Introduction and Overview of Neuroanatomy

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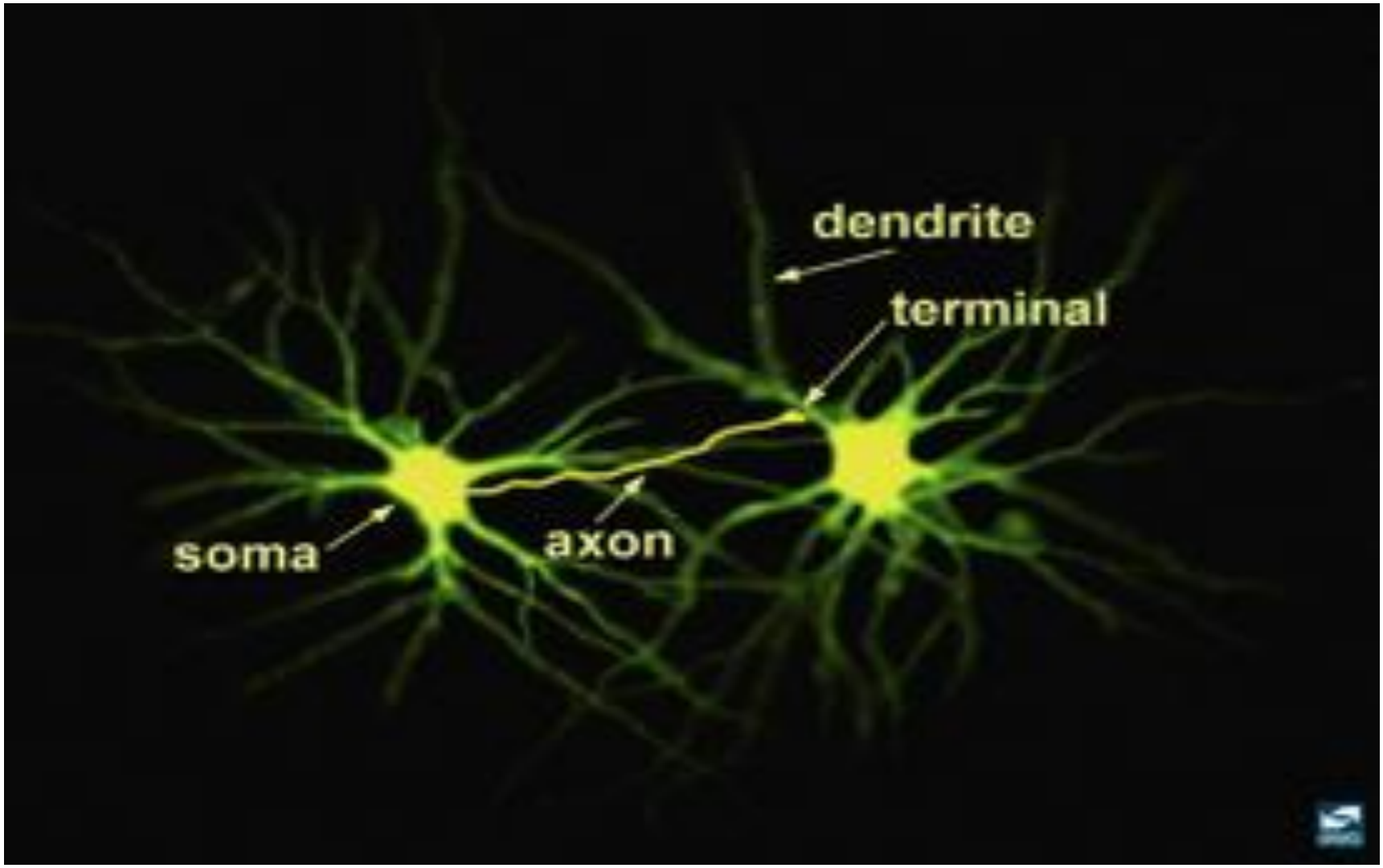
Neurone

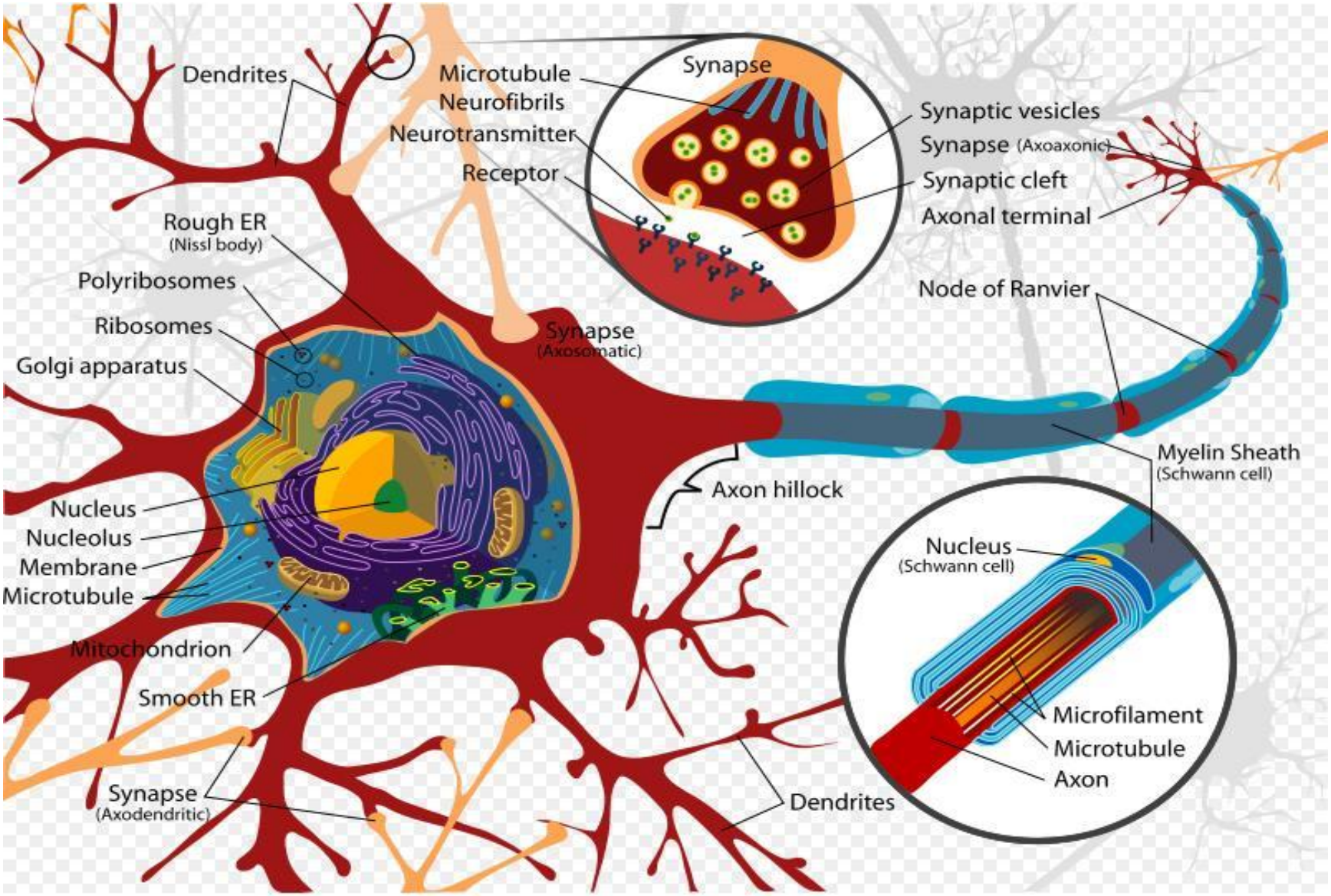
- The basic structural and functional unit of the nervous system
- The functions :

  to receive and integrate incoming information from sensory receptors or other neurones and to transmit information to other neurones or **effector organs**
- Information is passed between neurones at specialised regions called **synapses** where the membranes of adjacent cells are in close apposition

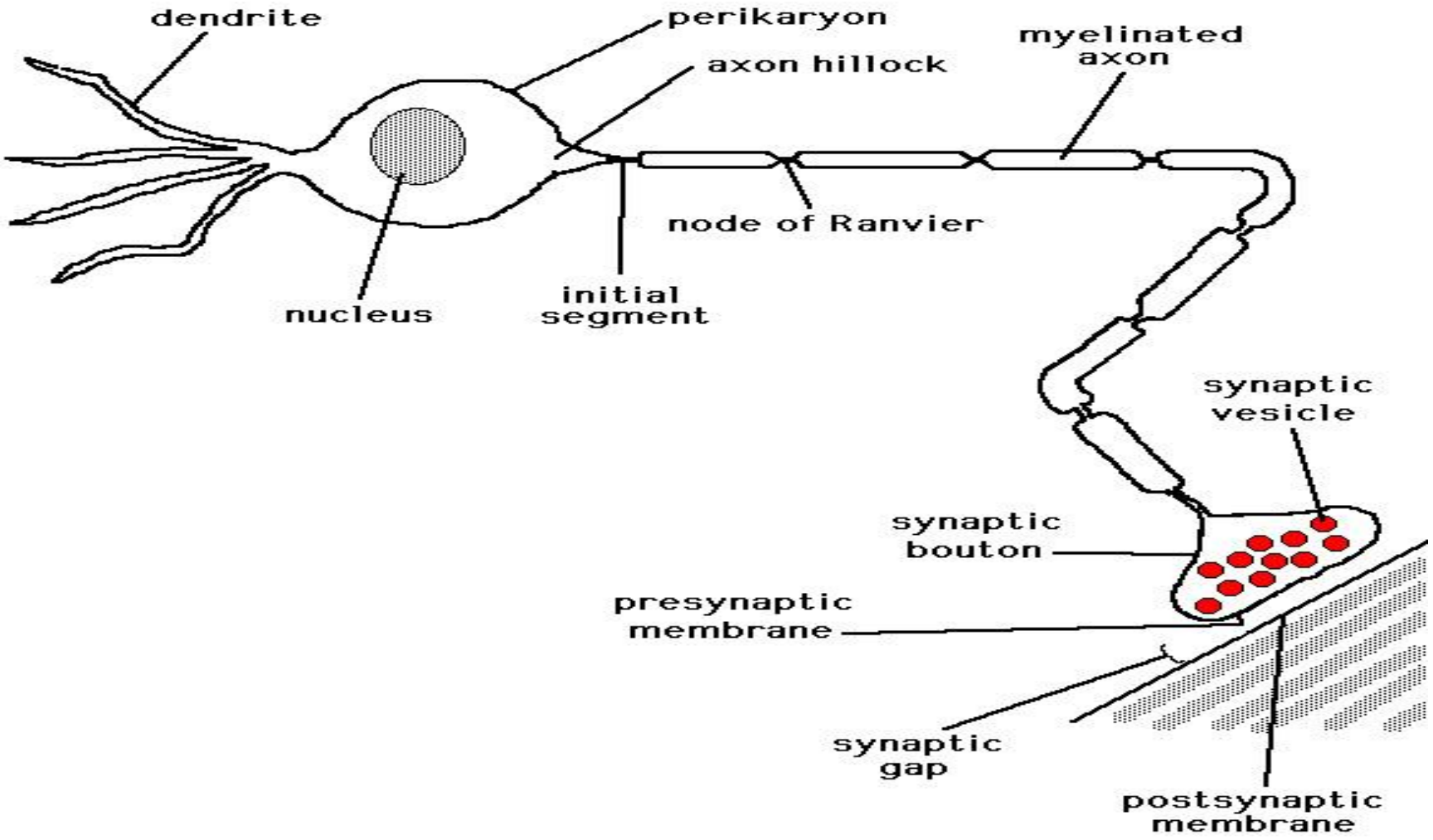
Neuron



Neuron


Dendrites
Microtubule
Neurofibrils
Neurotransmitter
Receptor
Synapse
Synaptic vesicles
Synapse (Axoaxonic)
Synaptic cleft
Axonal terminal
Rough ER
(Nissl body)
Polyribosomes
Ribosomes
Golgi apparatus
Synapse
(Axosomatic)
Node of Ranvier
Myelin Sheath
(Schwann cell)
Axon hillock
Nucleus
Nucleolus
Membrane
Microtubule
Mitochondrion
Smooth ER
Nucleus
(Schwann cell)
Microfilament
Microtubule
Axon
Synapse
(Axodendritic)
Dendrites

Neuron


dendrite
perikaryon
axon hillock
myelinated axon
node of Ranvier
nucleus
initial segment
synaptic vesicle
synaptic bouton
presynaptic membrane
synaptic gap
postsynaptic membrane

Neuroglial cells

- More numerous than nerve cells but have anciliary roles and are not directly involved in information processing.
- There are three main tipes of neuroglial cell

Type of Neuroglia

- Oligodendroglia (oligodendrocytes)

  which form the myelin sheath that many neuronal axons
- Astroglia (astrocyte)

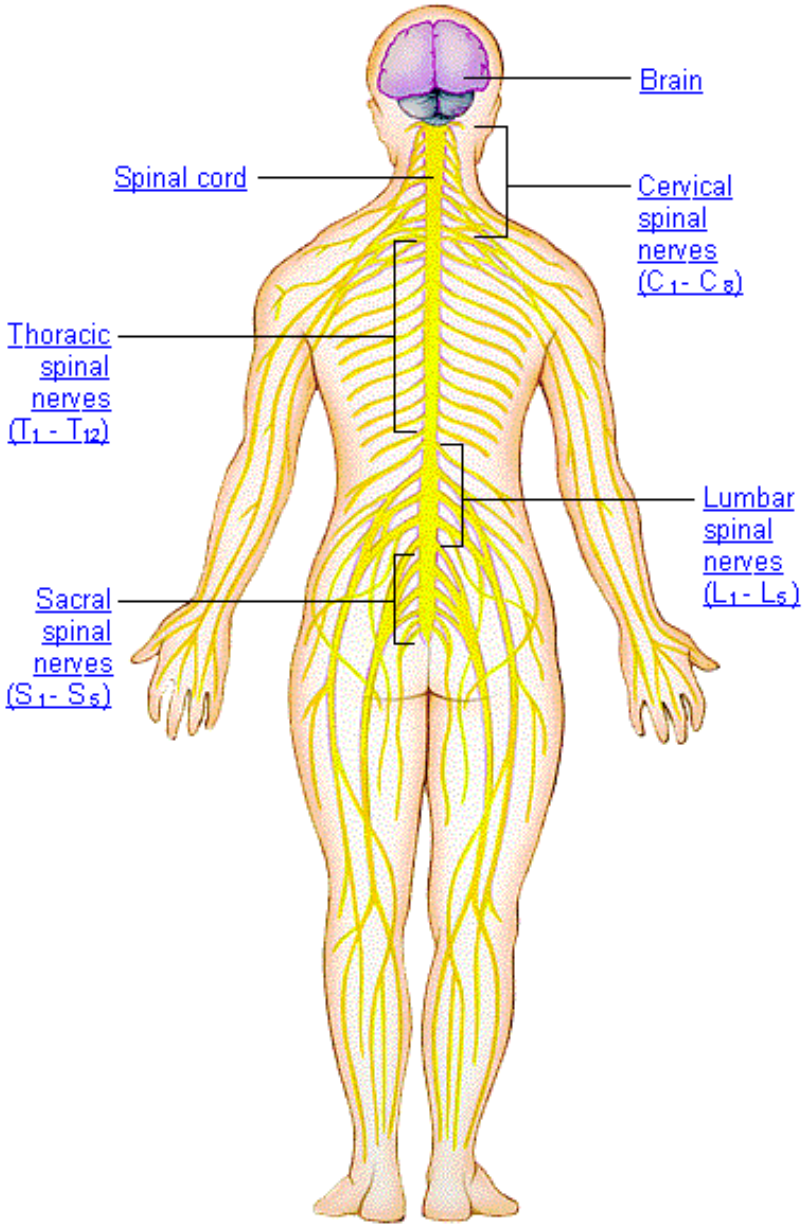
  May form the blood brain barrier
- Microglia

