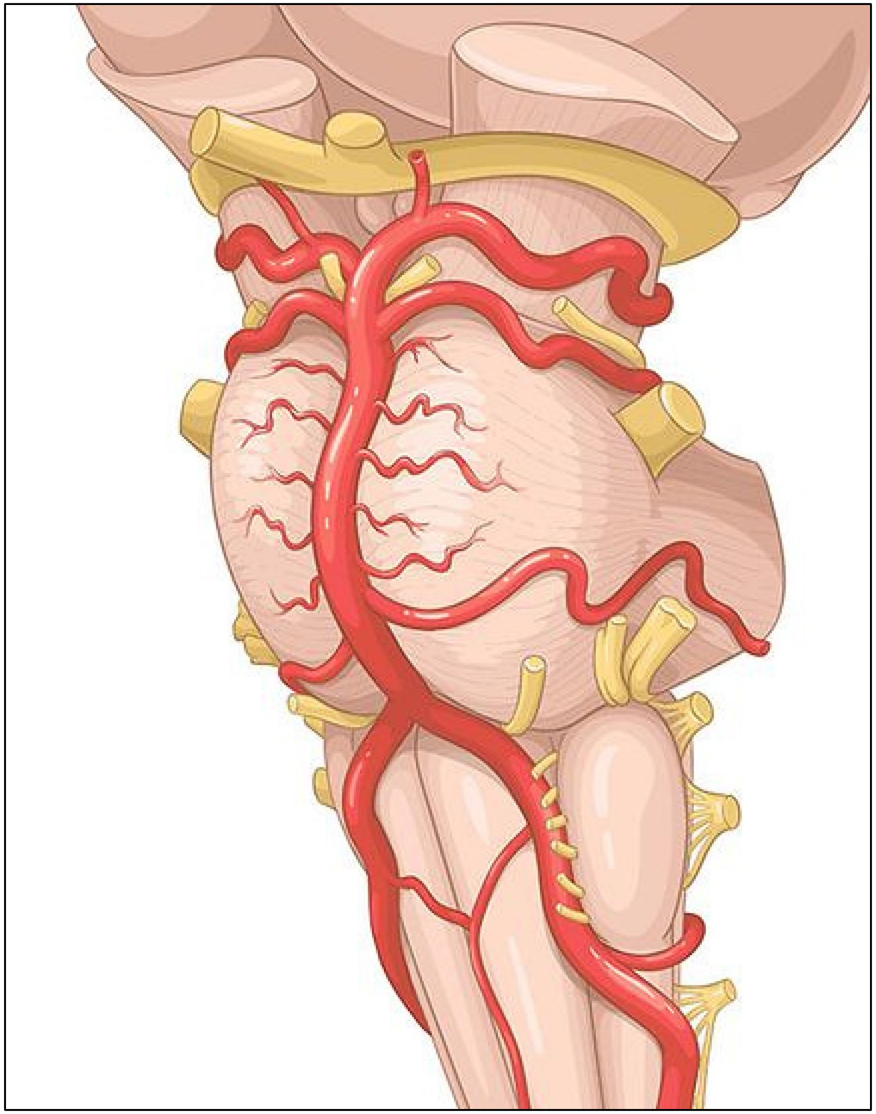




Cerebellar Arteries



Brainstem Blood Supply



Midbrain

- Basilar artery
- Posterior cerebral artery (PCA)
- Superior cerebellar artery (SCA)

