The Meninges of the Brain

&

The Flow of Cerebrospinal Fluid
Meninges of the Brain
Meninges

• Dura mater -- outermost, tough membrane
  – Dura matter actually two layers
    • outer periosteal layer against bone (periosteum)
    • inner meningeal layer (only layer that extends into spinal cord)
  – Two layers separate to form sinus, the dural venous sinuses that drain blood from brain into internal jugular vein
    • Superior sagittal sinus
    • Transverse sinus
  – supportive structures formed by dura mater
    • falx cerebri, falx cerebelli and tentorium cerebelli
  – epidural space filled with fat in spinal cavity
    • No epidural space within cranial cavity
    • epidural anaesthesia during childbirth

• Arachnoid and pia mater – continue into spinal cord
  – subarachnoid and subdural spaces
Meningitis

• Inflammation of the meninges

• Disease of infancy and childhood
  – between 3 months and 2 years of age

• Bacterial and virus invasion of the CNS by way of the nose and throat

• Signs include high fever, stiff neck, drowsiness and intense headache and may progress to coma

• Diagnose by examining the CSF
  – lumbar puncture (spinal tap)
  – CSF pressure 80mmHg to 180 mmHg
Flow of Cerebrospinal Fluid

1. CSF is secreted by choroid plexus in each lateral ventricle.
2. CSF flows through interventricular foramina into third ventricle.
3. Choroid plexus in third ventricle adds more CSF.
4. CSF flows down cerebral aqueduct to fourth ventricle.
5. Choroid plexus in fourth ventricle adds more CSF.
6. CSF flows out two lateral apertures and one median aperture.
7. CSF fills subarachnoid space and bathes external surfaces of brain and spinal cord.
8. At arachnoid villi, CSF is reabsorbed into venous blood of dural venous sinuses.
Brain Ventricles

(a) Lateral view
(b) Anterior view
Ventricles of the Brain

Longitudinal fissure
Frontal lobe
Gray matter (cortex)
White matter
Lateral ventricle
Temporal lobe
Third ventricle
Lateral sulcus
Insula
Lateral ventricle
Occipital lobe
Corpus callosum (anterior part)
Caudate nucleus
Septum pellucidum
Sulcus
Gyrus
Thalamus
Choroid plexus
Corpus callosum (posterior part)
Longitudinal fissure

(c) Caudal (posterior)
Blood-Blood and Blood-CSF Barriers

• Blood-Brain Barrier
  – endothelium / astrocyte / neuron
  – permeable to lipid-soluble materials
    • glucose, alcohol, O₂, CO₂, nicotine and anesthetics
  – circumventricular organs
    • in 3rd and 4th ventricles are breaks in the barrier where blood has direct access
    • monitors glucose, pH, osmolarity and others
    • route for HIV virus to invade the brain

• Blood-CSF Barrier
  – at choroid plexus is ependymal cells joined by tight junctions

• No CSF-Brain Barrier
  – CSF needs to be in contact with brain tissue
Ventricles and Cerebrospinal Fluid

- Internal chambers within the CNS
  - lateral ventricles in cerebral hemispheres
  - third ventricle = single vertical space under corpus callosum
  - cerebral aqueduct runs through midbrain
  - fourth ventricle = chamber between pons and cerebellum
  - central canal runs down through spinal cord

- Lined with ependymal cells

- Choroid plexus produce CSF
Cerebrospinal Fluid

- Fills ventricles and subarachnoid space

- Brain produces and absorbs 500 ml/day
  - choroid plexus creates by filtration of blood

- Functions
  - floats brain so it is neutrally buoyant
  - cushions from hitting inside of skull
  - chemical stability -- rinses away wastes

- Escapes (4th ventricle) to surround brain

- Absorbed into venous sinus by arachnoid villi