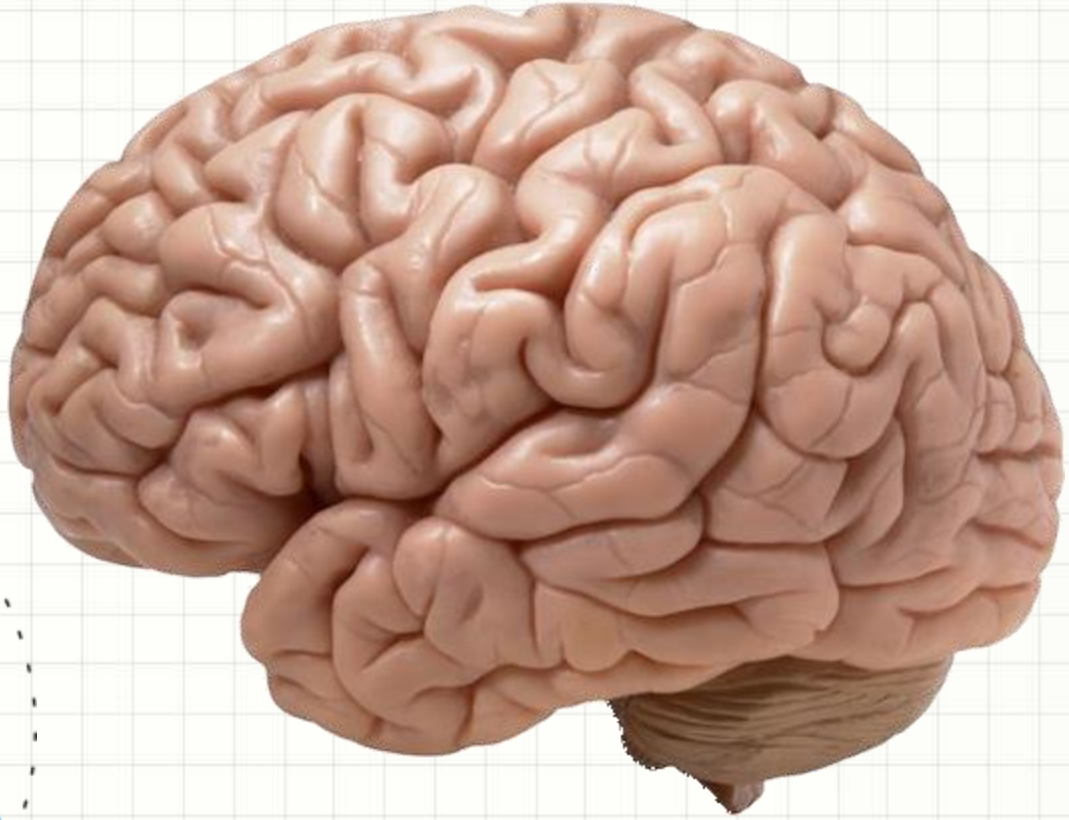
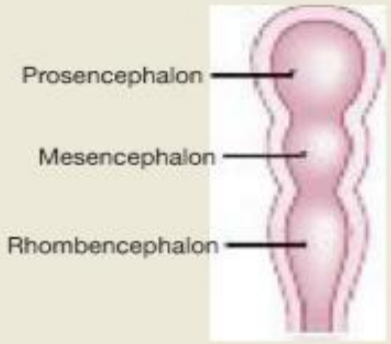
Introduction into anatomy of the Nervous system

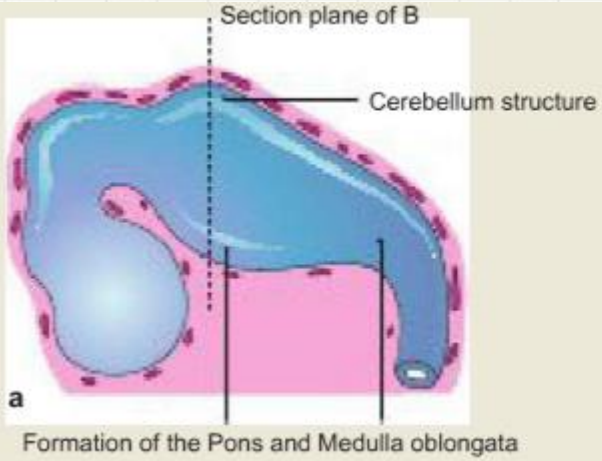


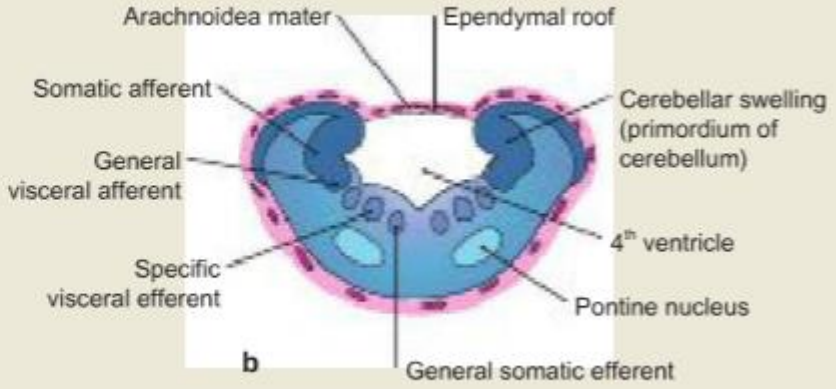
…and investigations

Developement



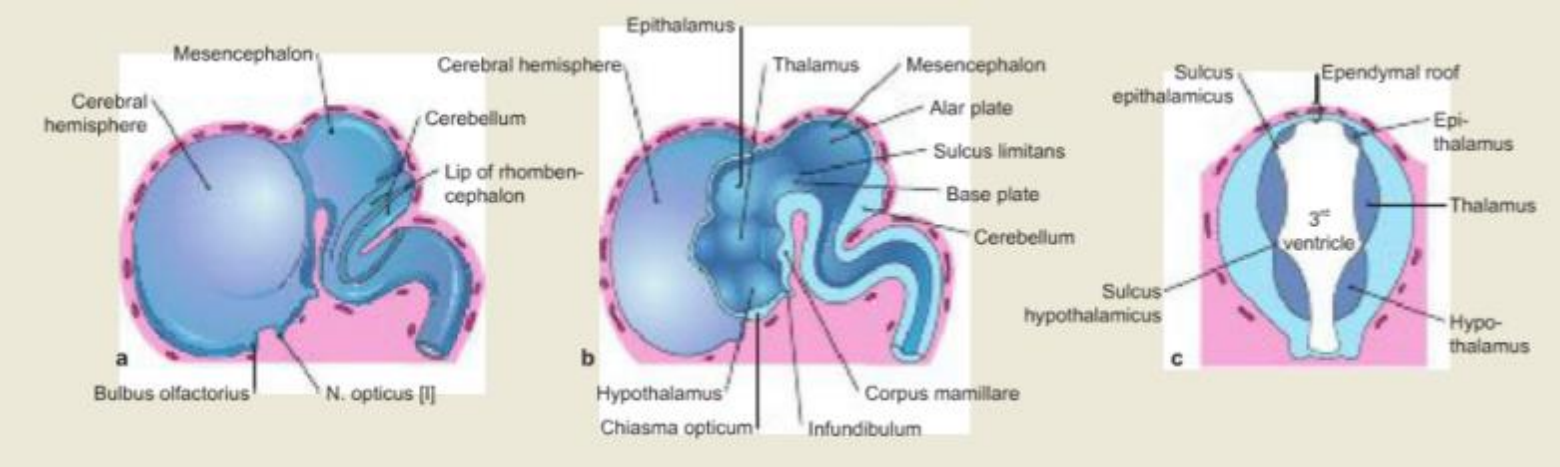
4 week

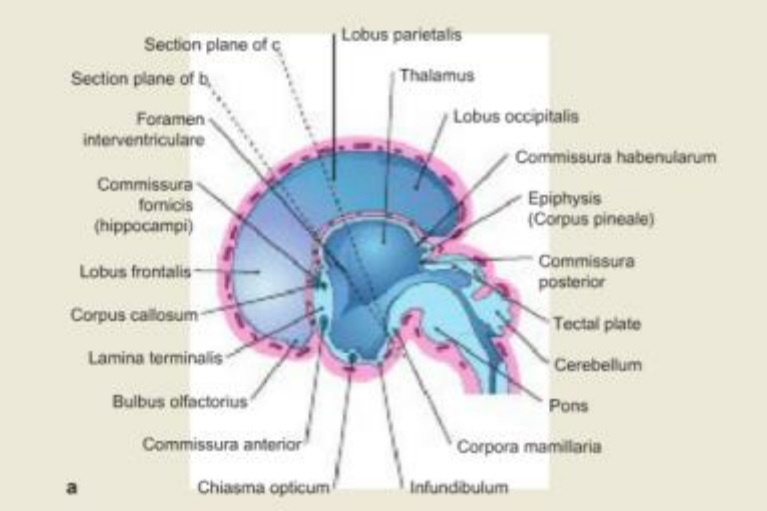




5 week

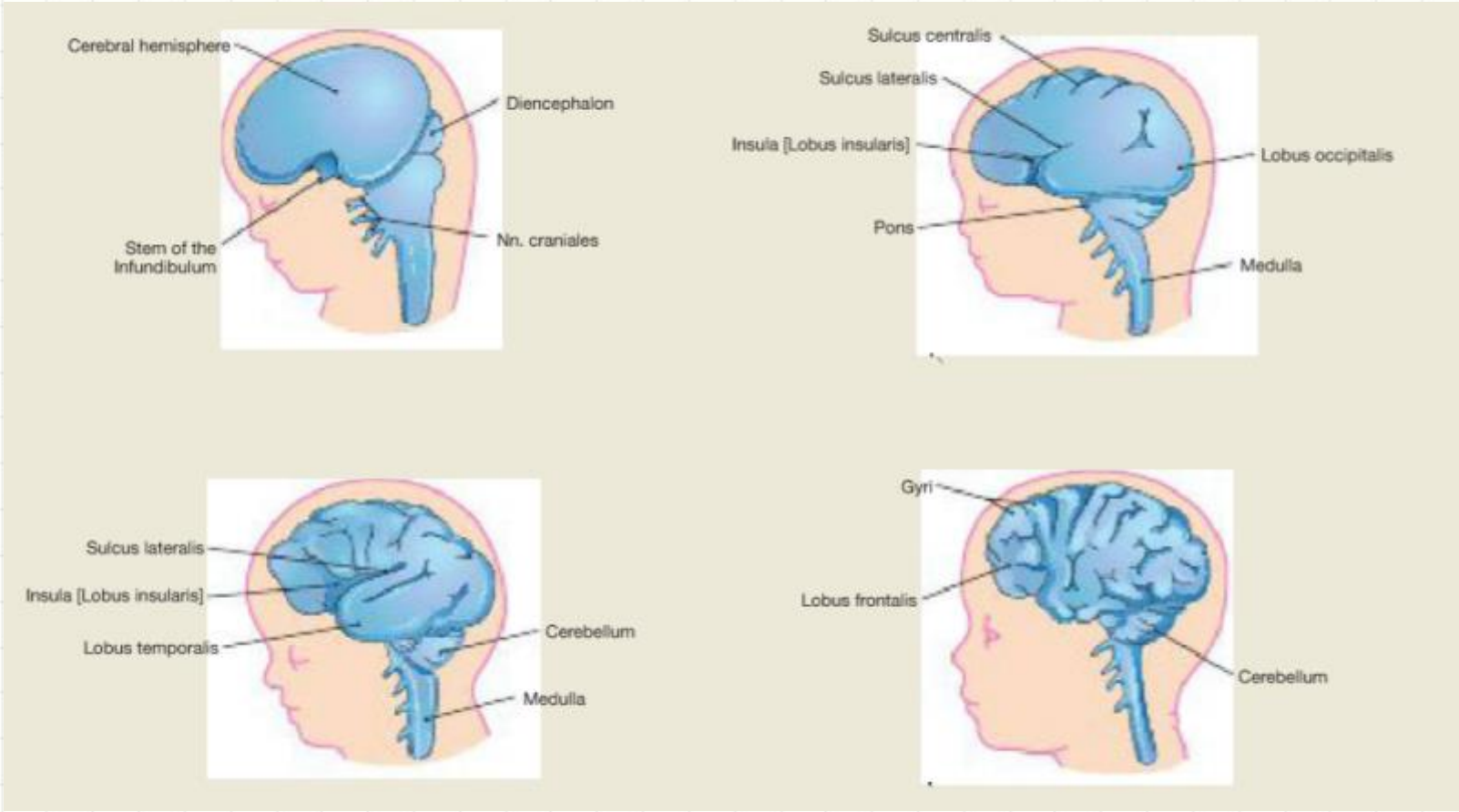
Developement



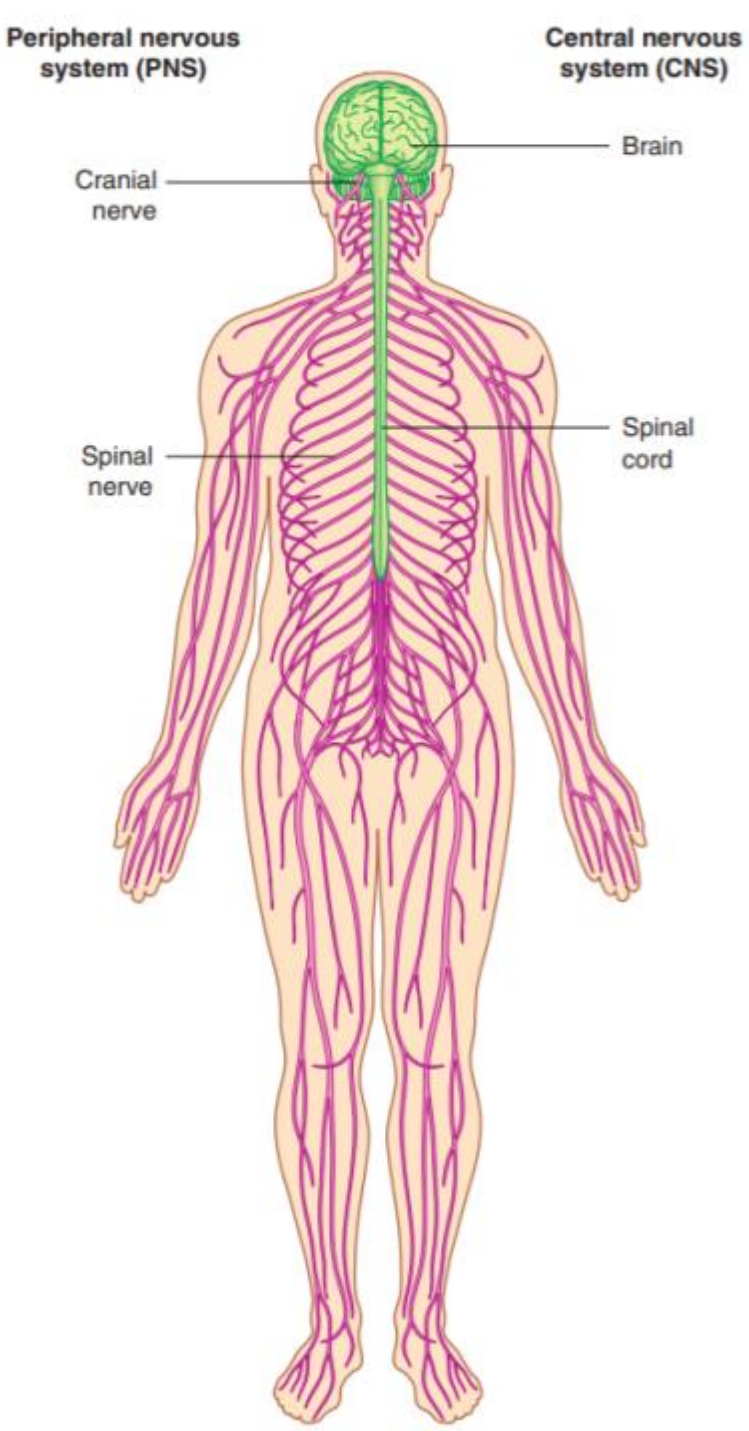


7-11 week

Development



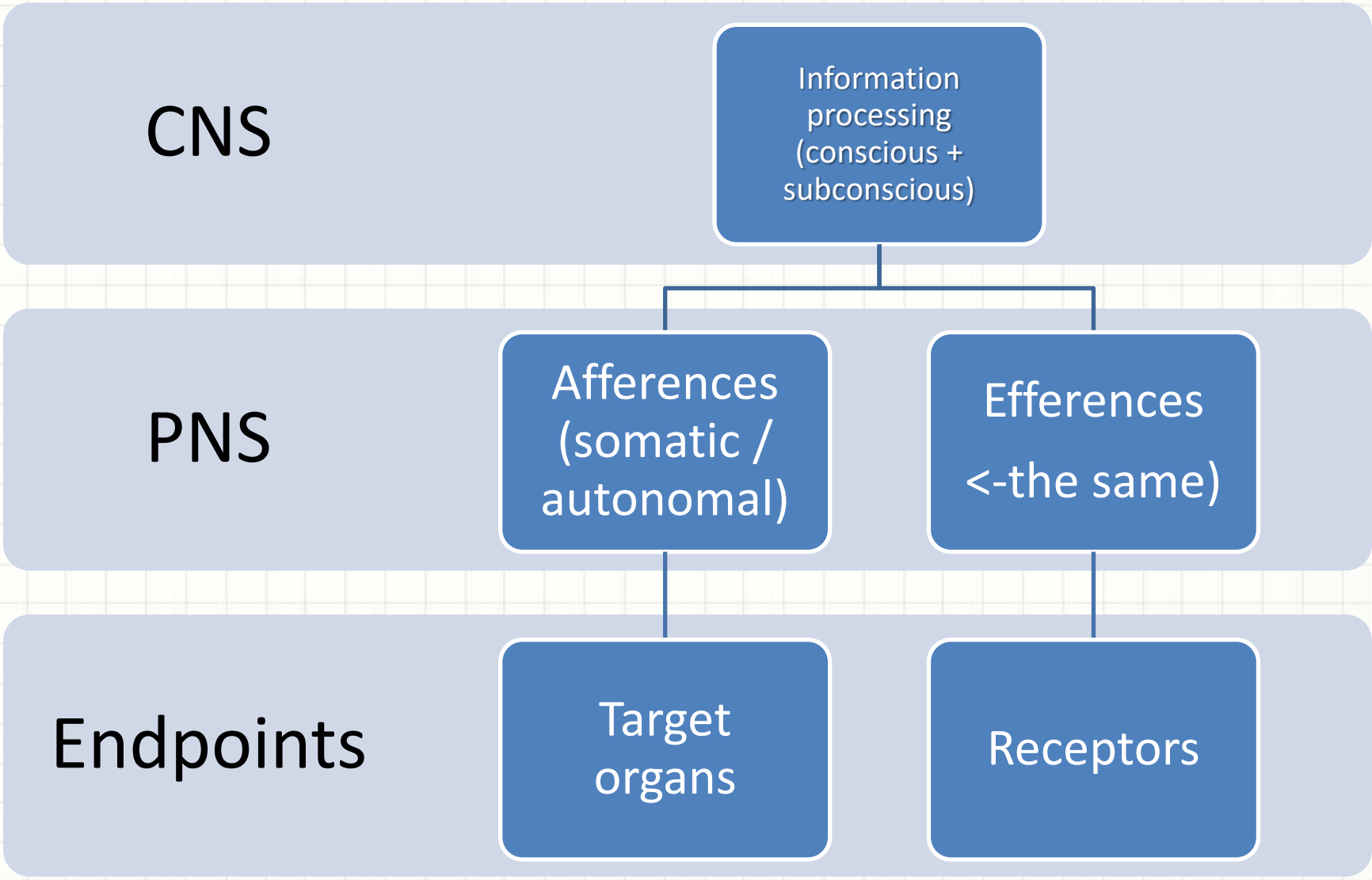
30-38 week



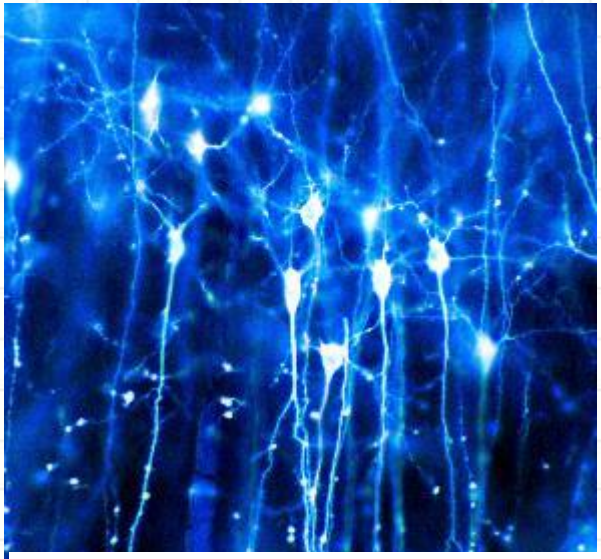
In general

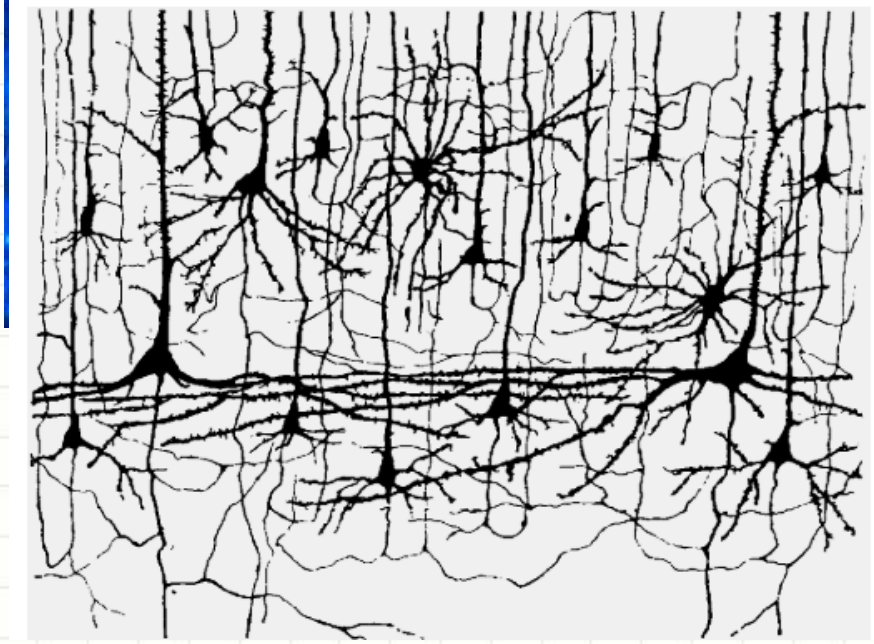
- Structurally we can divide nervous system into:
  - the central nervous system (CNS)
  - the peripheral nervous system (PNS)
- functionally:
  - somatic
  - visceral parts(autonomic).