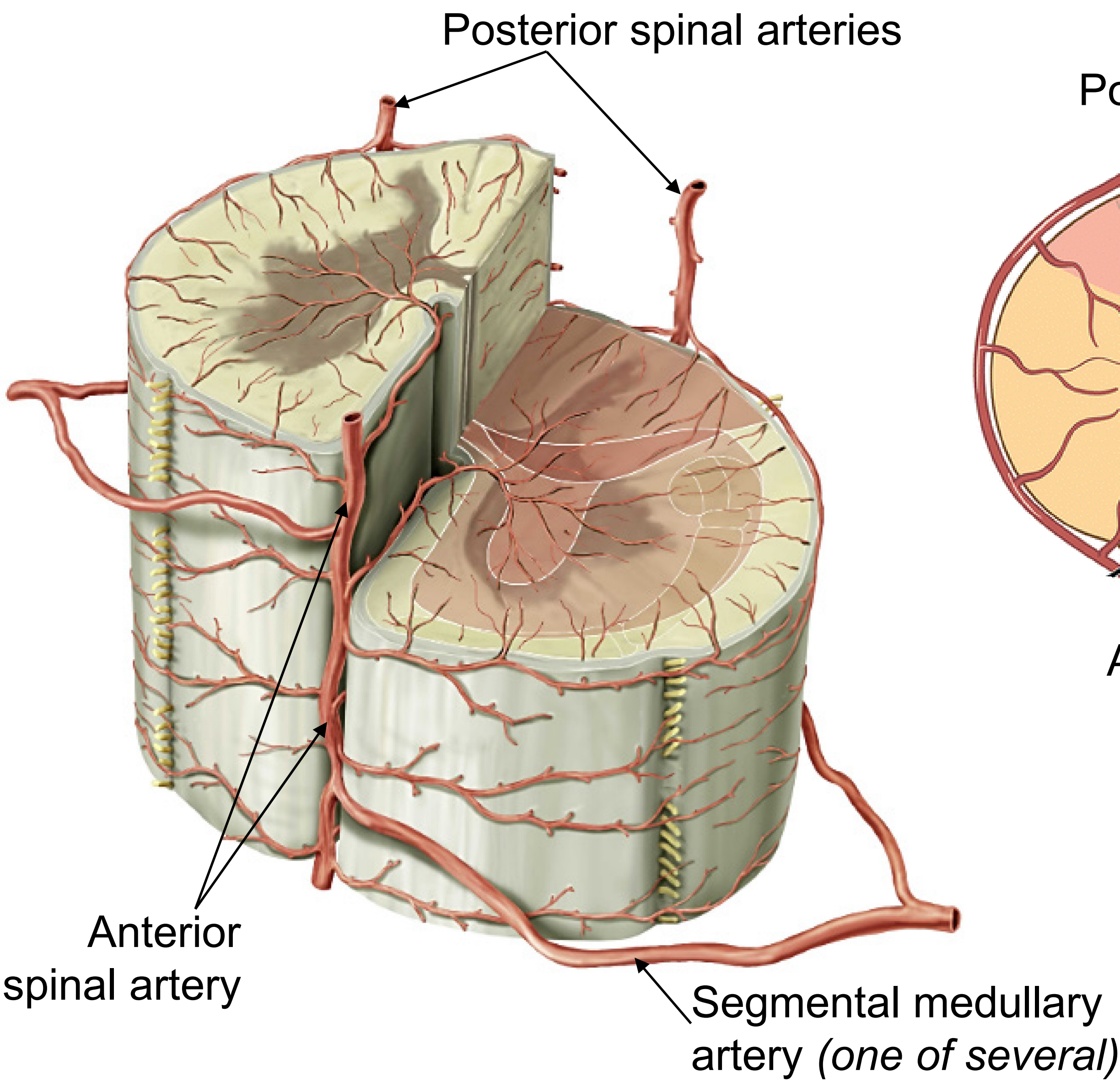
Pons

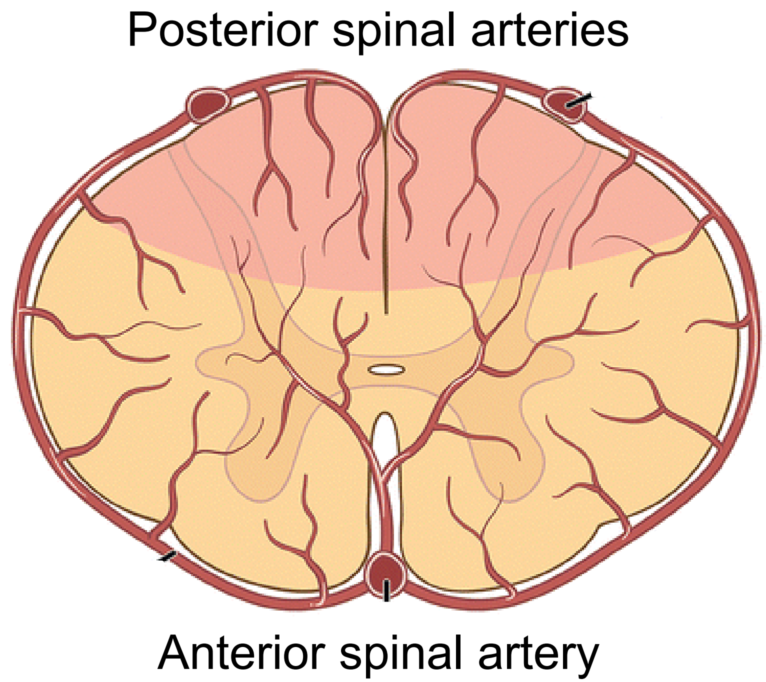
- Basilar artery
- Superior cerebellar artery (SCA)
- Anterior inferior cerebellar artery (AICA)

