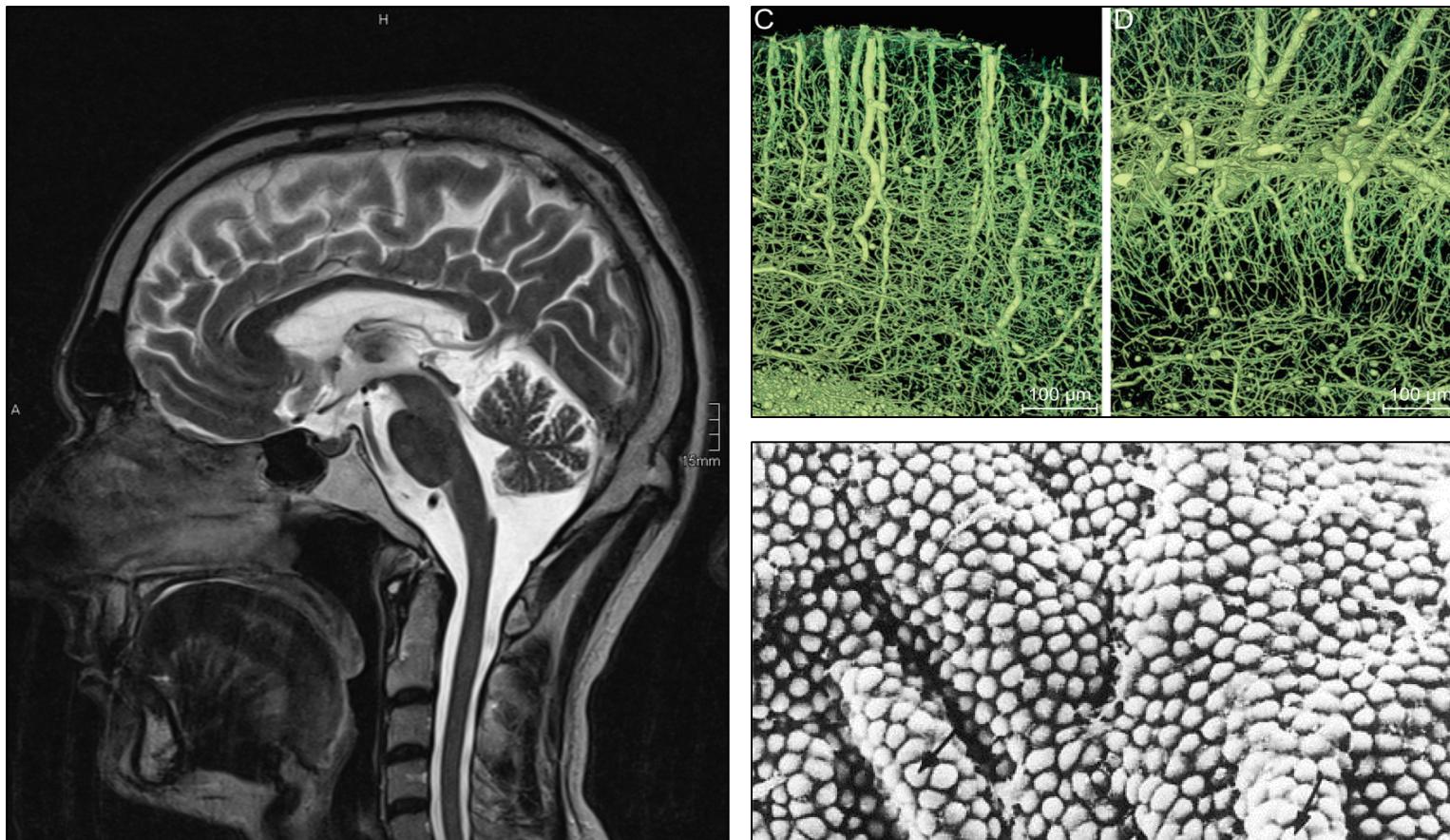
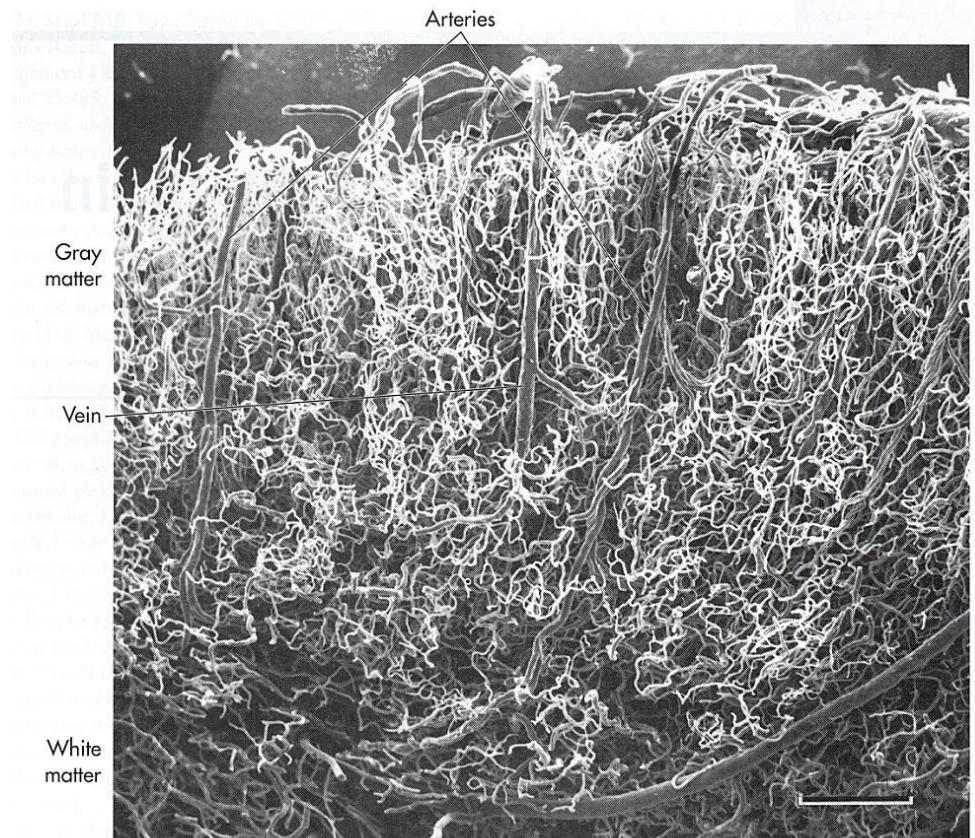