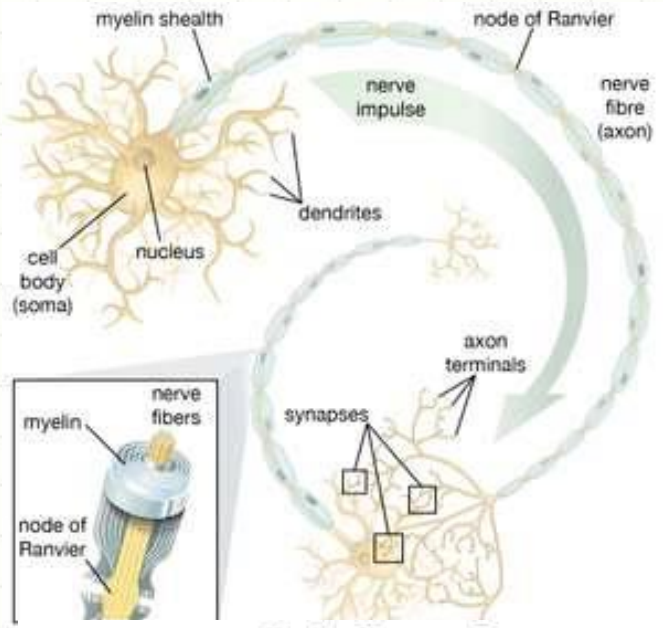
In more general…

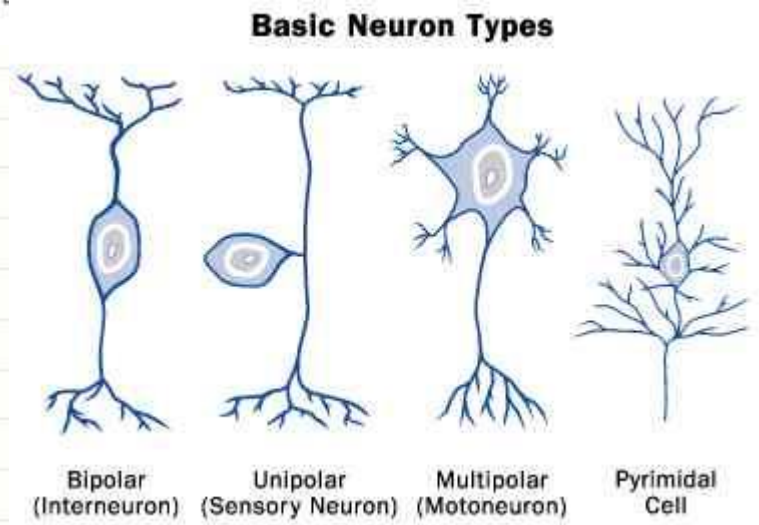


So lets start from scratch…



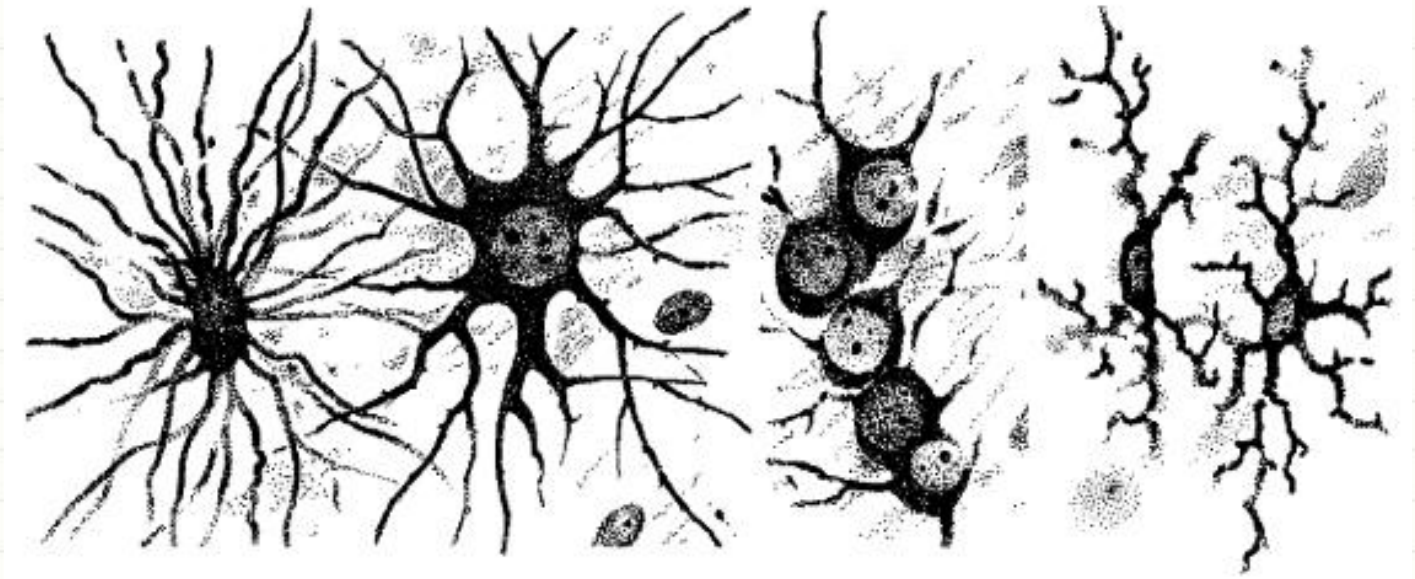




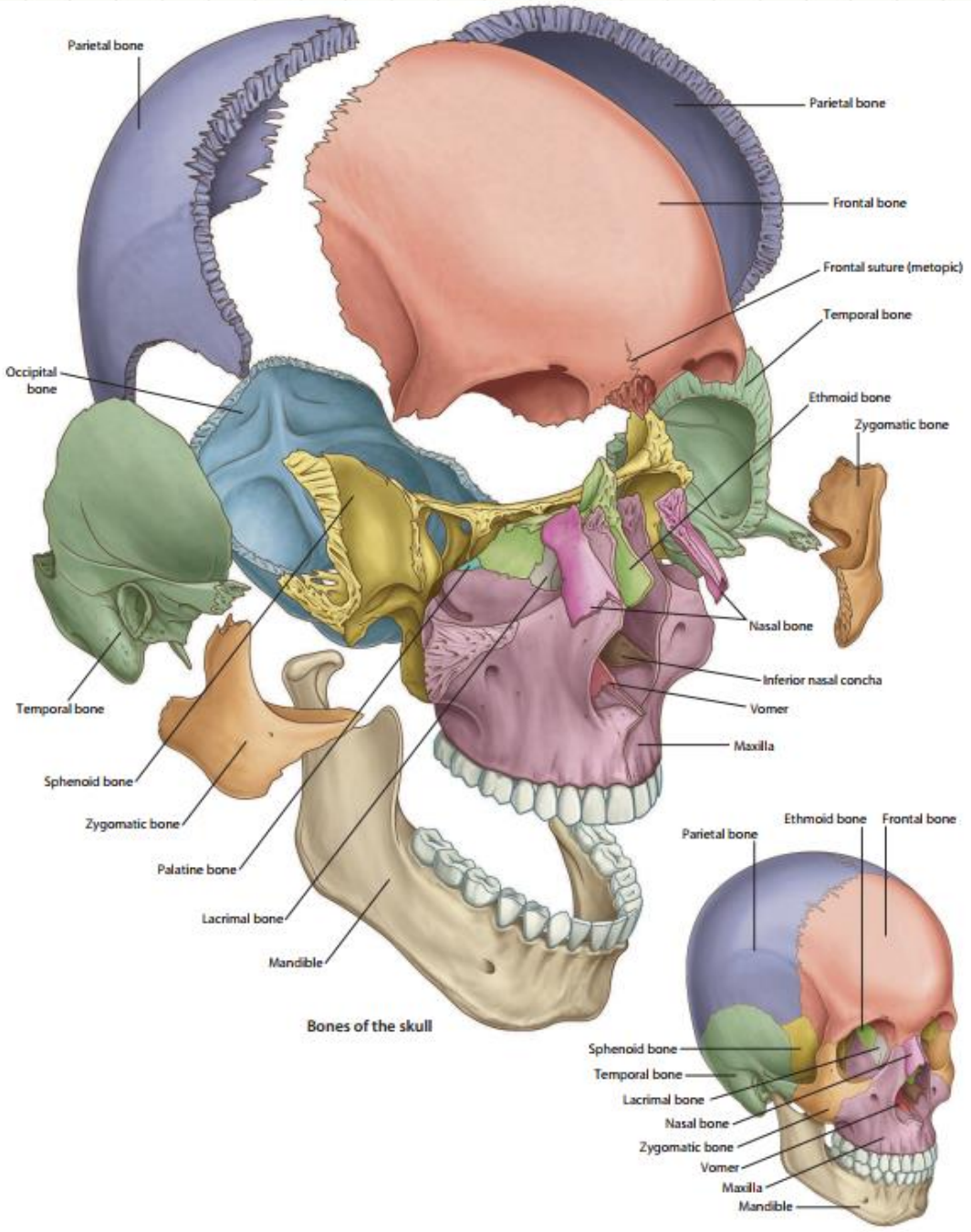


Neuroglia(a little neuron`s helper)

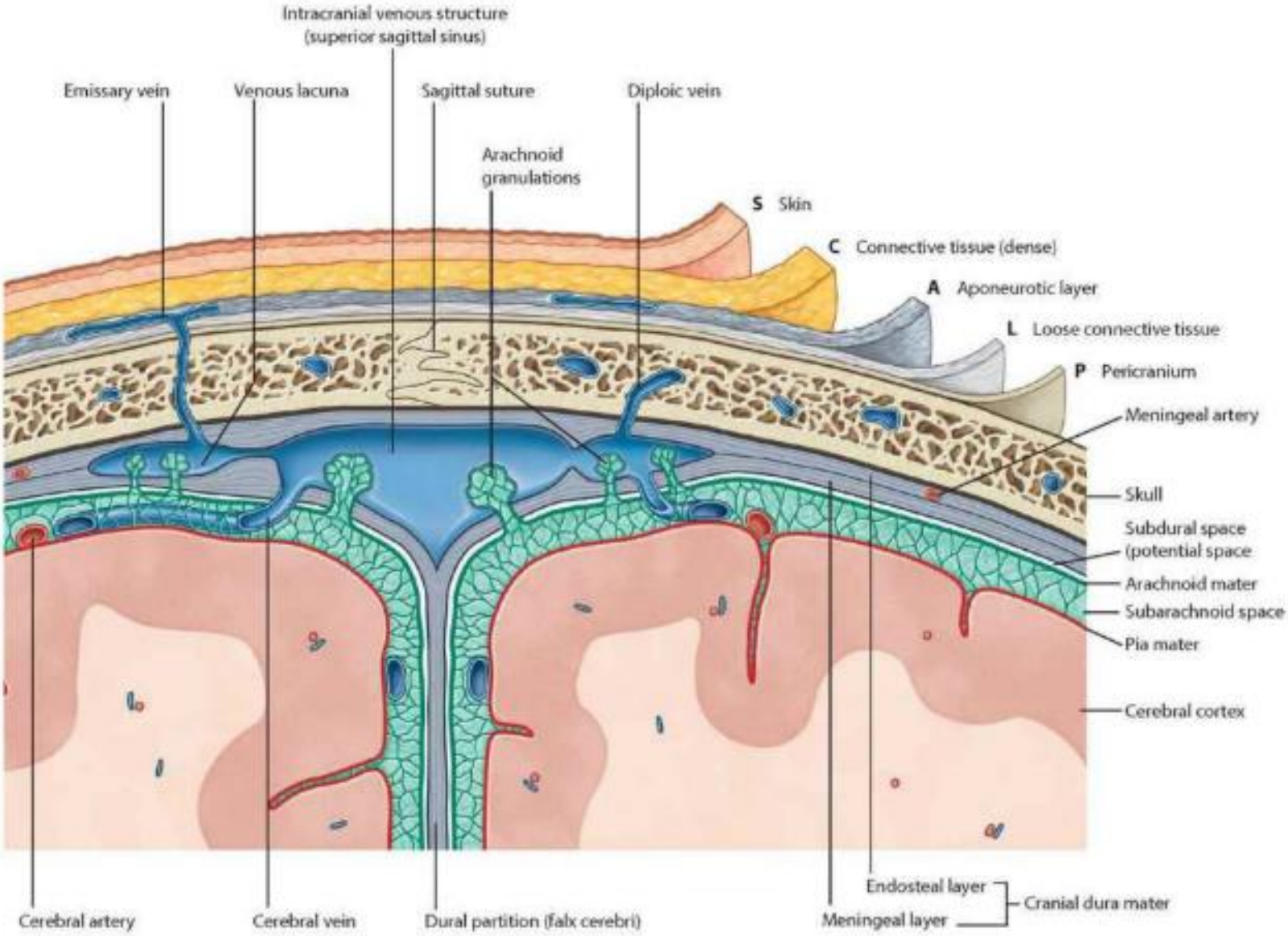
- Types of neuroglia: astroglia (also known as macroglia), oligodendroglia, and microglia



Cranium

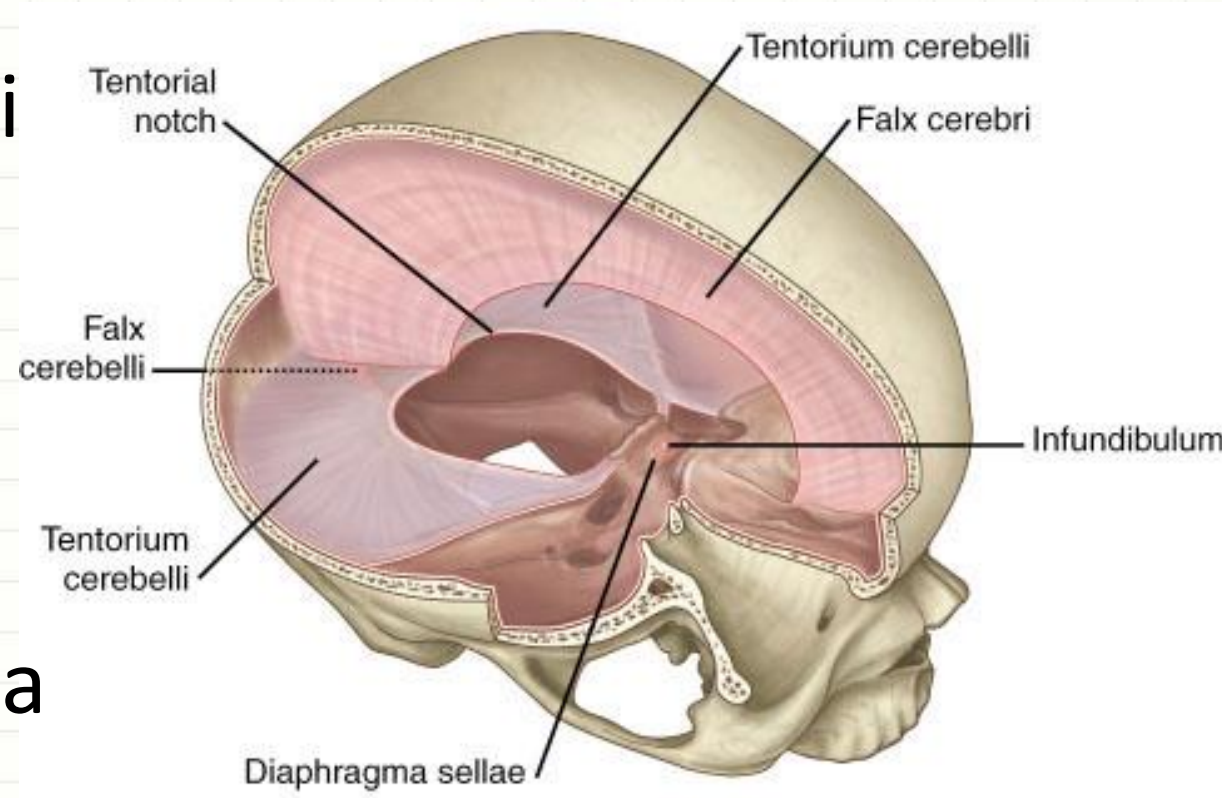

Parietal bone
Parietal bone
Frontal bone
Frontal suture (metopic)
Temporal bone
Occipital bone
Ethmoid bone
Zygomatic bone
Nasal bone
Inferior nasal concha
Vomer
Maxilla
Temporal bone
Sphenoid bone
Zygomatic bone
Palatine bone
Lacrimal bone
Mandible
Bones of the skull
Parietal bone
Ethmoid bone
Frontal bone
Sphenoid bone
Temporal bone
Lacrimal bone
Nasal bone
Zygomatic bone
Vomer
Maxilla
Mandible

Cranium – topographics.

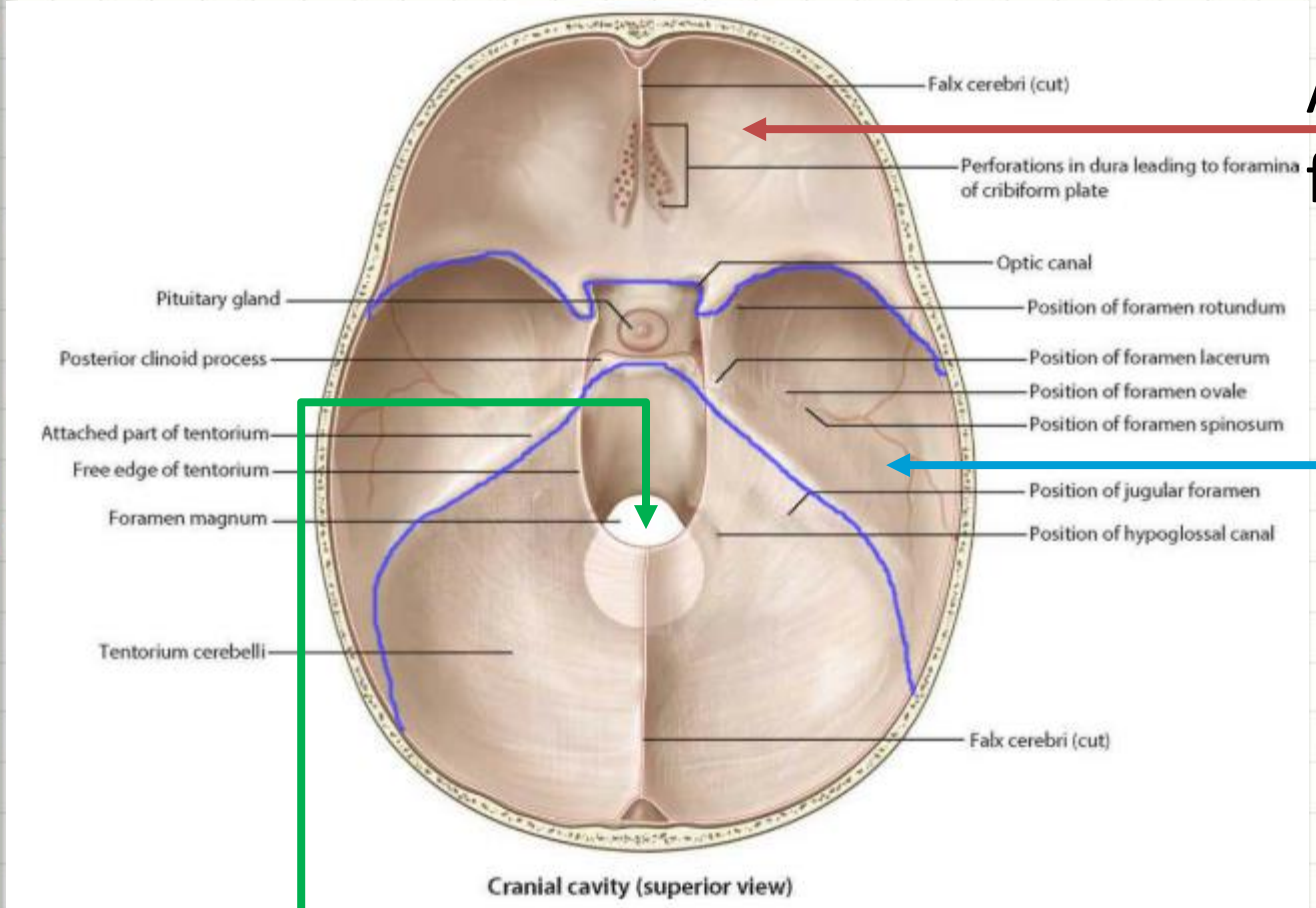


Meninges(duplicatures)

- Falx cerebri
- Tentorium cerebri
- Diaphragma sellae



Basis craniale



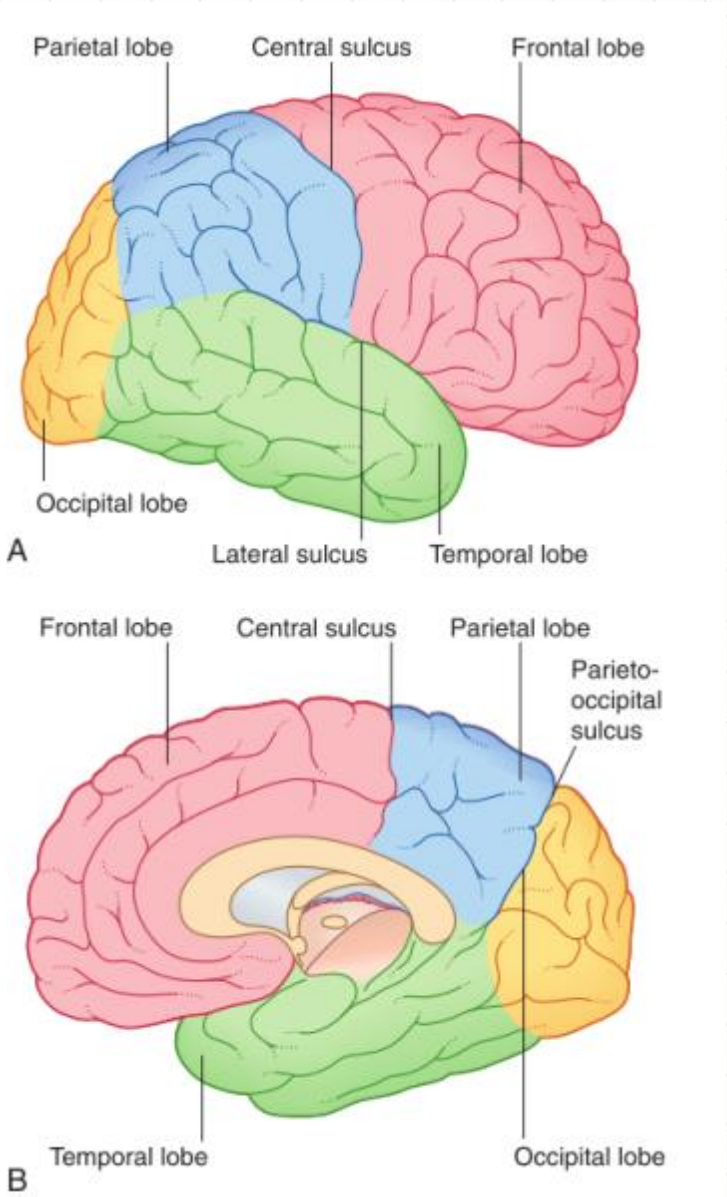
Anterior fossa

Middle fossa

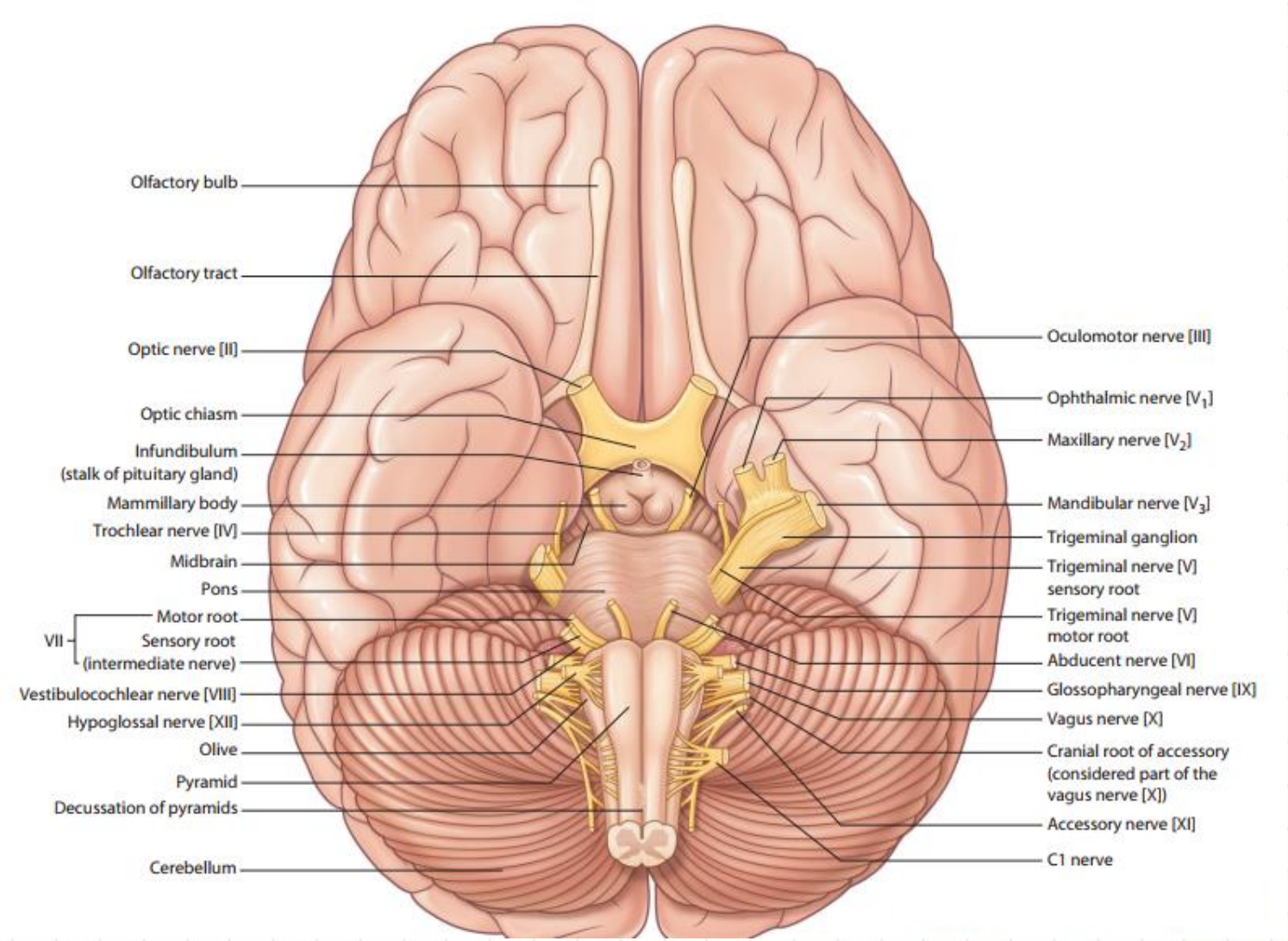
Posterior fossa

CNS: Brain(cortex)