Medulla

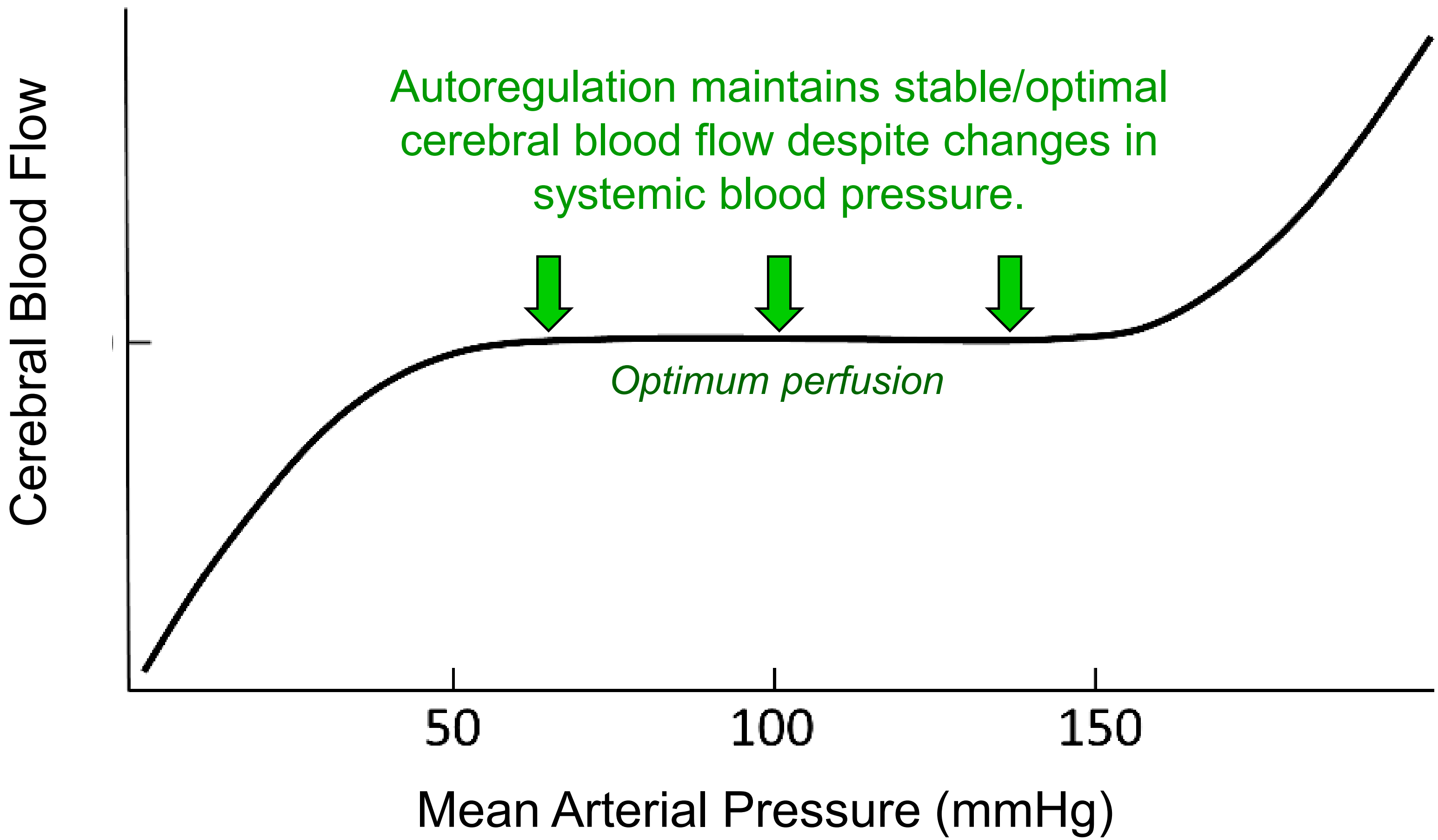
- Vertebral artery
- Posterior inferior cerebellar artery (PICA)
- Anterior spinal artery
- Posterior spinal artery *(not visible)*