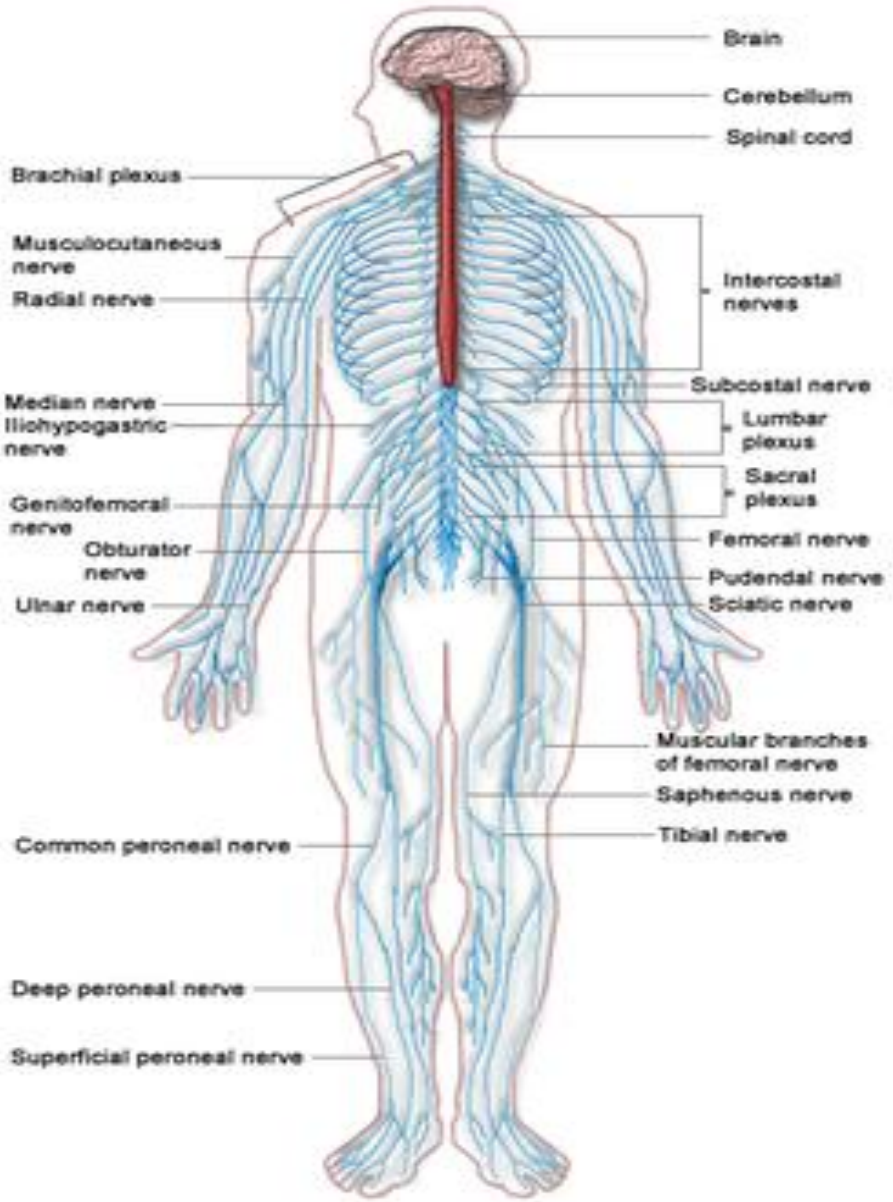
  have phagocytic function when the nervous system is damaged

Nervous system

- Central nervous system
  1. Brain
  2. Spinal cord
- Peripheral nervous system
  1. cranial nerves
  2. spinal nerves

CNS and PNS

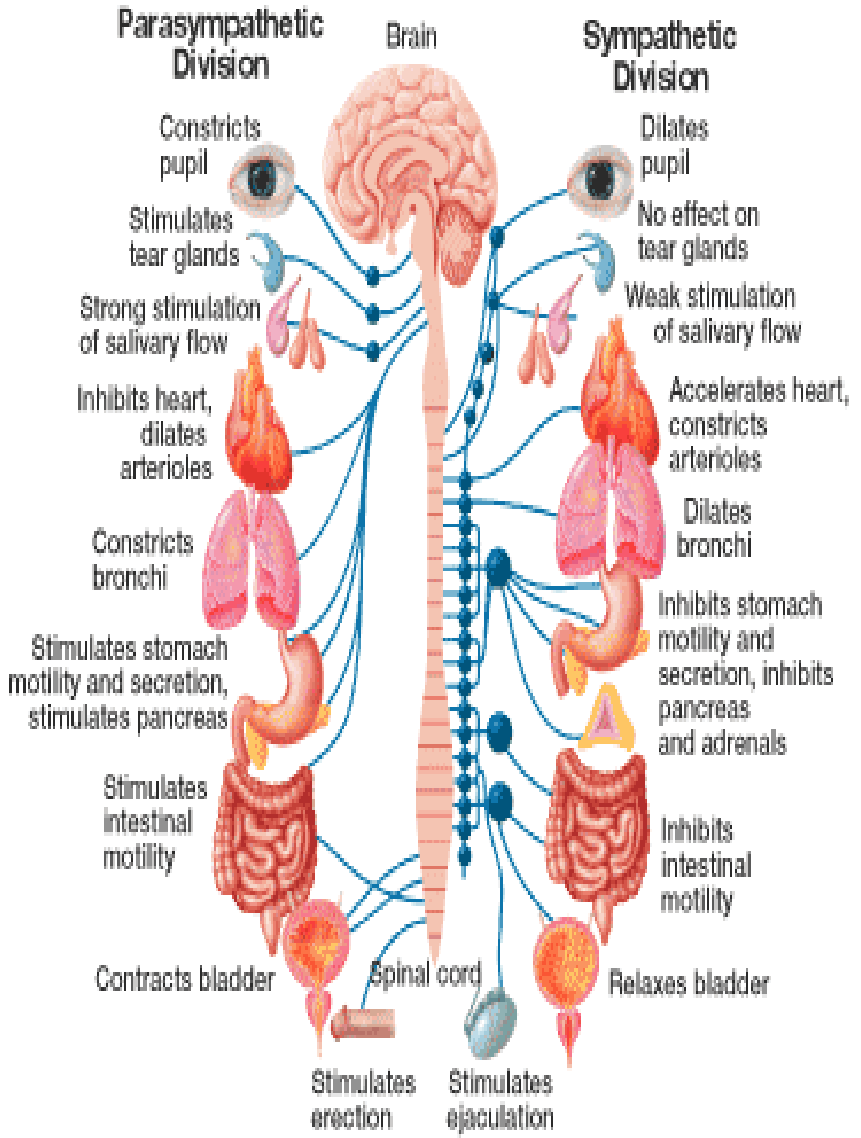

Brain
Spinal cord
Cervical spinal nerves (C1 - C8)
Thoracic spinal nerves (T1 - T12)
Lumbar spinal nerves (L1 - L5)
Sacral spinal nerves (S1 - S5)

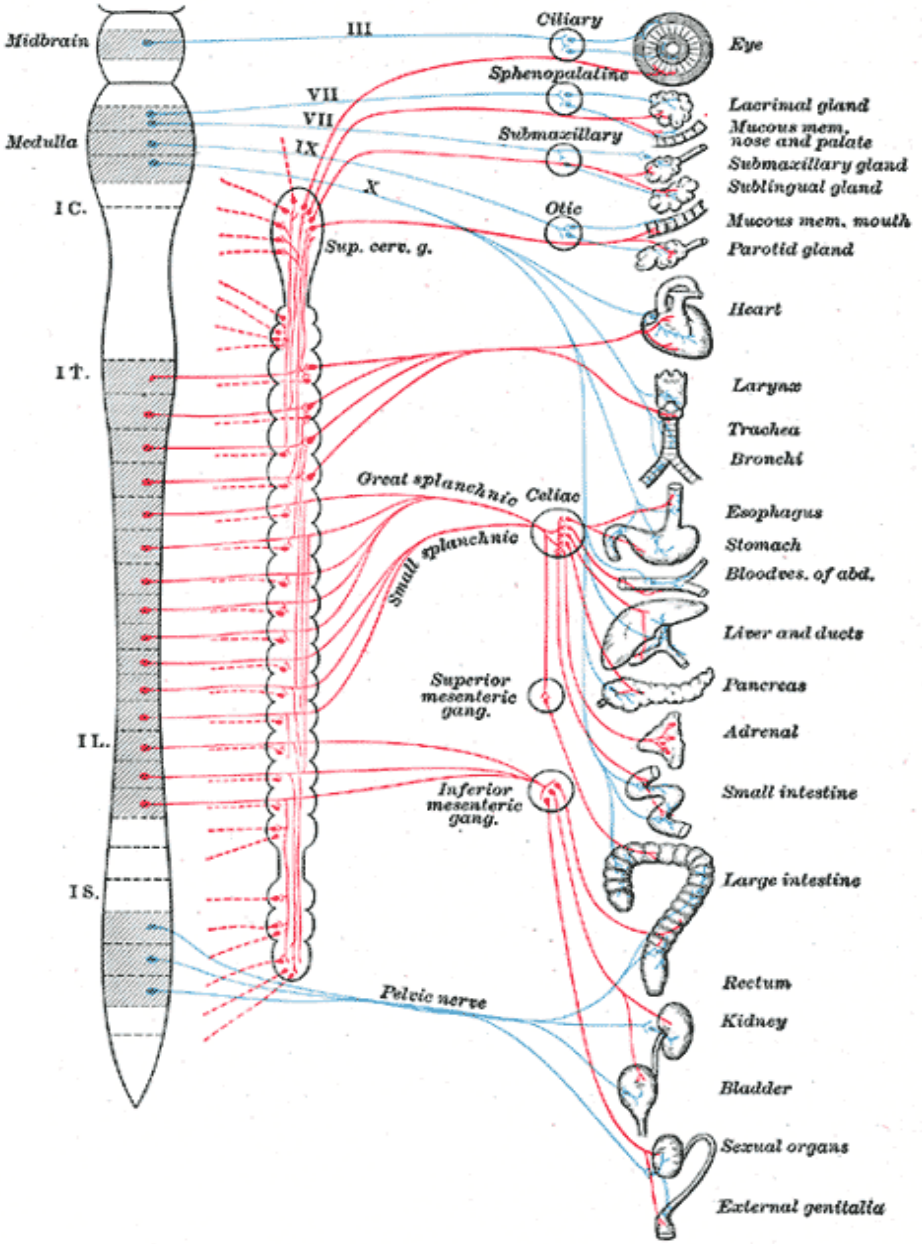

Brain
Cerebellum
Spinal cord
Brachial plexus
Musculocutaneous nerve
Radial nerve
Intercostal nerves
Subcostal nerve
Median nerve
Iliohypogastric nerve
Lumbar plexus
Sacral plexus
Genitofemoral nerve
Obturator nerve
Femoral nerve
Pudendal nerve
Ulnar nerve
Sciatic nerve
Muscular branches of femoral nerve
Saphenous nerve
Tibial nerve
Common peroneal nerve
Deep peroneal nerve
Superficial peroneal nerve

Autonomic Nervous System (ANS)

- Innervates visceral structure and is important in homeostasis of the internal environment.
- divided into two anatomically and functionally distinct parts, namely the **sympathetic** and **parasympathetic** divisions.
- ANS generally have opposing (antagonistic) effects on the structures that they innervate

Autonomic Nervous System

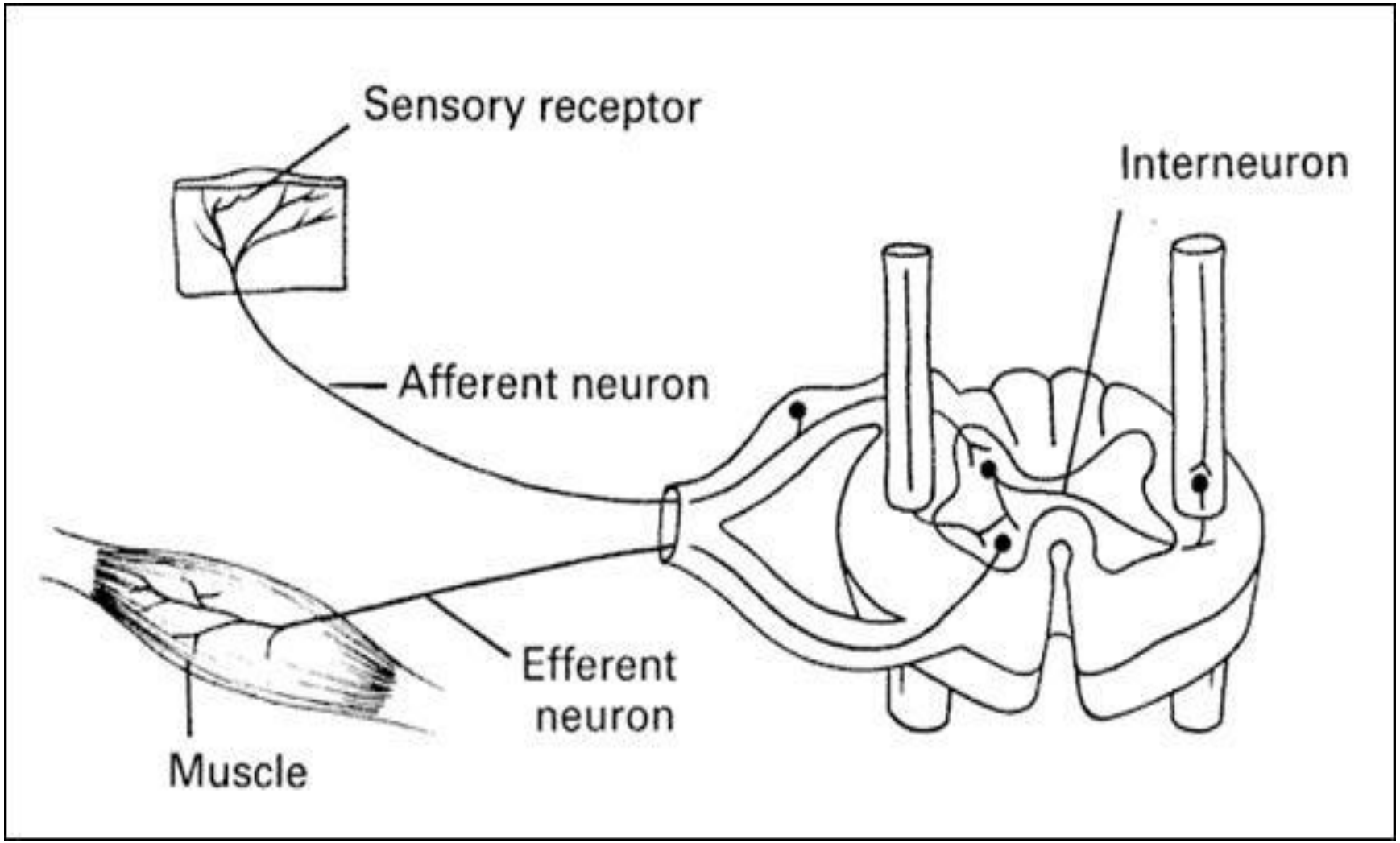




Afferent Neurone, Efferent Neurone and Interneurone

- Nerve cells that carry information from peripheral receptors to the CNS → **afferent neurones**
- the information that they carry ultimately reaches a conscious level → **sensory neurones**
- Efferent neurones carry impulses away from the CNS and if they innervate skeletal muscle to cause movement → **motor neurones**
- The vast majority of neurones, however, are located entirely within the CNS → **interneurones**