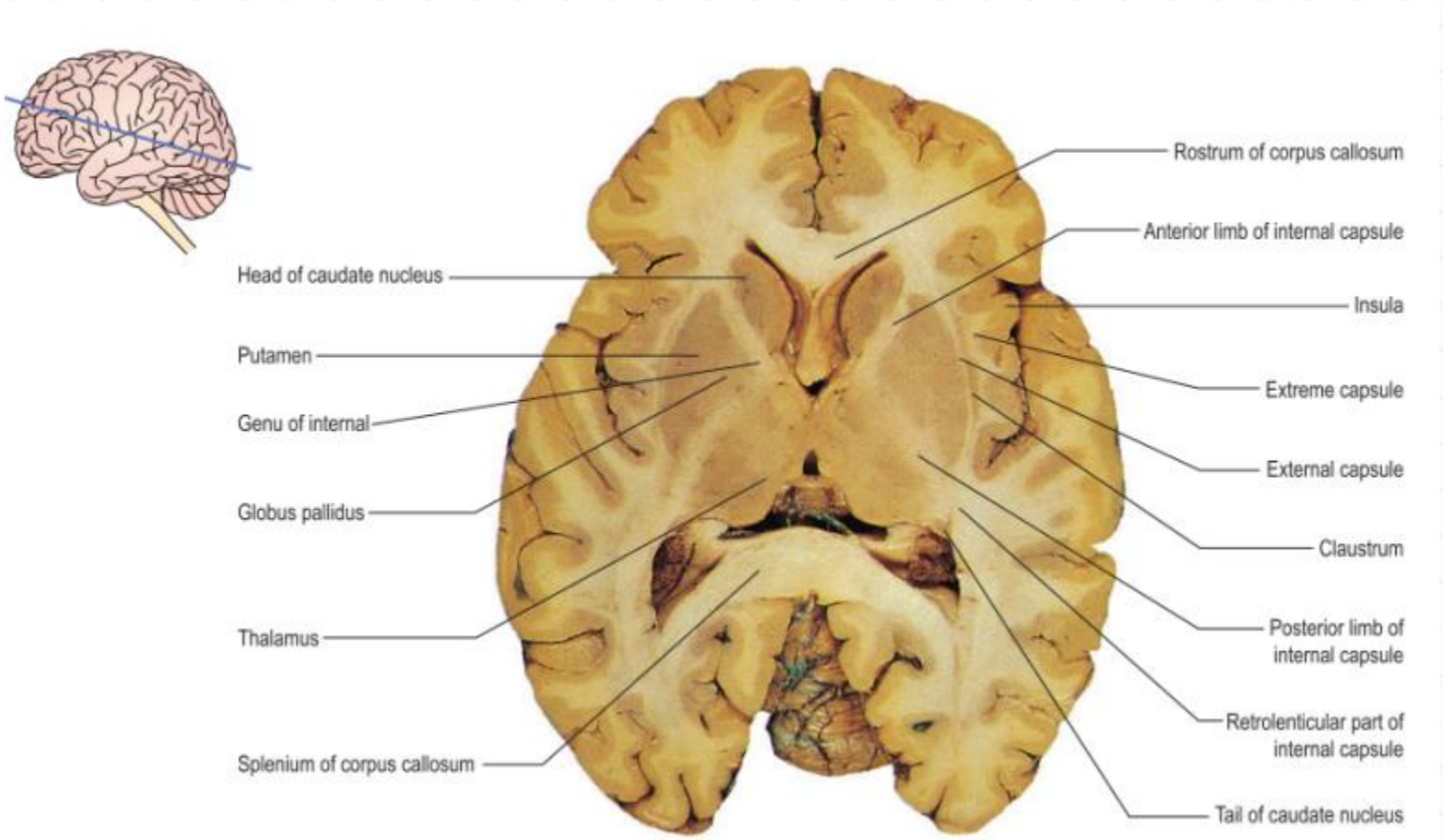
- 2 hemispheres, 4 lobes.
- Externally, the outer surface of the brain, or cerebral cortex, is composed of **6 layers of cell** bodies referred to as gray matter.
- **Frontal lobe** divided from **parietal** by **Rolandic sulcus**(central) and from **temporal** by **Sylvian**(lateral)
- No specific demarcation between parietal and occipital except **parieto-occipital** sulcus on midline



CNS: Basal surface



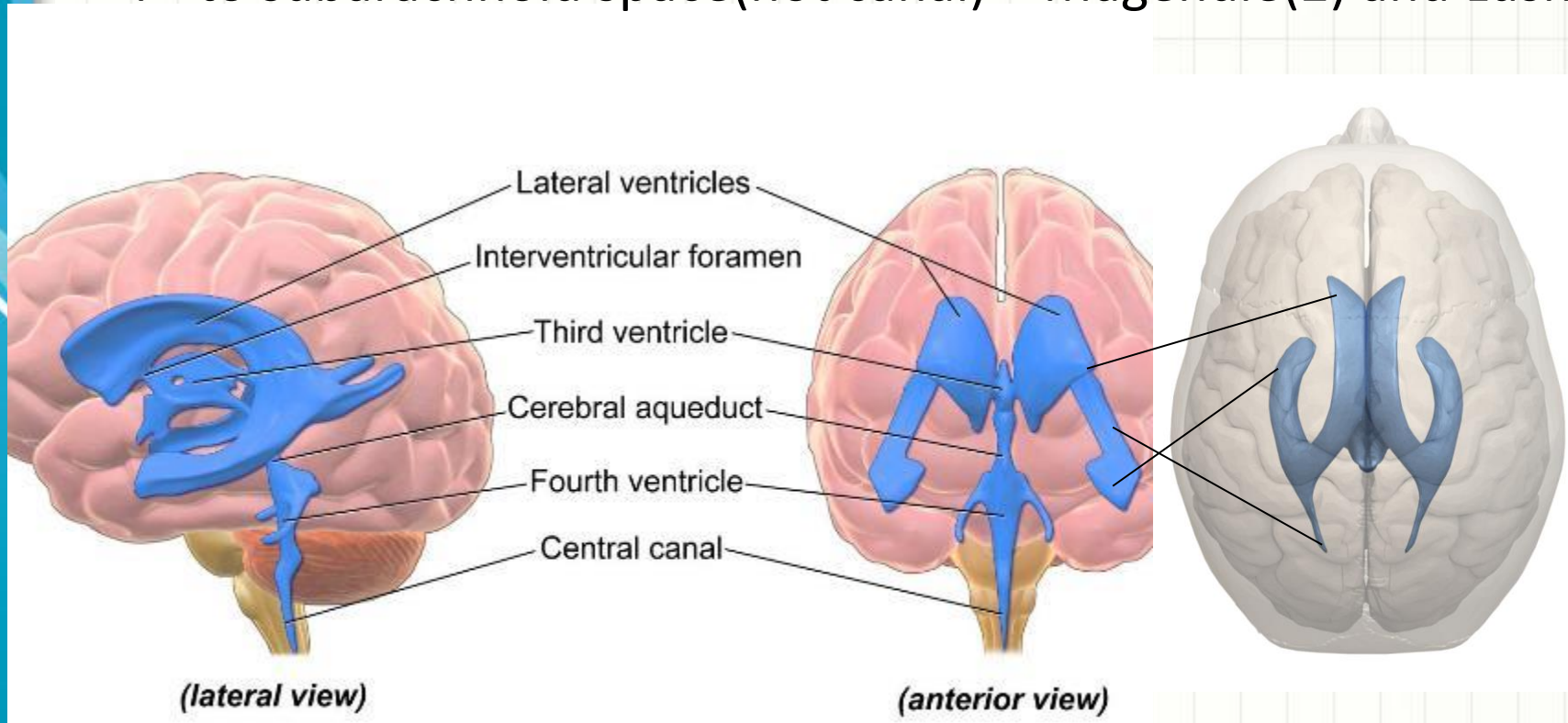
CNS: Subcortical



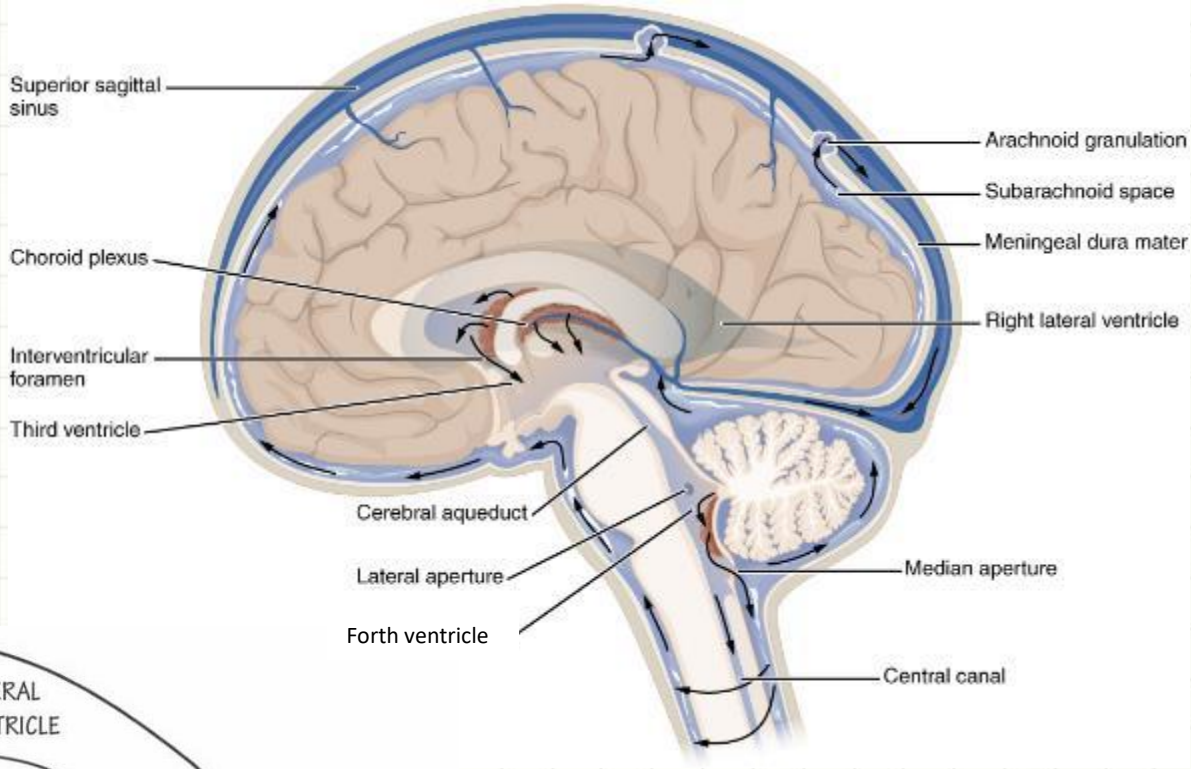
- Gray matter outside(cortex), white matter inside – myelinated axons with drops of greyness

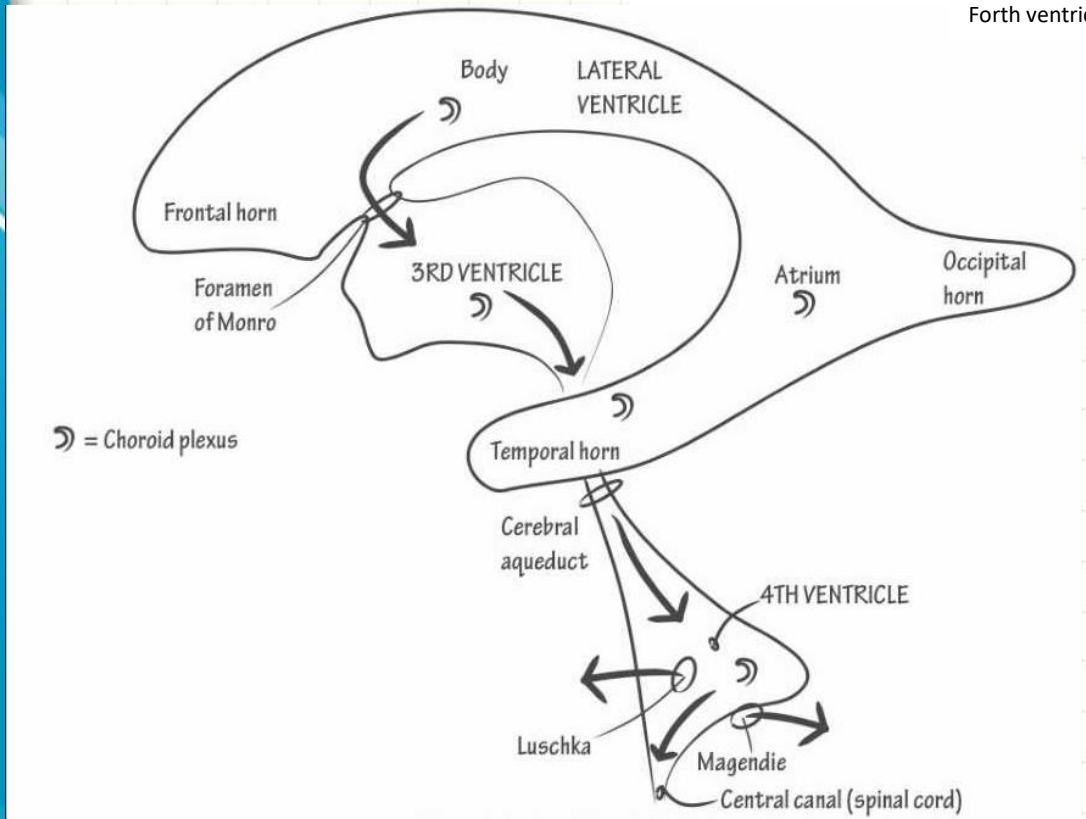
CNS: Ventricles

- 4 ventricles: 2 lateral + 1 third + 1 4th
- Lateral to 3d – through Monroe foramen
- 3d to 4th – Aqueductus Sylvii
- 4th to subarachnoid space(not canal) – Magendie(2) and Lushka(1)



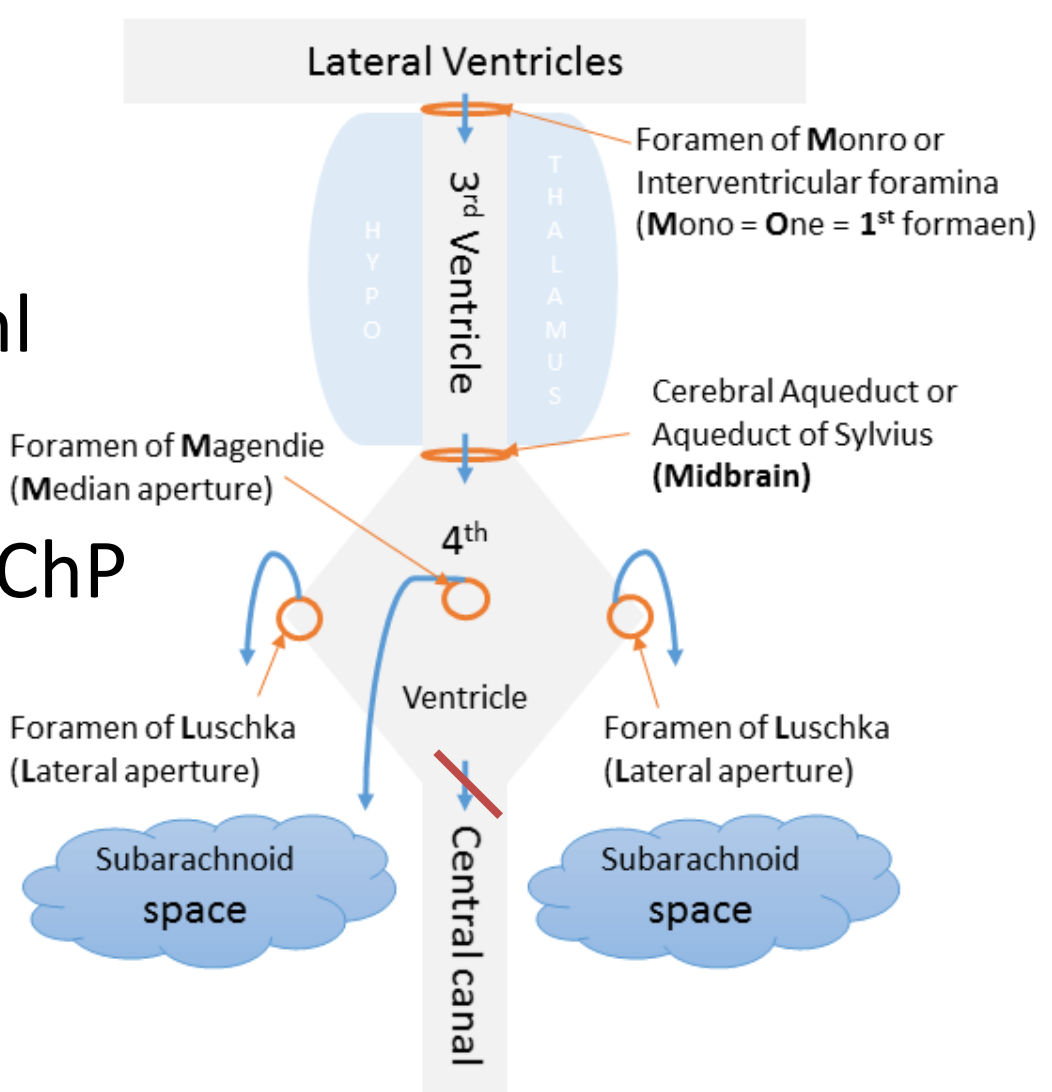
CNS: CSF


Superior sagittal sinus
Arachnoid granulation
Subarachnoid space
Meningeal dura mater
Choroid plexus
Right lateral ventricle
Interventricular foramen
Third ventricle
Cerebral aqueduct
Lateral aperture
Median aperture
Forth ventricle
Central canal

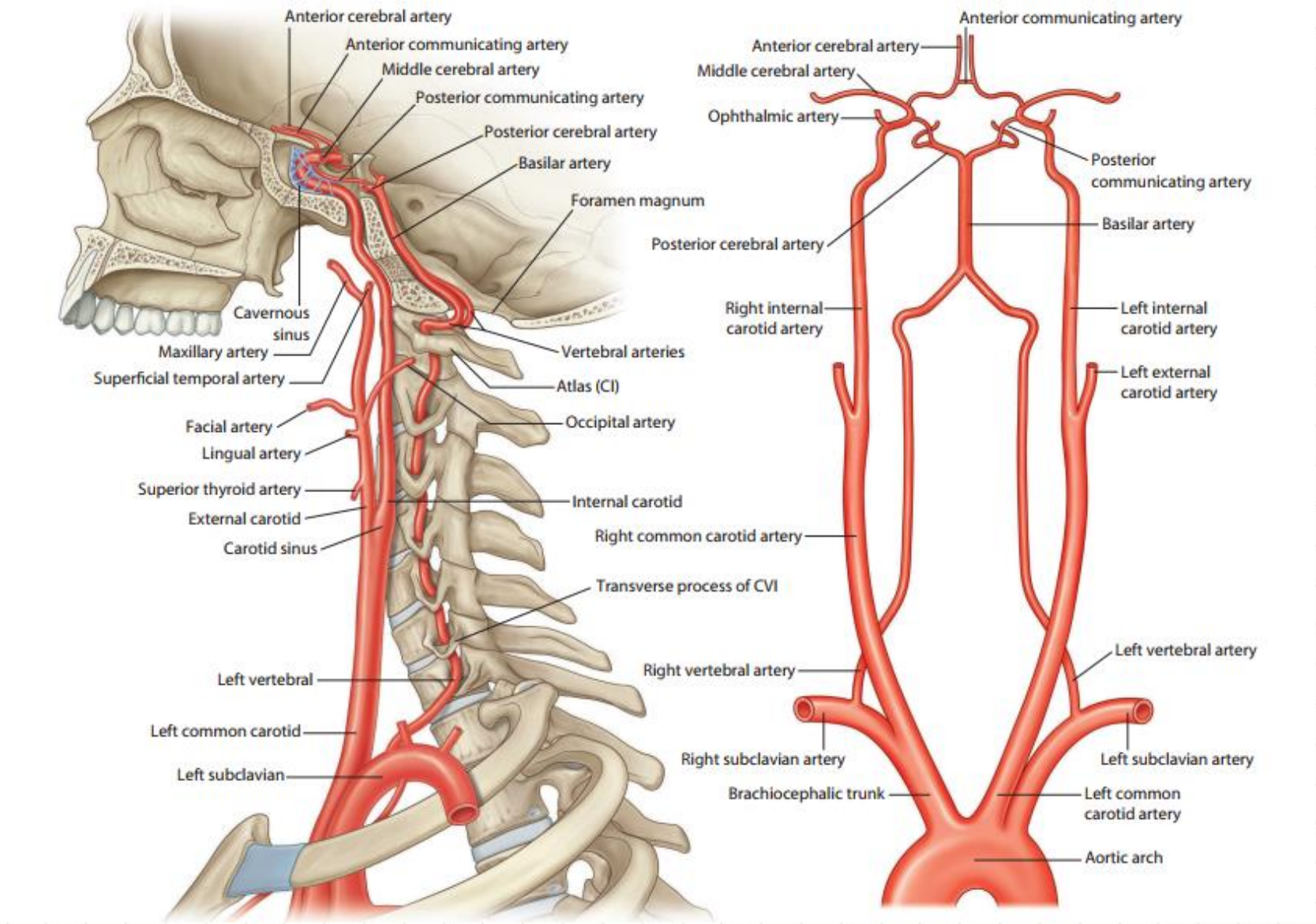

Body
LATERAL VENTRICLE
Frontal horn
Foramen of Monro
3RD VENTRICLE
Atrium
Occipital horn
= Choroid plexus
Temporal horn
Cerebral aqueduct
4TH VENTRICLE
Luschka
Magendie
Central canal (spinal cord)