Spinal Cord Arteries





Autoregulation of Cerebral Blood Flow

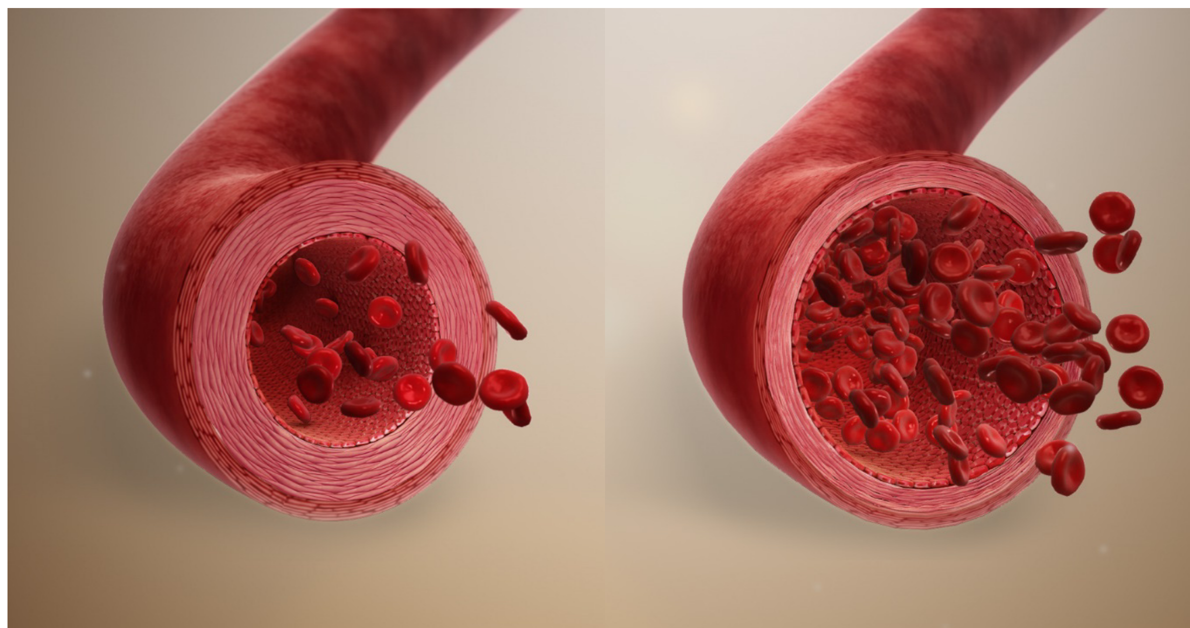


Autoregulation of Cerebral Blood Flow

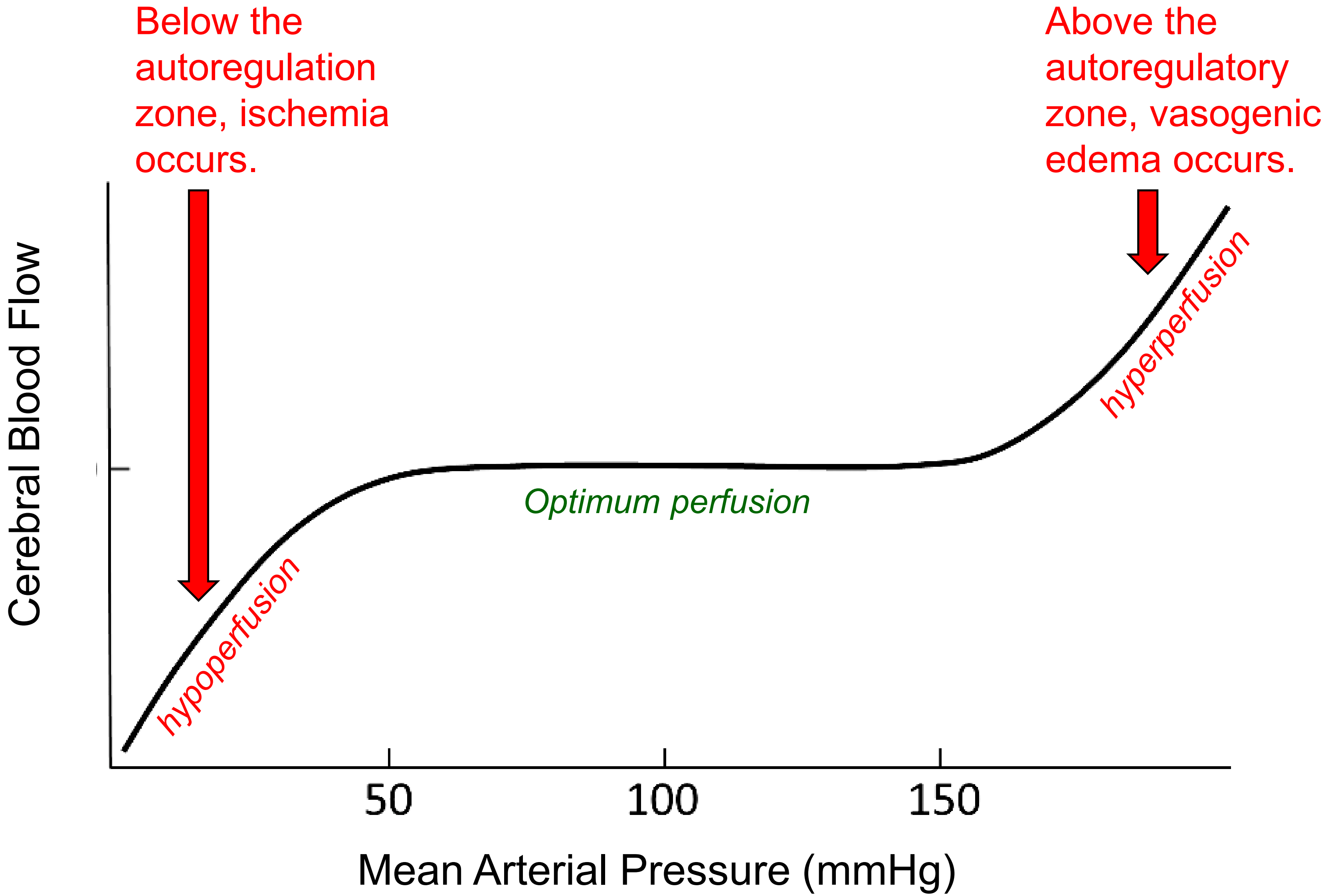
The goal of brain arterioles is to keep blood flow constant (750-1000 ml/min)

Global brain arteriole responses to changes in systemic blood pressure

- When systemic blood pressure rises, brain arterioles ____________ to keep blood flow constant
- When systemic blood pressure falls, brain arterioles ____________ to keep blood flow constant