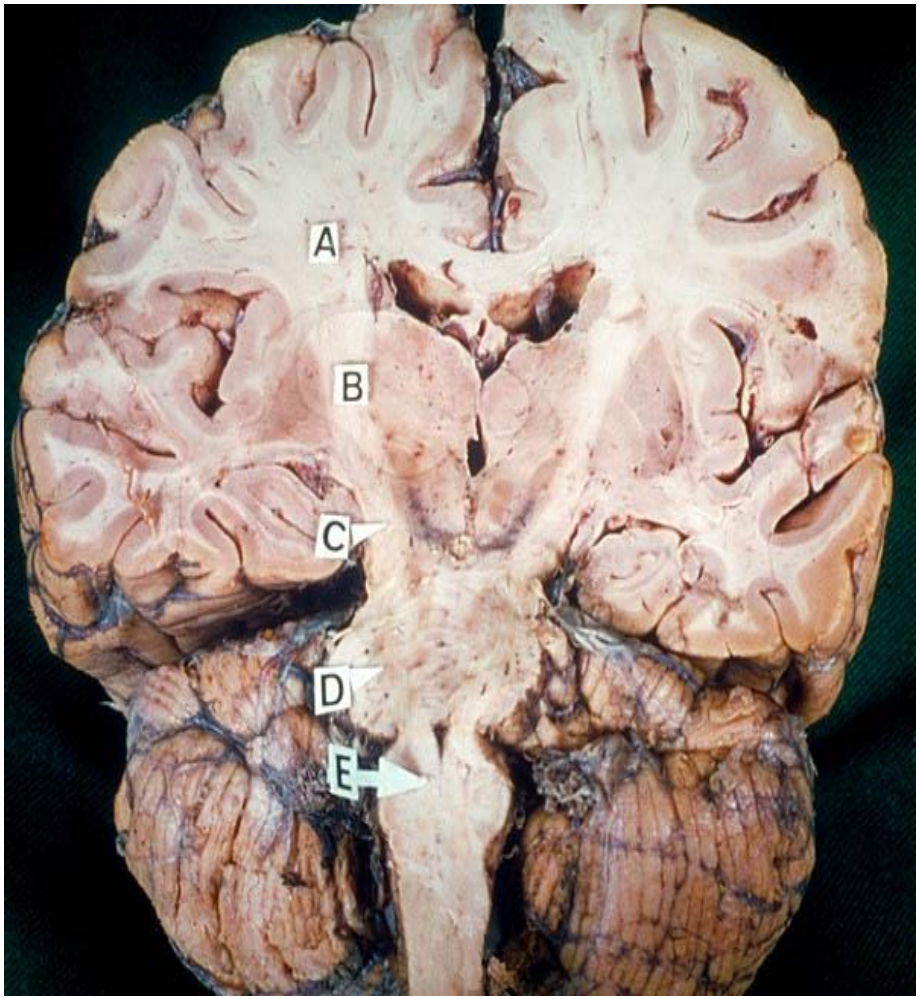
Afferent neurone, efferent neurone and interneurone

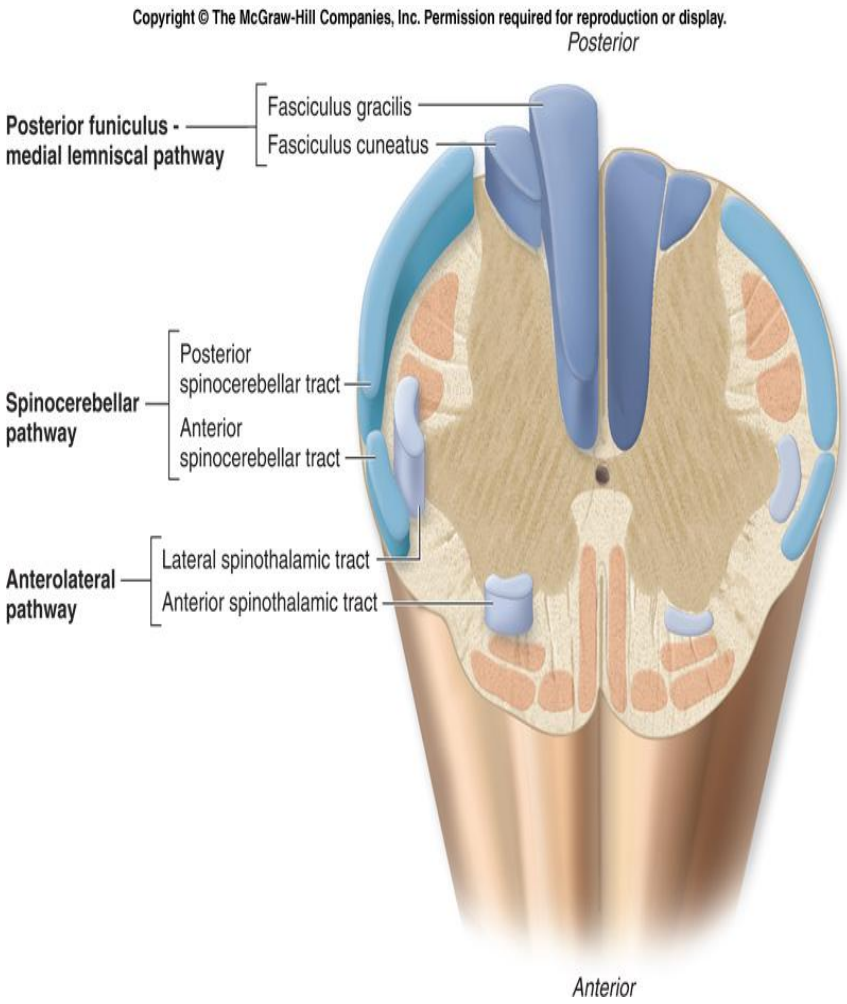


Grey and White Matter of CNS

- Some regions are relatively enriched in nerve cell bodies (e.g. the central portion of the spinal cord and the surface of the cerebral hemisphere) and are referred to as **grey matter**
- Other regions contain mostly nerve processes (usually axons). These are often myelinated (ensheathed in myelin), which confers a paler coloration - hence the term **white matter**.

Grey and White matter of CNS

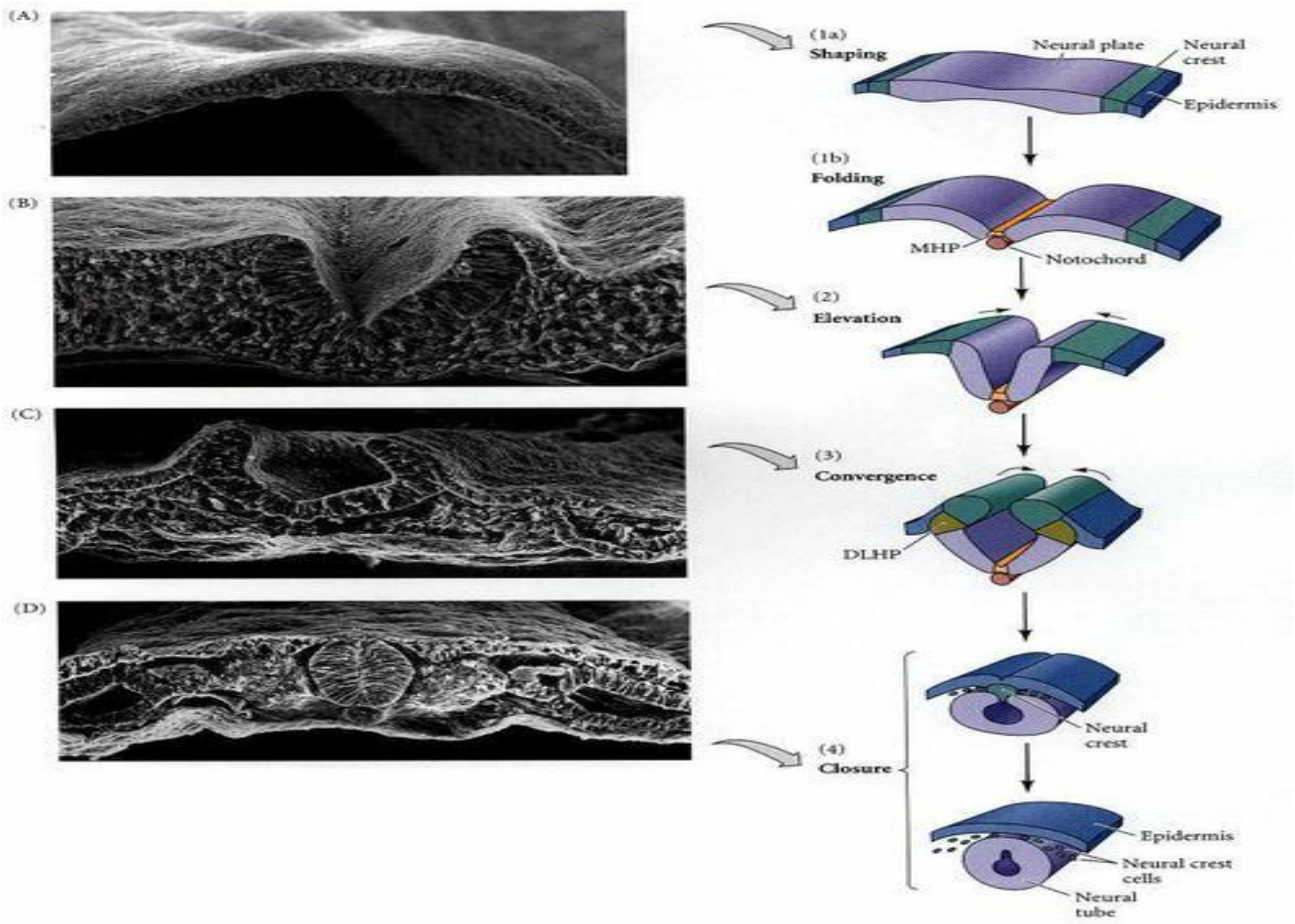


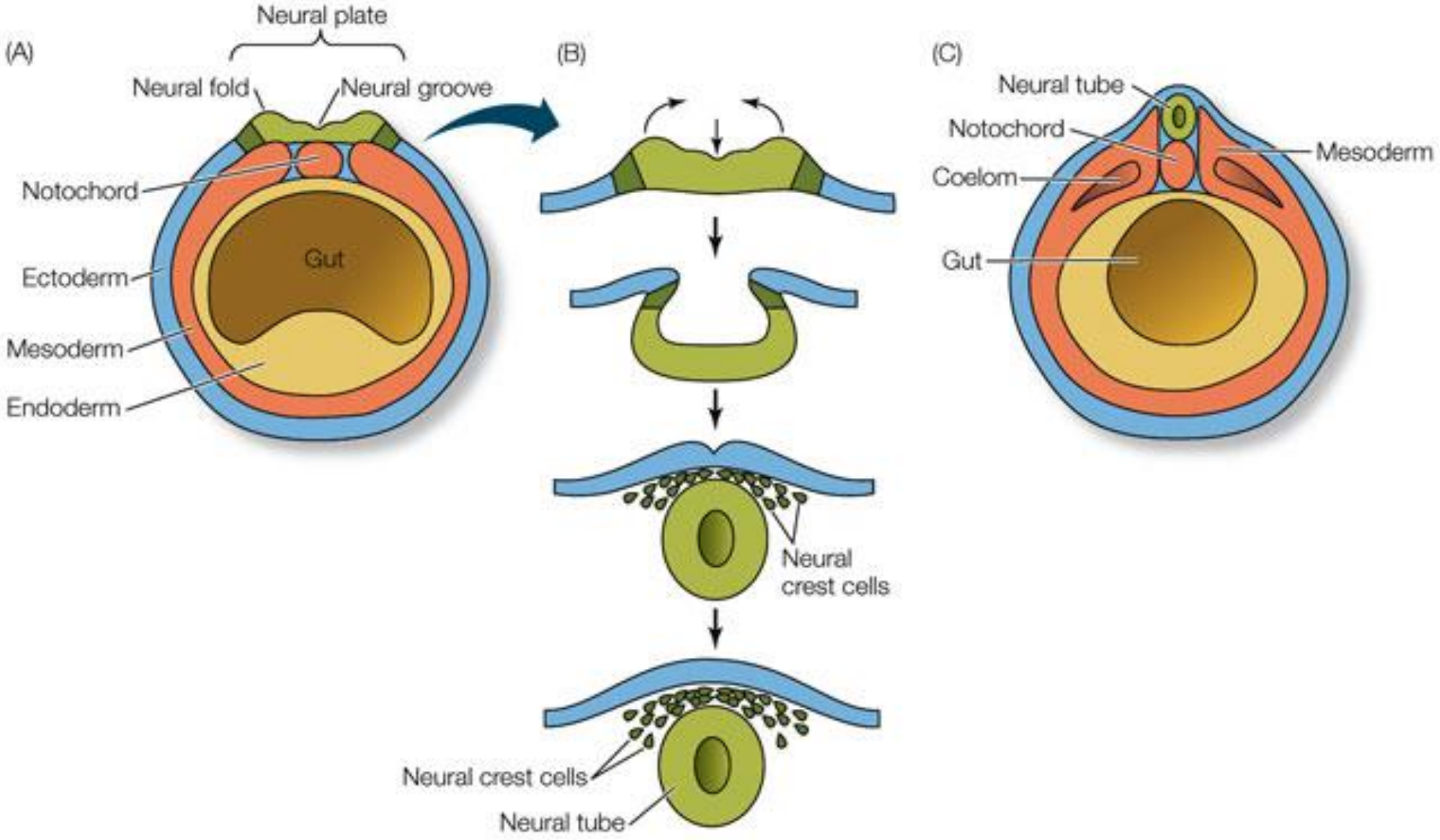


Development of the CNS

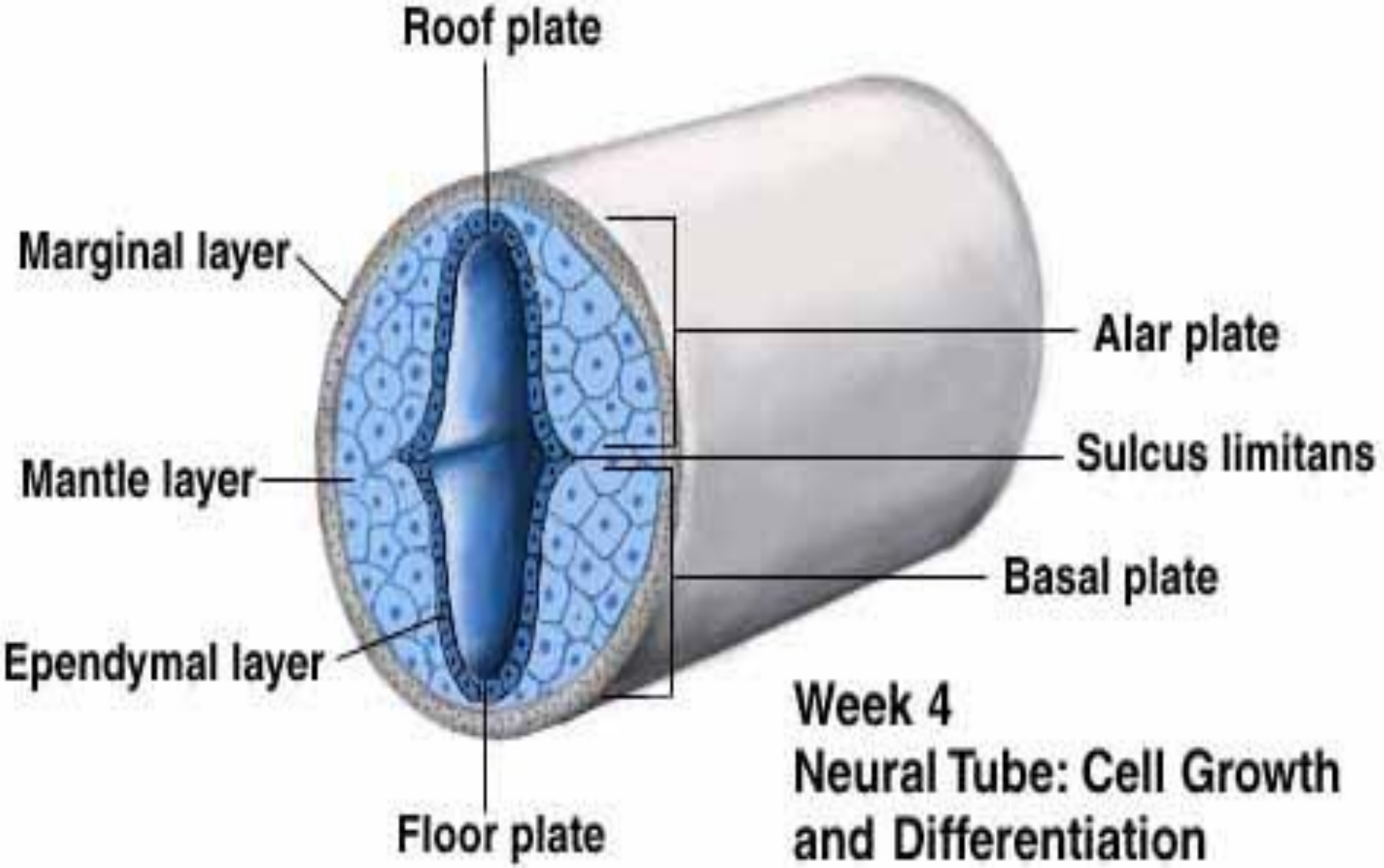
- The process of formation of the embryonic nervous system is referred to as **neurulation**
- During the third week of embryonic development, the dorsal midline ectoderm undergoes thickening to form the **neural plate**
- The lateral margins of the neural plate become elevated, forming **neural folds** on either side of a longitudinal, midline depression, **the neural groove**
- The neural folds then become apposed and fuse together, thus sealing the neural groove and creating **the neural tube**