CNS: CSF

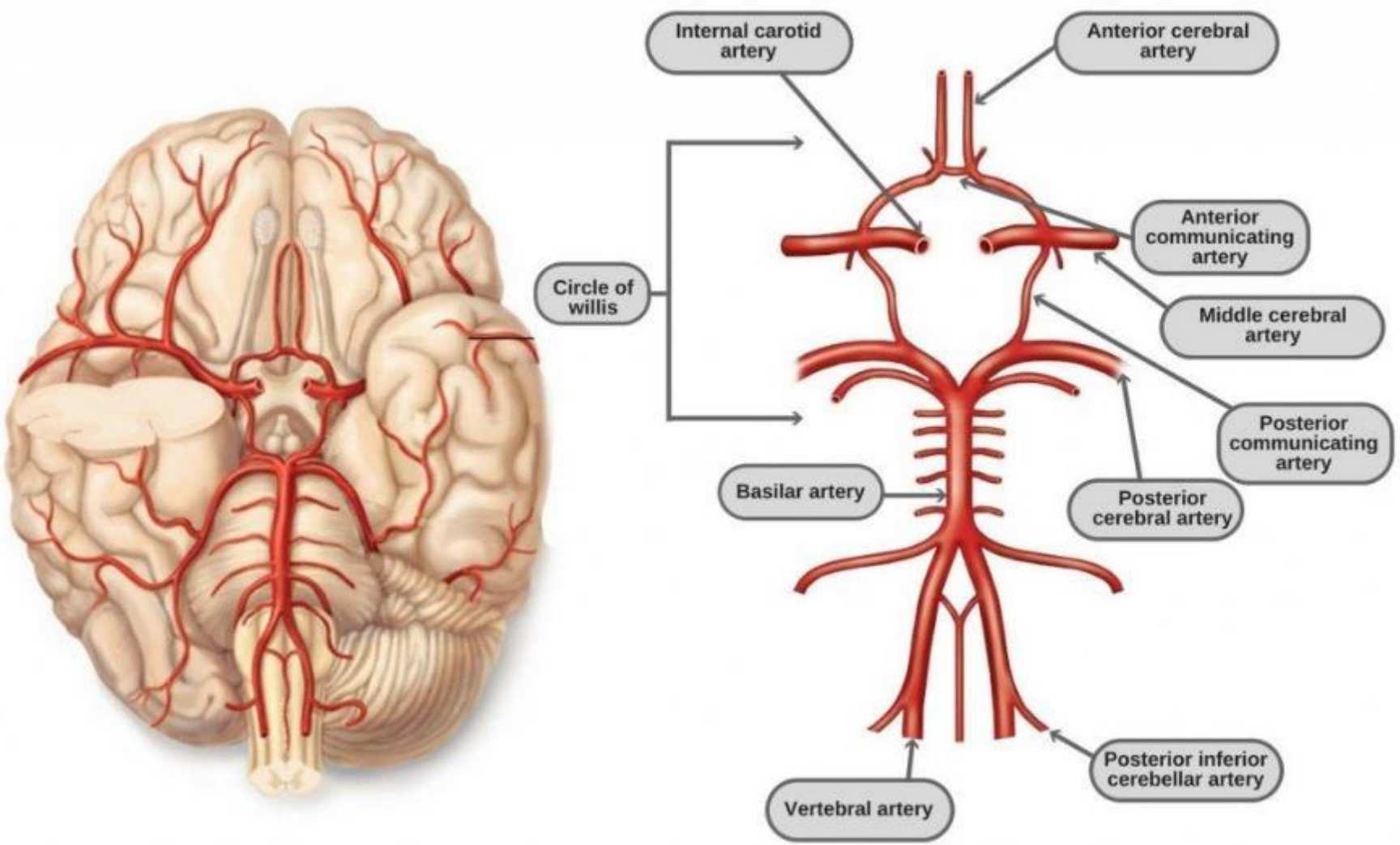
- Circa 500ml/d
- About 125–150 ml
- 80% produced in ChP
- Normal pressure 10–30 cmH2O



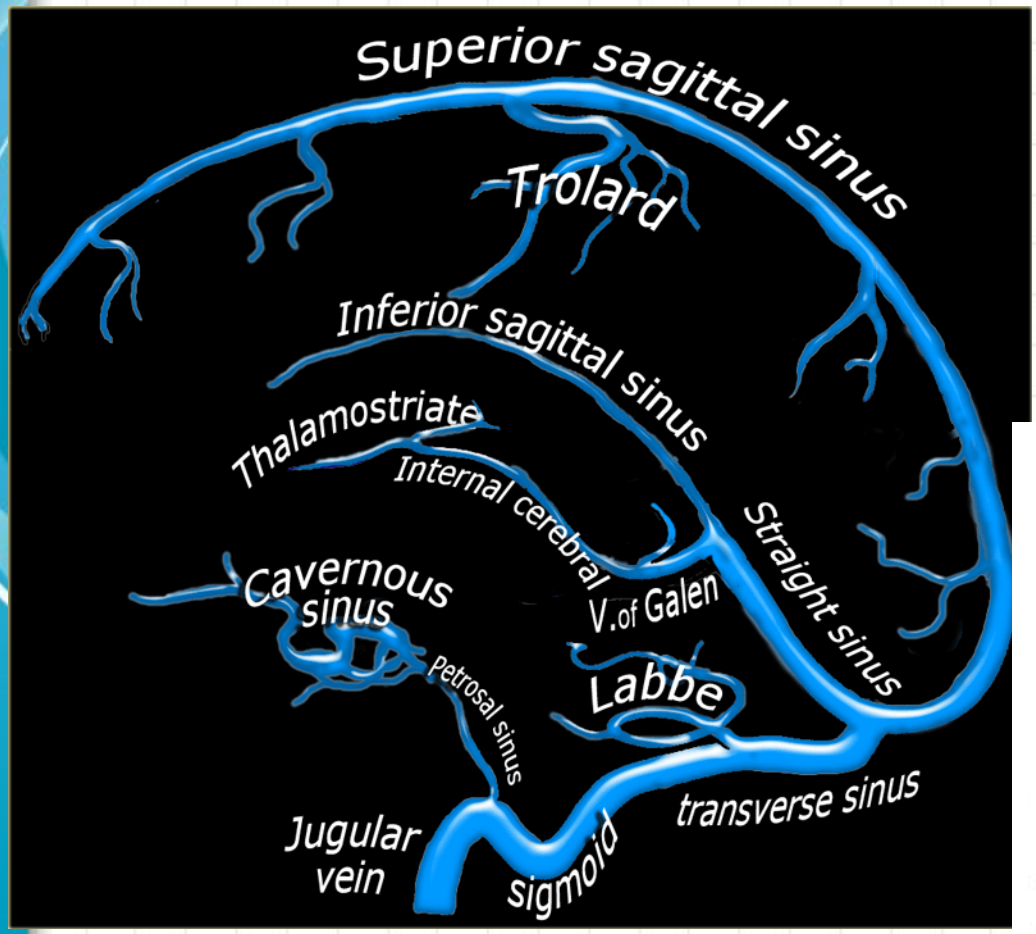
Cerebrum: Arteries(extracranial part)

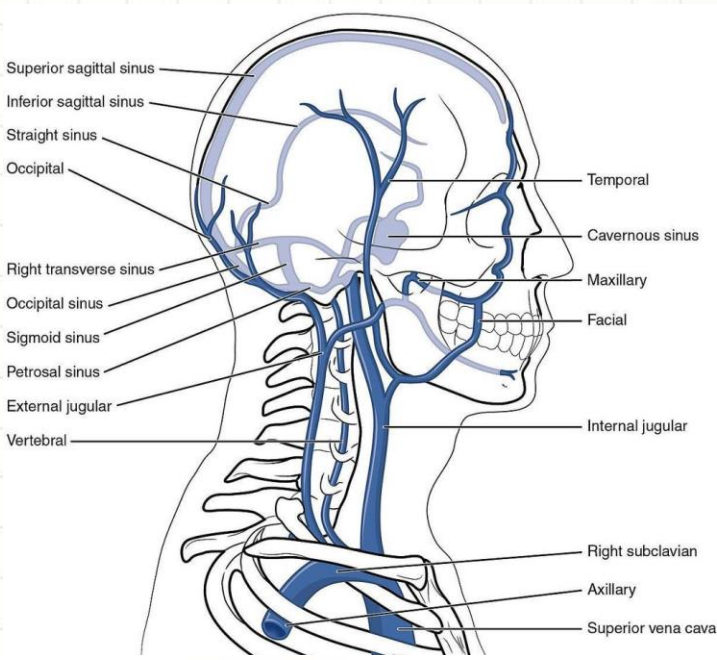


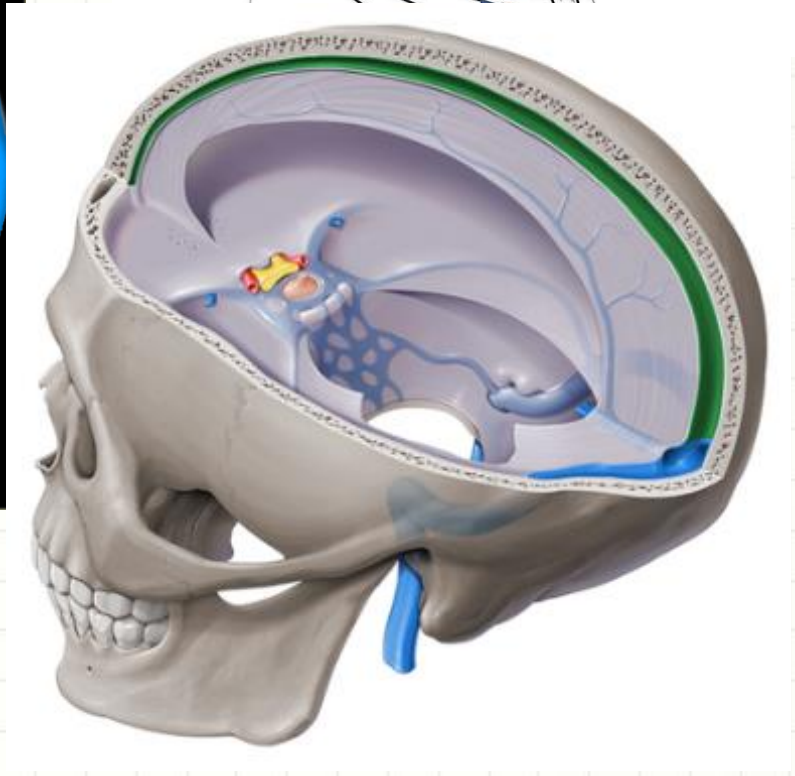
Cerebrum: Arteries(intracranial part)



CNS: Veins

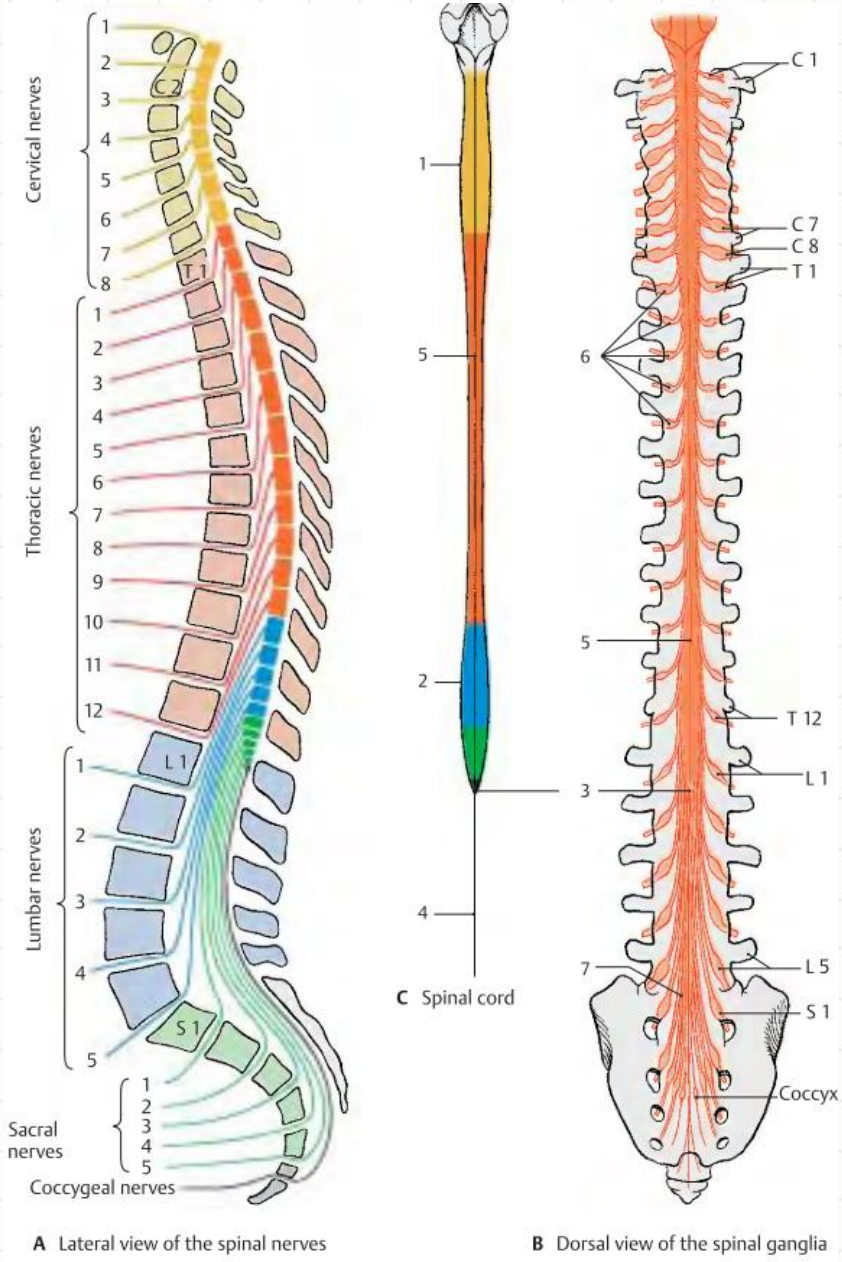

Superior sagittal sinus
Trolard
Inferior sagittal sinus
Thalamostriate
Internal cerebral
V. of Galen
Straight sinus
Cavernous sinus
Petrosal sinus
Labbe
Jugular vein
Sigmoid
transverse sinus


Superior sagittal sinus
Inferior sagittal sinus
Straight sinus
Occipital
Right transverse sinus
Occipital sinus
Sigmoid sinus
Petrosal sinus
External jugular
Vertebral
Temporal
Cavernous sinus
Maxillary
Facial
Internal jugular
Right subclavian
Axillary
Superior vena cava



CNS: Spinal cord

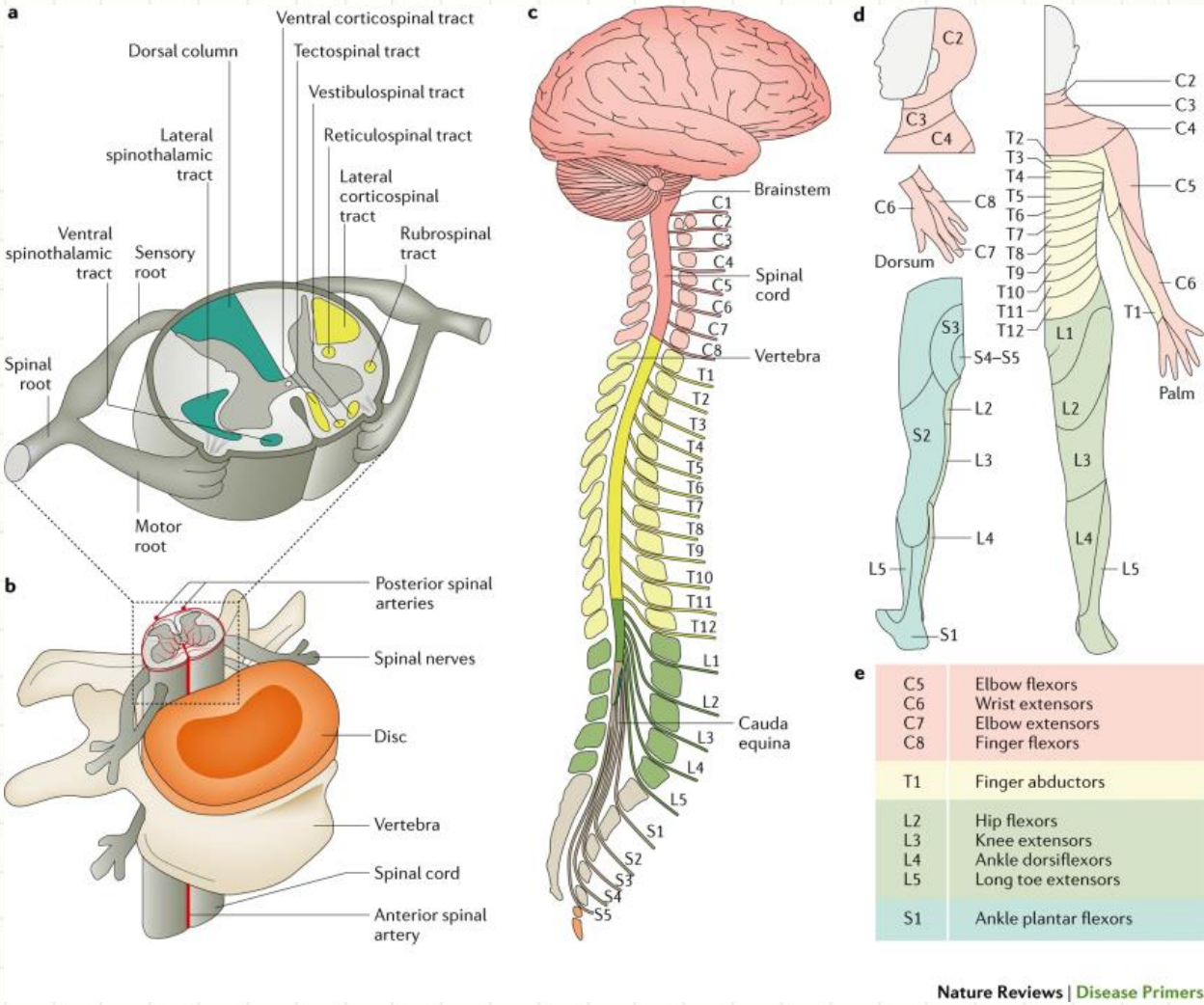
- 8 pairs of cervical nerves (C1–C8) (the first pair emerges between occipital bone and atlas)
- 12 pairs of thoracic nerves (T1–T12) (the first pair emerges between the first and second thoracic vertebrae
- 5 pairs of lumbar nerves (L1–L5) (the first pair emerges between the first and second lumbar vertebrae)
- 5 pairs of sacral nerves (S1–S5) (the first pair emerges through the upper sacral foramina)
- one pair of coccygeal nerves (emerging between the first and second coccygeal vertebrae)



A Lateral view of the spinal nerves
B Dorsal view of the spinal ganglia

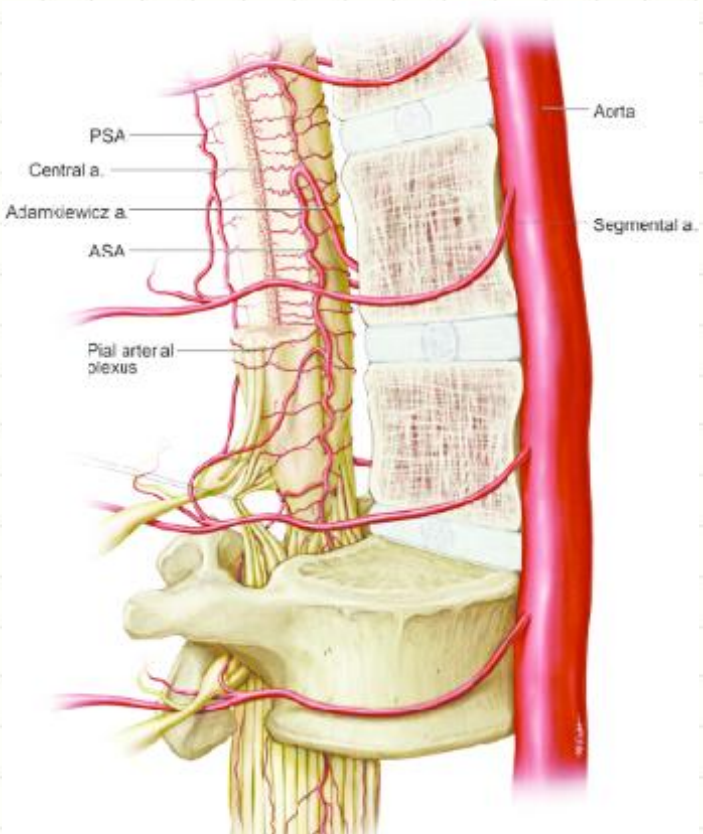
CNS:Spinal cord

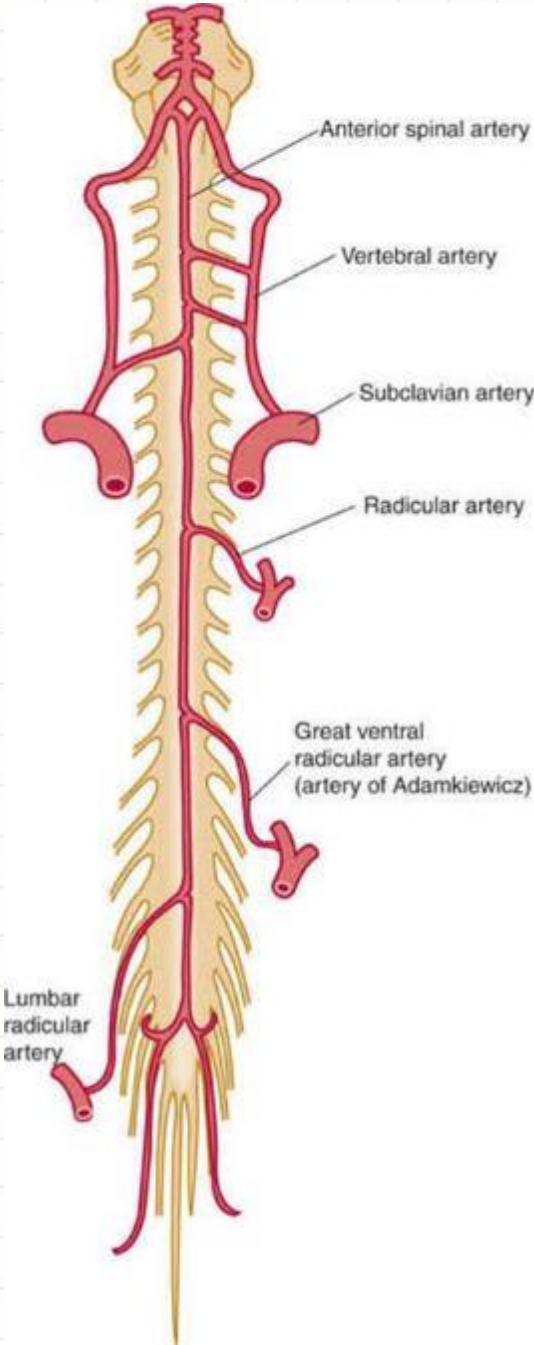
- CSF flows over the spinal cord
- Anterior – motor
- Posterior - sensory