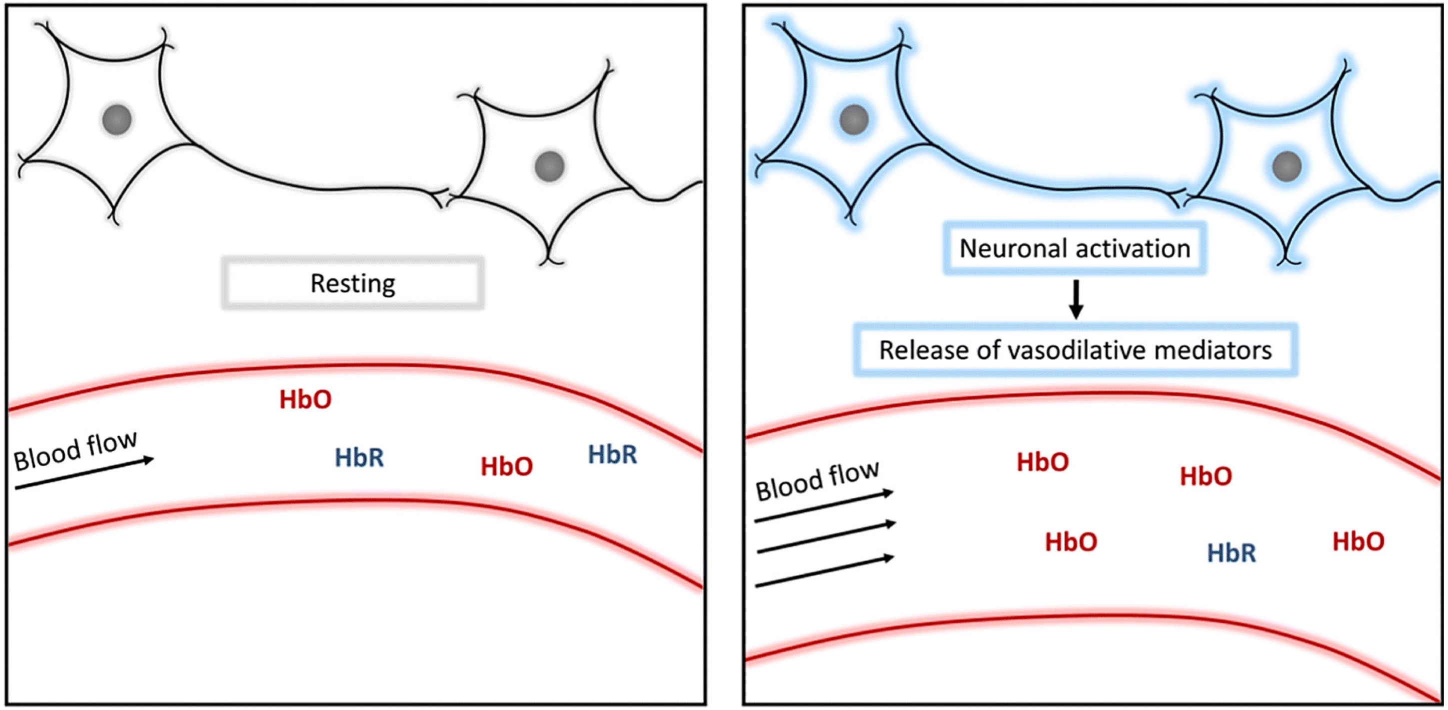
Autoregulation of Cerebral Blood Flow



Neurovascular Coupling

- Neurovascular coupling adjusts blood flow to meet the needs to active or inactive neurons

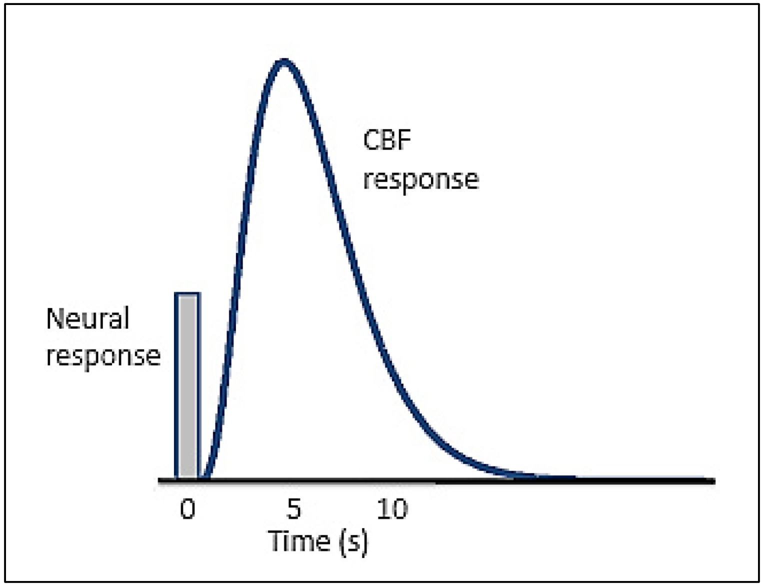
- Active neurons release multiple vasoactive signals
  - CO_2 becomes carbonic acid, decreasing pH
  - Nitric oxide (NO)
  - Adenosine
  - Prostaglandins

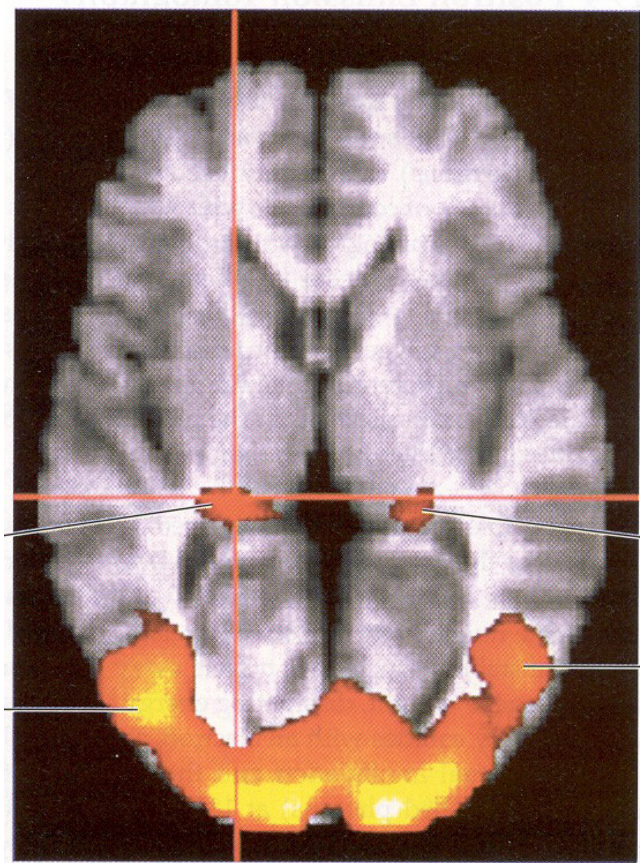


Neurovascular Coupling

Local brain arteriole responses to changes in environment

- Conditions of high CO_2, low pH, high vasoactive signals cause local arterioles to ___________
- Conditions of low CO_2, high pH, and low vasoactive signals cause local arterioles to ___________