Brain Fluids: The Blood-Brain Barrier, Choroid Plexus, and CSF



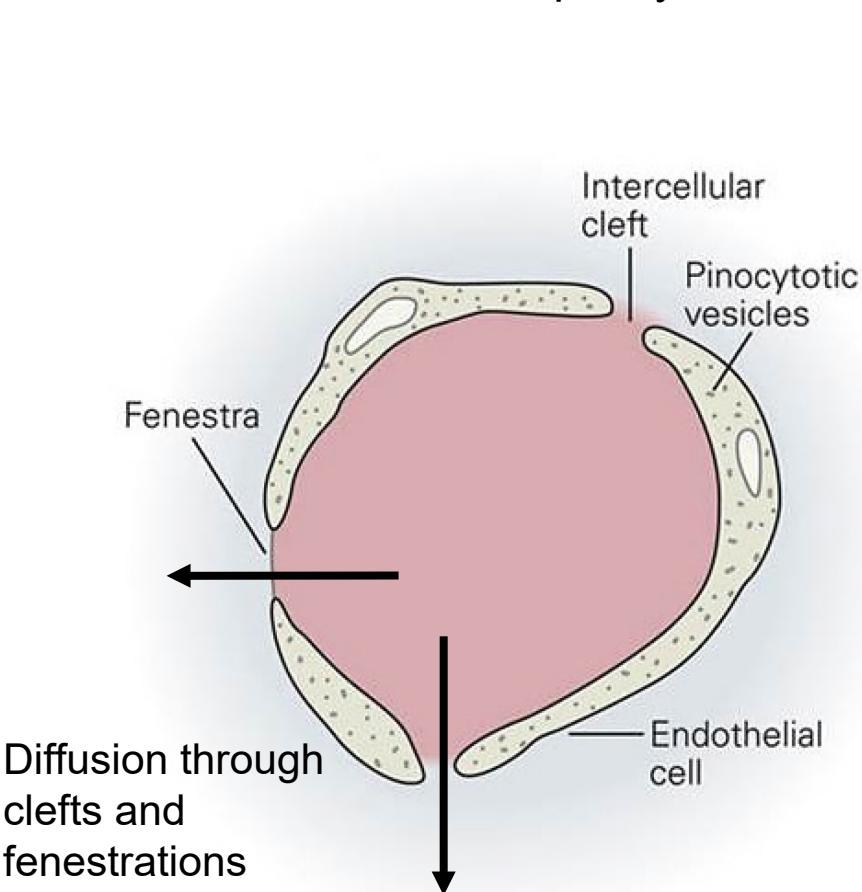
The Blood-Brain Barrier



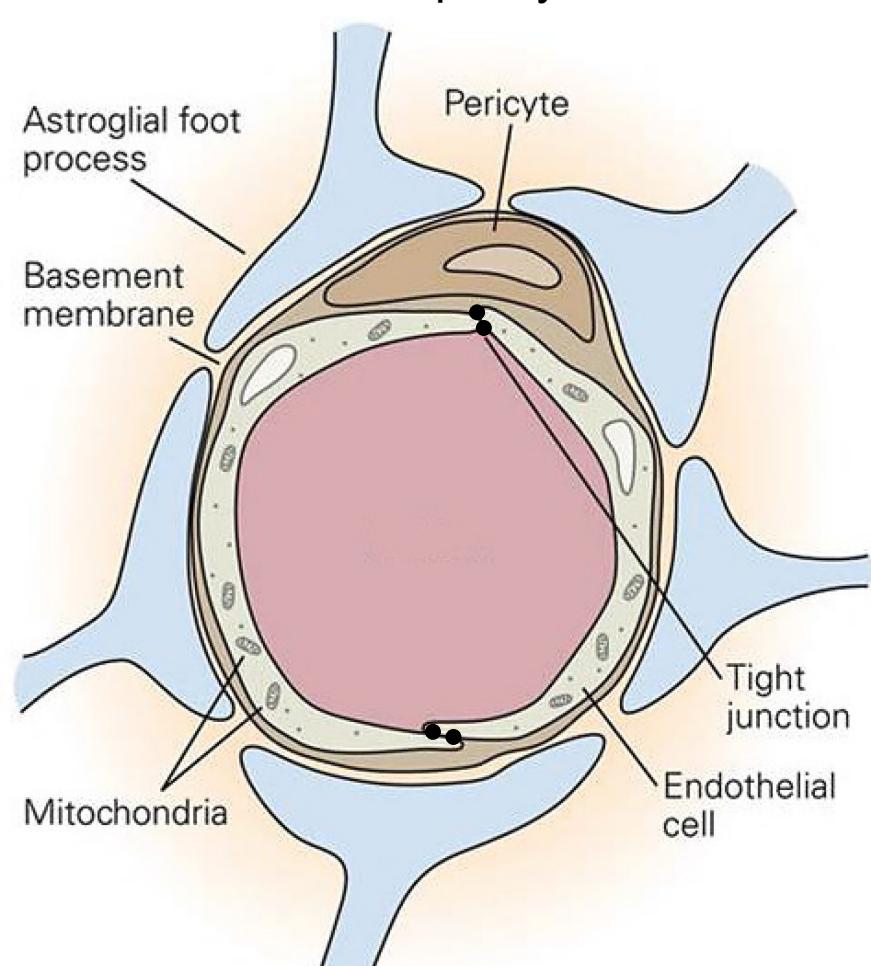
The Blood-Brain Barrier

Function: Maintain stable environment for neurons by *excluding* toxins, wastes and neuroactive substances while *providing* glucose & other essential nutrients

Anatomy: General capillary



Brain capillary



Diffusion through
clefts and
fenestrations

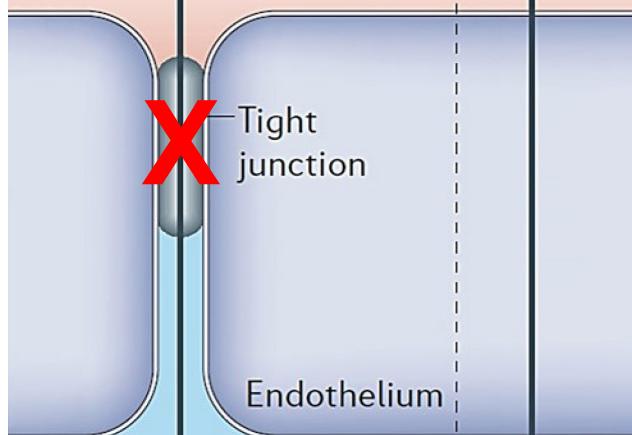
Transport Mechanisms of the BBB

Capillary lumen

Paracellular route

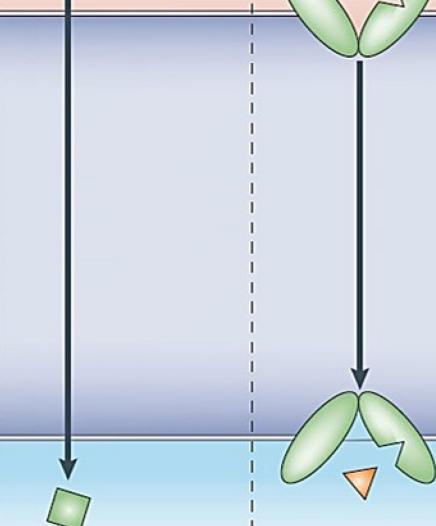
Water-soluble agents

X
Tight junction



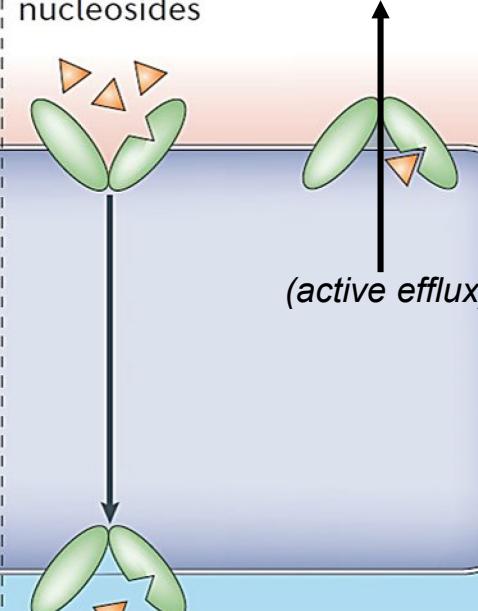
Diffusion (lipophilic pathway)