CNS:Spinal cord(arteries)

- The main blood supply to the spinal cord is via the single anterior spinal artery (ASA) and the two posterior spinal arteries (PSA).
- Main radicular suppliers are:
  - Vertebral a.
  - Adamkiewicz a.
  - Lumbar a.(aka Desproges-gotteron)

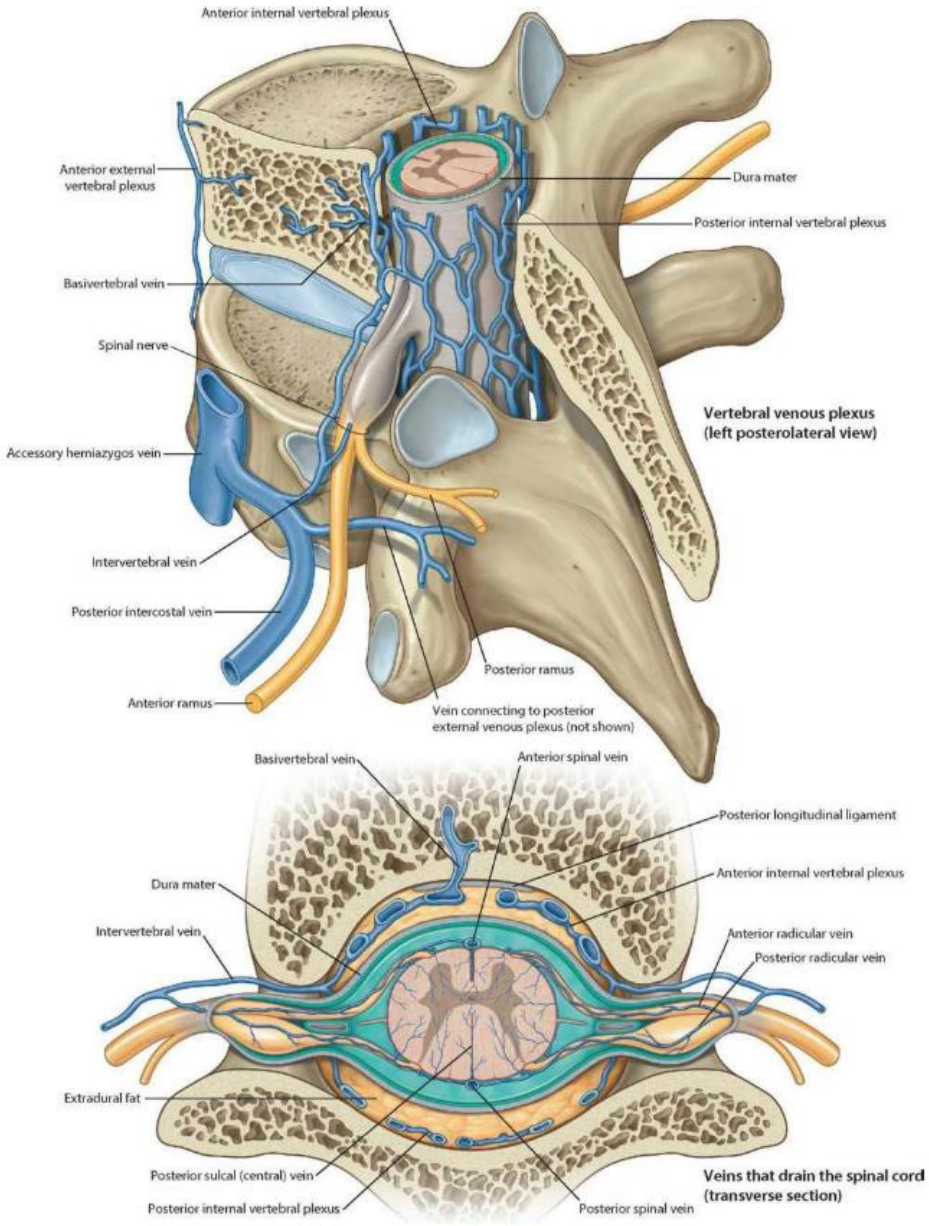




CNS:Spinal cord(veins)

The spinal cord blood is drained by two major veins: the dorsal spinal and the ventral spinal veins .

- The **dorsal spinal vein** runs along the dorsal median sulcus. Drains into spinal branches of the vertebral, intercostal, lumbar and sacral veins.
- The **ventral spinal vein** runs throughout the ventral median fissure Drains in ventral radicular branches.
- The veins of the spinal cord are connected to vertebral venous plexuses. These venous plexuses do not have valves and they communicate with the dural sinuses(**Batsons plexus** f.exmpl).



Tea time….

Investigations in neurosurgery

- **NONINVASIVE**
  - **Cause No Harm**

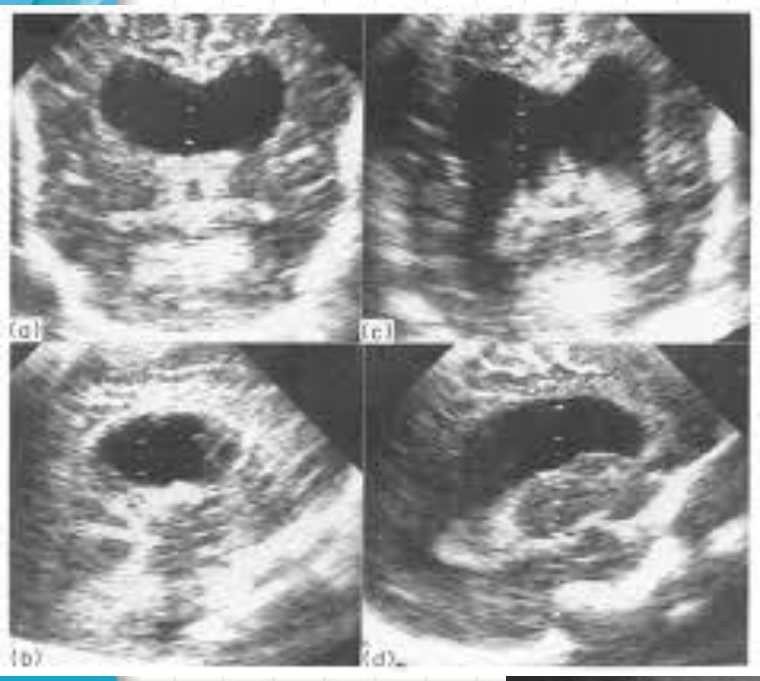
- **INVASIVE**
  - **Cause Some Harm**

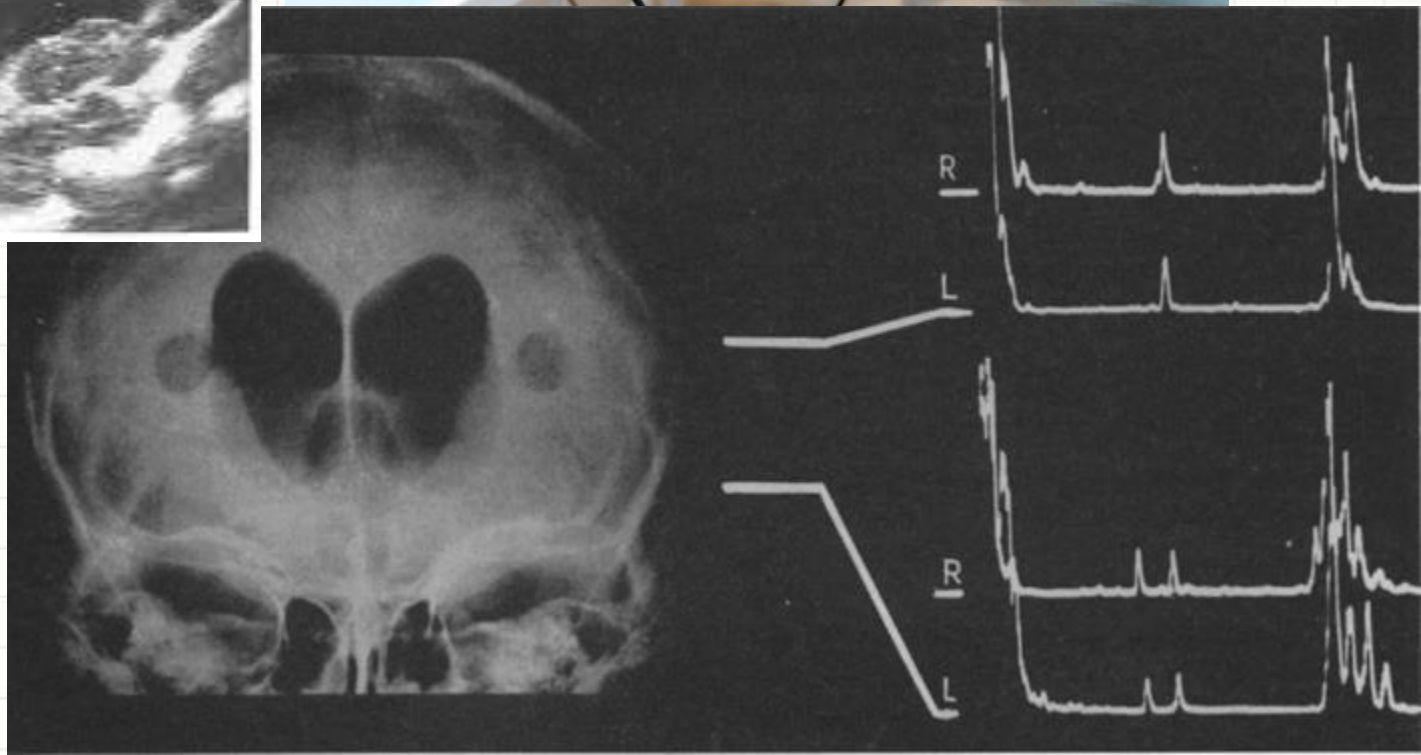
- **AUXILIARY**
  - **Ask a colleague…**

Noninvasive

- **Ehoencephalography;**
- **Transcranial Doppler sonography;**
- **Electroencephalography;**
- **Electroneuromyography;**
- **Radiography of the skull and spine(aka X-Ray);**
- **Computed tomography of the brain and spine (with contrast);**
- **Magnetic resonance imaging of the brain and spinal cord (with contrast);**

Echoencephalography

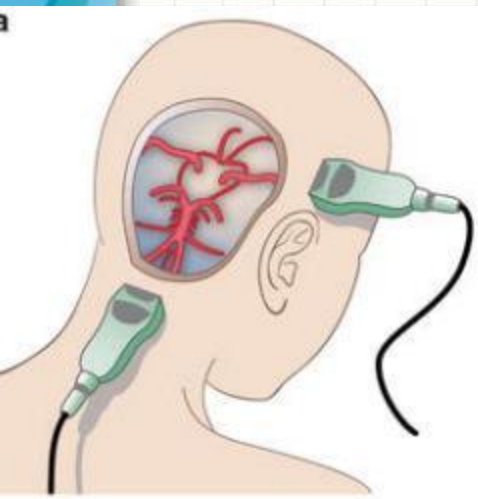


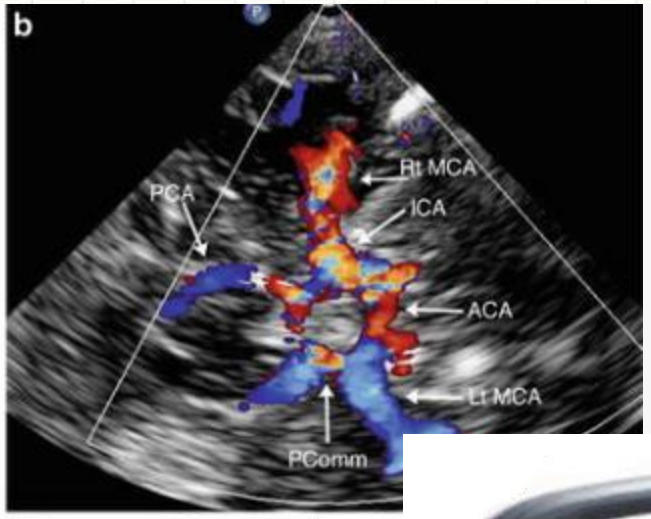


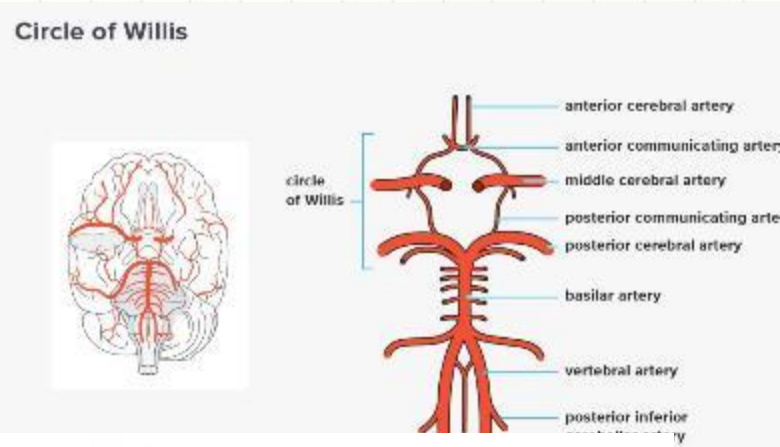
Echoencephalography

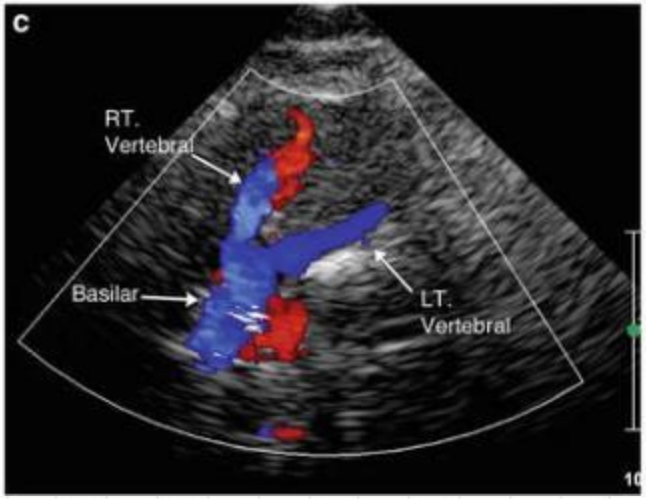
- Was developed in 1950s, but still useful today
- At first it was possible only to detect midline shift(and that's what is possible today, in adult population)
- Intracranial ultrasound is now ubiquitous in neonatal ICU while it is safe, quick, cheap and can help to diagnose brain lesions quickly

Transcranial Doppler sonography





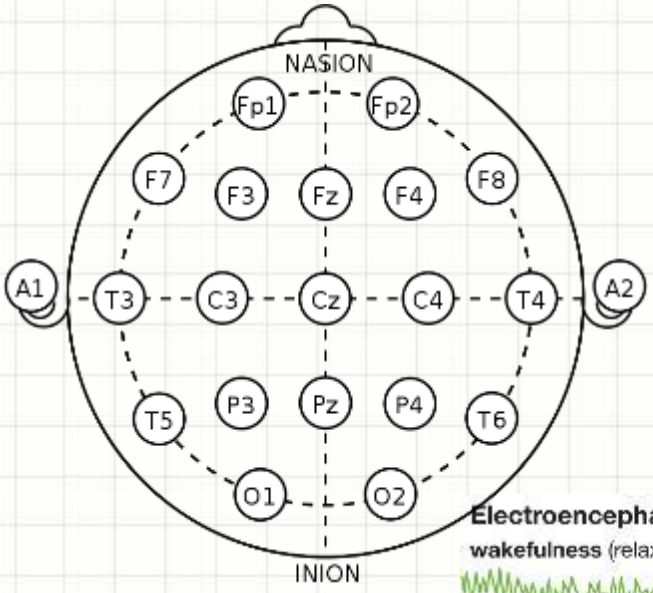


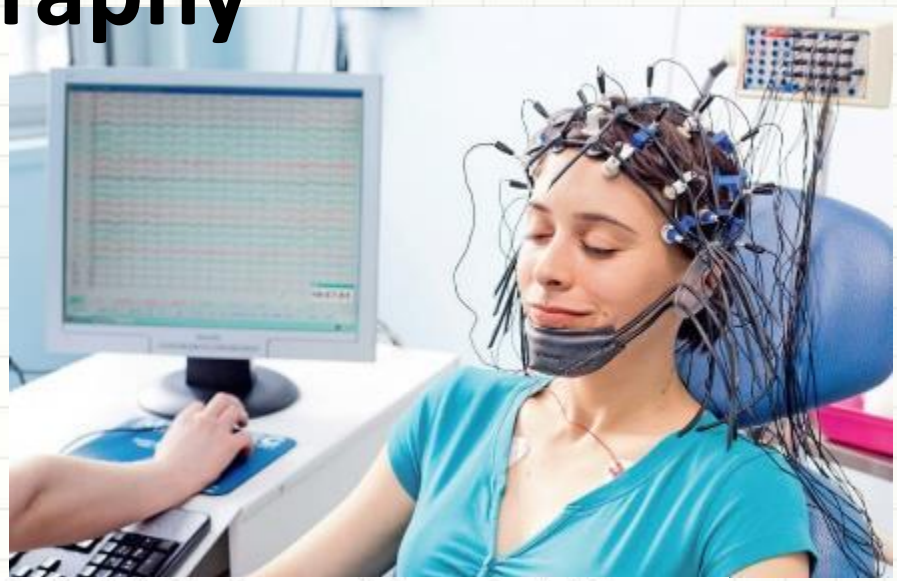


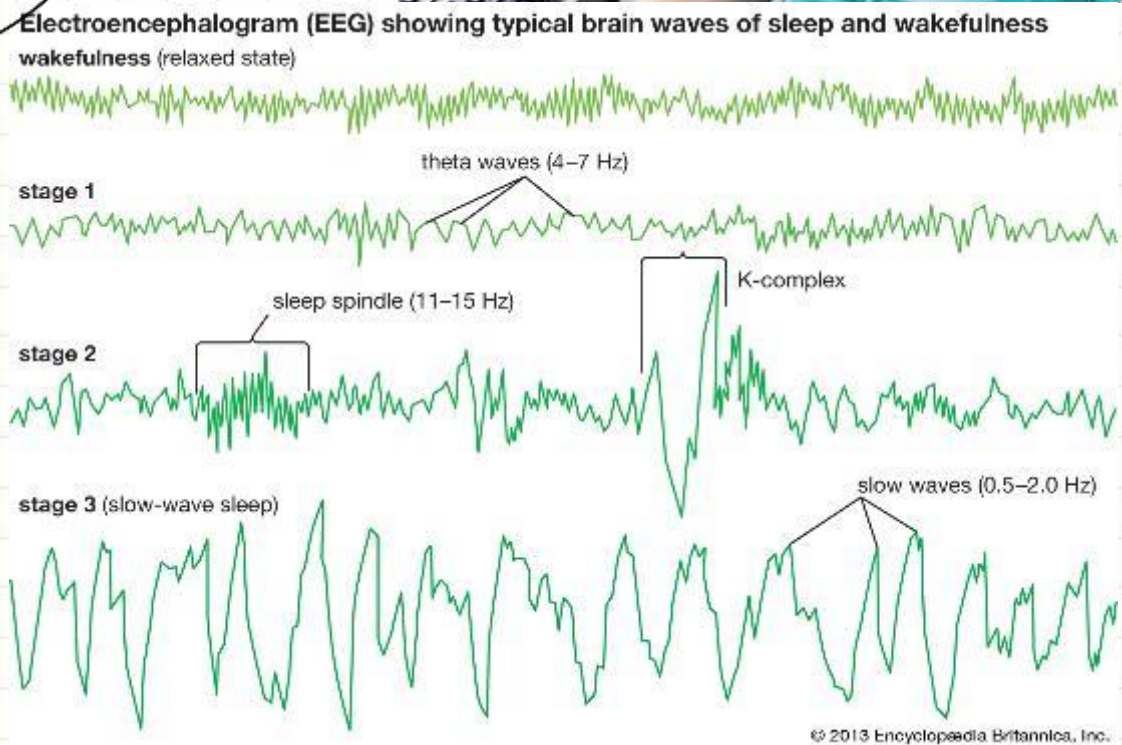
Transcranial Doppler sonography

- first described in 1982
- low-frequency (≤2 MHz) transducer probe
- used to measure cerebral blood flow velocity (CBF-V) in the major intracranial arteries
- Current applications:
  - vasospasm
  - intra- and extracranial arterial stenosis and occlusion
  - brain stem death
  - head injury
  - raised intracranial pressure (ICP)
  - impaired vasomotor function
  - cerebral microembolism in right to left cardiac shunts (bubble test).