Development of the CNS





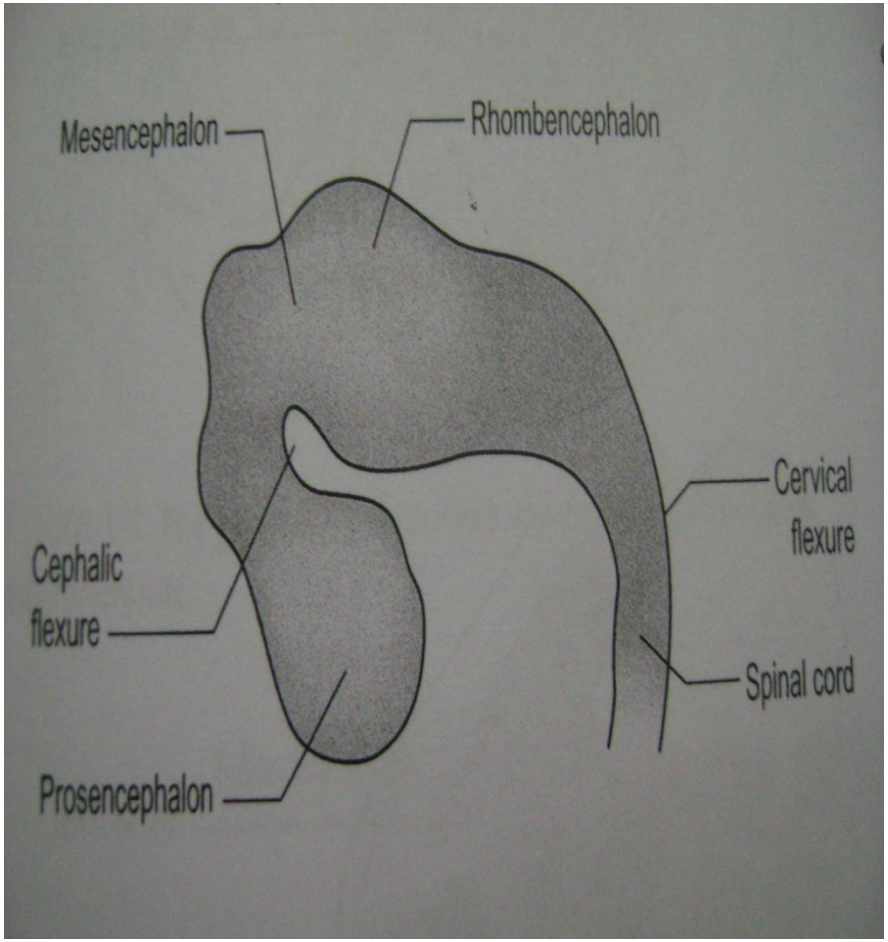
***LIFE 8e*, Figure 43.14**



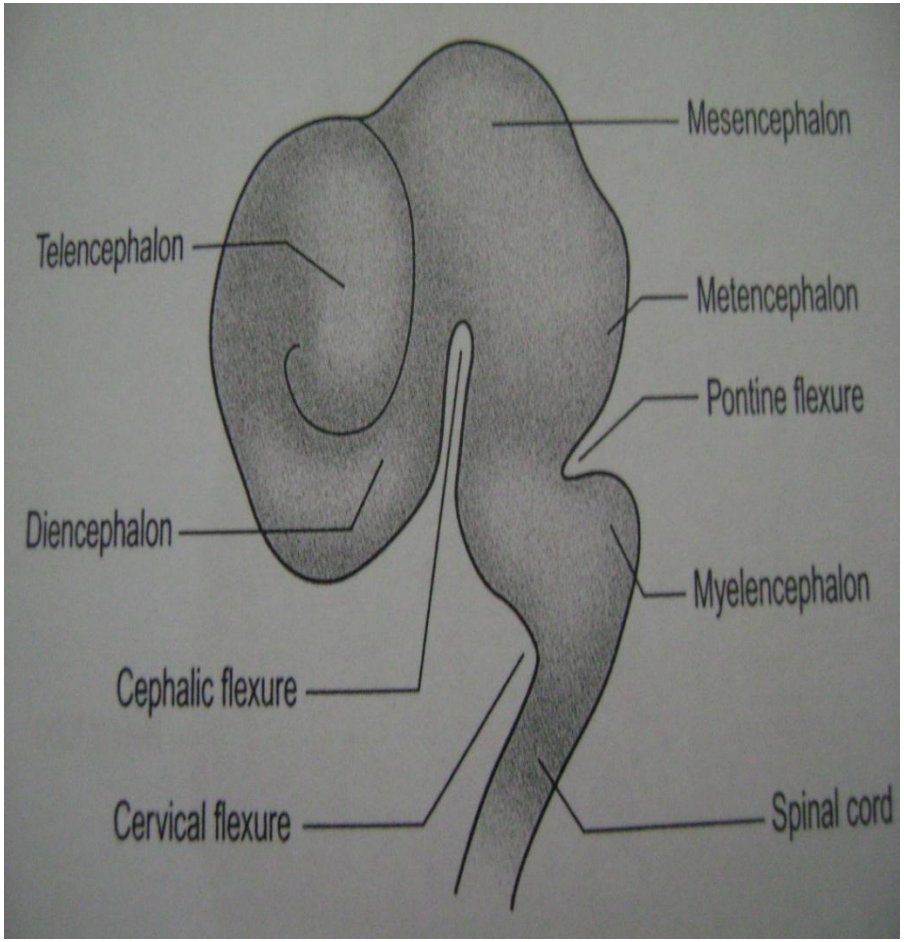
Week 4
Neural Tube: Cell Growth and Differentiation

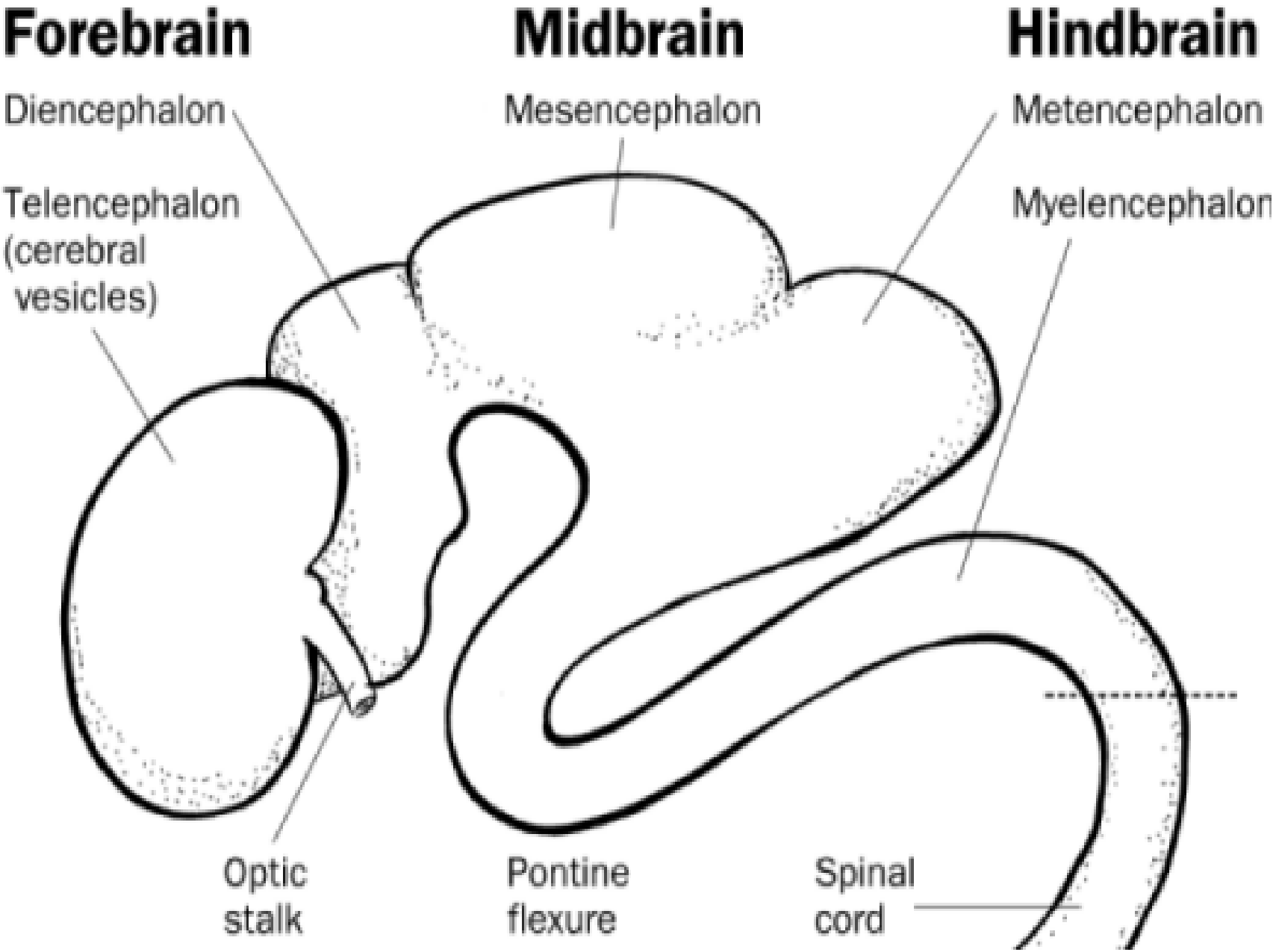
Development of the brain

Primary brain vesicle (4-5 weeks)



Secondary brain vesicle (7-8 weeks)




Forebrain
Midbrain
Hindbrain
Diencephalon
Telencephalon (cerebral vesicles)
Mesencephalon
Metencephalon
Myelencephalon
Optic stalk
Pontine flexure
Spinal cord

Central Nervous system (brain)

- Procencephalon (forebrain) :

  Telencephalon → hemisphere

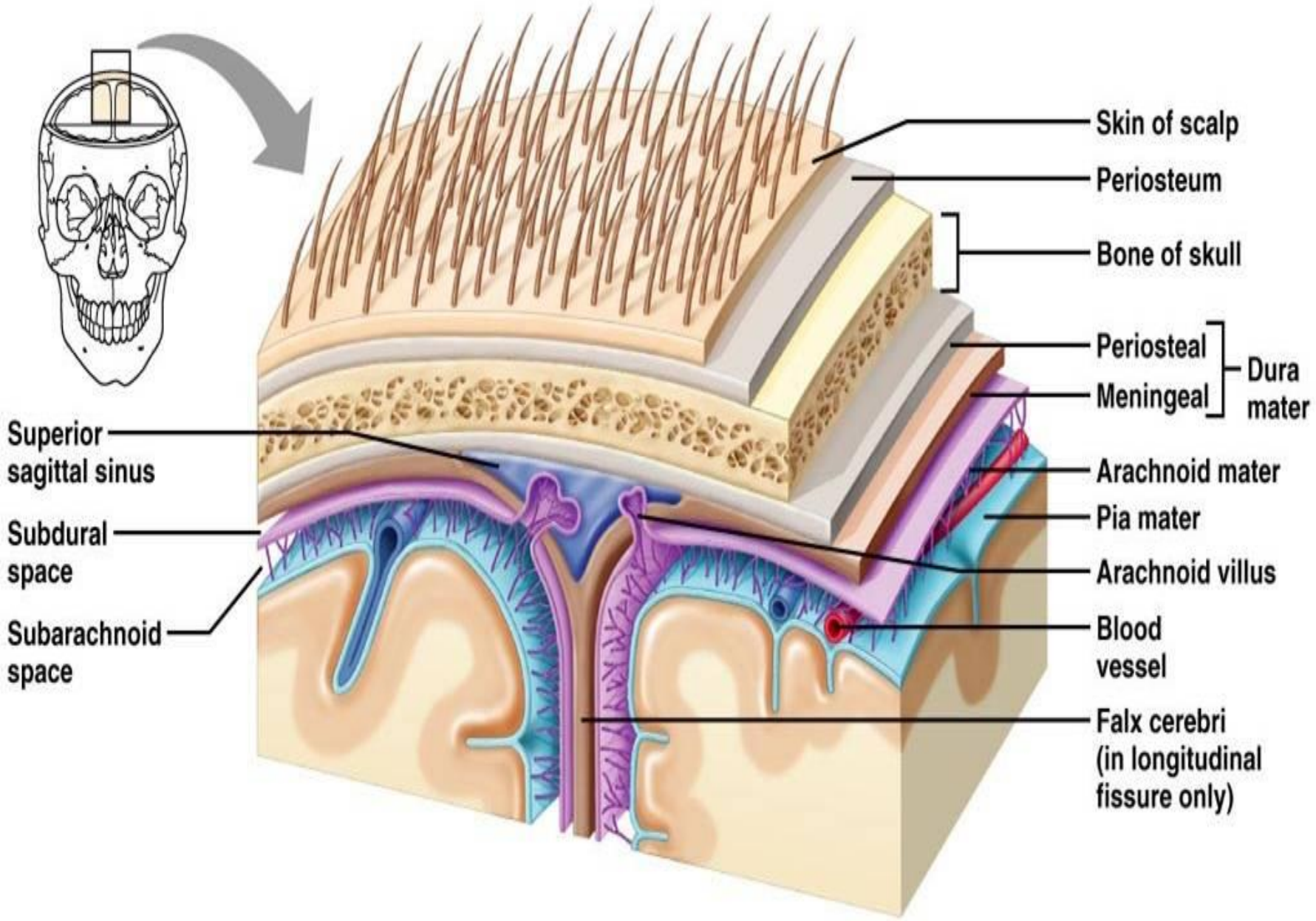
  Diencephalon → thalamus, hipothalamus, metathalamus, subthalamus, hypothalamus.
- Mesencephalon (midbrain)
- Rhombencephalon (hindbrain)