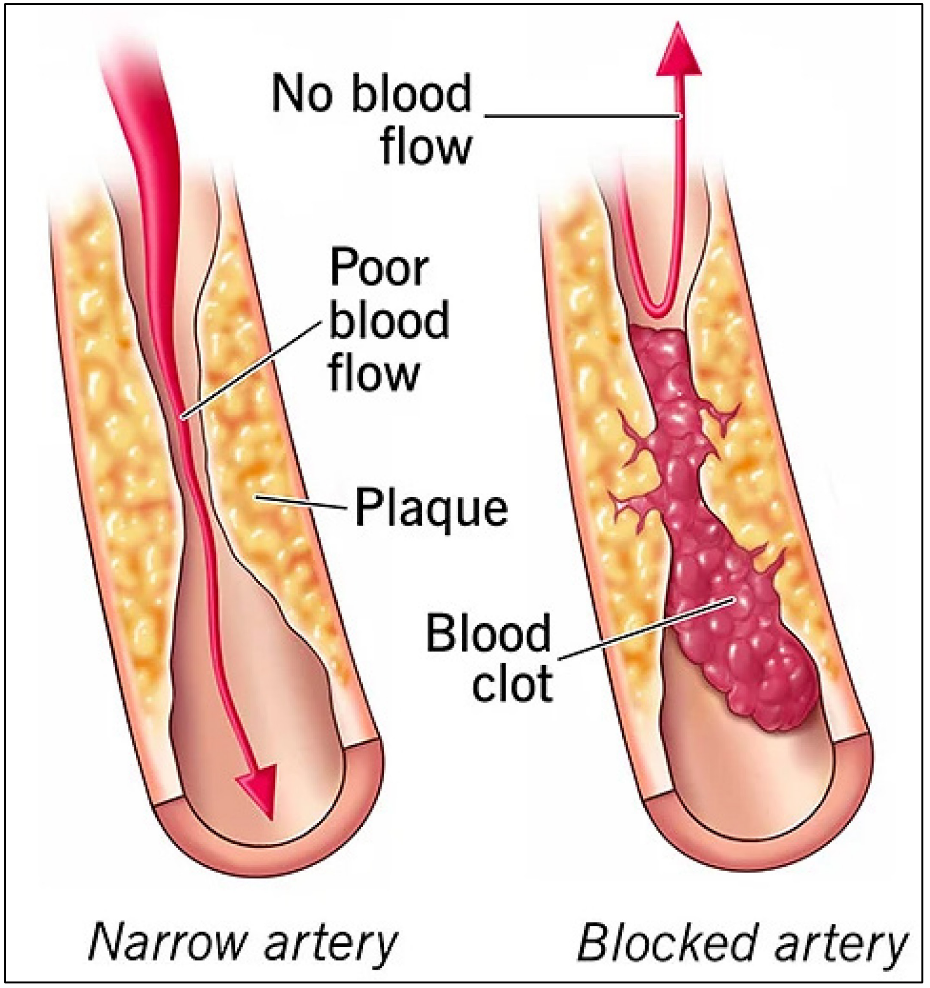




Neurovascular coupling is the basis of functional MRI imaging

Occlusive Stroke

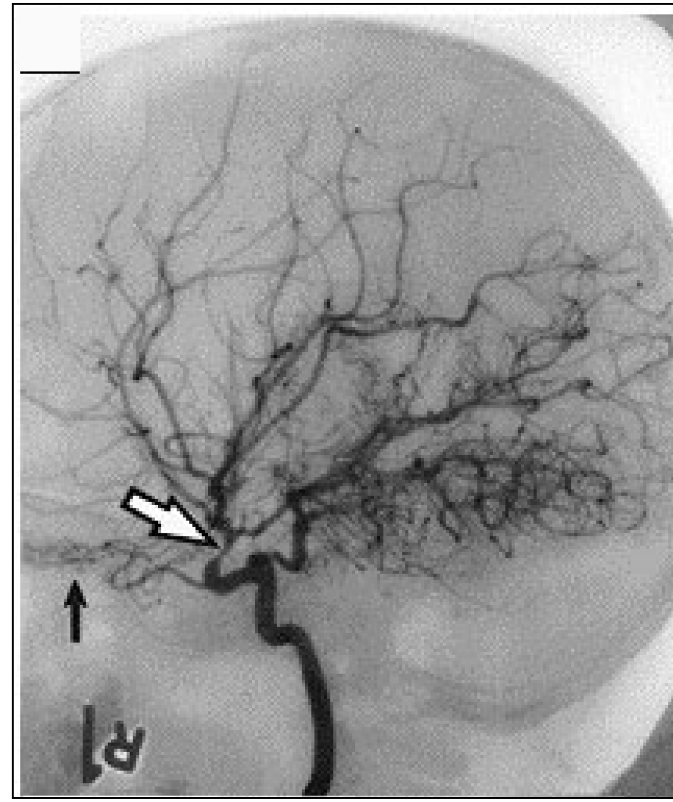
- Most common type of stroke
- Brain blood vessel is narrowed or blocked, severely reducing blood flow (ischemia)
- Causes
  - Atherosclerosis (fatty plaque buildup that narrows the blood vessel lumen)
  - Thrombus or embolus (blood clots)