Electroencephalography





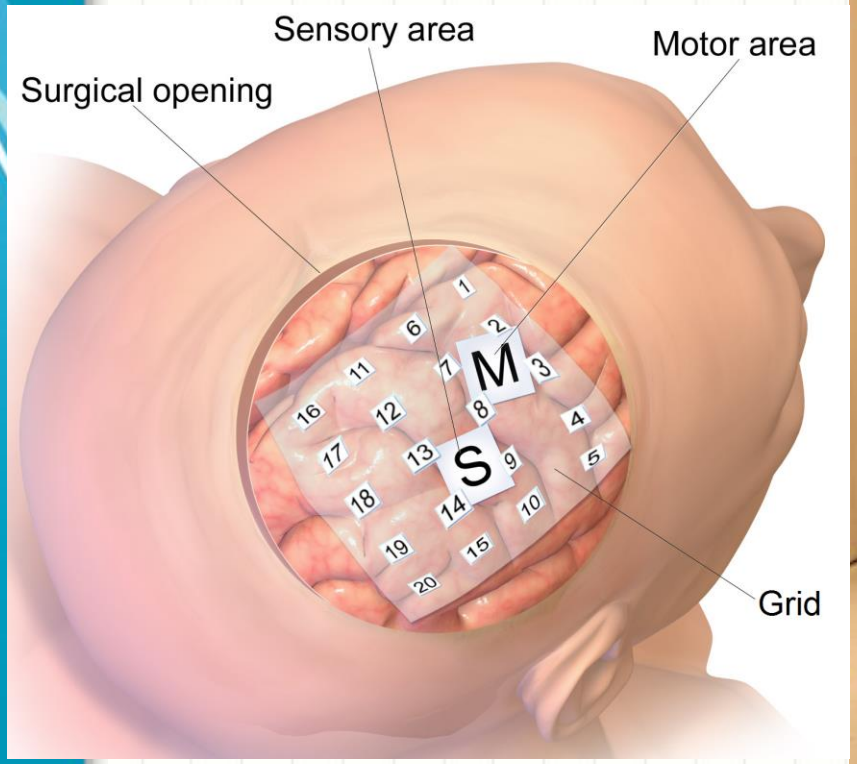


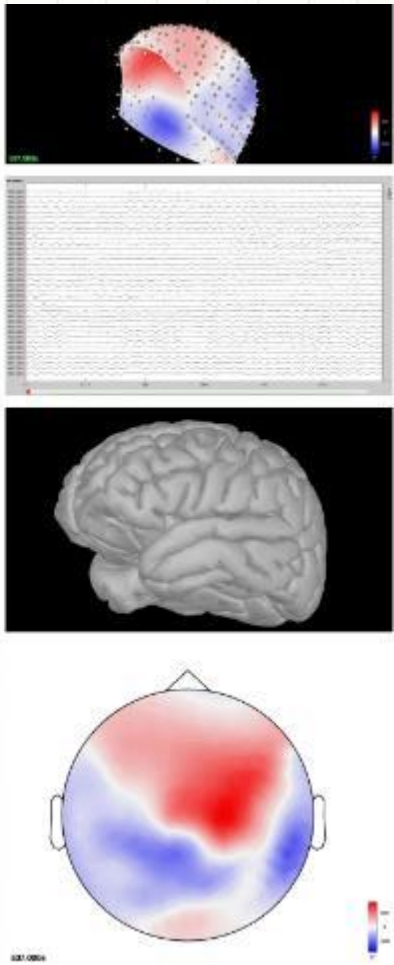
Electroencephalography

- In 1929 German scientist Hans Berger published the results of the first study to employ an electroencephalograph
- technique for recording and interpreting the electrical activity of the brain.
- Useful for assesing;:
  - serious head injuries
  - brain tumours
  - cerebral infections
  - sleep disorders
  - epilepsy
  - degenerative diseases of the nervous system.

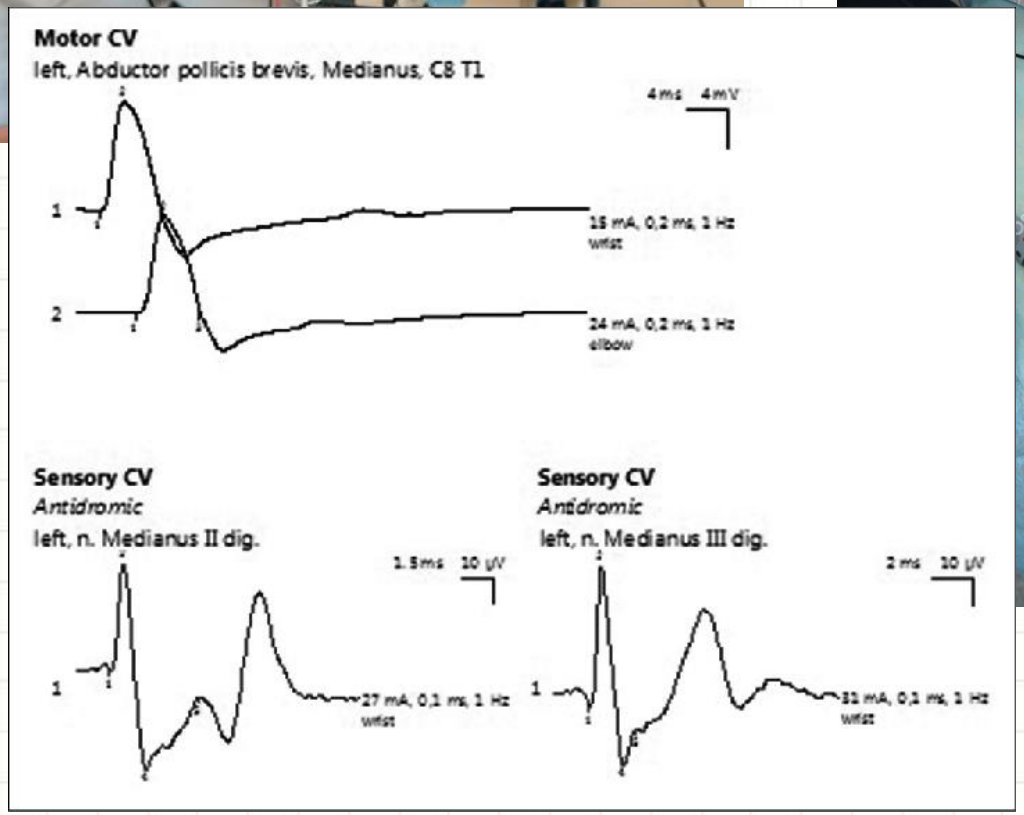
Electroencephalography and…

- Magnetoencephalography
- Electrocorticography





Electroneuromyography(ENMG)



ENMG

- Actually…two different methods
  - **Electroneurography (ENG)**
    - investigates periferal nerve
    - nerves are stimulated using surface electrodes
    - measurements are taken of the speedof electrical signal through nerve and the strength of nerve stimulation in the corresponding muscle.

ENMG

- Actually…two different methods
  - **Electromyography (EMG)**
  - used to record electrical activity in a muscle
  - thin needle electrodes are inserted directly into the muscle
  - Helps determine whether muscle weakness is due to the muscle itself being diseased or whether the flow of information from the nerve to the muscle is disrupted.

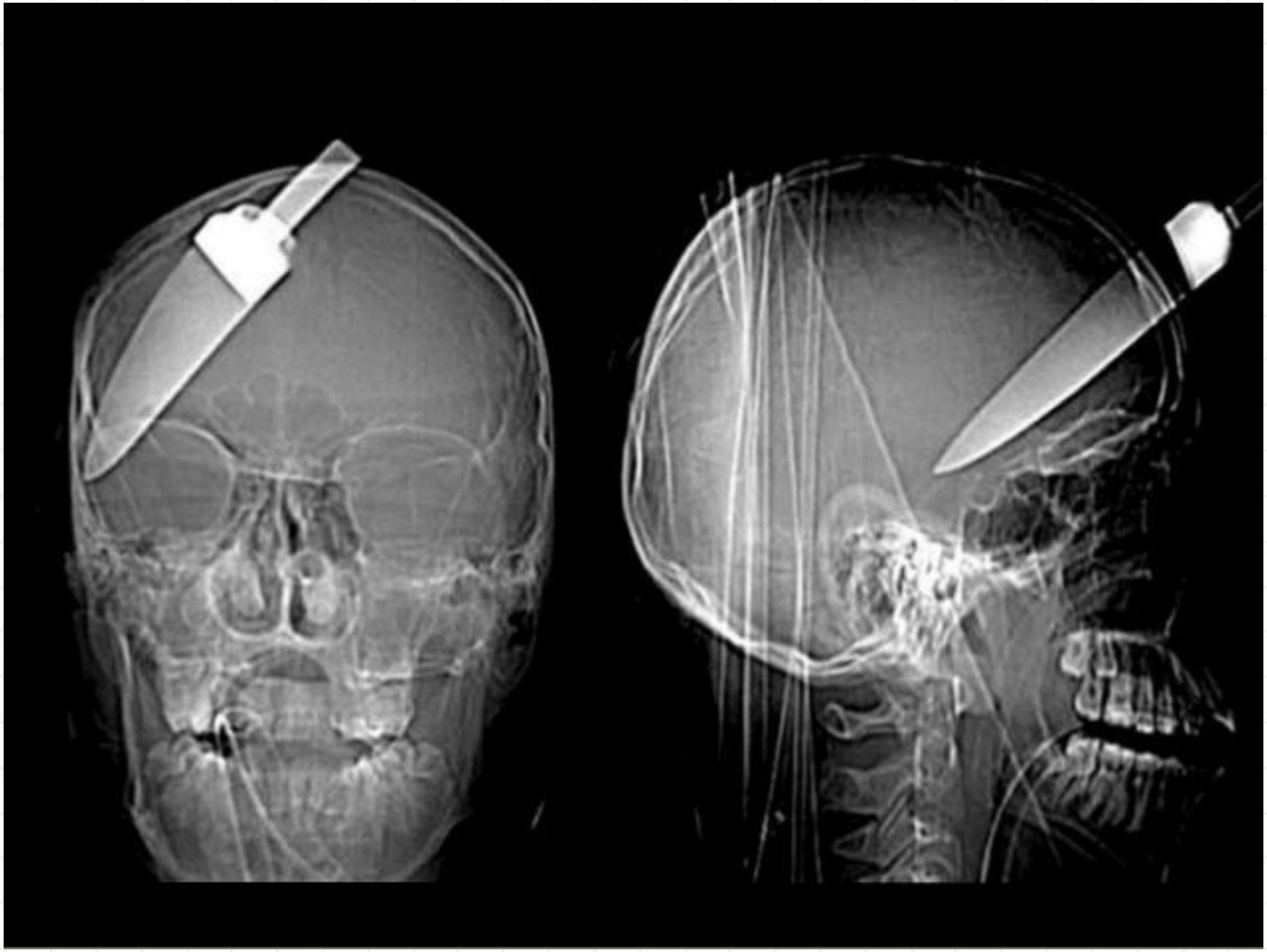
Radiography of the skull and spine(aka X-Ray)

Cranial X-Ray (findings)

1. Direct signs:
    1. Fracture
    2. Foreign object
    3. Ossifications(tumors, prasites, calcified vessels etc.)
2. Indirect signs
    a. Sella turc. deformation(adenoma)
    b. Convolutional markings (increased intracranial pressure)

Linear fractures

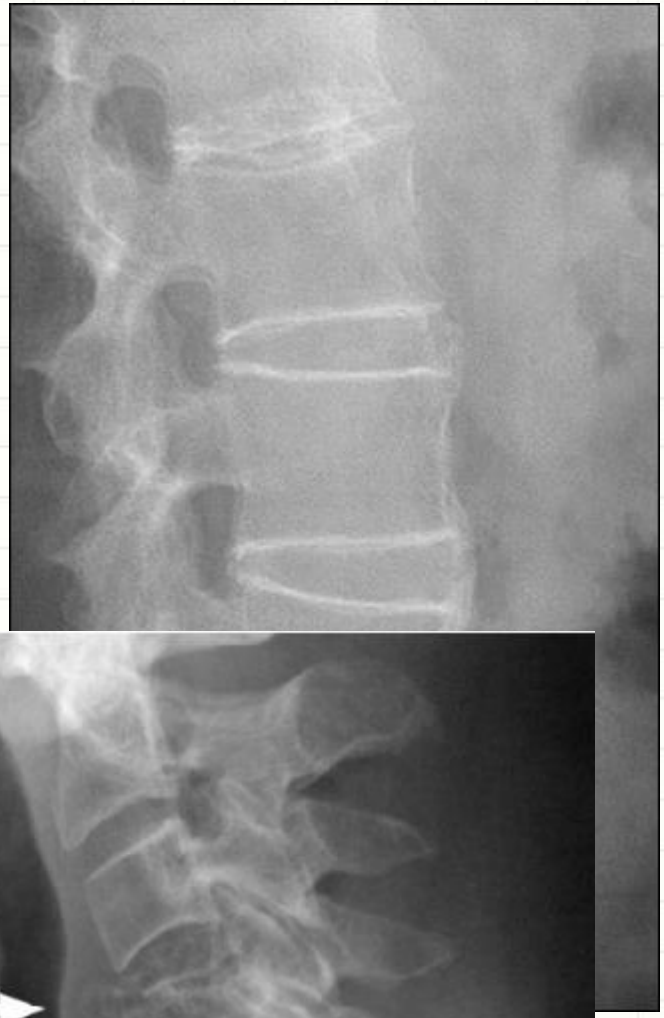
Foreign object



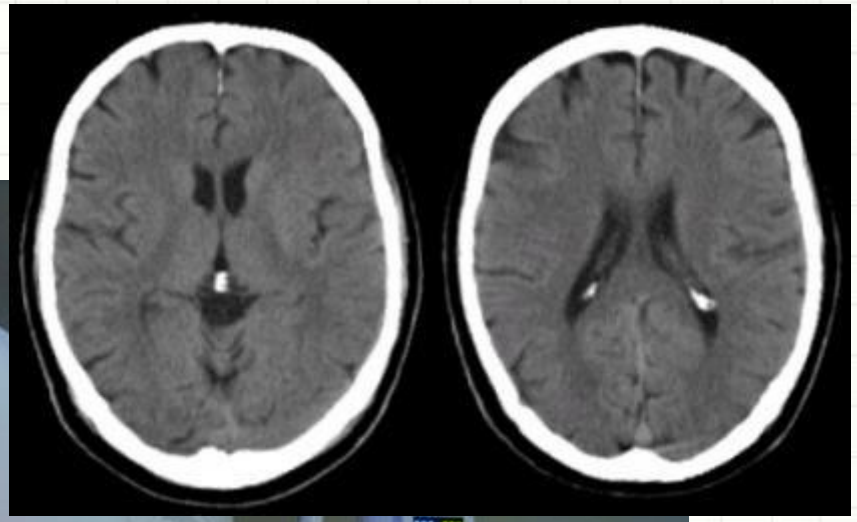
Ossified subdural haematoma

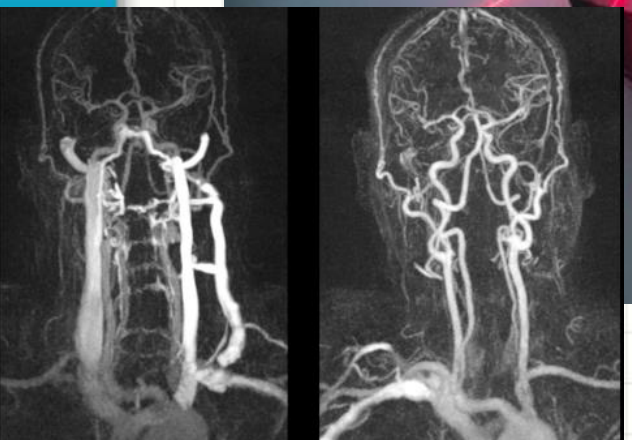
Copper beaten skull

Spine x-ray



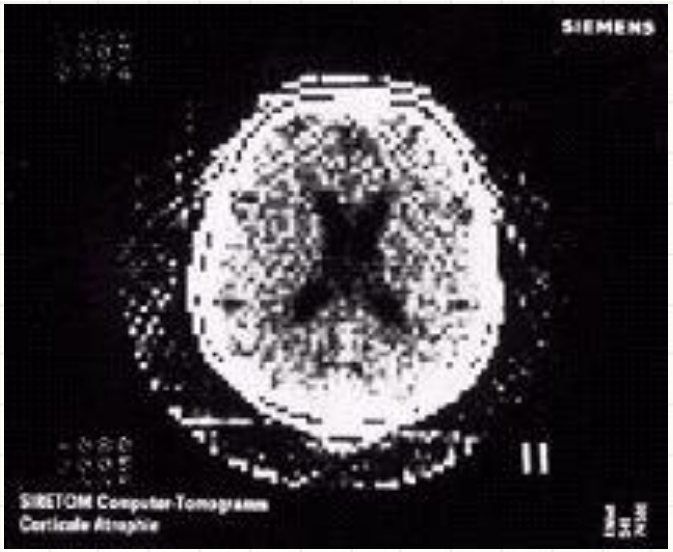
Computer tomography(CT)





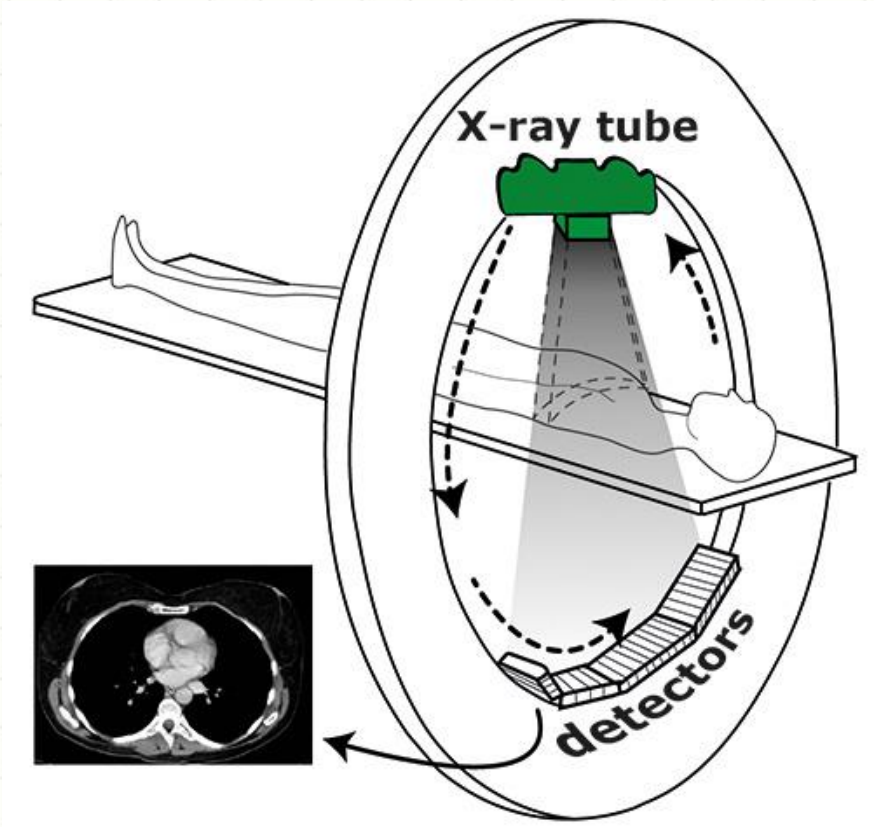
CT

- CT was invented in 1972 by British engineer Godfrey Hounsfield and by physicist Allan Cormack



CT

- X-ray tube + detector +computer = PROFIT!



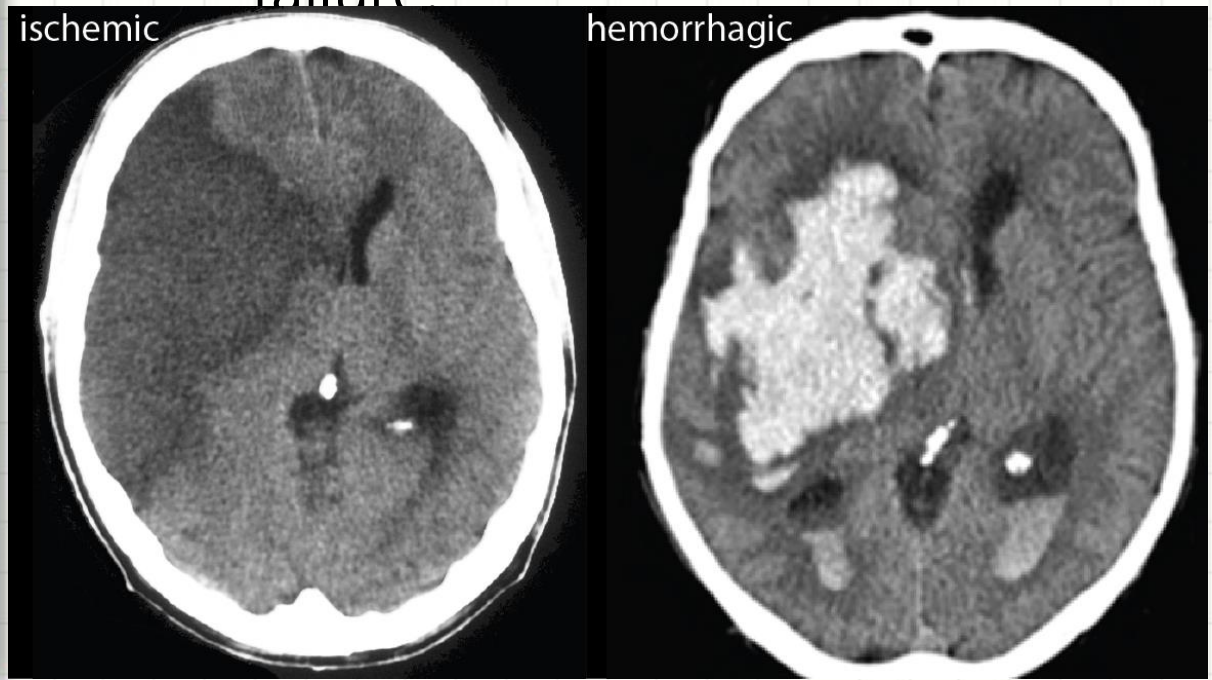
*but you probably should also find out what are Voxels and Housfield Units(HU) are….