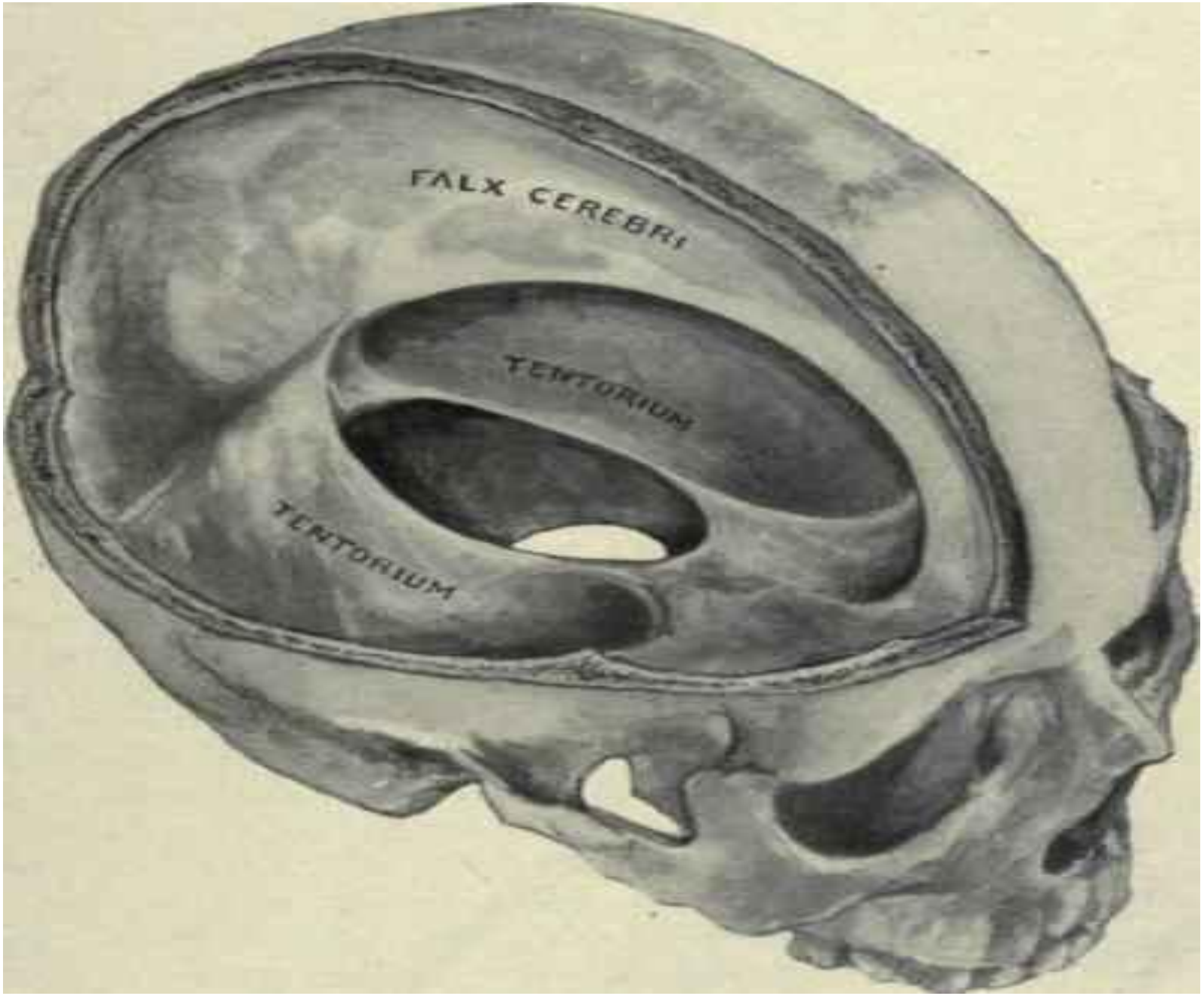
  Metencephalon → pons, cerebellum

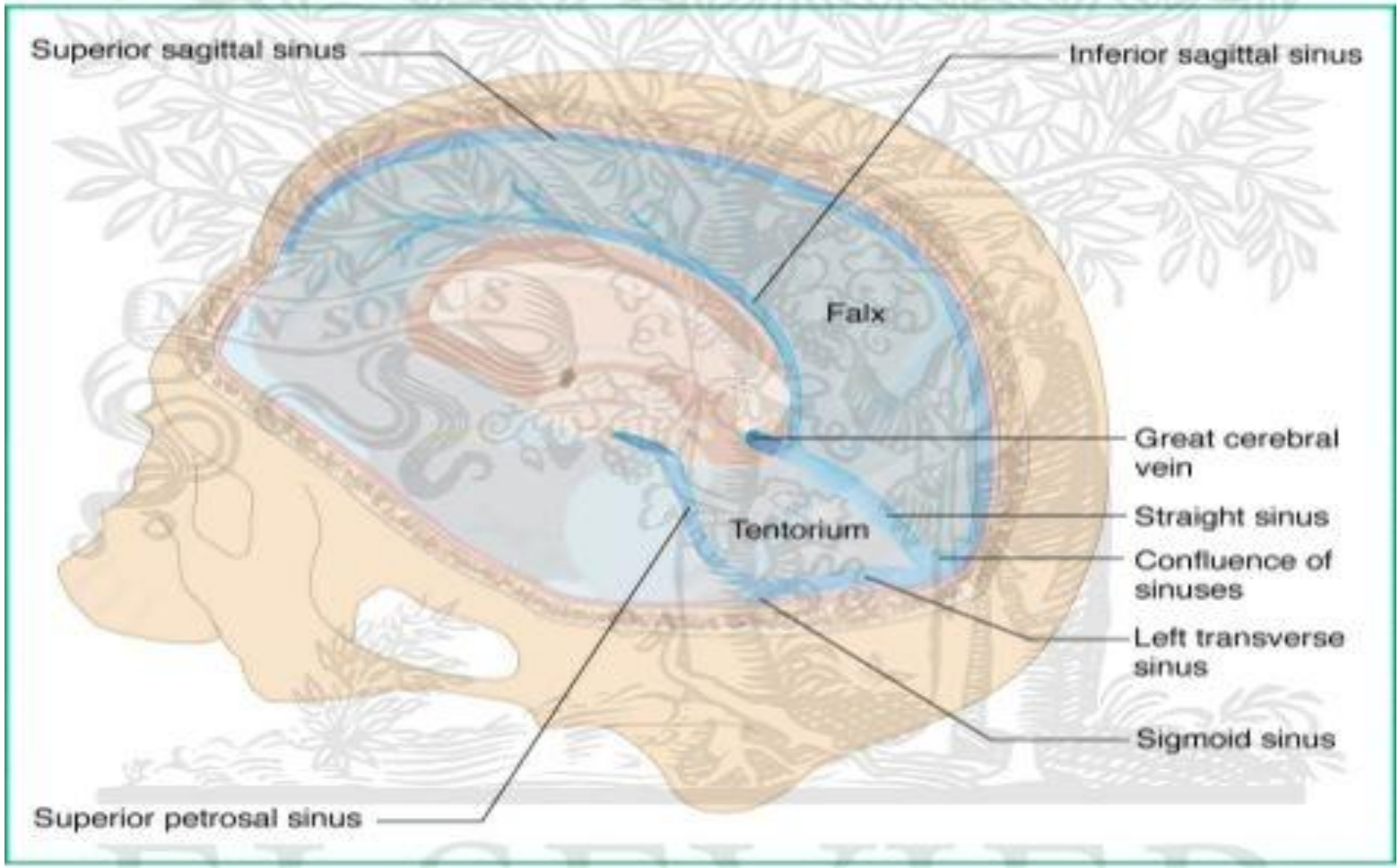
  Myelencephalon → Medulla oblongata

Coverings and blood supply of the CNS

- The brain and spinal cord are invested by three meningeal layers: the dura mater, arachnoid mater and pia mater
- Two sheets of cranial dura mater, the falx cerebri and tentorium cerebelli, incompletely divide the cranial cavity into compartments
- The cranial dura mater contains dural venous sinuses, which act as channels for the venous drainage of the brain
- Beneath the arachnoid mater lies the subarachnoid space in which cerebrospinal fluid (CSF) circulates
- The spinal cord is supplied by vessels arising from the vertebral arteries, reinforced by radicular arteries derived from segmental vessels


Skin of scalp
Periosteum
Bone of skull
Periosteal
Meningeal
Dura mater
Superior sagittal sinus
Arachnoid mater
Pia mater
Subdural space
Arachnoid villus
Subarachnoid space
Blood vessel
Falx cerebri (in longitudinal fissure only)


FALX CEREBRI
TENTORIUM
TENTORIUM



Anatomy of the spinal cord

- The spinal cord lies within the vertebral canal.

  It bears 31 pairs of spinal nerves through which it receives fibres from, and sends fibres to, the periphery
- Near the cord, spinal nerves divide to form dorsal and ventral roots

- dorsal roots, carry afferent fibres with cell bodies in dorsal root ganglia

- ventral roots, carry efferent fibres

- The spinal cord consists :

- central core of grey matter, containing nerve cell bodies

- outer layer of white matter or nerve fibres.

Anatomy of the spinal cord (cont.…)

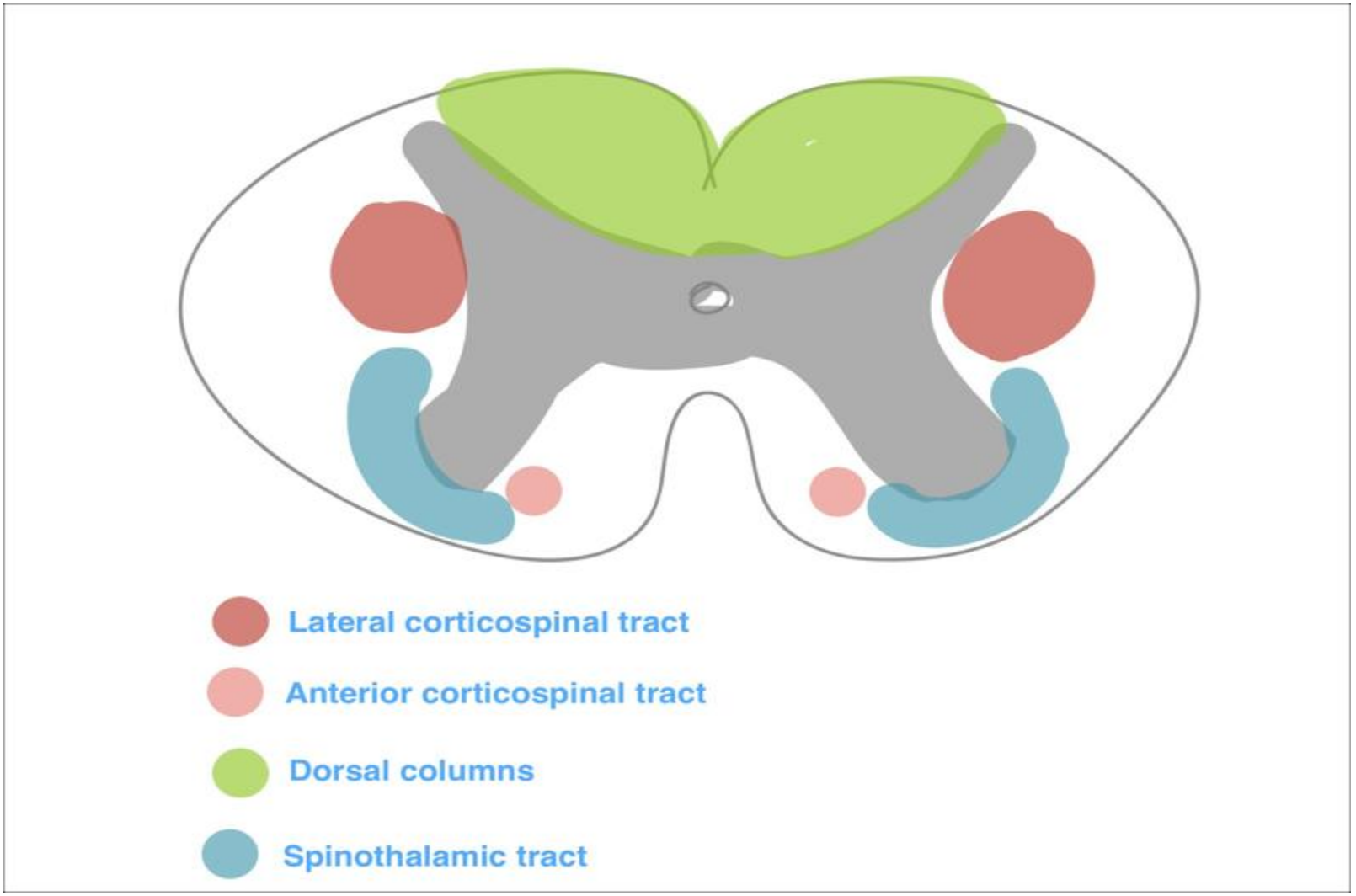
- Grey matter :

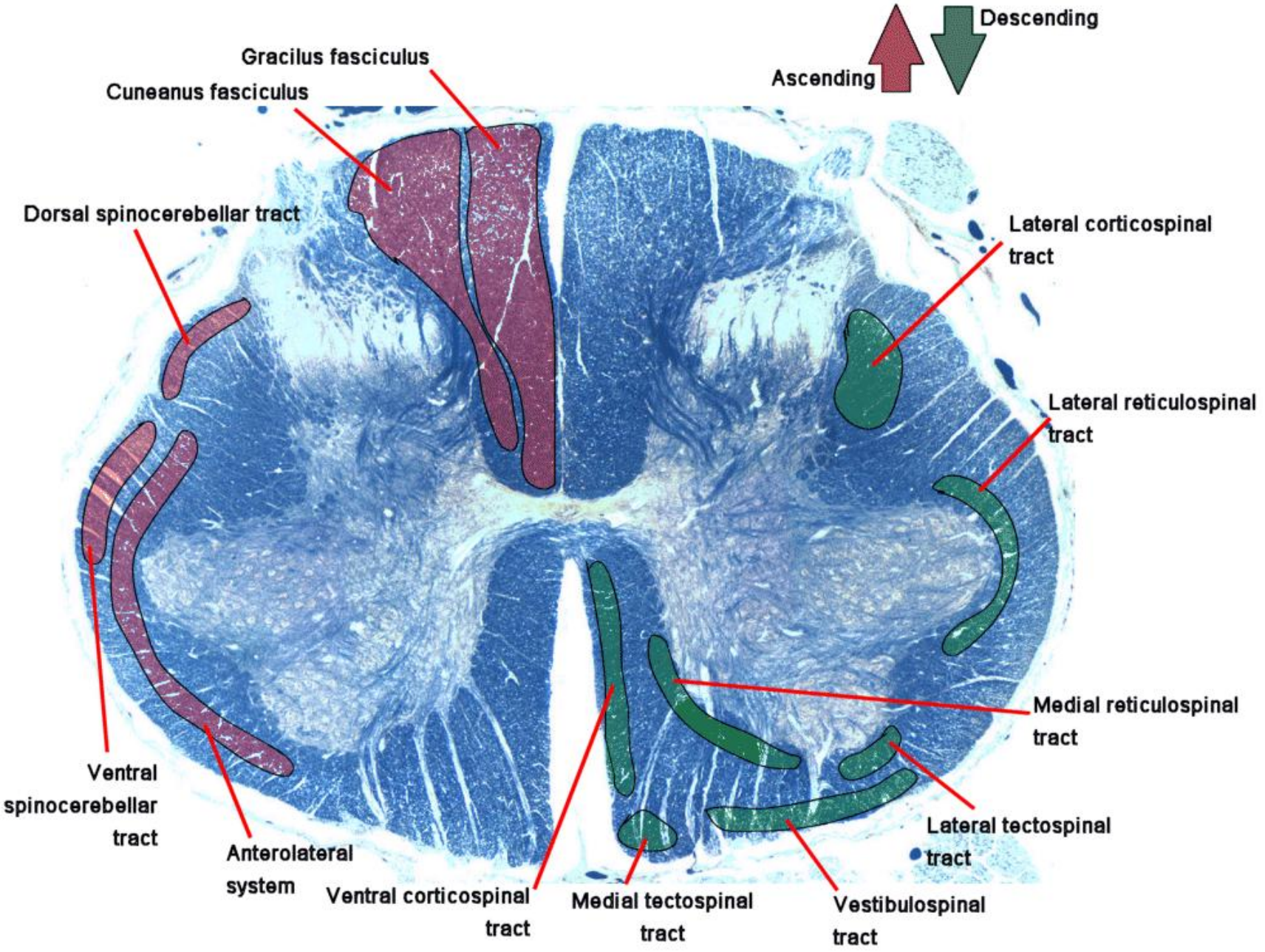
- dorsal horn → sensory neurones
- ventral horn → motor neurones
- lateral horn → preganglionic sympathetic neurones

- The principal ascending tracts :
  - dorsal columns
  - spinothalamic tracts
  - spinocerebellar tract