Lipid-soluble agents



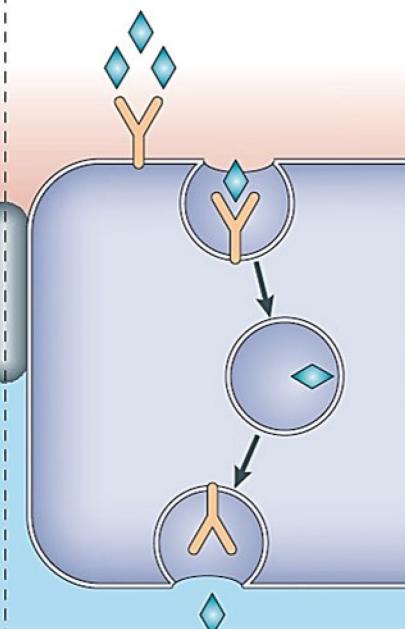
Carrier-mediated transport

Glucose, amino acids, nucleosides



Receptor-mediated transport

Insulin, transferrin

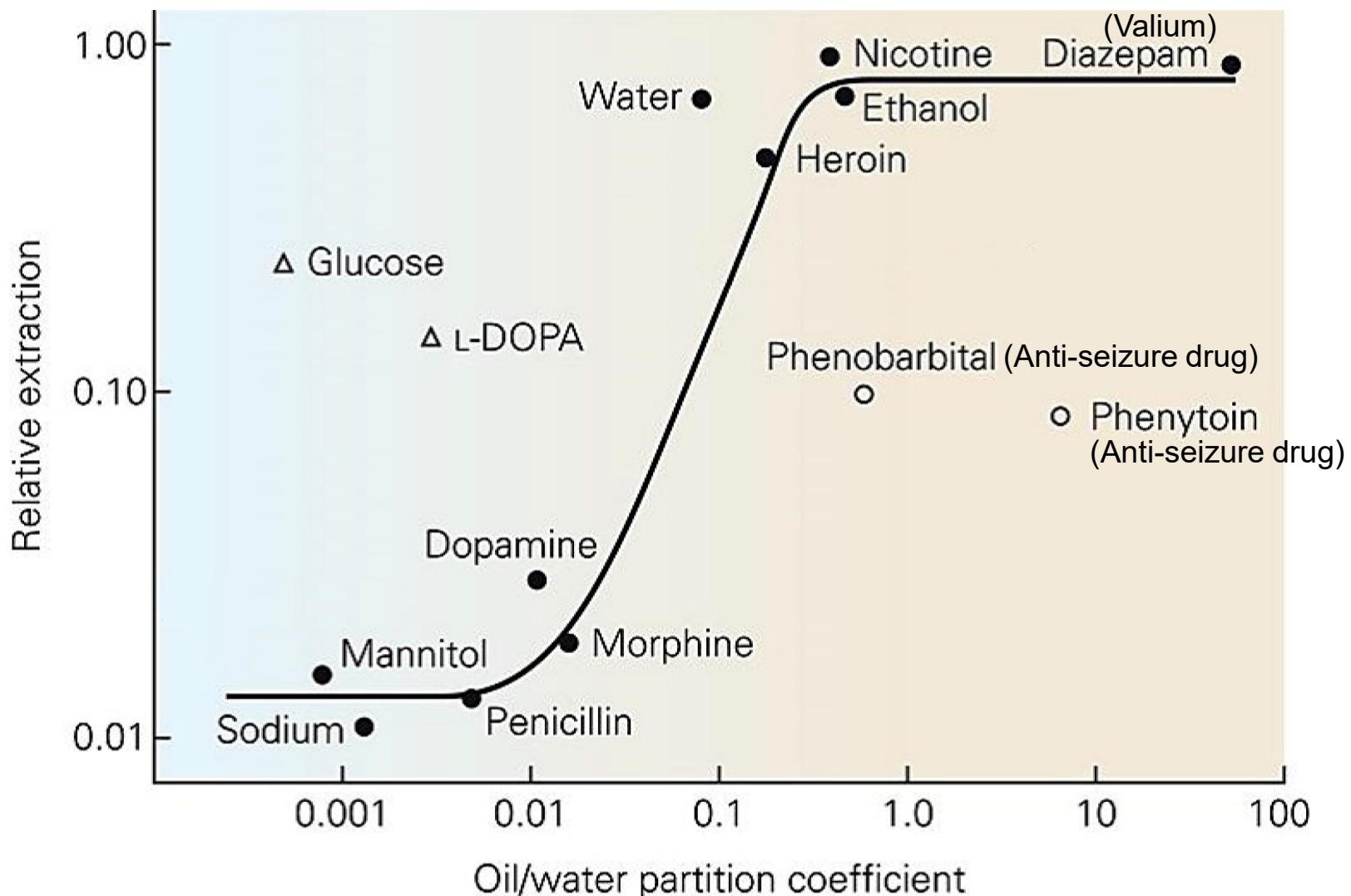


Brain Tissue

Interstitial Fluid

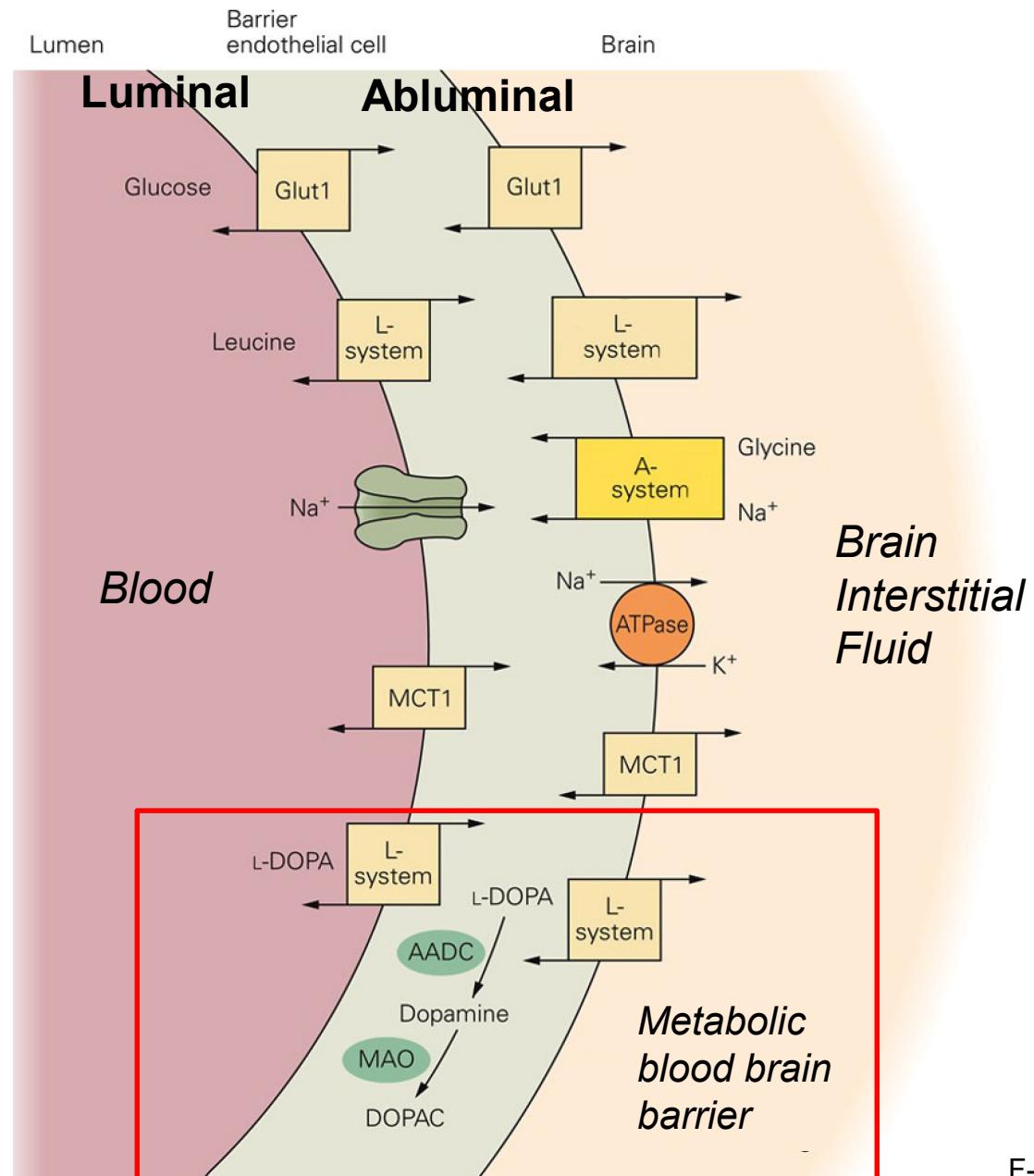
Intracellular Fluid

Diffusion Across the BBB



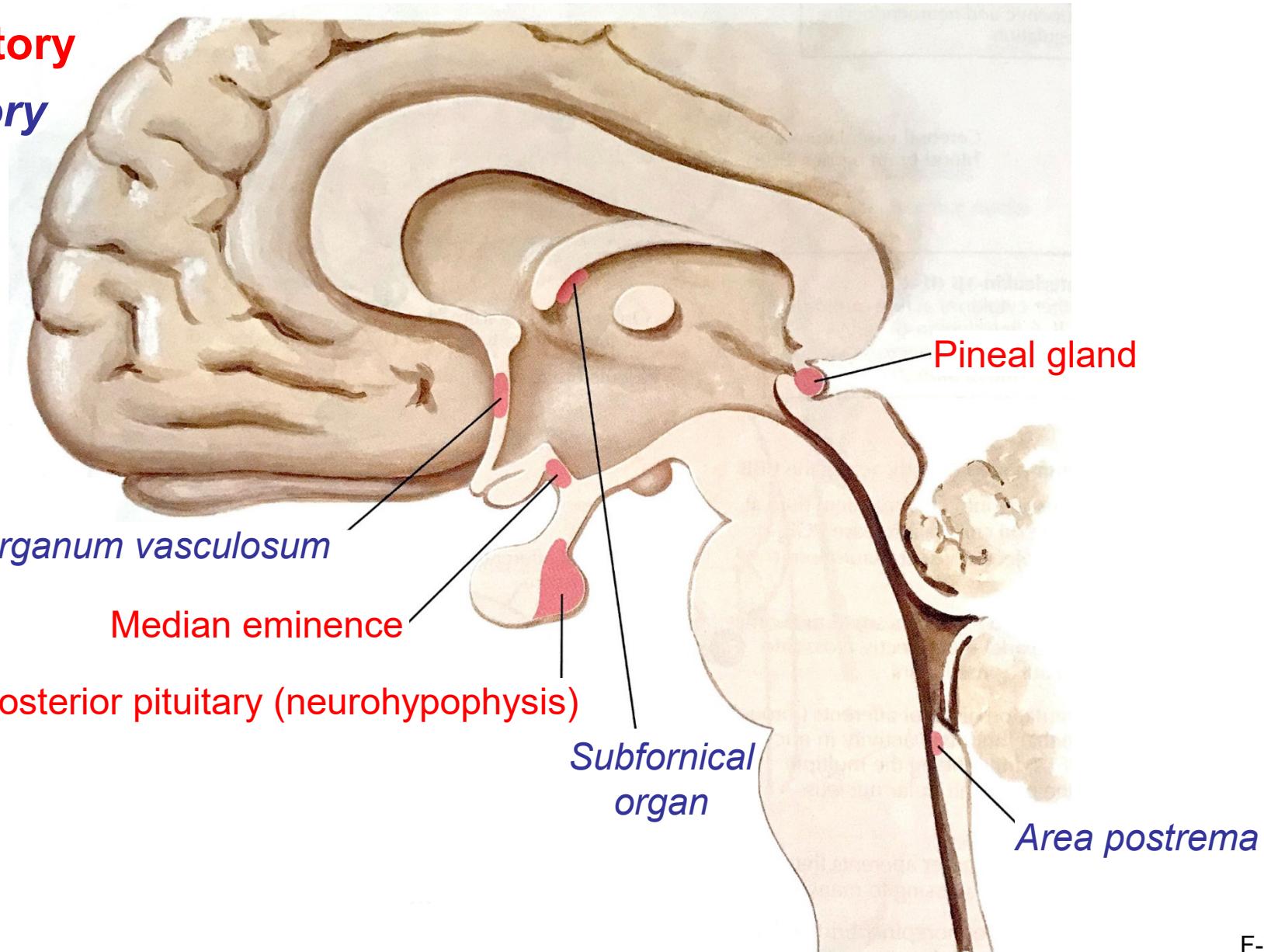
Transport Mechanisms of the BBB

- Carrier-mediated transport occurring by facilitated diffusion
- Primary active transport
- Carrier-mediated transport occurring by secondary active transport (active efflux)