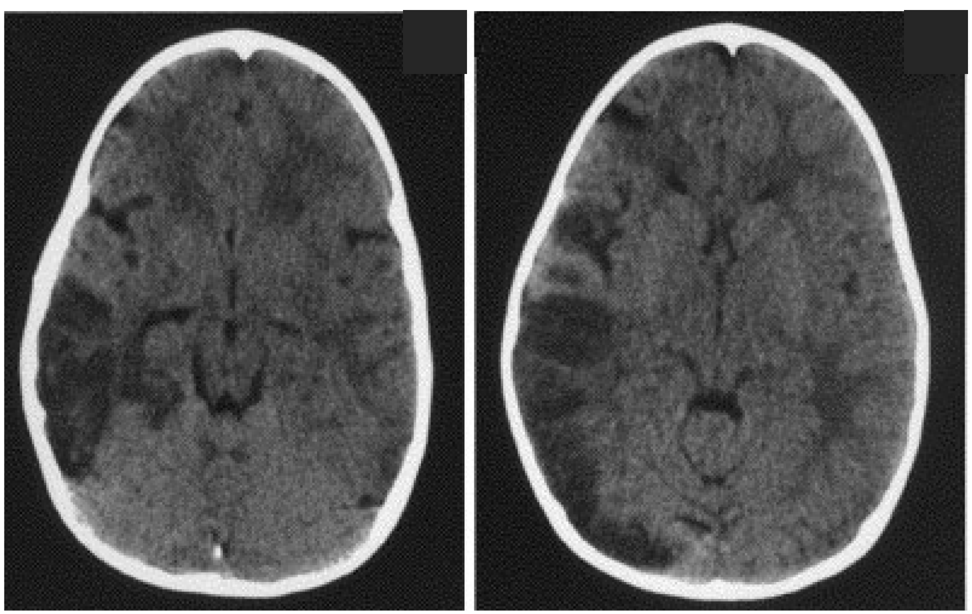


Occlusive Stroke

Treatment

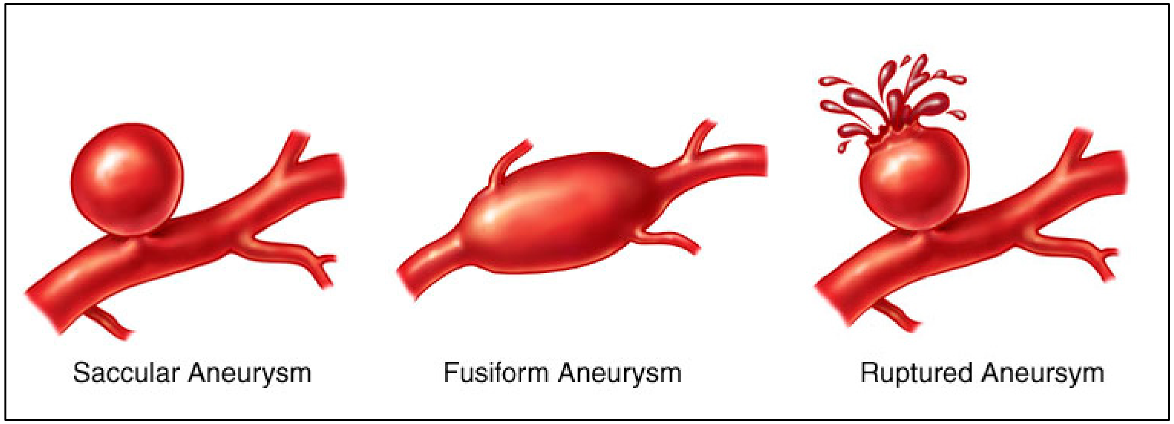
- Tissue plasminogen activator (tPA) dissolves clots to restore blood flow, must be given within first three hours
- Surgery to physically remove the clot or widen the blood vessel lumen
- Blood thinners