  The important descending tract :
  - corticospinal tract

Medulla spinalis



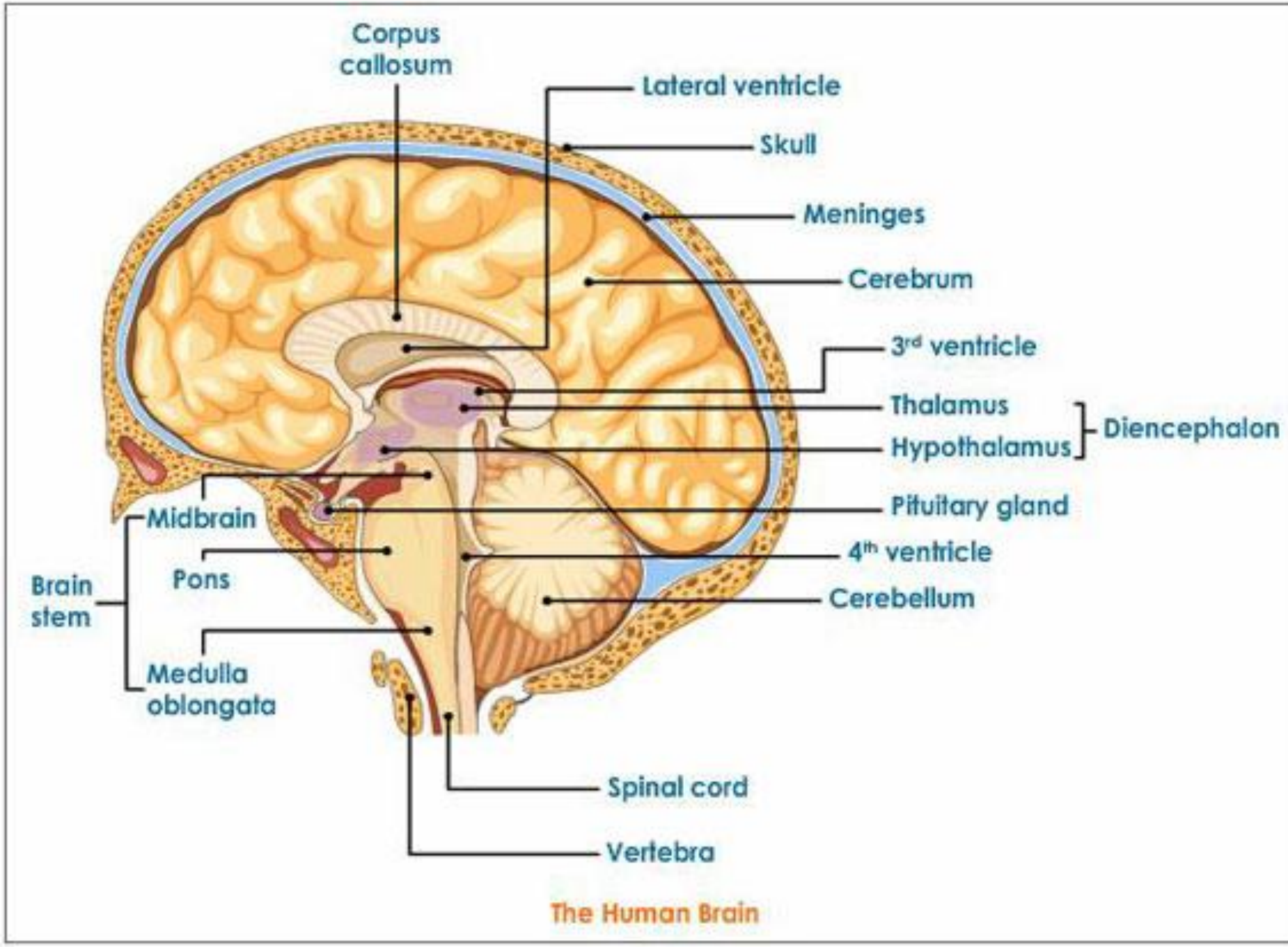

Descending
Ascending
Gracilus fasciculus
Cuneanus fasciculus
Dorsal spinocerebellar tract
Lateral corticospinal tract
Lateral reticulospinal tract
Medial reticulospinal tract
Lateral tectospinal tract
Vestibulospinal tract
Medial tectospinal tract
Ventral corticospinal tract
Anterolateral system
Ventral spinocerebellar tract

Anatomy of the brain

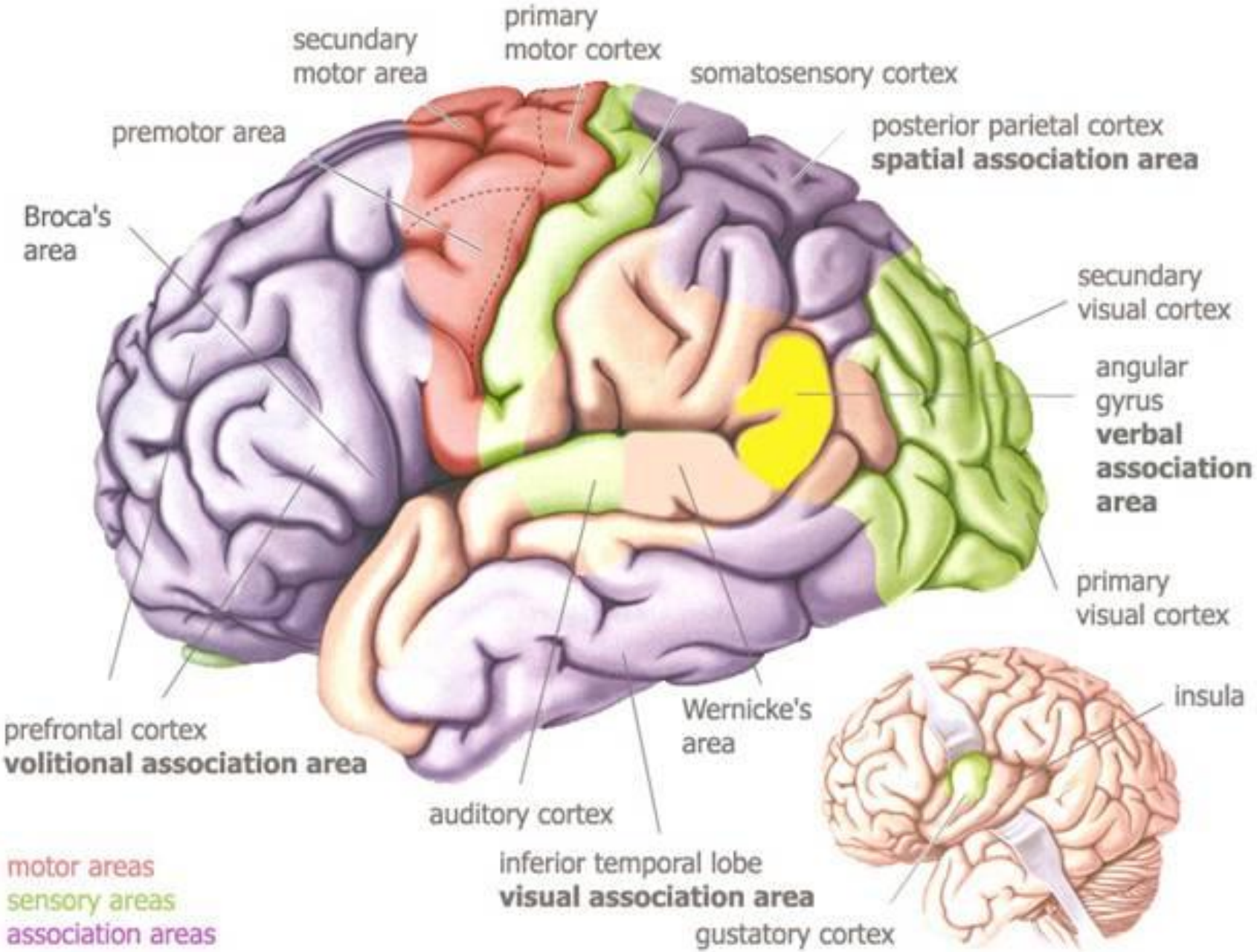
- The brain :

  1. forebrain
     - cerebral hemisphere
     - diencephalon (thalamus and hypothalamus)
  2. midbrain
     - mesencephalon
  3. hindbrain
     - cerebellum
     - pons
     - medulla oblongata

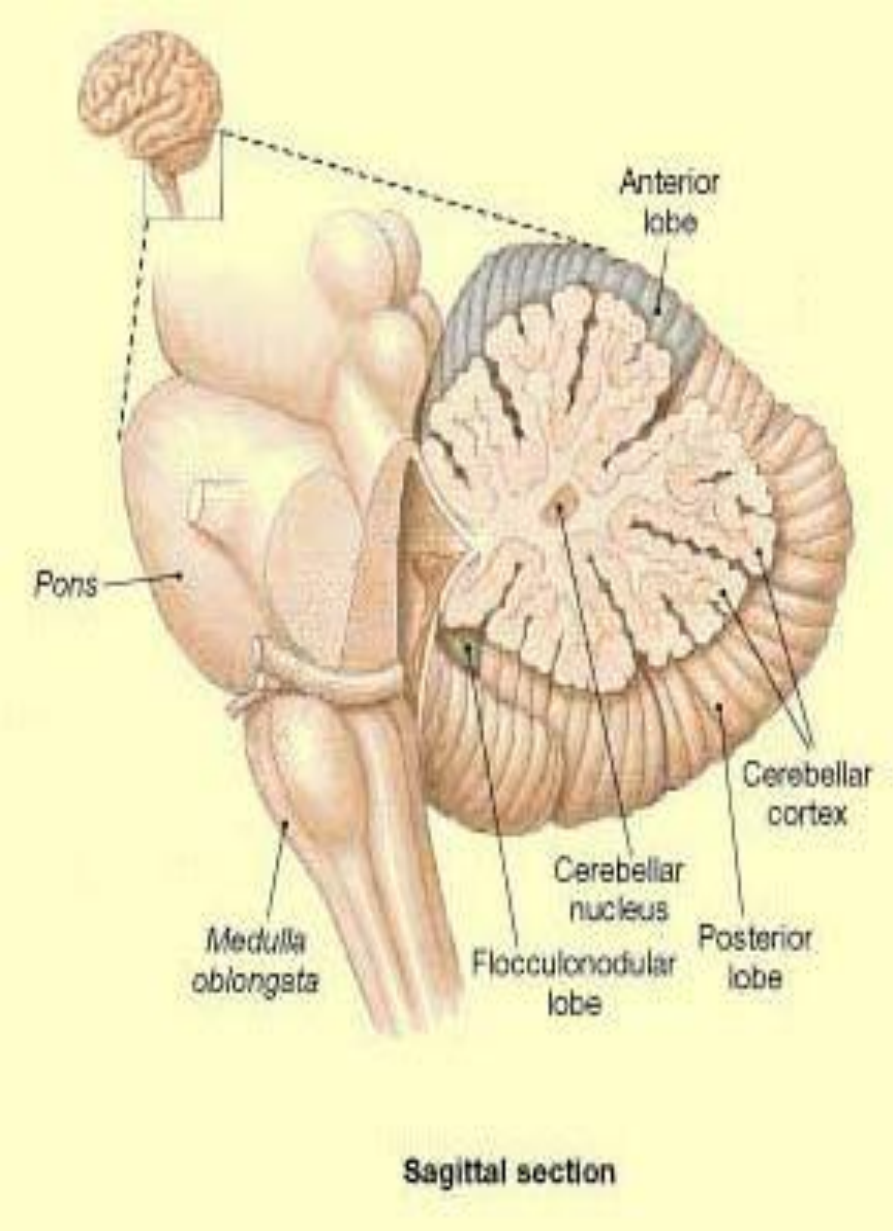
- The medulla, pons and mesencephalon → brain stem

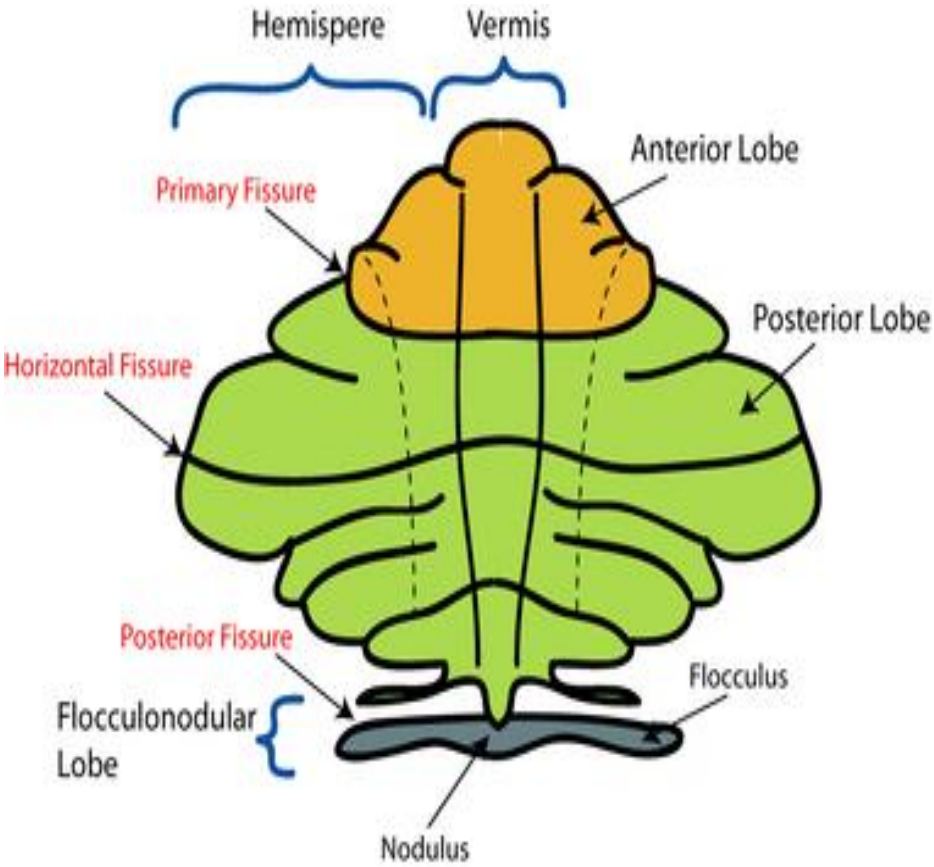


The Human Brain


secundary
motor area
primary
motor cortex
somatosensory cortex
premotor area
posterior parietal cortex
spatial association area
Broca's
area
secundary
visual cortex
angular
gyrus
**verbal
association
area**
primary
visual cortex
insula
Wernicke's
area
prefrontal cortex
volitional association area
auditory cortex
inferior temporal lobe
visual association area
gustatory cortex
motor areas
sensory areas
association areas

Cerebellum

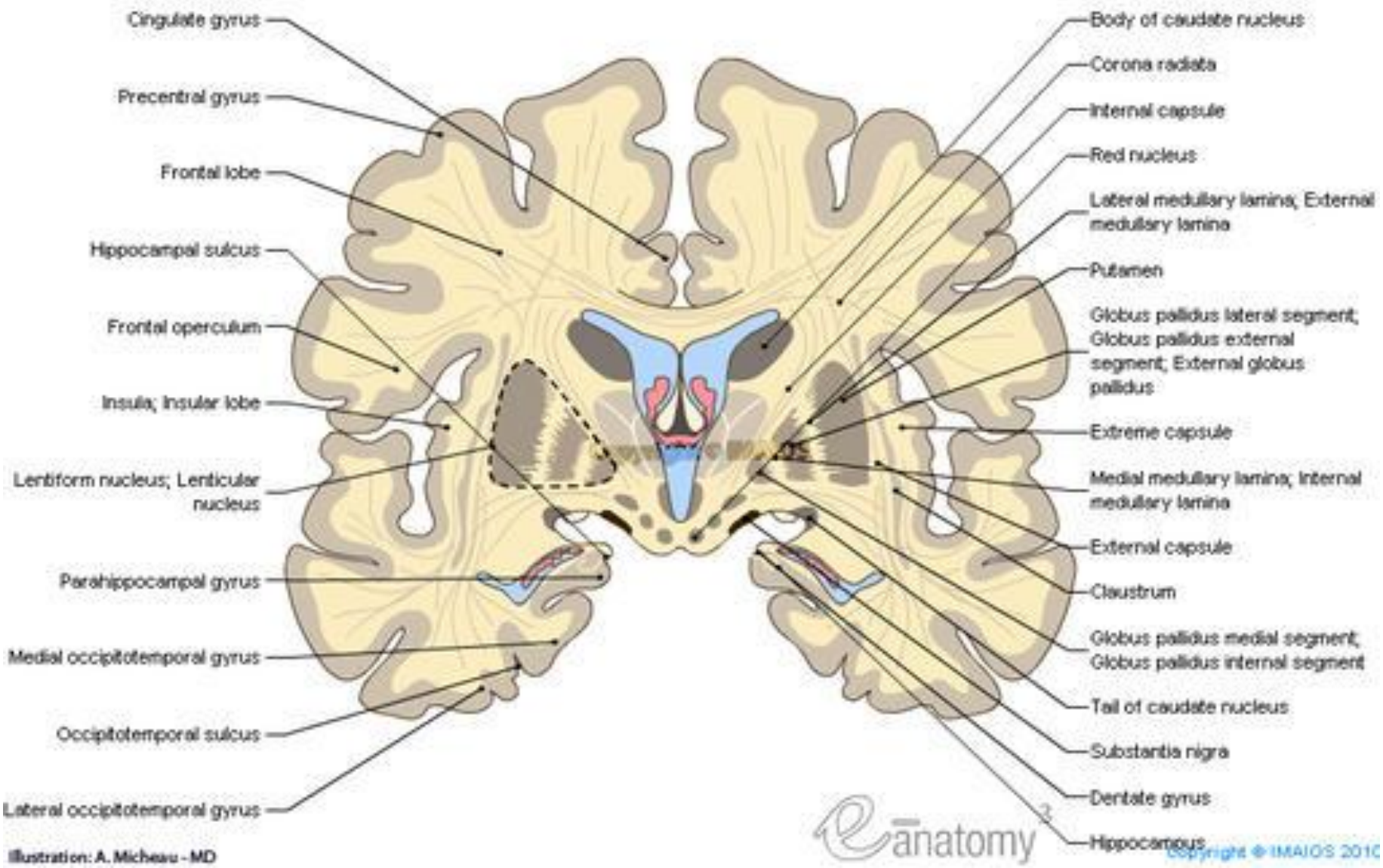

Anterior lobe
Pons
Cerebellar cortex
Cerebellar nucleus
Medulla oblongata
Flocculonodular lobe
Posterior lobe
Sagittal section