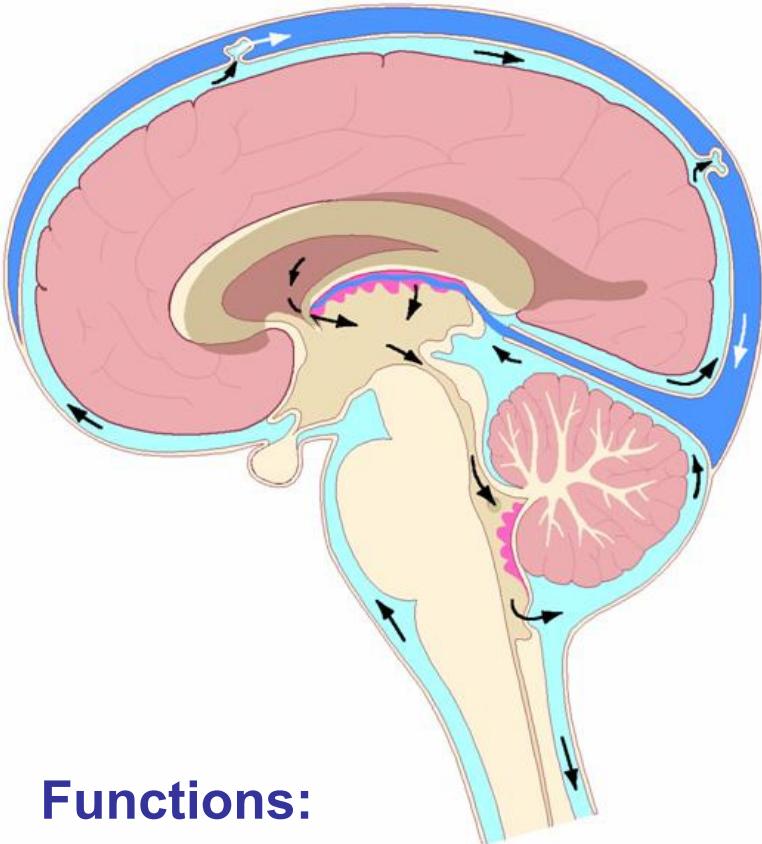


Circumventricular Organs Lack a BBB

Secretory
Sensory



Cerebrospinal Fluid (CSF)



Functions:

- Buoy the brain
- Mechanical cushion
- Stabilize neuronal environment

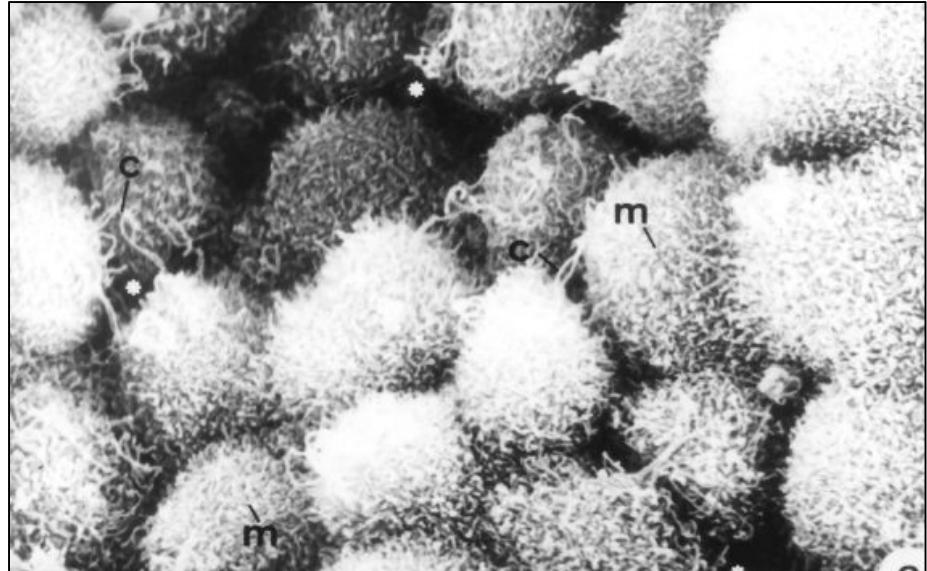
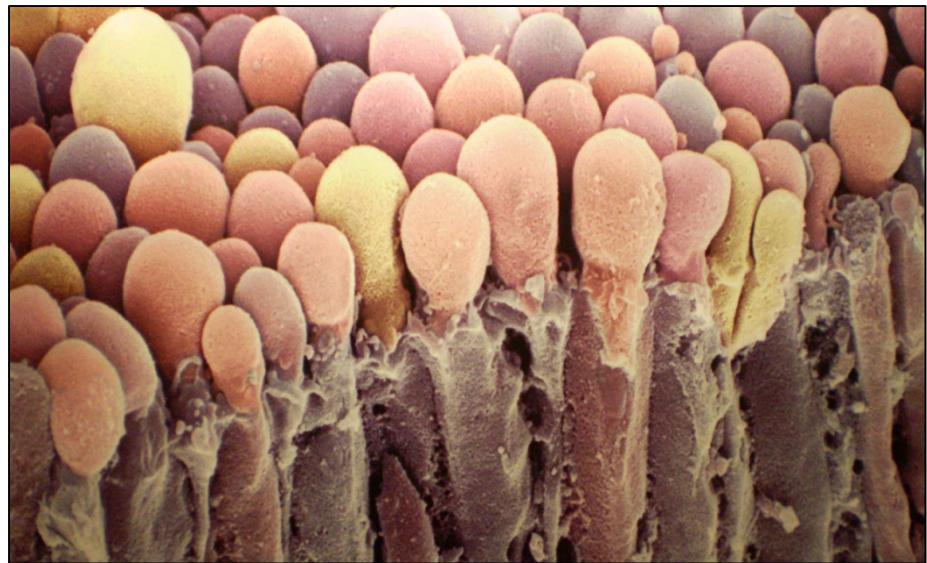
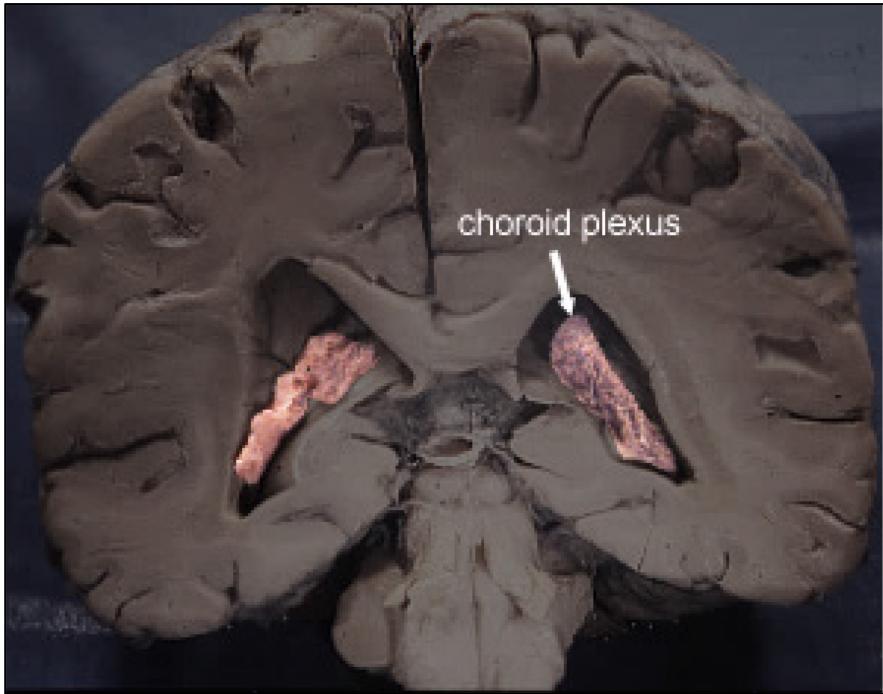
Composition:

- Clear, watery fluid
- Colorless
- No cells are present

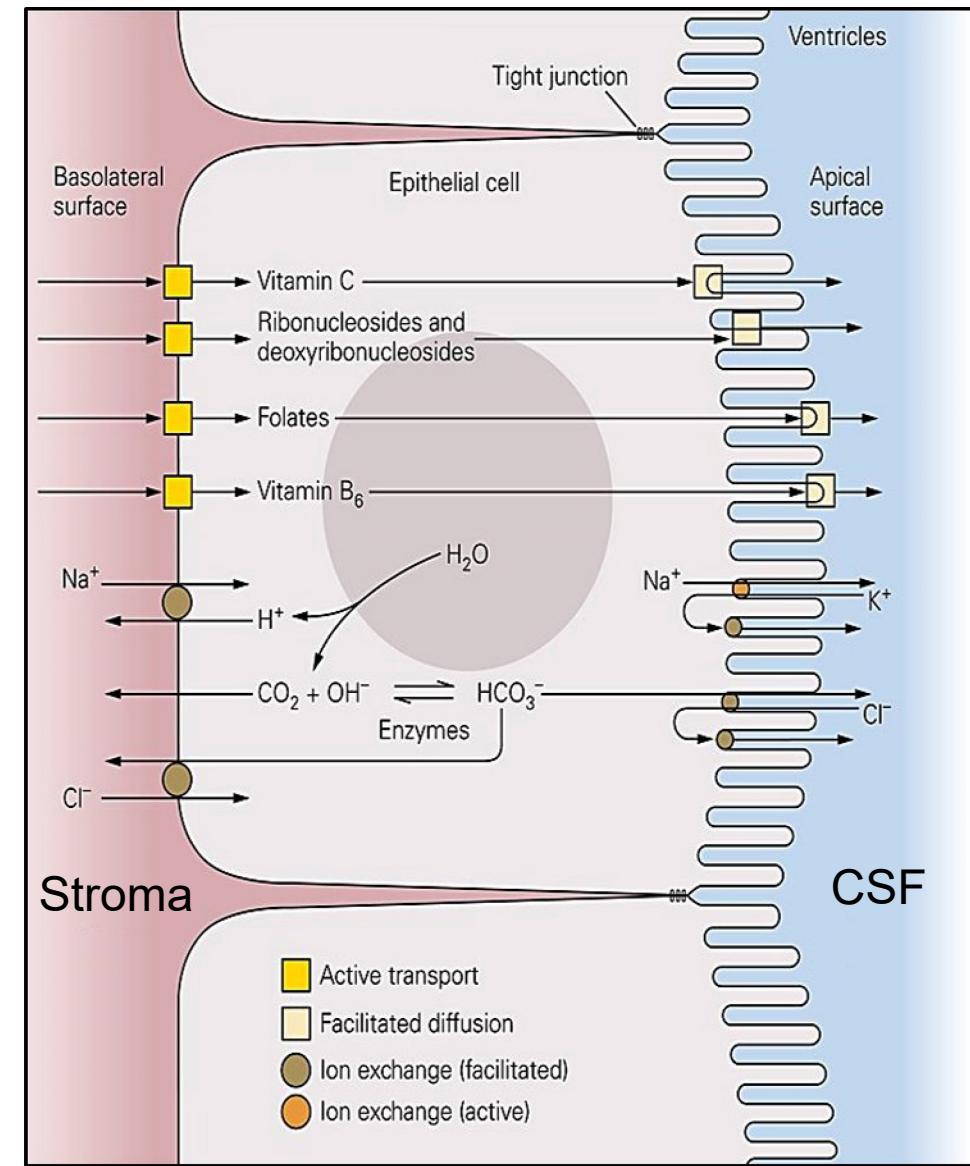
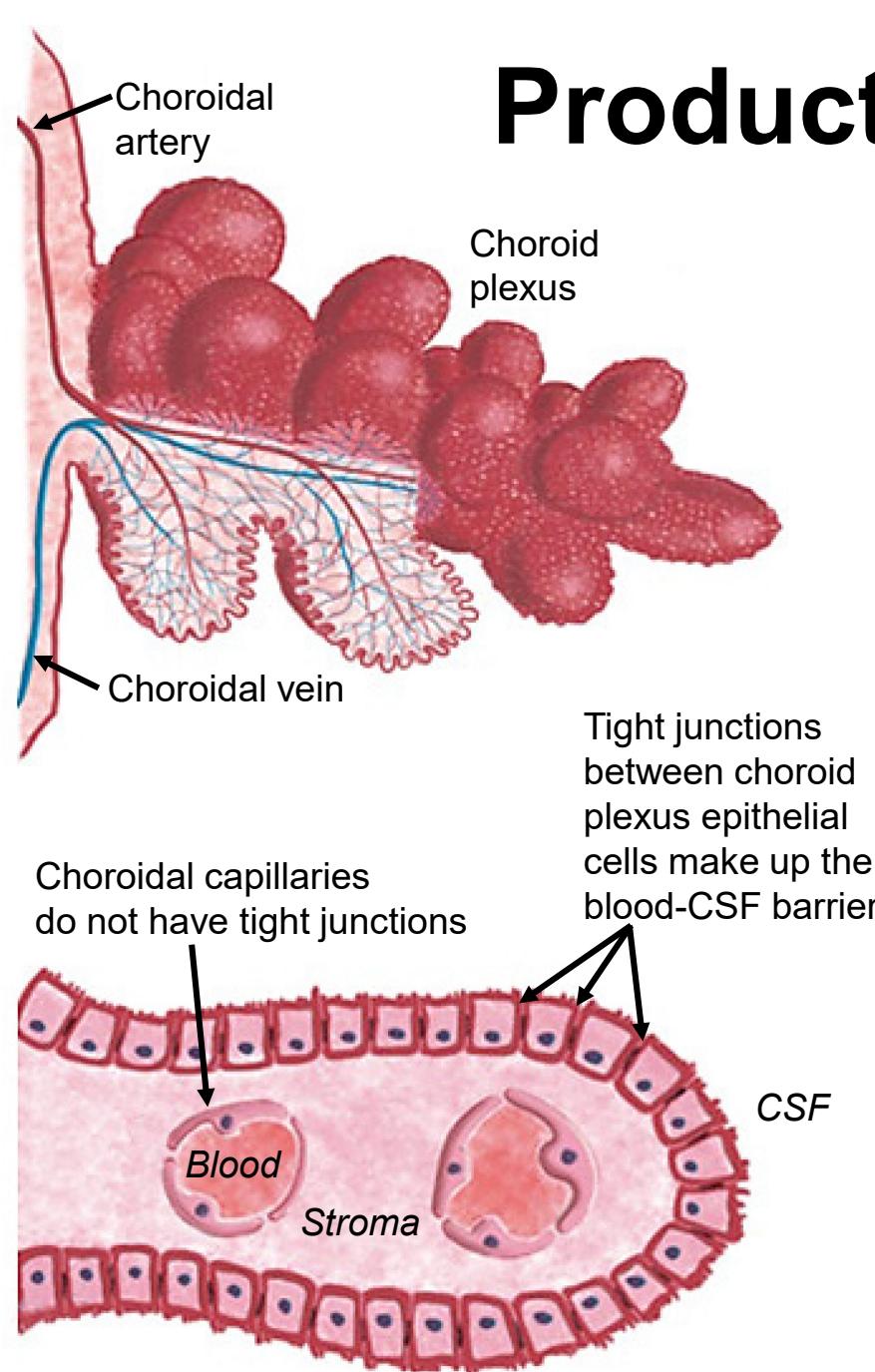


Component	CSF ¹	Serum ¹
Water content (%)	99	93
★ Protein (mg/dl)	35	7000
★ Glucose (mg/dl)	60	90
★ Osmolarity (mOsm/liter)	295	295
Na ⁺ (meq/liter)	138	138
K ⁺ (meq/liter)	2.8	4.5
Ca ²⁺ (meq/liter)	2.1	4.8
Mg ²⁺ (meq/liter)	0.3	1.7
Cl ⁻ (meq/liter)	119	102
★ pH	7.33	7.41