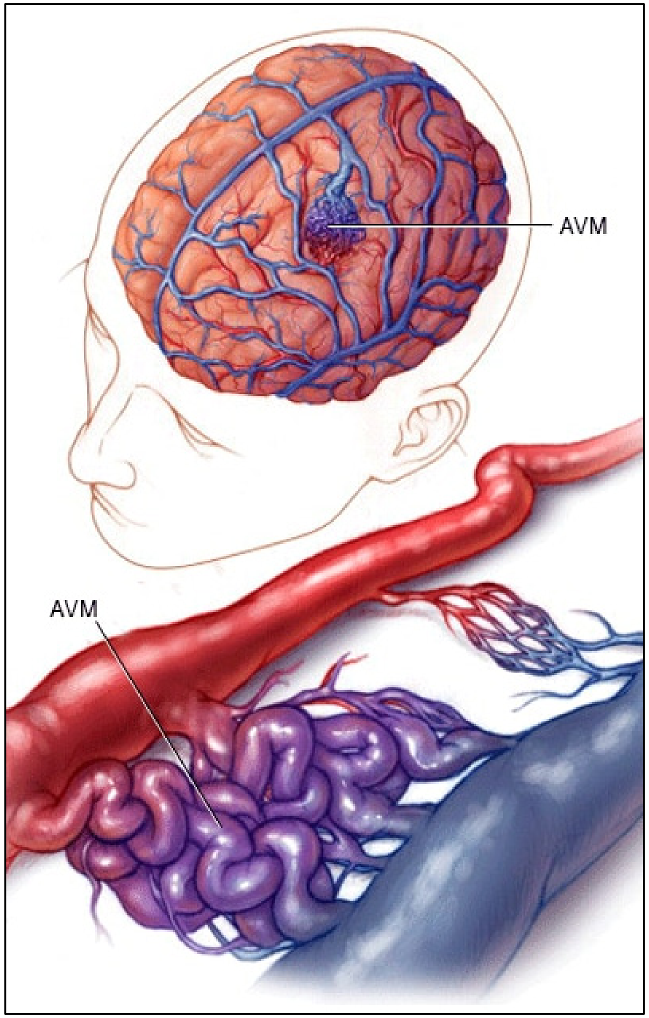




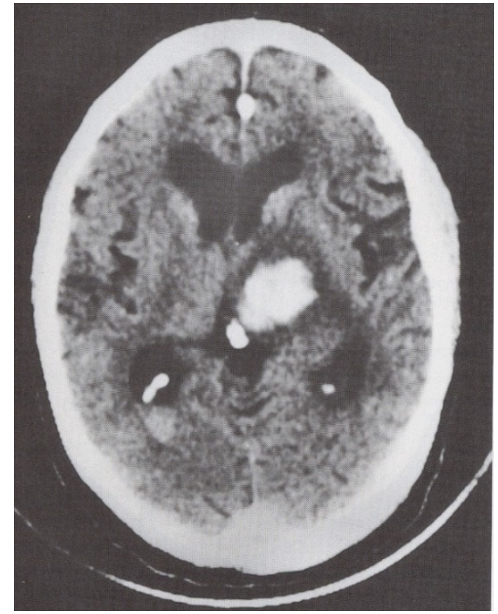
Hemorrhagic Stroke

- Brain blood vessel leaks or ruptures
- Causes
  - Hypertension (high blood pressure)
  - Aneurysm (weakened blood vessel wall that has ballooned out)
  - Arteriovenous malformation (blood vessel tangle)
  - Trauma (such as a car accident)



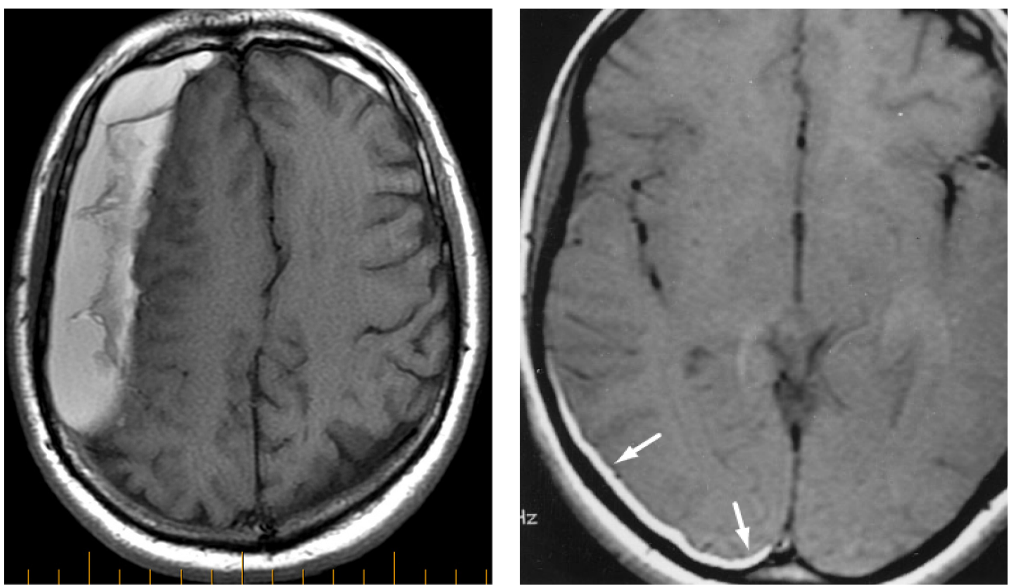


Hemorrhagic Stroke

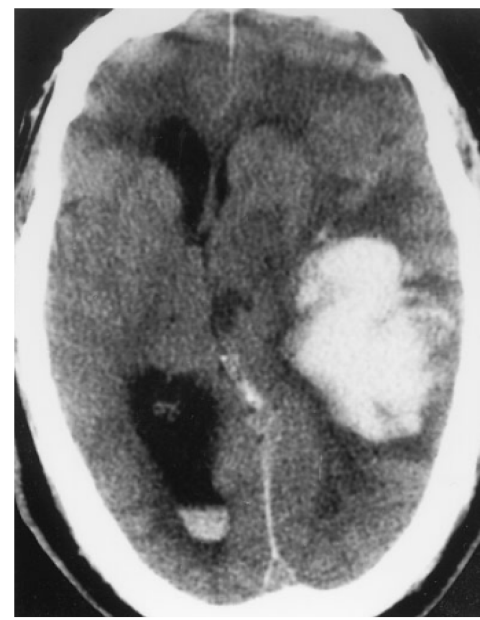


Treatment

- Surgery to stop the bleeding, remove the blood, and repair the cause
- Reduce blood pressure with medication



Extraparenchymal



Intraparenchymal

Cellular Mechanisms of Stroke

Occlusion, hemorrhage, or hypoperfusion

Ischemia and Anoxia

Loss of oxidative phosphorylation

Calcium enters neighboring neurons. High calcium levels shut down mitochondria

Loss of ATP

Cytoskeletal breakdown

Glutamate binds to AMPA and NMDA receptors on neighboring neurons.

Na+/K+ pumps shut down. Na+ accumulates inside the neuron.

Glutamate is released as cells depolarize.

Osmotic swelling (cytotoxic edema)

Activation of 2nd messengers

Enzymes damage DNA, proteins and lipids

Cell Death