Hemispere
Vermis
Anterior Lobe
Primary Fissure
Posterior Lobe
Horizontal Fissure
Posterior Fissure
Flocculus
Flocculonodular Lobe
Nodulus

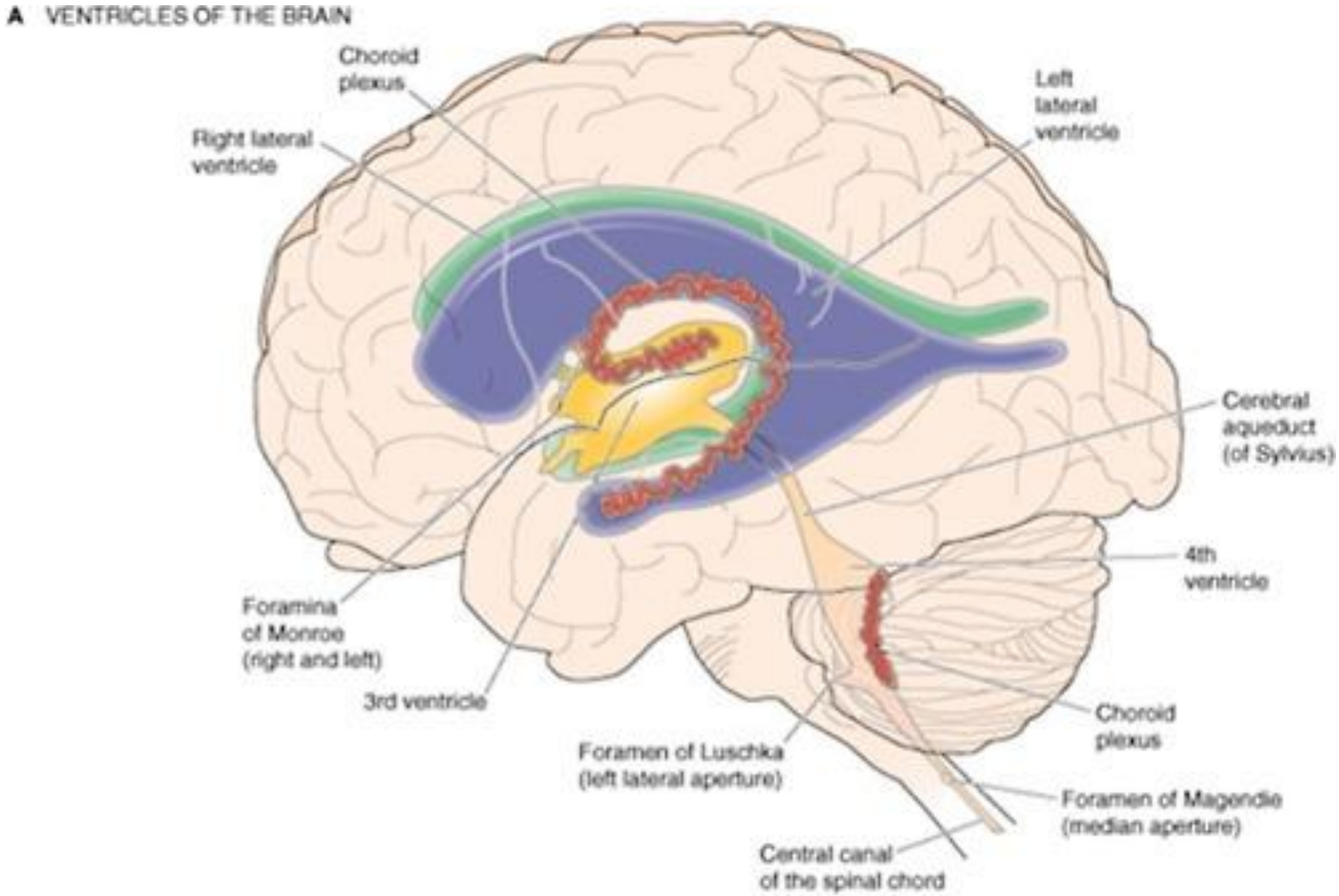
Anatomy of the brain

- Within the cerebral hemisphere lie several large nuclei → basal ganglia or corpus striatum
- The brain contains a system of cavities or ventricles containing CSF, which is produced by the choroid plexus
- The brain possesses 12 pairs of cranial nerves, which carry afferent and efferent fibres
- The two cerebral hemispheres are linked by the fibres of the corpus callosum

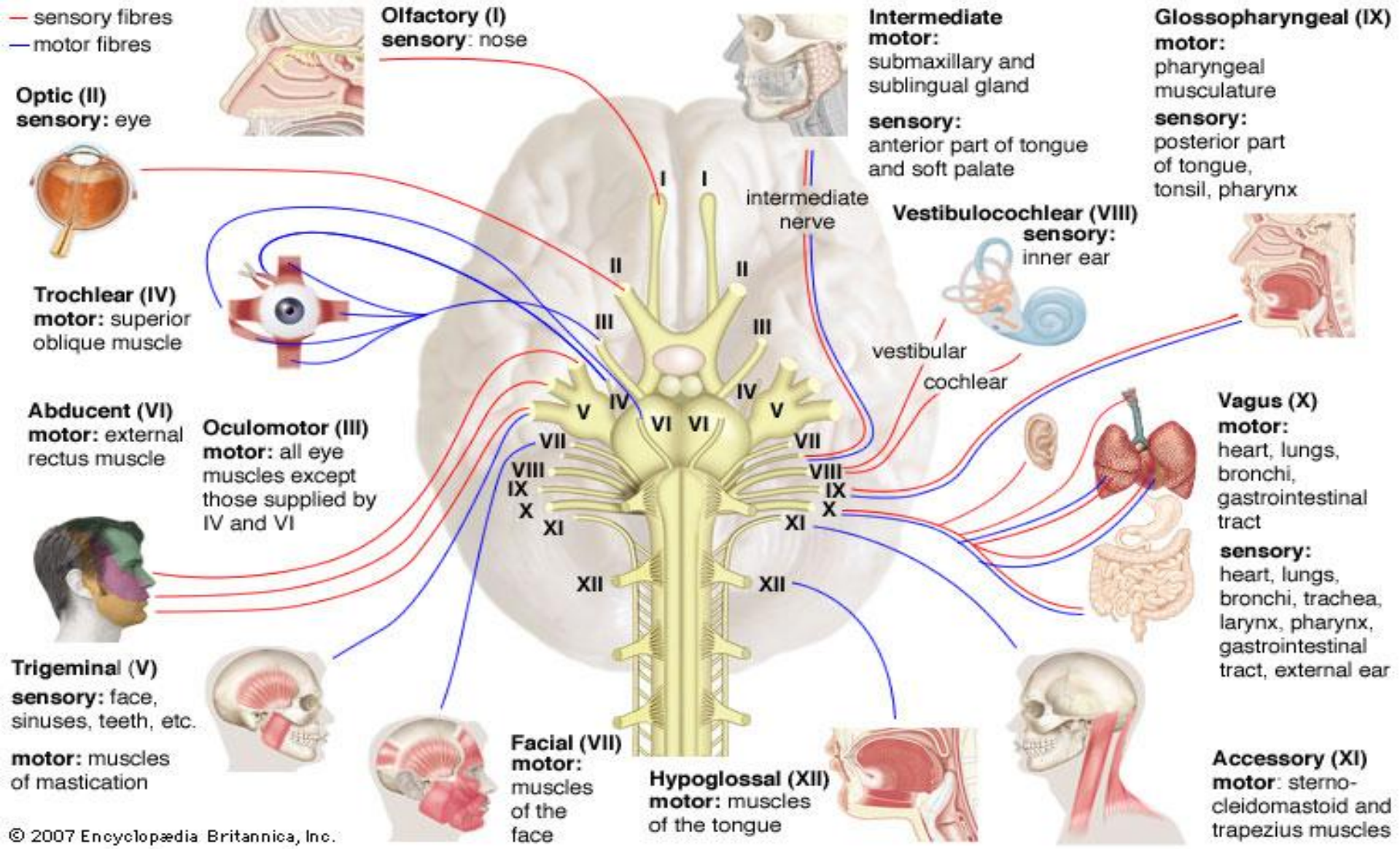
Ganglia basalis



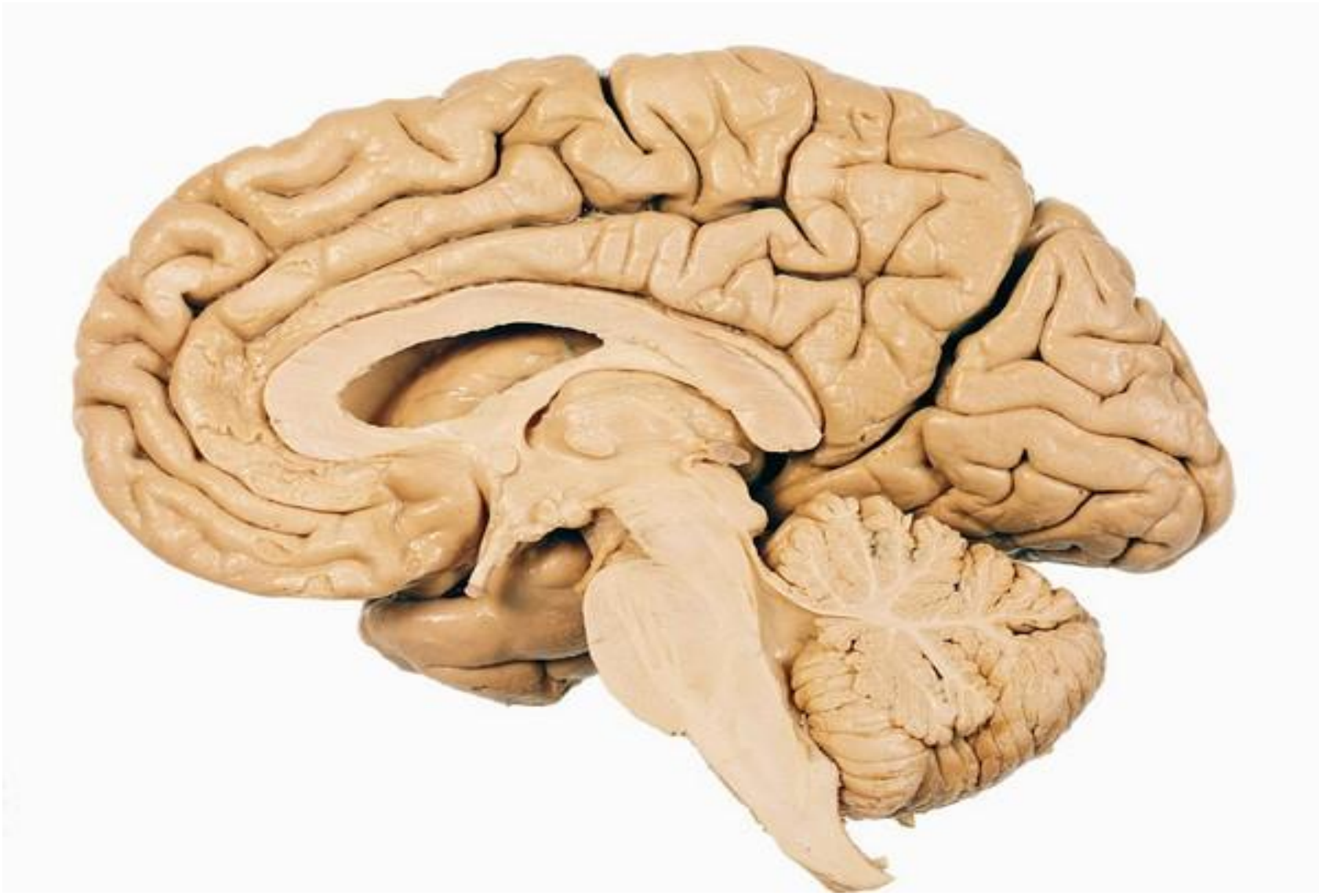
Ventricular system



Cranial nerves



Corpus callosum



Basic clinical diagnostic principles

- History-taking, clinical examination and investigations lead to the diagnosis of the cause (aetiology) of disease
- The site of the lesion(s) determines the clinical syndrome revealed by the neurological examination
- Disorders of the nervous system can be classified as intrinsic, extrinsic, systemic, or vascular

Intrinsic disorders

- primary disorders of the nervous system itself
- Intrinsic disorders consist of system degenerations (atrophy), inborn errors of metabolism, paroxysmal disorders, neoplasms, infections and immune disorders
- Examples :

  1. consciousness (epilepsy),
  2. excessive sleep (narcolepcy)
  3. headache (migraine)
  4. Muscular dystrophies
  5. Hereditary sensorimotor neuropathies
  6. Hereditary spastic paraparesis
  7. Cerebelar ataxias and Huntington's disease.

Extrinsic disorders

- Extrinsic disorders lead to compression of the brain, spinal cord, nerve roots and peripheral nerves
- The brain may be compressed on its outer surface by blood clots (haematomas), abscesses and tumours
- fluid-filled ventricles may compress the brain (hydrocephalus)
- The spinal cord may be compessed by disease of the spine, such as arthritis (spondylosis), meningiomas

Systemic disorders

- primarily disorders of organs other than the nervous system that disrupt neuromuscular function by abnormal metabolism
- Examples :

  failure of the cardiorespiratory system, liver or kidneys, or hormonal (endocrine)disorders such as thyroid disease, diabetes mellitus and abnormalities in calcium and potassium balance

Vascular disorders

- Occlusion of the vessels (thrombosis)
- Restriction of the blood and oxygen supply (infarction)
- Bleeding into the nervous tissues (haemorrhage)

Lower motor neuron (LMN) syndrome

- Weakness (paresis) or paralysis (plegia) of individual muscles
- Wasting of muscles
- Visible spontaneous contractions of motor units (fasciculation)
- Reduced resistance to passive stretching (hypotonia)
- Diminution or loss of deep tendon reflexes (hyporeflexia or areflexia).

Upper motor neurone (UMN) syndrome

- Weakness or paralysis of specific movements (extension of the upper limbs and flexion of the lower limbs, termed 'pyramidal weakness')
- No wasting of muscles
- Increased resistance to passive stretching of muscles (spasticity); initial resistance to muscular stretching followed by relaxation (clasp-knife response)
- Hyperactivity of deep tendon reflexes (hyperreflexia)
- Emergence of the extensor plantar response (positif Babinski reflex) leading to dorsiflexion of the great toe on stimulation of the sole of the foot
- Loss of abdominal reflexes.