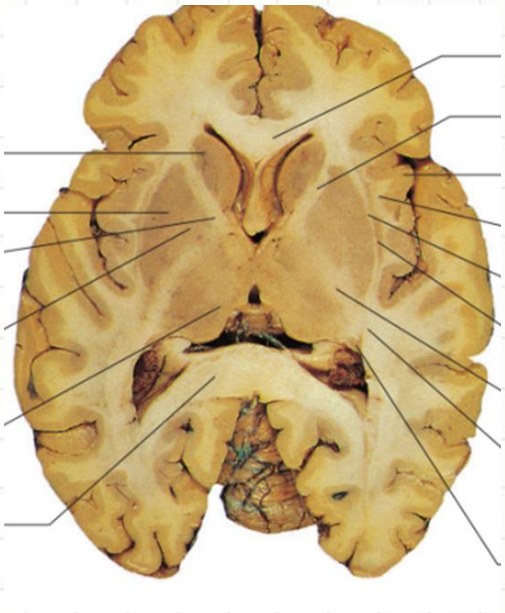
CT

- Precautions:
  - Pregnancy
  - Iodine allergy
  - Renal failure
  - Diabetes(metformine+contrast = metabolic acidosis)
- Investigations could be:
  - without contrast media
  - with IV contrast
  - with intrathecal media

CT

- Indications:
  - Noncontrast CT:
    - acute hemorrhag
    - gross structural changes without concern about contrast allergy or renal failure

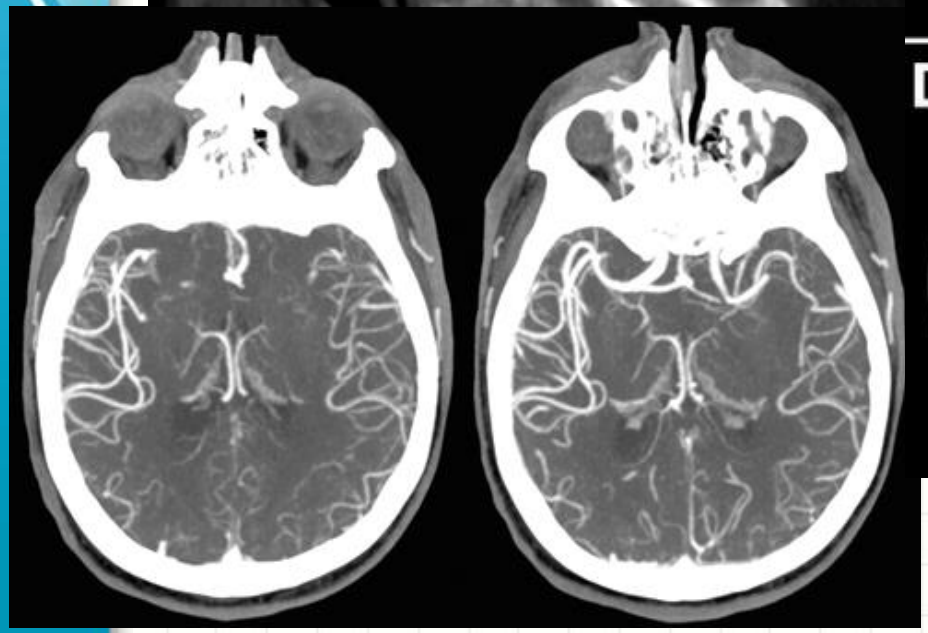


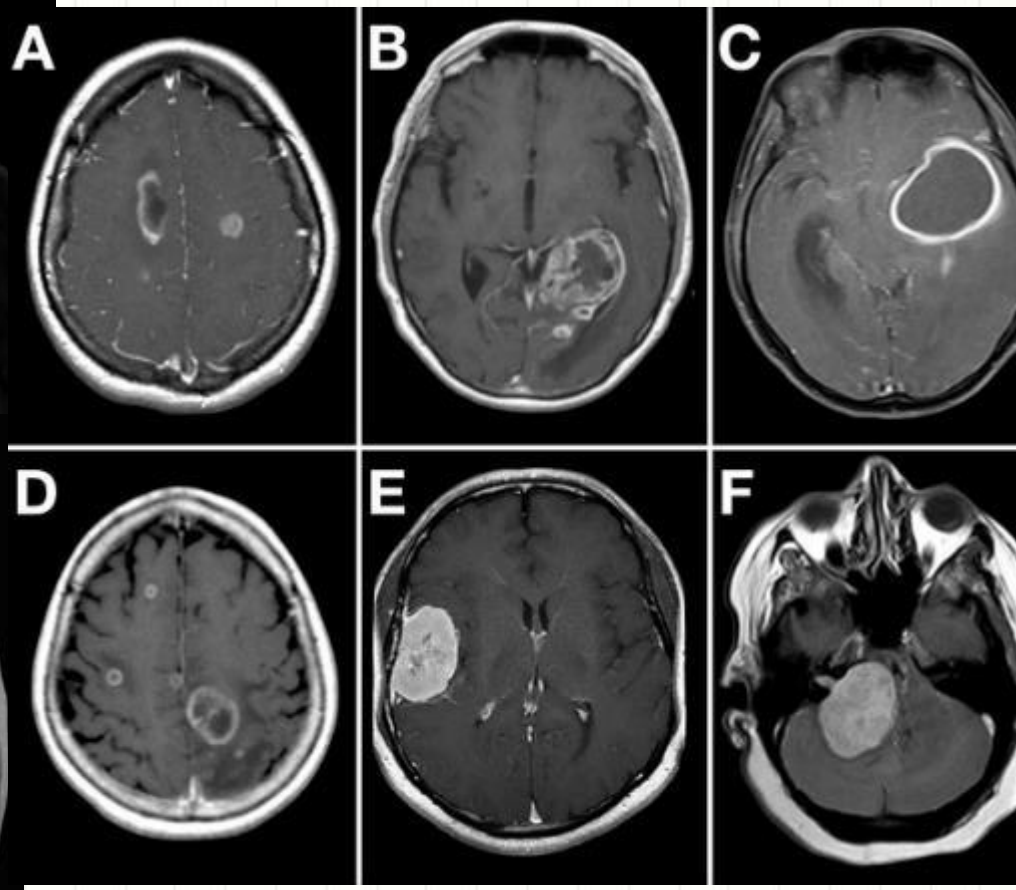


CT

- Contrast CT:
  - brain tumors and brain abscesses.
  - with an intrathecal agent, CT can outline abnormalities encroaching on the brain stem, spinal cord, or spinal nerve roots (eg, meningeal carcinoma, herniated disk) and may detect a syrinx in the spinal cord.
  - CT angiography using a contrast agent can show the cerebral blood vessels, obviating the need for MRI or angiography.

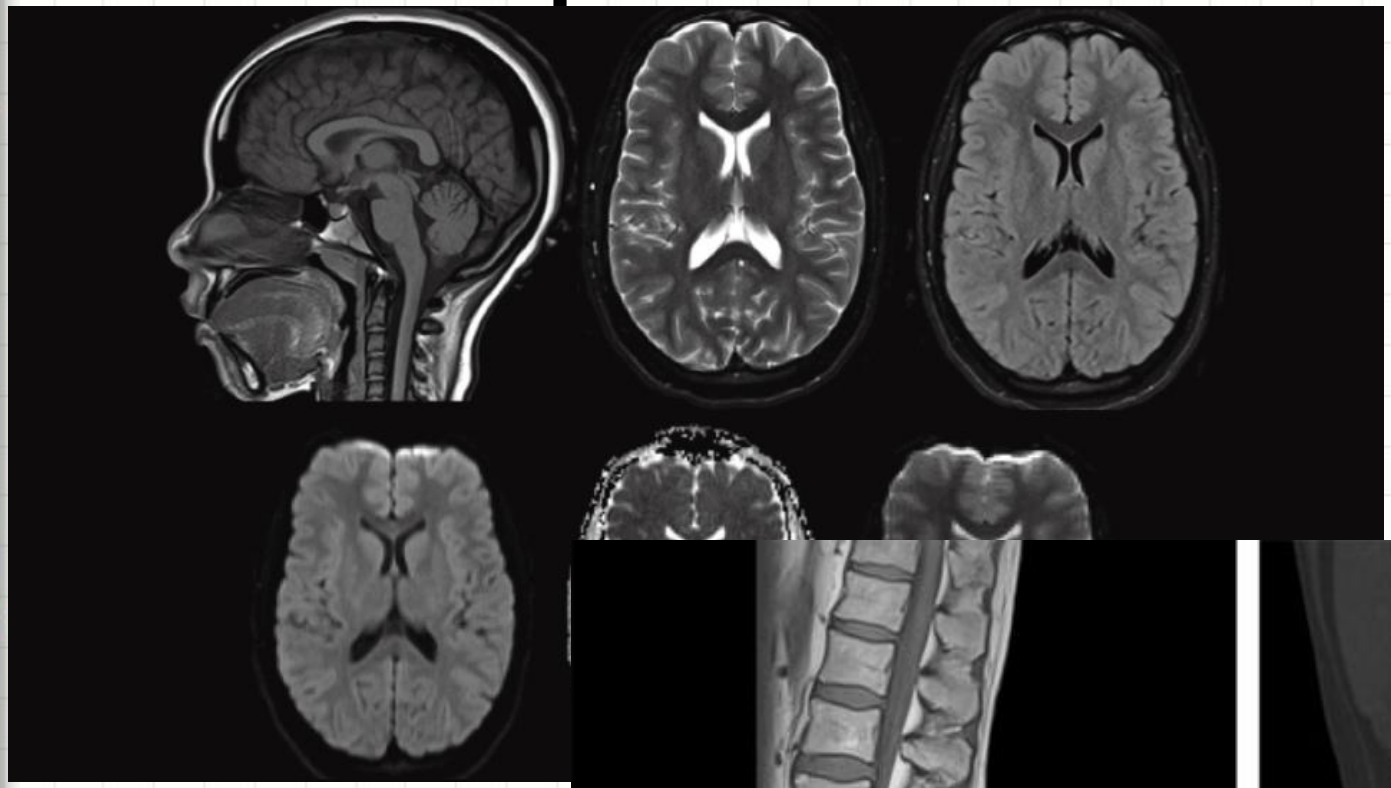
Contrast CT



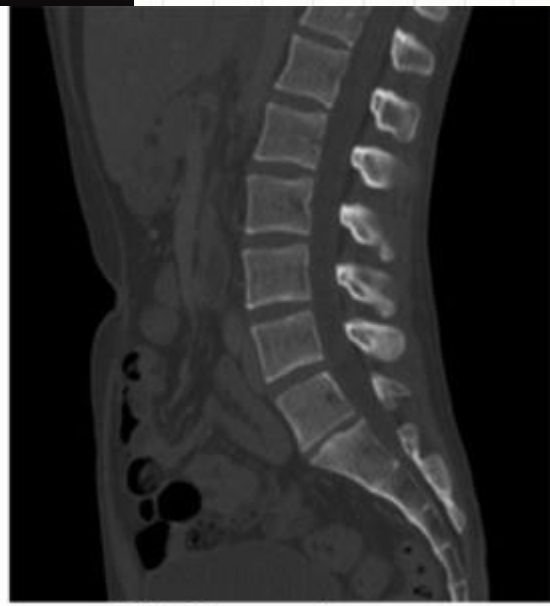


Magnetic resonance imaging of the brain and spinal cord

Magnetic resonance imaging of the brain and spinal cord



MRI Scan Image



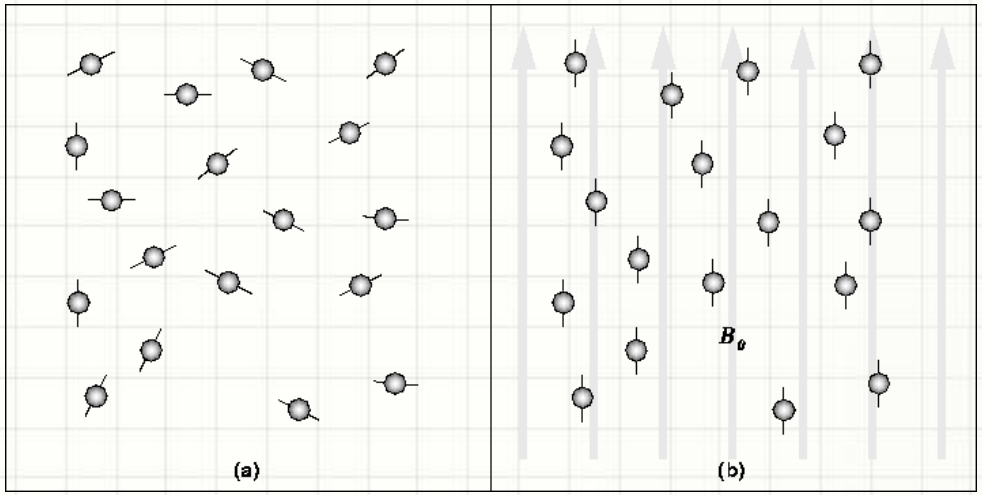
CT Scan Image

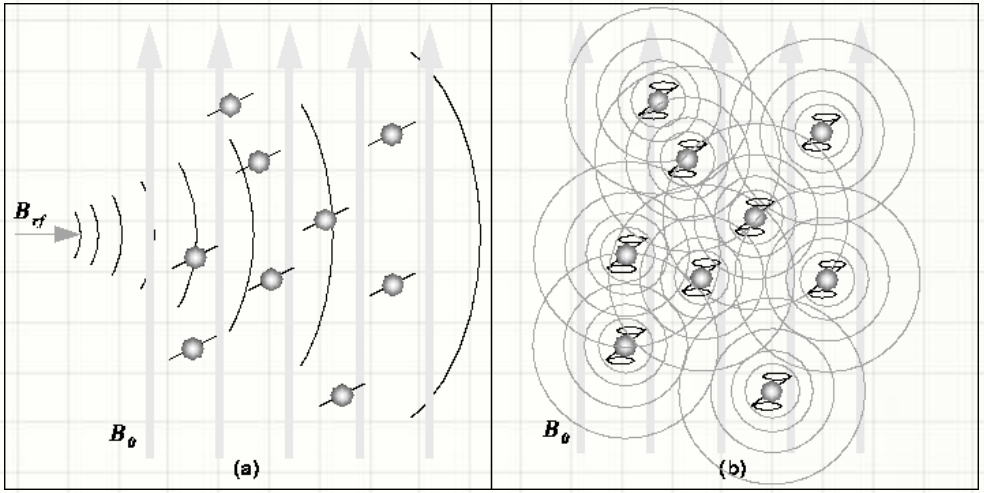
Magnetic resonance imaging of the brain and spinal cord

- MR imaging was invented by Paul C. Lauterbur who developed a mechanism to encode spatial information into an NMR signal using magnetic field gradients in September 1971; he published the theory behind it in March 1973.
- On 28 August 1980 the first clinically useful image of a patient's internal tissues using MRI was obtained.
- **MRI does not involve X-rays or the use of ionizing radiation, which distinguishes it from CT and PET scans.**

Magnetic resonance imaging of the brain and spinal cord

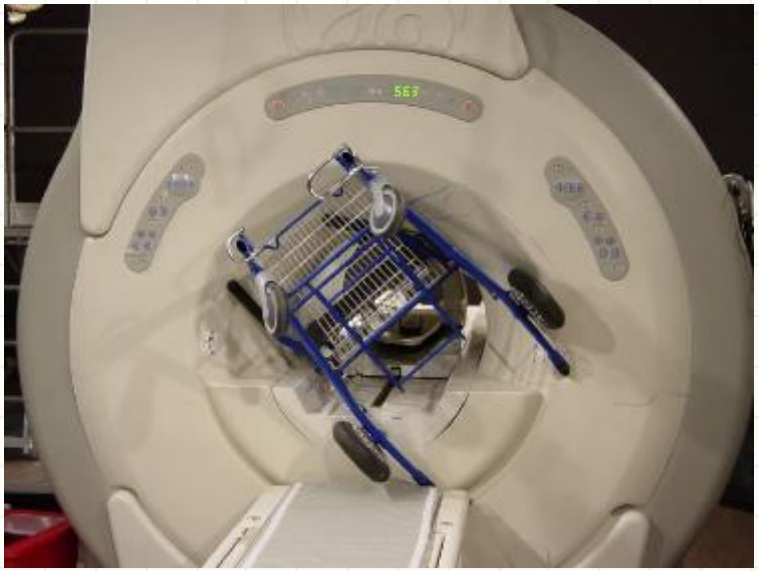
- **Nuclei** containing an odd number of protons and/or neutrons have a characteristic motion(a)
- **1 step** – magnetic field realigns neutron spin(motion) to Bo.
- **2 step** – RF signal sent to tilt neutron from Bo.
- **T1** – radiofrequency detected(emitted by) while neutron return to Bo in longitudinal plane.
- **T2** – the same in transverse plane.





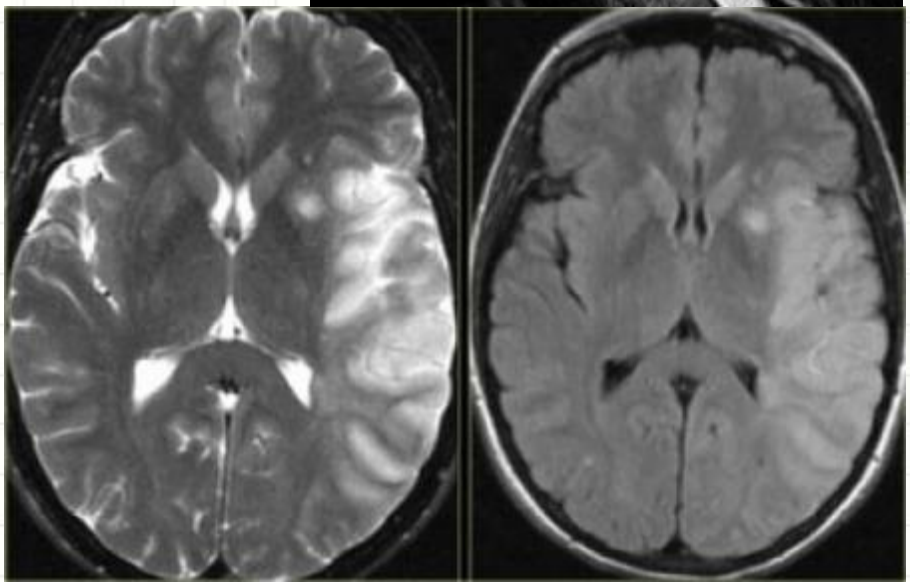
Magnetic resonance imaging of the brain and spinal cord

- Contraindications:
  1. Metallic implants
  2. Claustrophobia
  3. Pacemakers, although new protocols allow imaging in selected cases
  4. MR-incompatible prosthetic heart valves
  5. Contrast allergy
  6. Body weight (MRI tables have specific weight limitations)



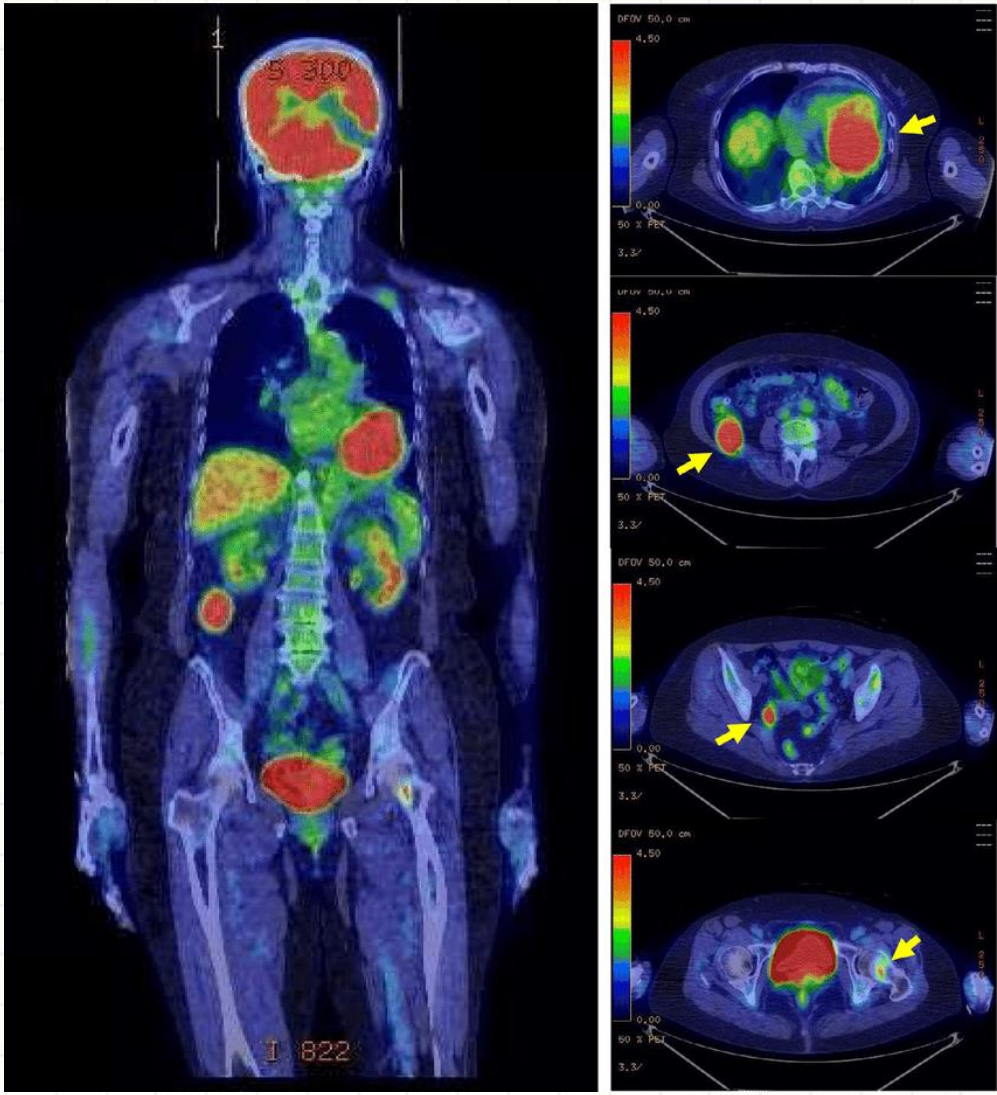
Magnetic resonance imaging of the brain and spinal cord

- Indications:
  1. Blood vessel damage
  2. Brain injury
  3. Cancer
  4. Multiple sclerosis (MS)
  5. Spinal cord injuries
  6. Stroke
  7. Eye problems
  8. Inner ear problems



Positron emission tomography(PET)

- Functional imaging technique that uses radioactive substances known as radiotracers to visualize and measure changes in metabolic processes, and in other physiological activities

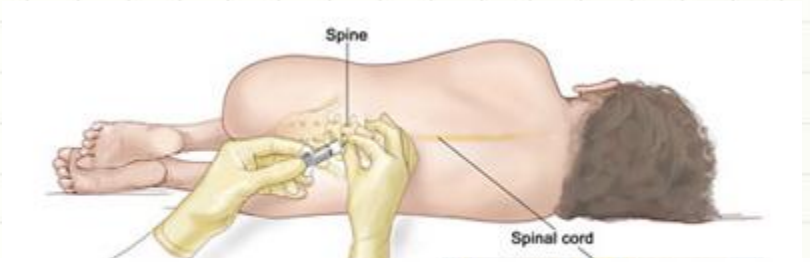


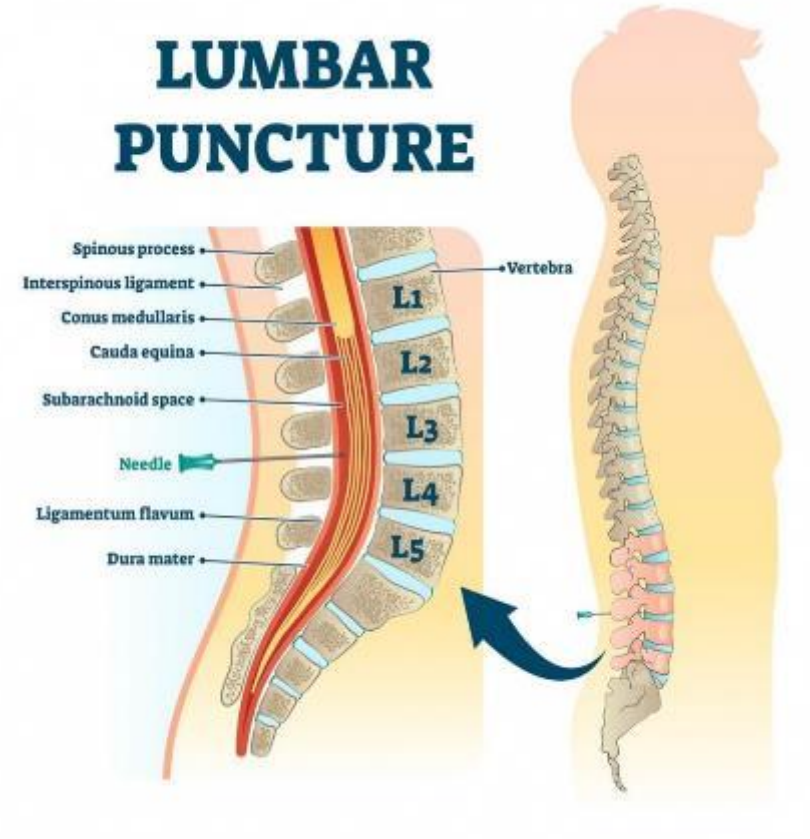
Invasive diagnostic methods

- Puncture:
  - Lumbar
    - CSF clinics
    - myelography
  - Ventricular
    - ventriculography
  - Suboccipital
- Selective angiography
- Biopsy

Puncture: Lumbar(spinal tap)

