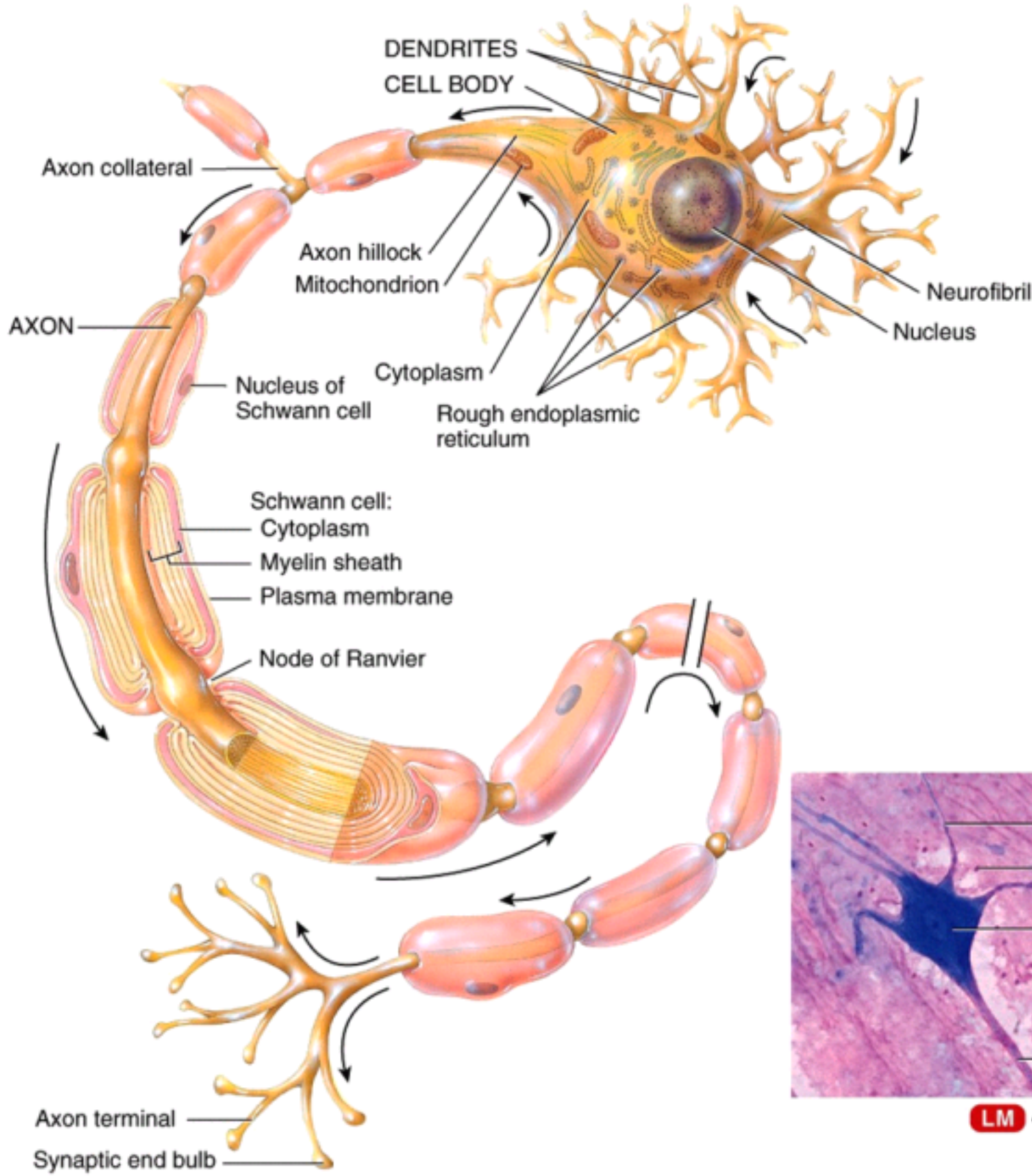
The Brain and Cranial Nerves

- Central Nervous System (CNS)
- Brain and spinal cord
- Peripheral Nervous System (PNS)

All nervous system structures outside of the CNS

- Somatic (SNS); Sensory, Motor
- Autonomic (ANS) nervous systems; Sensory, Motor
- Sympathetic
- Parasympathetic
- Enteric nervous system (ENS)