Disorders of the cerebellum

Cerebellum is concerned with the coordination of movement

Cerebellar lesions cause:

- Nystagmus
- Dysarthria (scanning speech)
- Intention tremor
- Ataxia

The signs and symptoms occur ipsilateral to the lesion

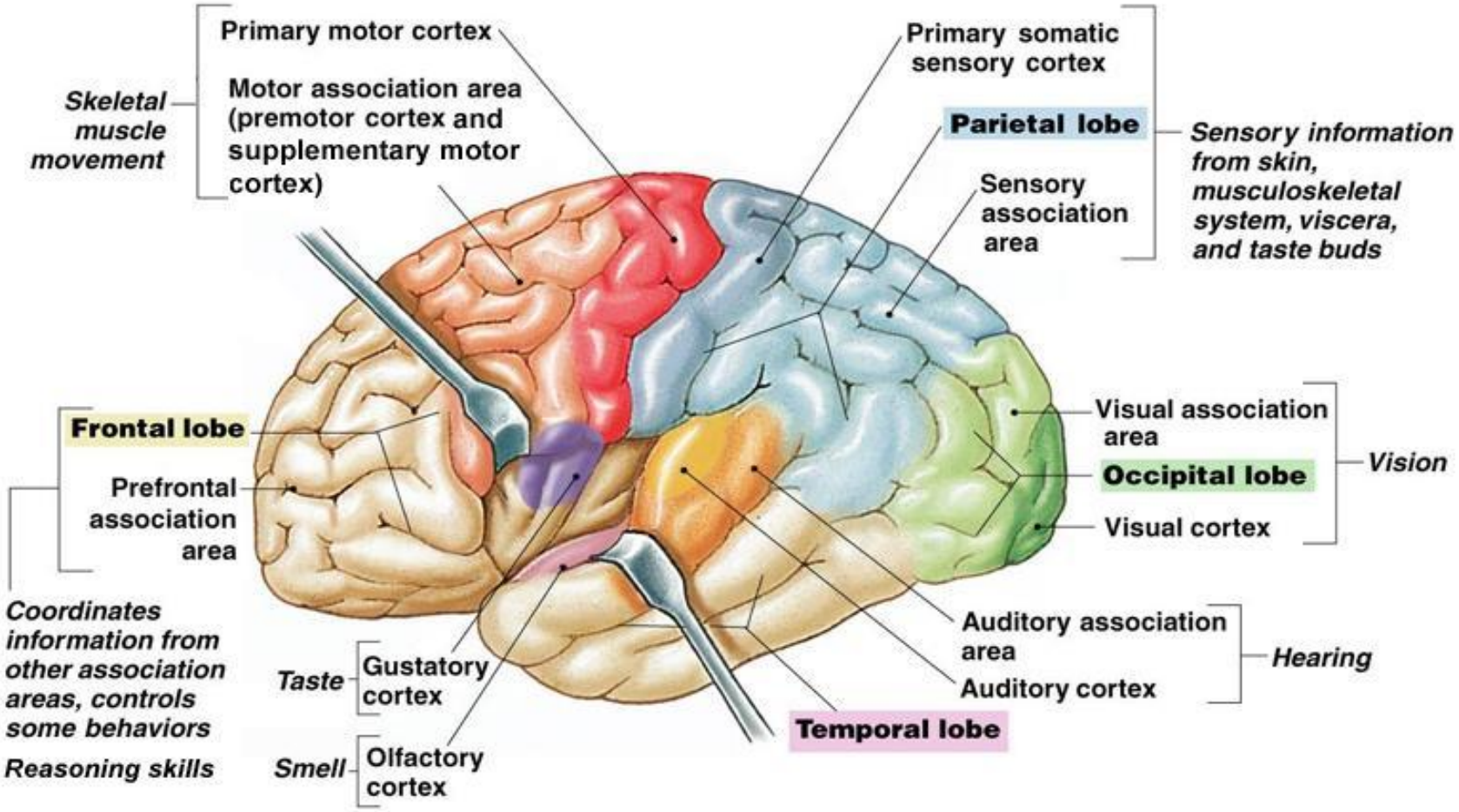
Disorder of the Basal Ganglia

Basal ganglia lesion cause:

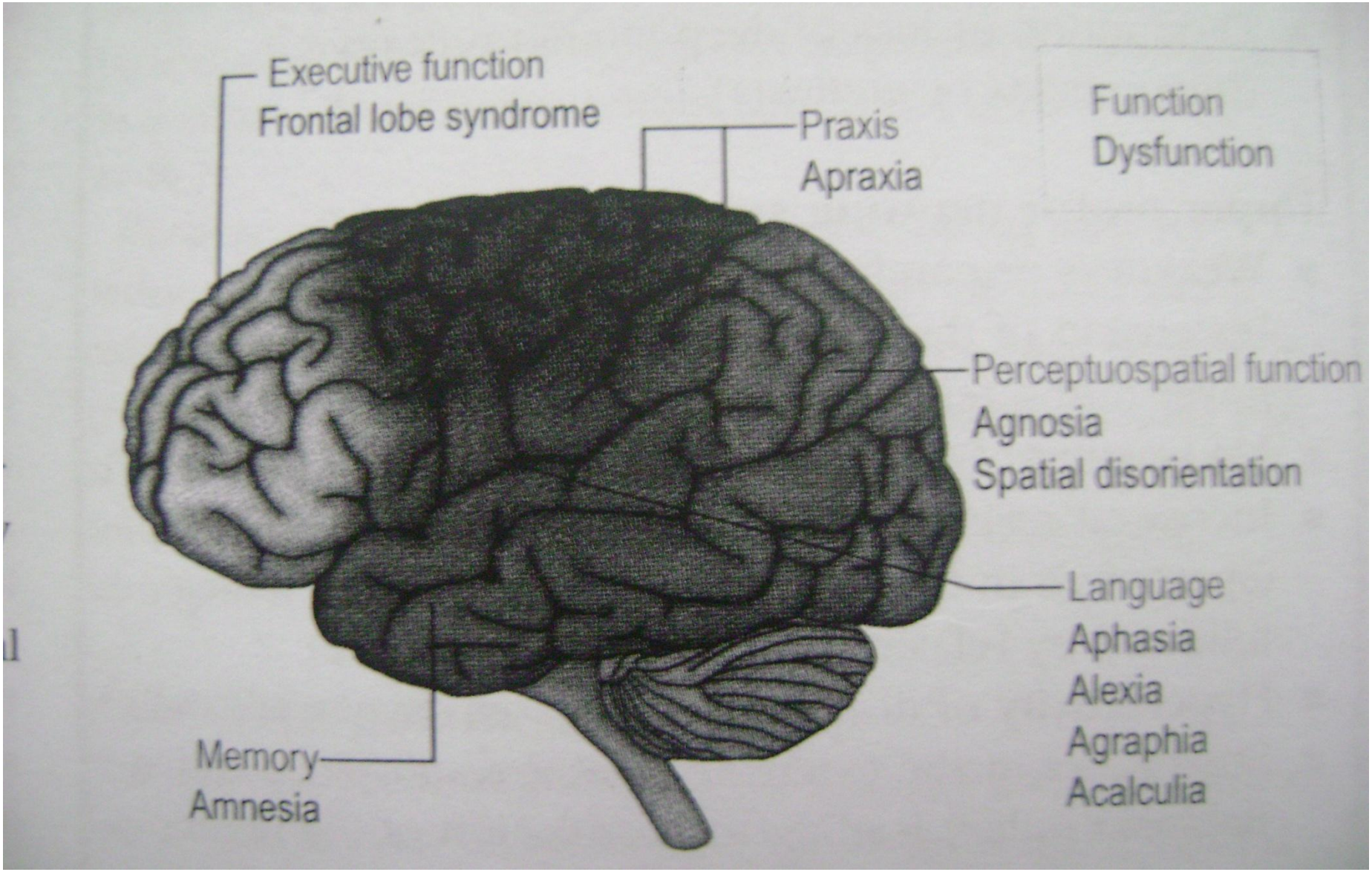
- Slow initiation and execution of movement (akinesia)
- Increased muscular tone (rigidity)
- Abnormal involuntary movements (dyskinesias)

The sign and symptoms occur contralateral to the lesion.

Neuropsychological Functions



Neuropsychological Functions

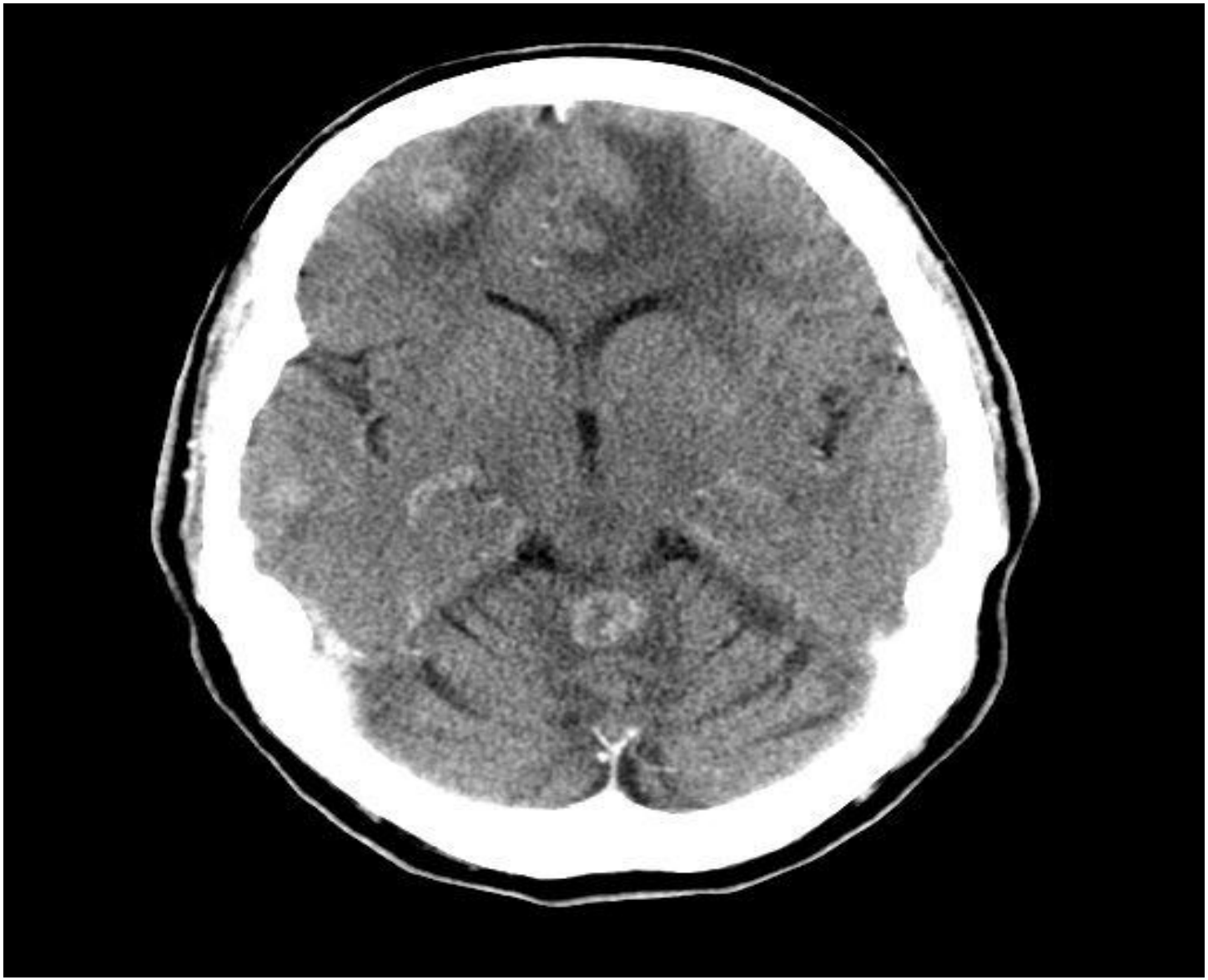


Investigations of Neuromuscular Disease

The major focus of investigations involves:

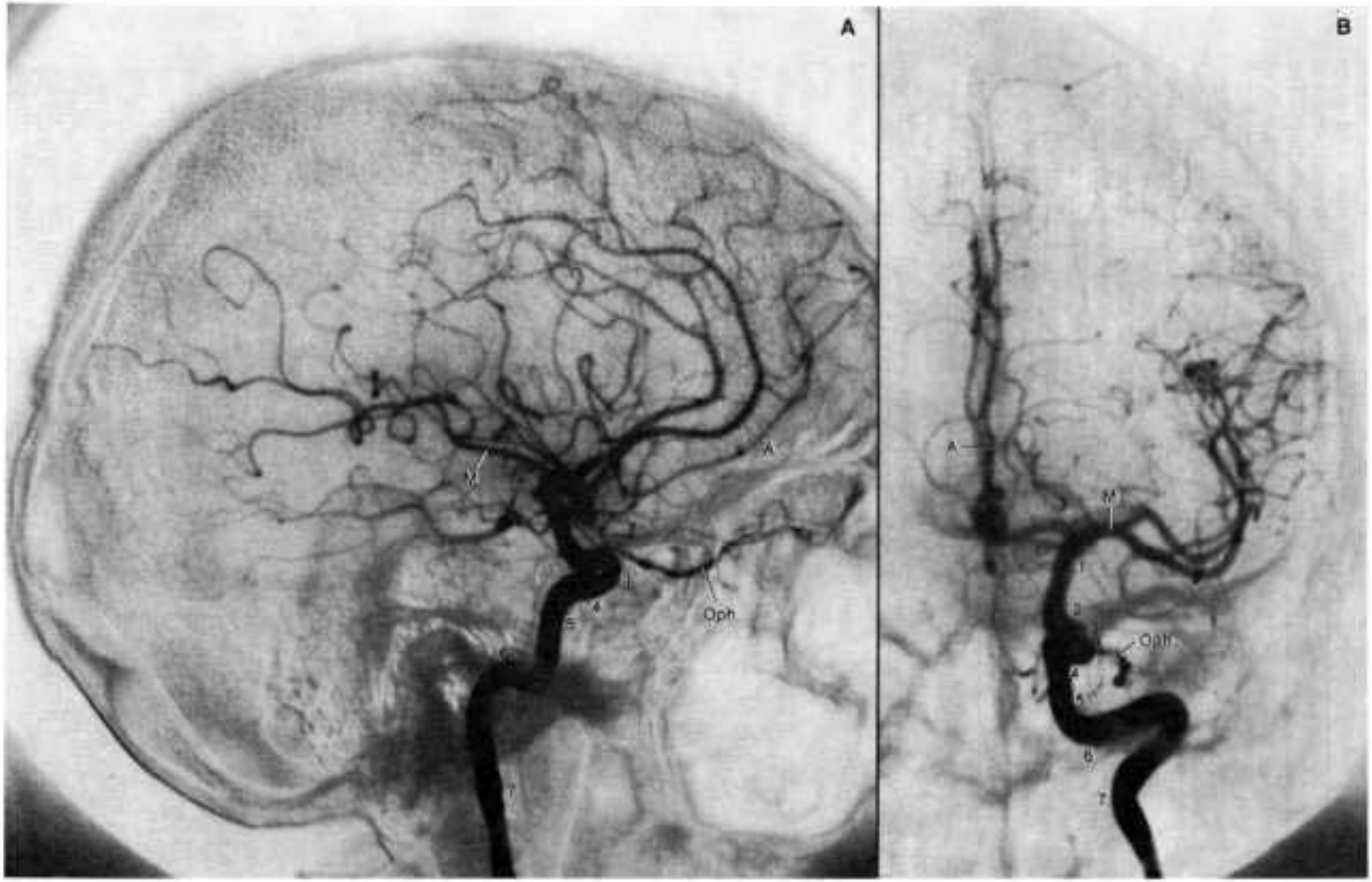
- CSF analysis
- Neuroradiology
- Neurophysiology
- Neuropathology (biopsy)

Computed Tomography (CT)



Magnetic Resonance Imaging (MRI)

Carotid angiogram




Thank You