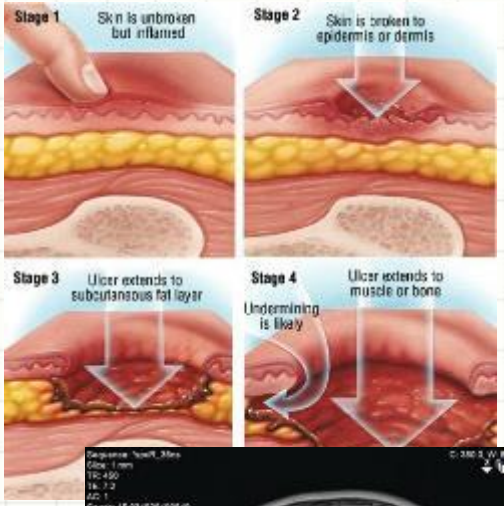
- Suspicion of meningitis
- Suspicion of subarachnoid hemorrhage (SAH)
- Suspicion of nervous system diseases such as Guillain-Barré syndrome [6] and carcinomatous meningitis
- Therapeutic relief of pseudotumor cerebri

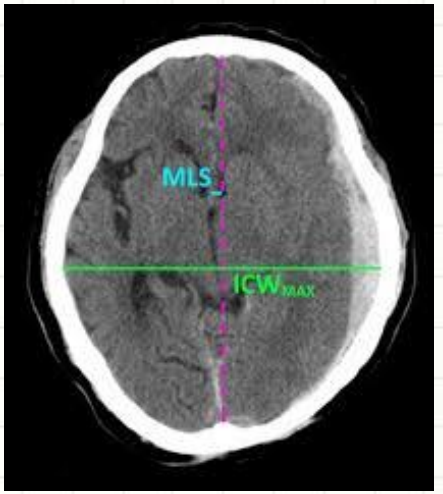


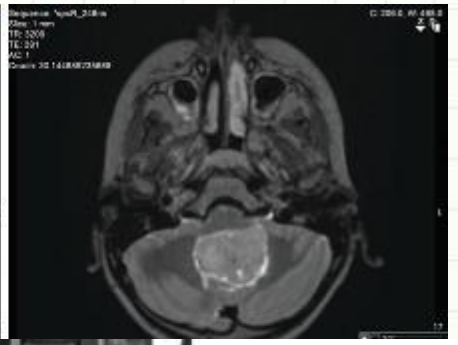


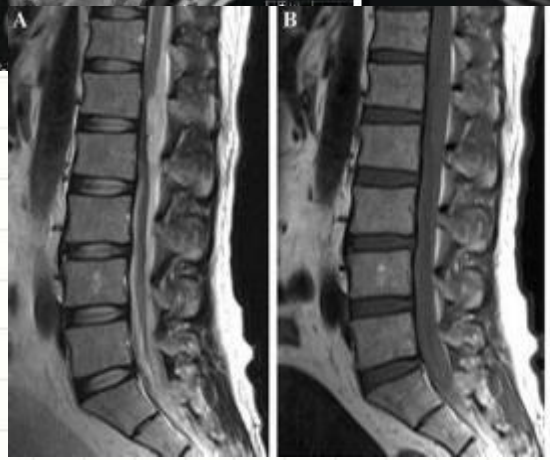
Spinal tap: contraindications

- Midline shift
- Use of anticoagulants
- Evidence of cellulitis or abscess over the area where LP would be performed
- Significant degenerative joint disease or prior back surgeries where hardware maybe in place
- Posterior fossa mass



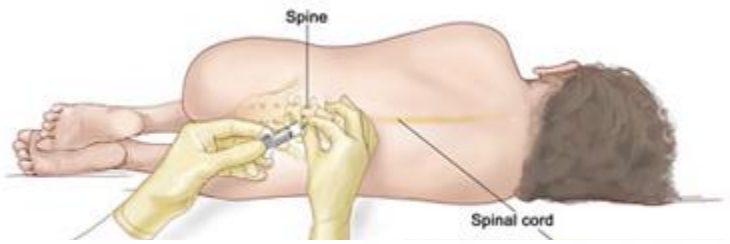


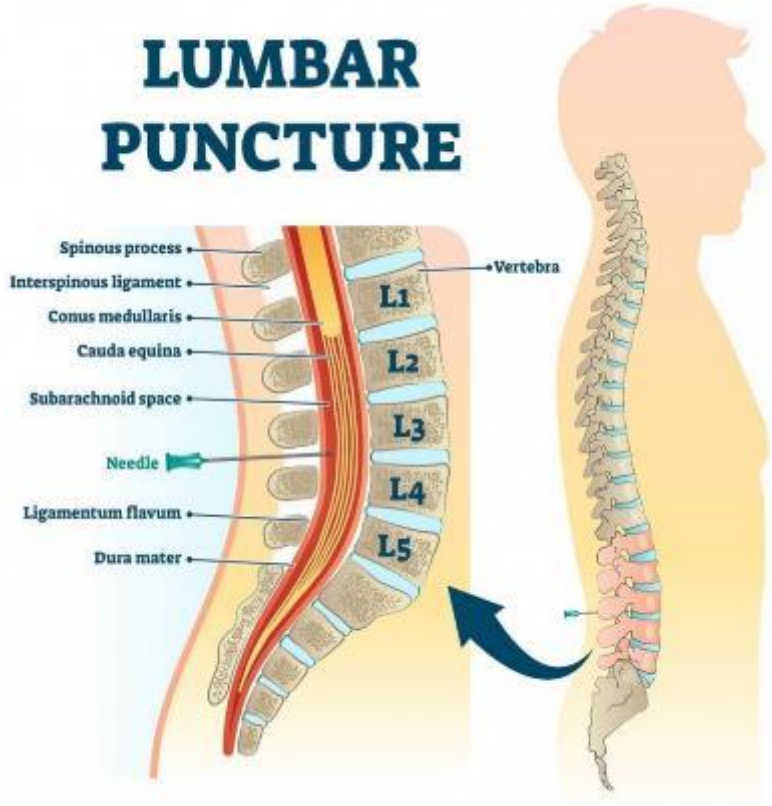




Spinal tap: technique

- G20/G22 needle
- L2-3 segments and lower
- Sitting/lateral position
- Preferably – use anaestetic
- Once the needle is in position, the CSF pressure is measured and a sample of 1 to 10 milliliters (mL) of CSF is collected





COMMON LABORATORY (CSF) VALUES

CSF opening pressure: 50–180 mmH_2O
Glucose: 40–85 mg/dL.
Protein (total): 15–45 mg/dL.
Lactate dehyrogenase: 1/10 of serum level.
Lactate: less than 35 mg/dL.
Leukocytes (**WBC**): 0–5/μL (adults / children); up to 30/μL (newborns).
Gram stain: negative.
Culture: sterile.
Specific gravity: 1.006–1.009.
Syphilis serology: negative.
Gross appearance: Normal CSF is clear and colorless.
Differential: 60–70% lymphocytes; up to 30% monocytes
and macrophages; other cells 2% or less.

Myelography

- Lumbar tap + injection of contrast material in the space around the spinal cord and nerve roots
- X-ray or CT for visualization
- Contraindications

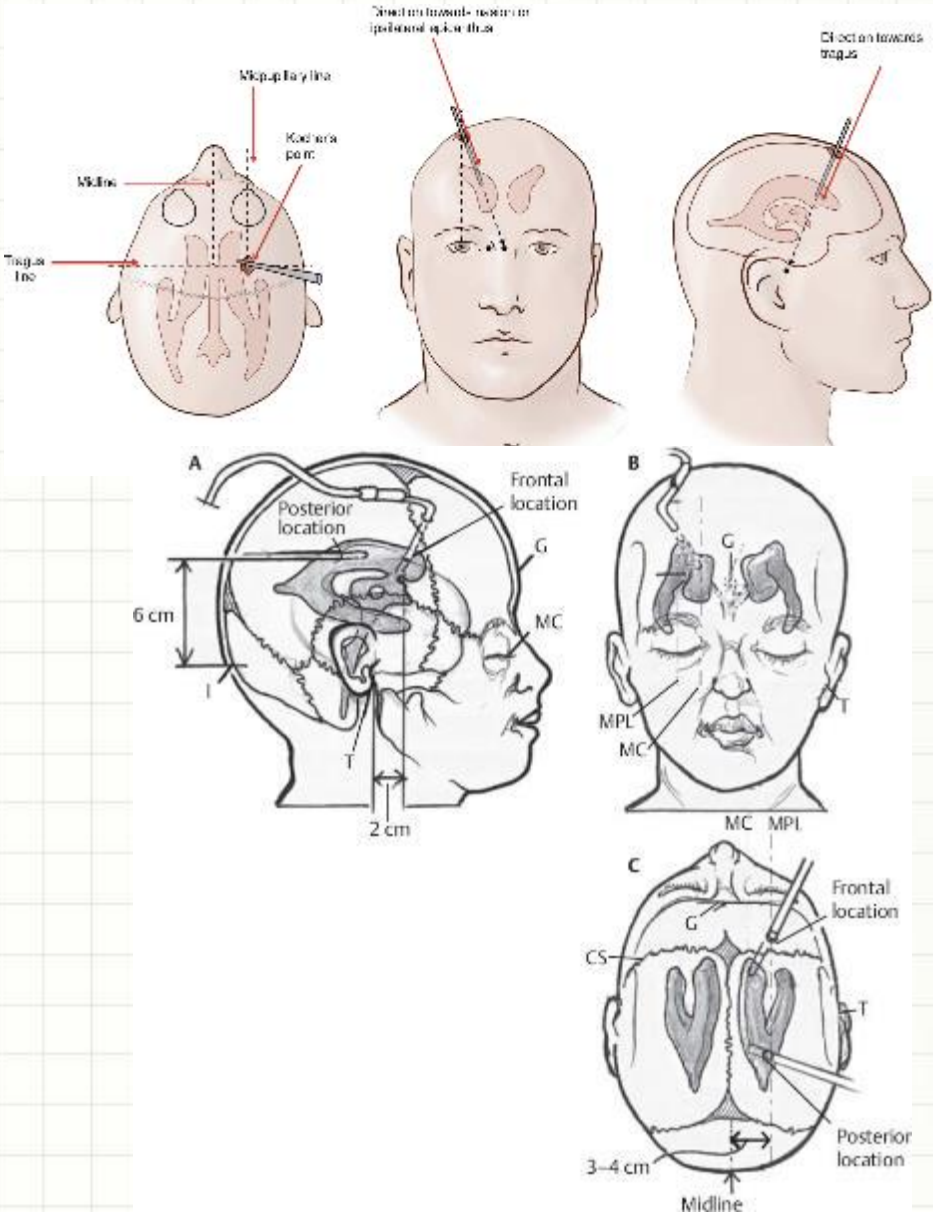
  the same as for LP

Myelography: indications

1. In patients who require imaging as a result of a clinical diagnosis of nerve root, thecal sac or spinal cord compression from disc, tumour or spinal stenosis, where MRI is:
   - contraindicated (see referrer information on MRI)
   - not possible (due to claustrophobia or large patient size)
   - diagnostically equivocal.
2. In patients with clinical symptoms and signs of a CSF leak.

Ventricular puncture

- a surgical procedure in which an opening from the outside is made to the lateral ventricle areas of the brain.



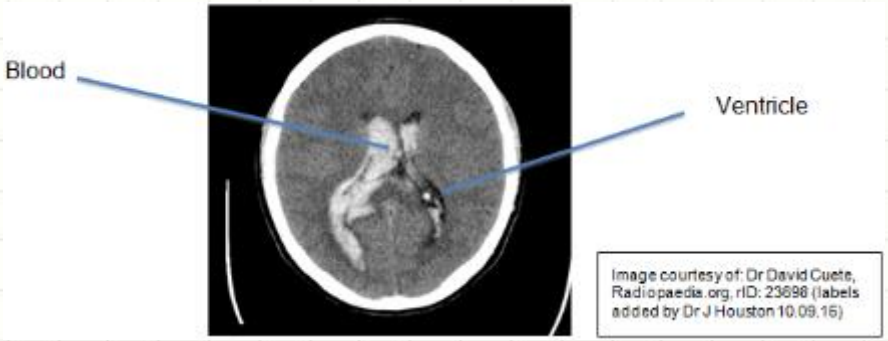
VP: indications

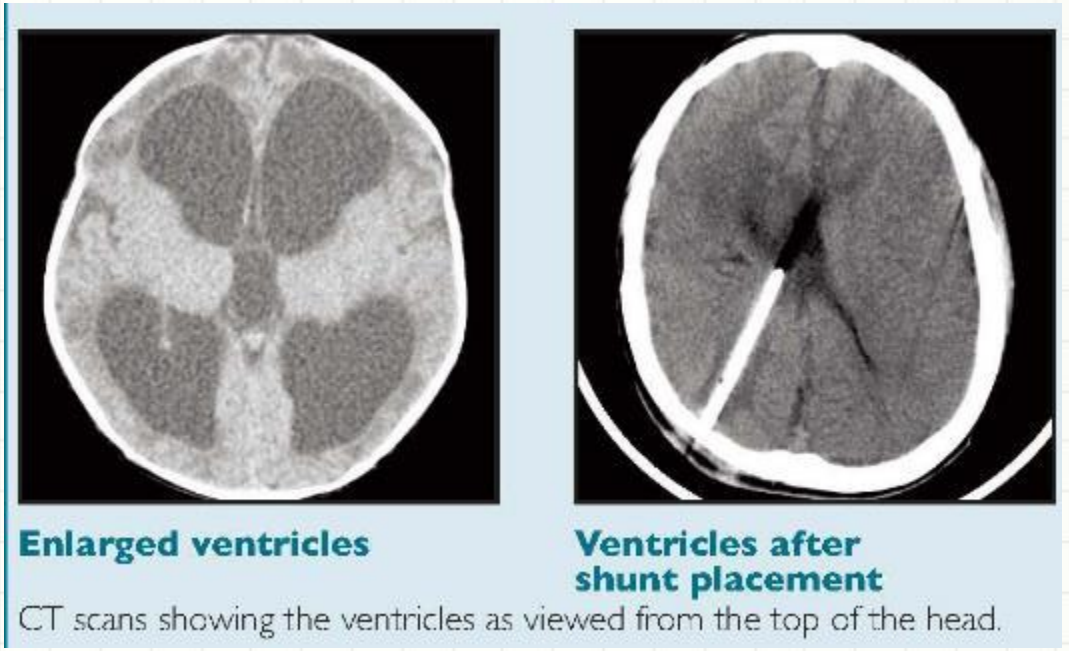
- Reduce intracranial pressure (ICP), eg, pre-, intra-, or postoperative.
- Monitor CSF chemistry, cytology, and physiology.
- Provide temporary CSF drainage in patients with infected cerebrospinal fluid shunts.

- Severe head injury
- Subarachnoid hemorrhage graded III, IV, or V preoperatively
- Reyes syndrome or similar encephalopathies
- Hydrocephalus
- Intracranial hemorrhage
- Miscellaneous problems when drainage is to be used as a therapeutic maneuver.

VP:contraindications and complications

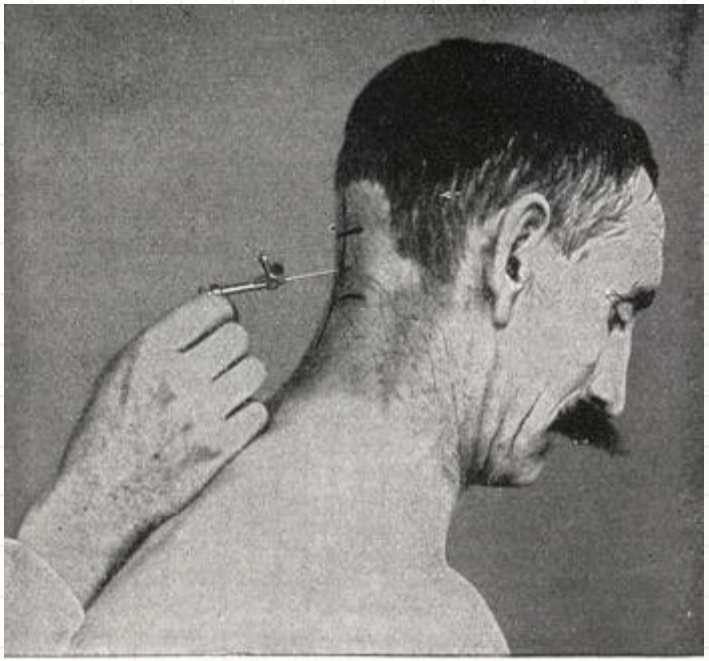
- Contra:
  - local infection
- Complications:
  - infection
  - bleeding
  - overdrainage

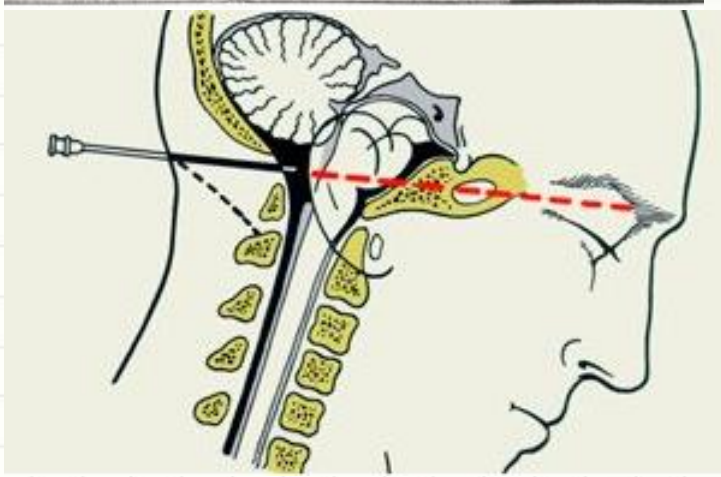




Suboccipital puncture

- Was first described by Ayer in 1920.
- Prescribed only when CSF cannot be obtained from the lumbar space
- Cisternal tap may be used in myelography



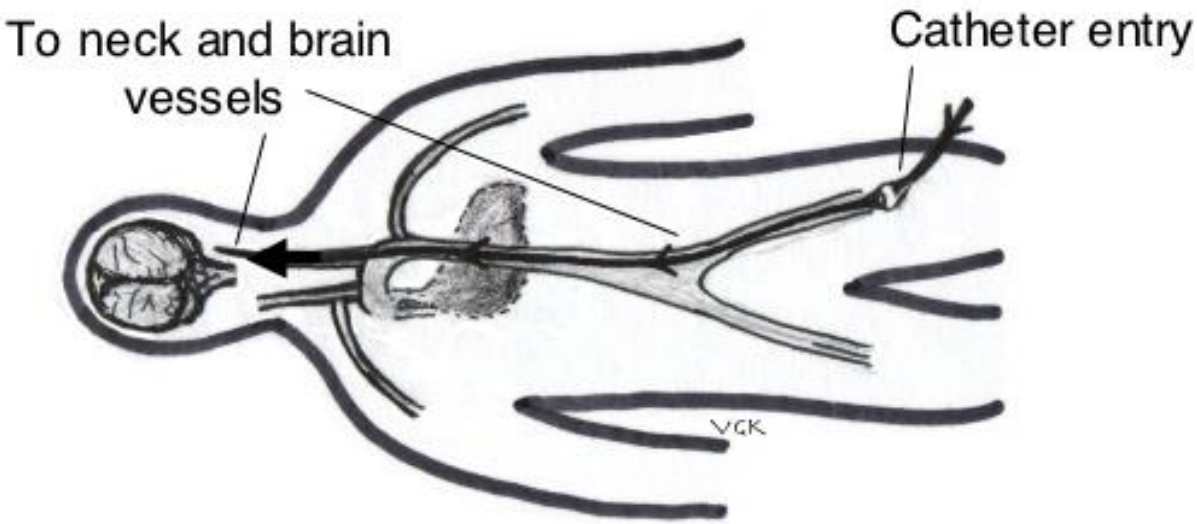


Selective cerebral angiography

- Method of diagnostics by introduction of a contrast substance directly into the central circulation by means of a cardiac catheter. The opaque medium thus delivered in high concentration at the site deemed most likely to reveal the lesion.
- Catheter could be placed through femoral radial or carotid artery

Selective cerebral angiography – indications

- cerebral ischaemia
- subarachnoid haemorrhage, e.g. cerebral aneurysm, arteriovenous malformation
- venous sinus thrombosis
- tumors



Cerebral angiography

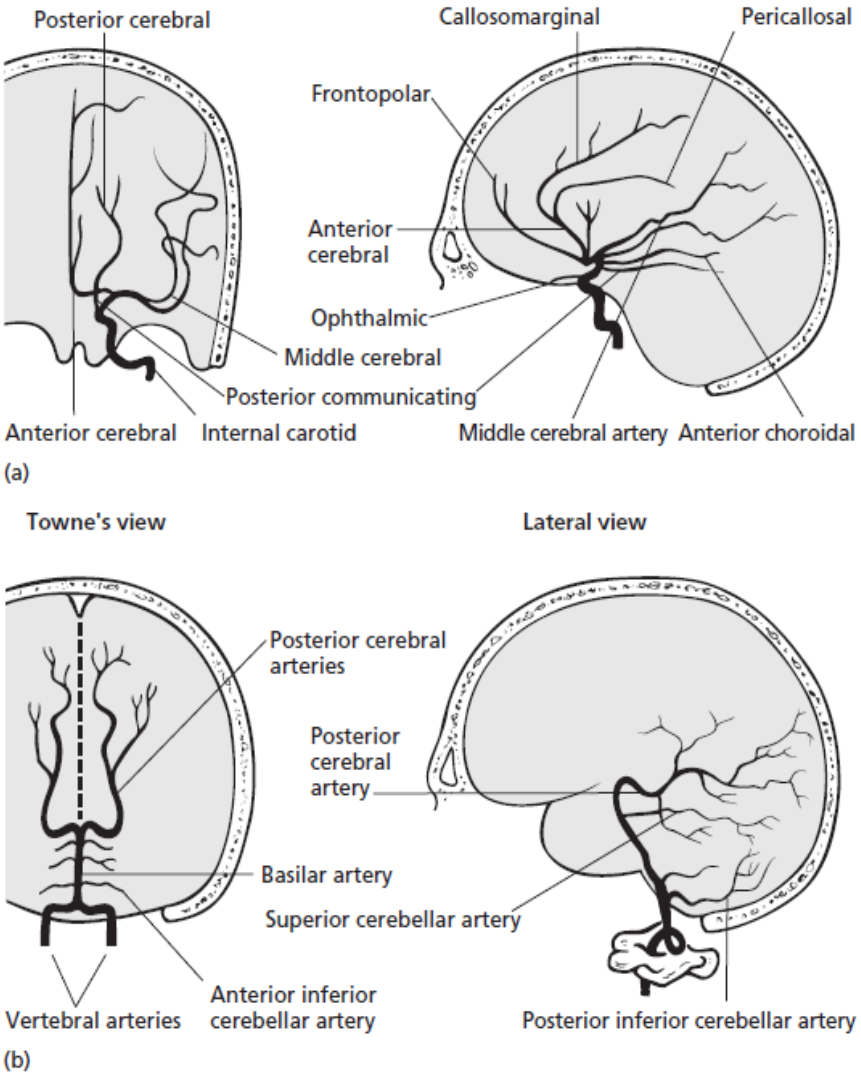


Fig. 2.2 The major intracranial vessels seen on cerebral angiography.

Biopsy

- It’s all the same concept in every organ
- https://www.webmd.com/cancer/what-is-a-biopsy#1
- Could be performed through
  - Stereotactic frame
  - Navigation system
  - Directly

The End

Thanks