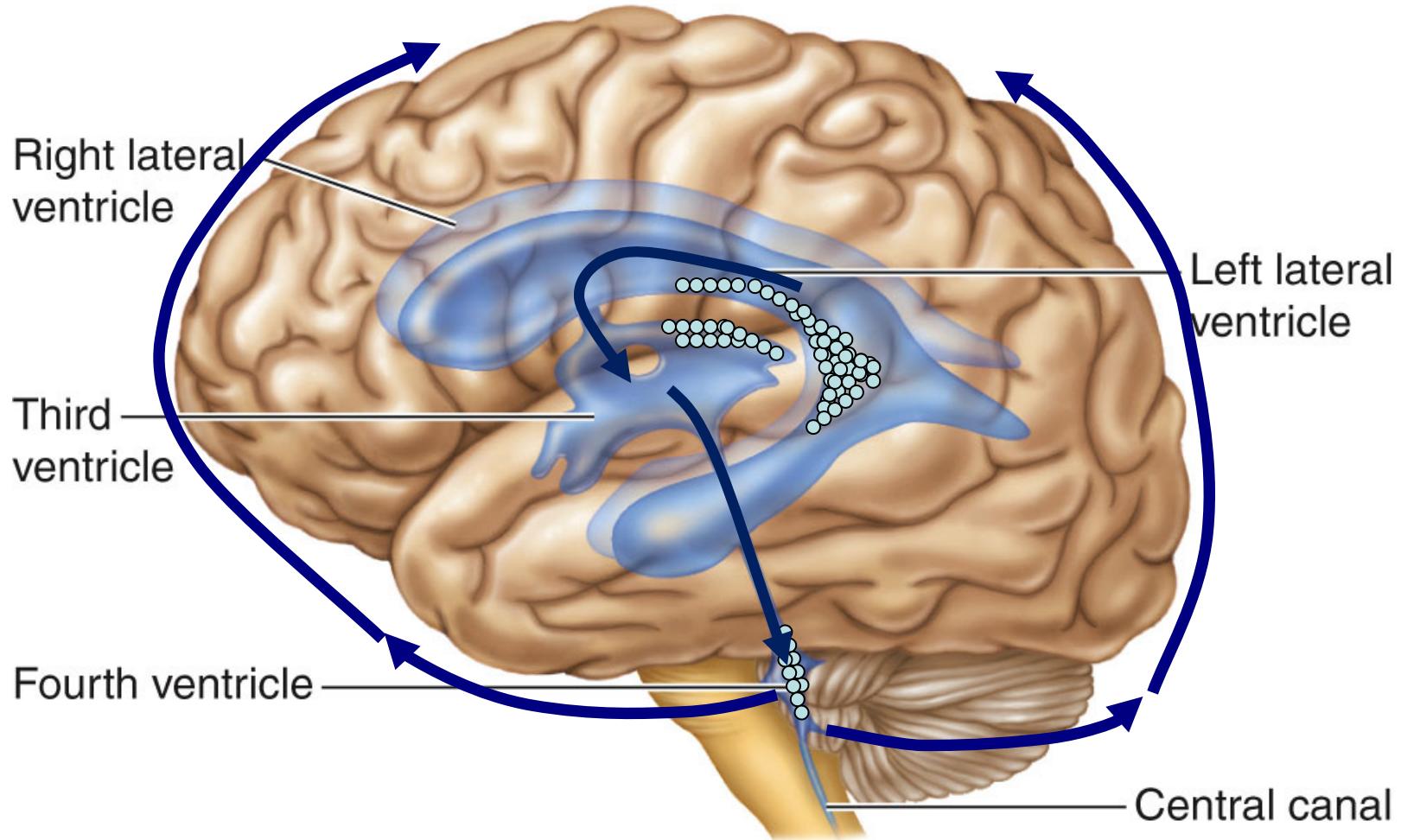
Cerebrospinal Fluid is Produced by the Choroid Plexus



Production of CSF

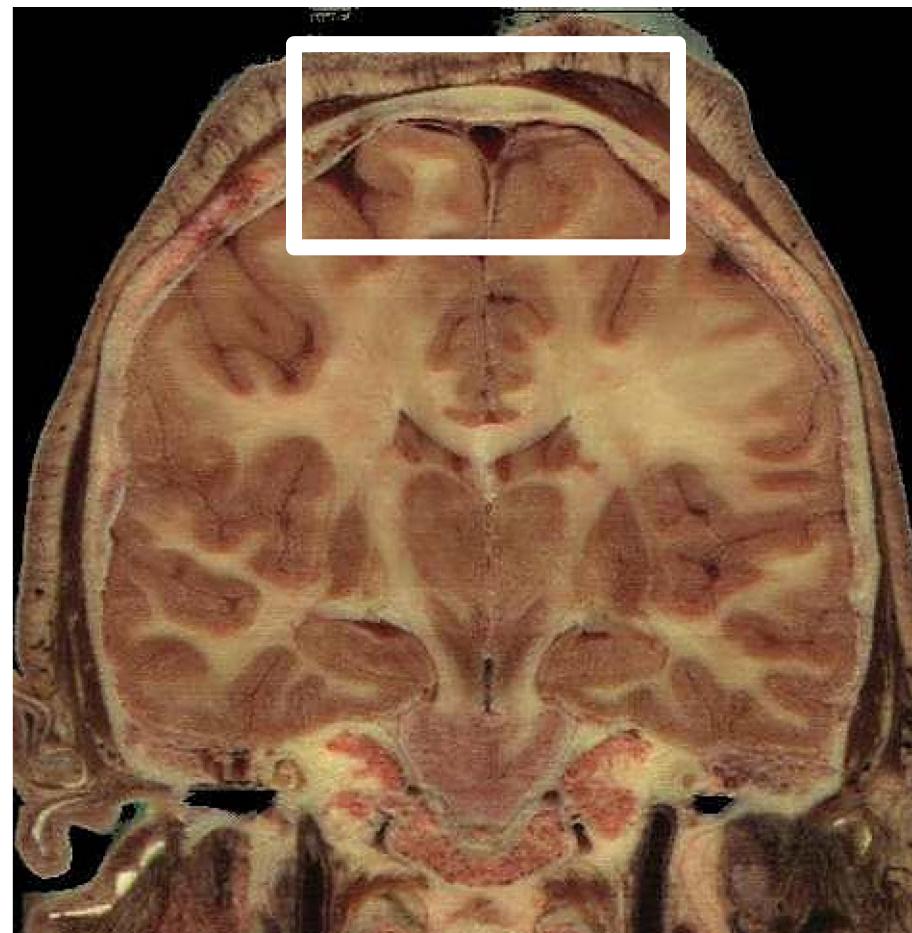
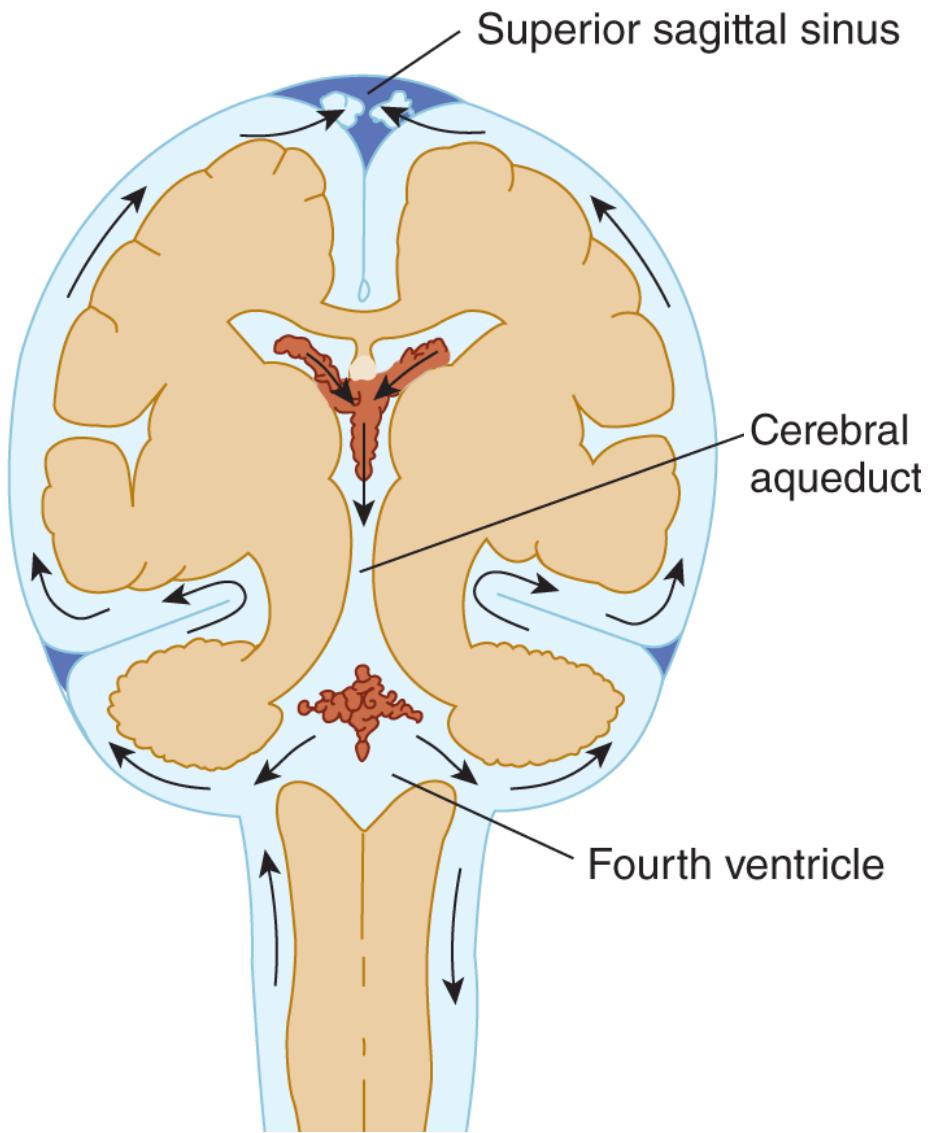


Cerebrospinal Fluid Circulation

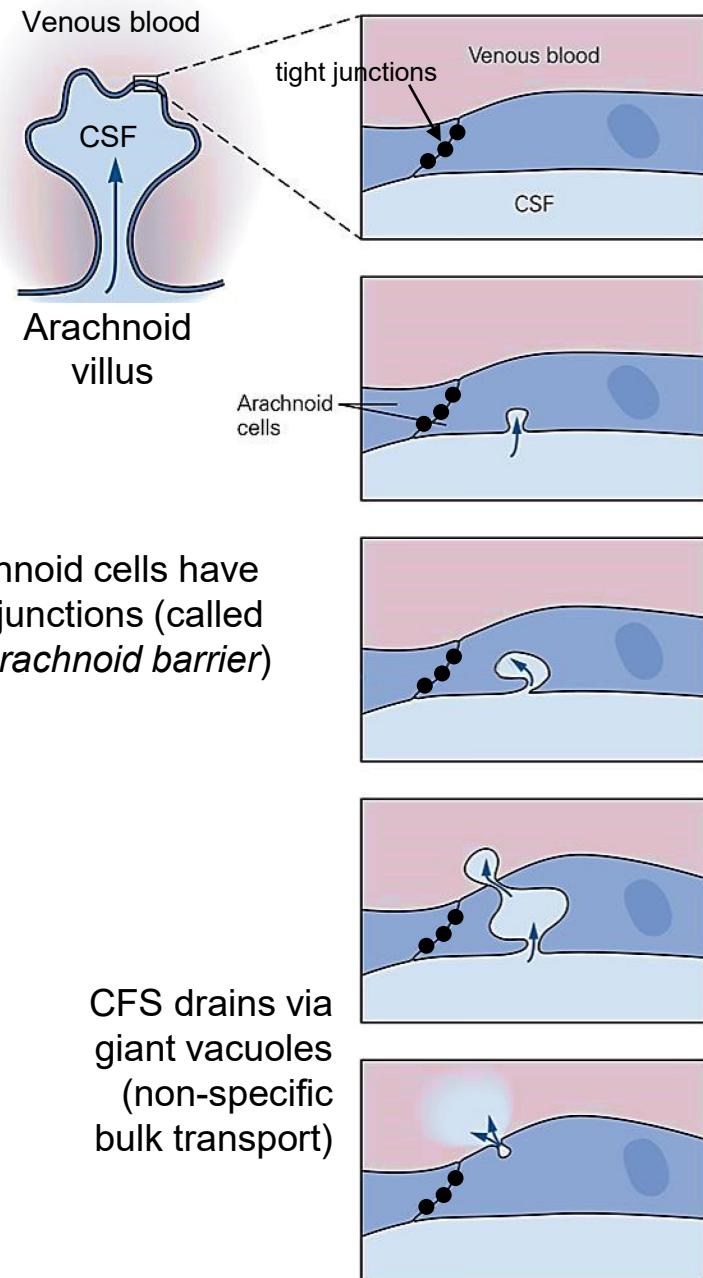
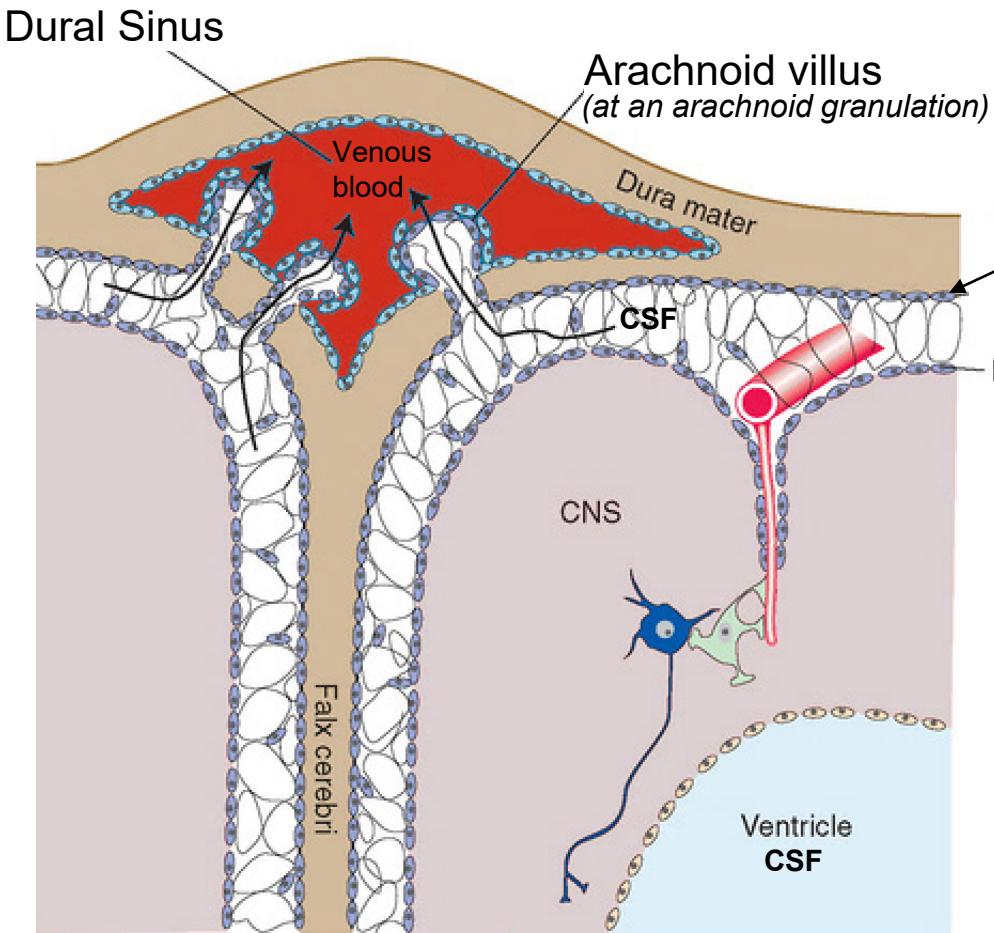


- Choroid plexus is found in all four ventricles
- CSF circulates through the ventricles to the subarachnoid space
- Adults have ~140 ml of CSF at any one time. ~500 ml is produced daily.

Drainage of CSF into Dural Sinuses

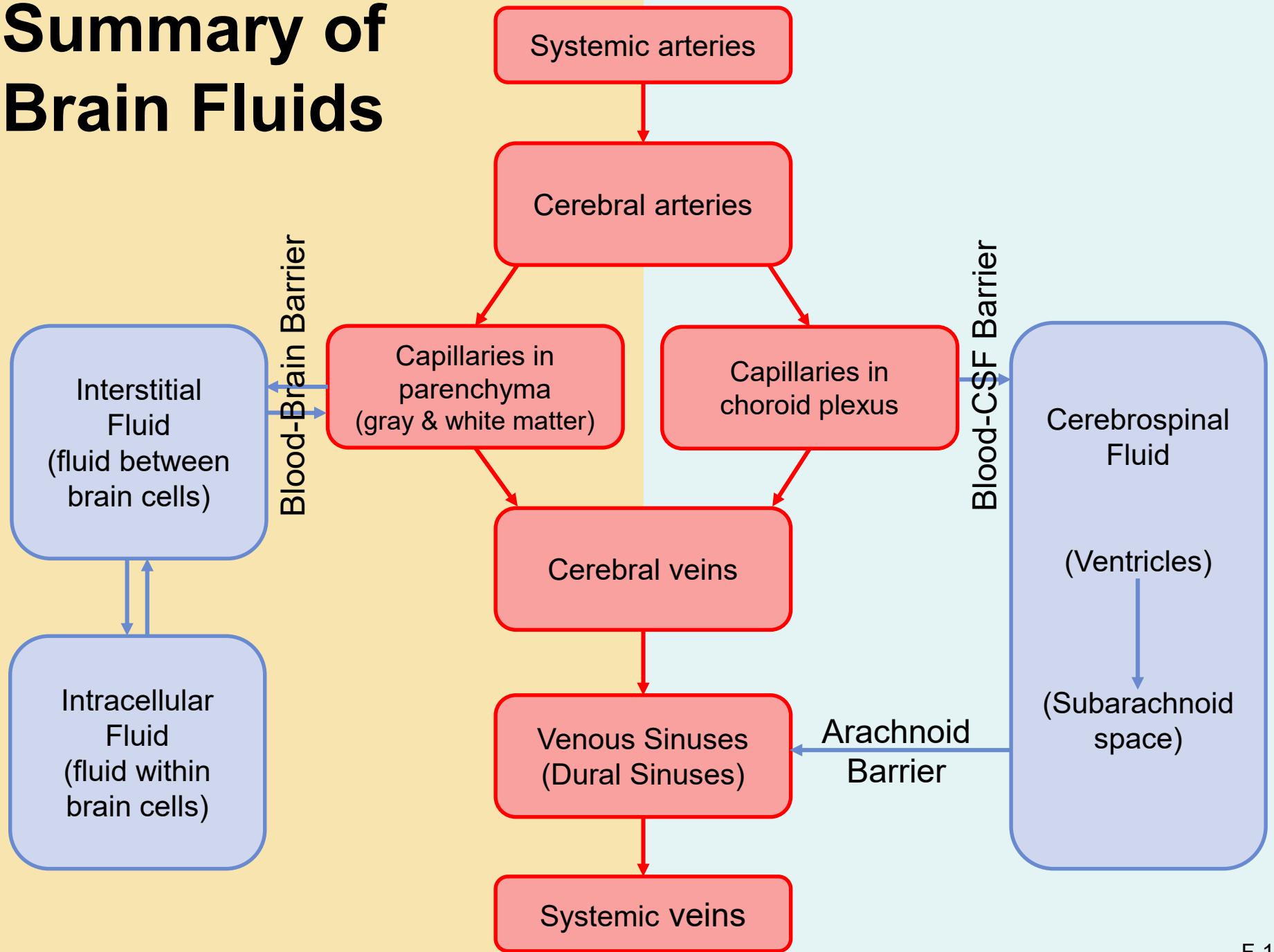


Drainage of CSF at Arachnoid Villi



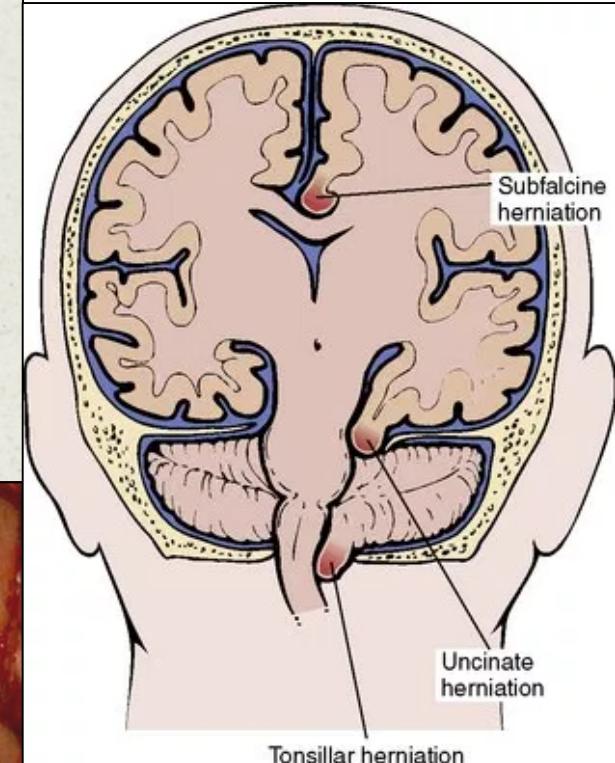
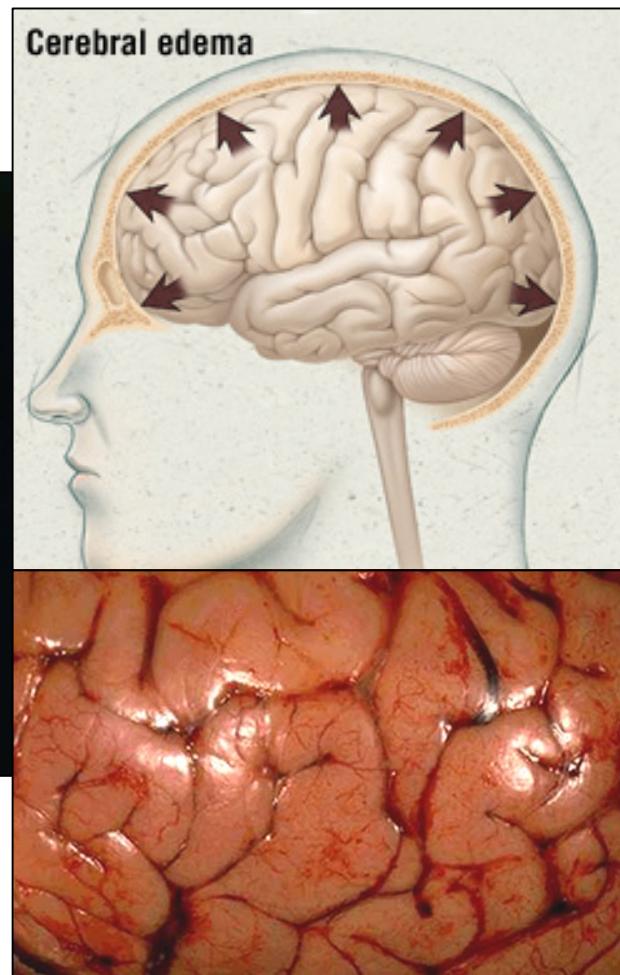
CSF drains via
giant vacuoles
(non-specific
bulk transport)

Summary of Brain Fluids



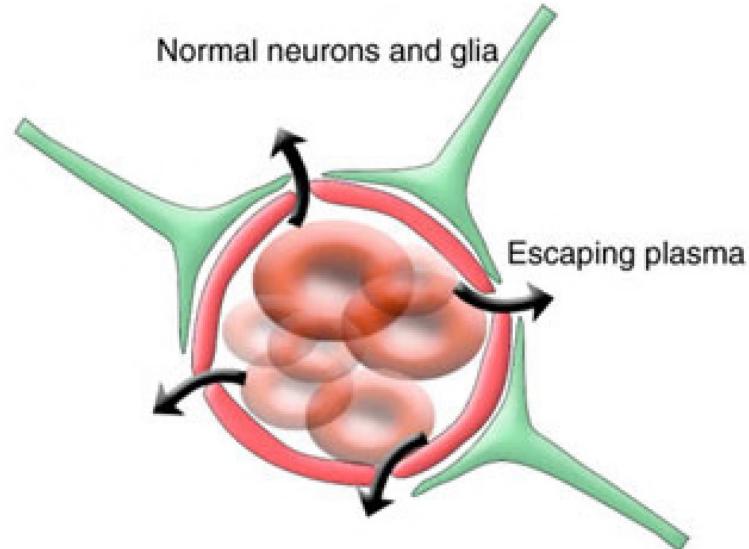
Cerebral Edema

- Excess accumulation of fluid in the interstitial or intracellular fluid compartments
- Ventricles become **compressed**, gyri are flattened, sulci are narrowed
- Increased intracranial pressure damages brain cells
- May cause brain herniation



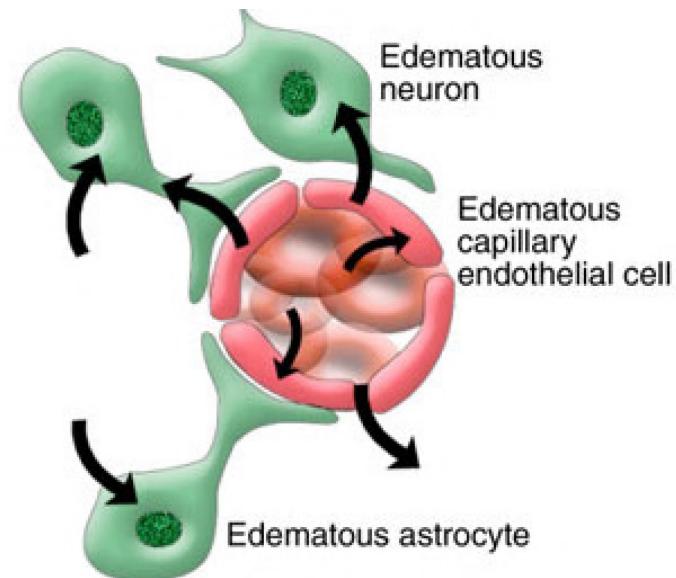
Vasogenic Edema

- Breakdown of BBB leads to an increase in brain interstitial fluid
- Causes: trauma, contusion (bruise), tumors, focal inflammation



Cytotoxic Edema

- BBB remains intact
- Na^+/K^+ pump shuts down, Na^+ accumulates inside neurons and glia, water follows by osmosis
- Neurons and glia swell and may burst
- Causes: hypoxia (asphyxia), ischemia (cardiac arrest or stroke)



Hydrocephalus

- Excess accumulation of cerebrospinal fluid in the brain's ventricles
- Ventricles become *enlarged*, gyri are flattened, sulci are narrowed
- Increased intracranial pressure damages brain cells. In children, it can cause head enlargement.
- Causes: overproduction of CSF, obstruction of CSF flow, or impaired CSF drainage