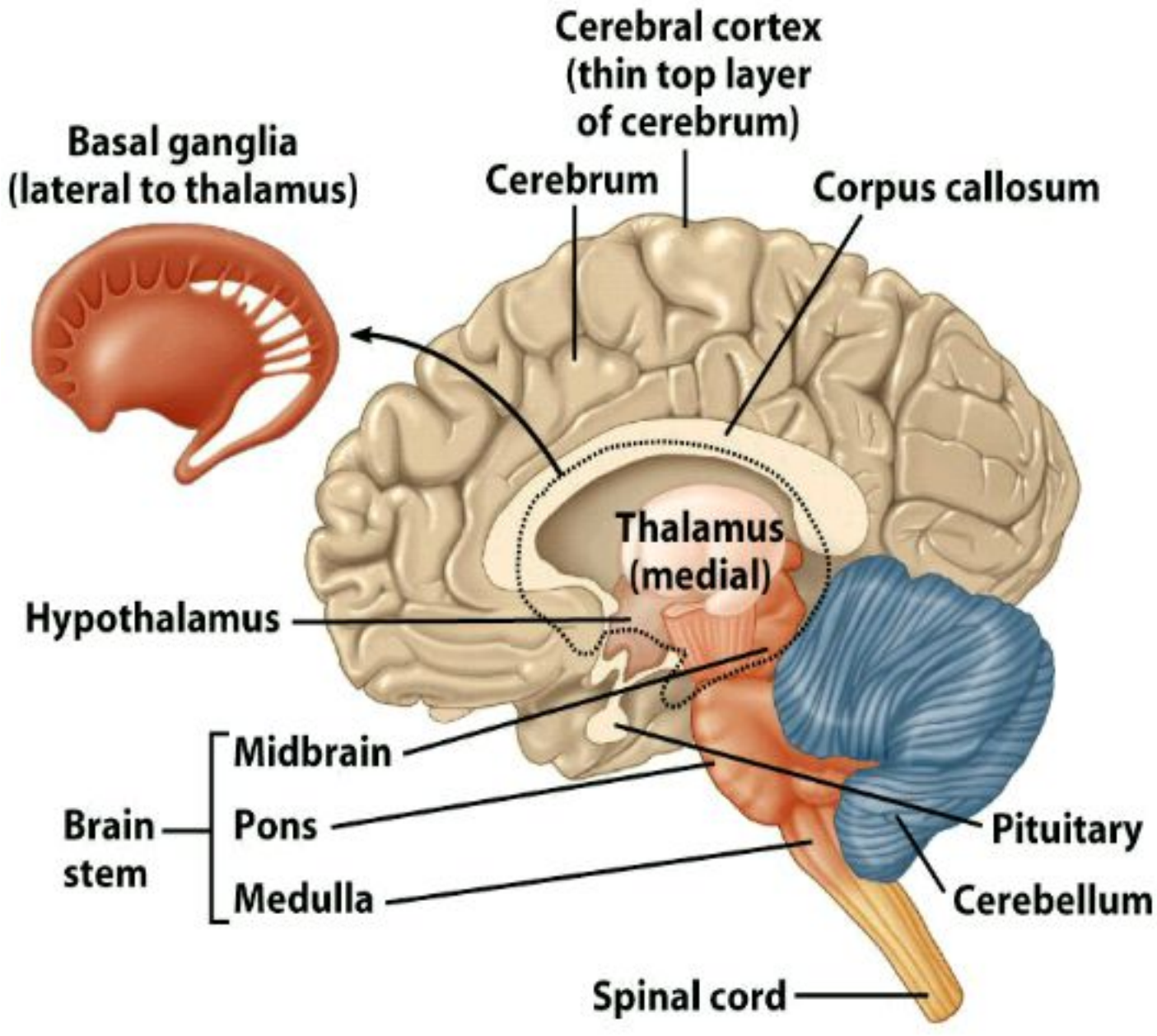

DENDRITES
CELL BODY
Axon collateral
Axon hillock
Mitochondrion
AXON
Nucleus of Schwann cell
Cytoplasm
Rough endoplasmic reticulum
Neurofibril
Nucleus
Schwann cell:
Cytoplasm
Myelin sheath
Plasma membrane
Node of Ranvier
Axon terminal
Synaptic end bulb

Dendrite
Neuroglial cell
Cell body
Axon
LM 400x

Functions of the Nervous System

- Sensory receptors and sensory nerves
- Carry information into brain and spinal cord
- Integration: information processing
- Perception = awareness of sensory input
- Analyzing and storing information to help lead to appropriate responses
- Motor activity: efferent nerves

The major parts of the adult brain are shown here



Cerebral cortex
- Receives sensory information
- Sends messages to move skeletal muscles
- Integrates incoming and outgoing nerve impulses
- Performs activities such as thinking, learning, and remembering

Basal ganglia
- Helps coordinate slow, sustained movements
- Suppresses useless patterns of movement

Thalamus
- Relays most sensory information from the spinal cord and certain parts of the brain to the cerebral cortex
- Interprets certain sensory messages such as those of pain, temperature, and pressure

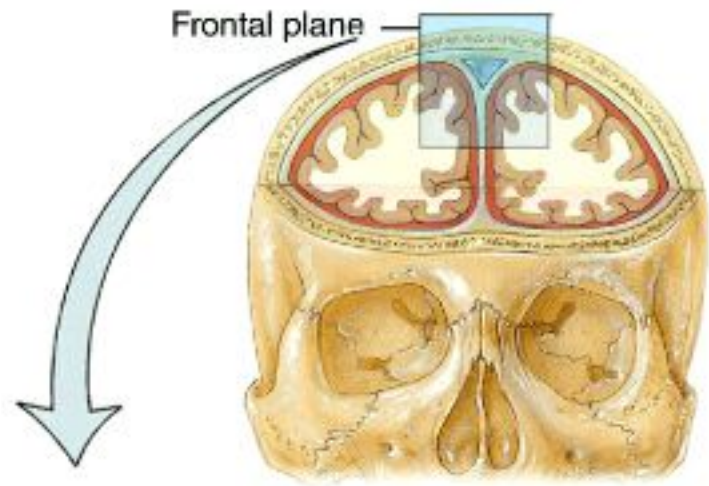
Hypothalamus
- Controls various homeostatic functions such as body temperature, respiration, and heartbeat
- Directs hormone secretions of the pituitary

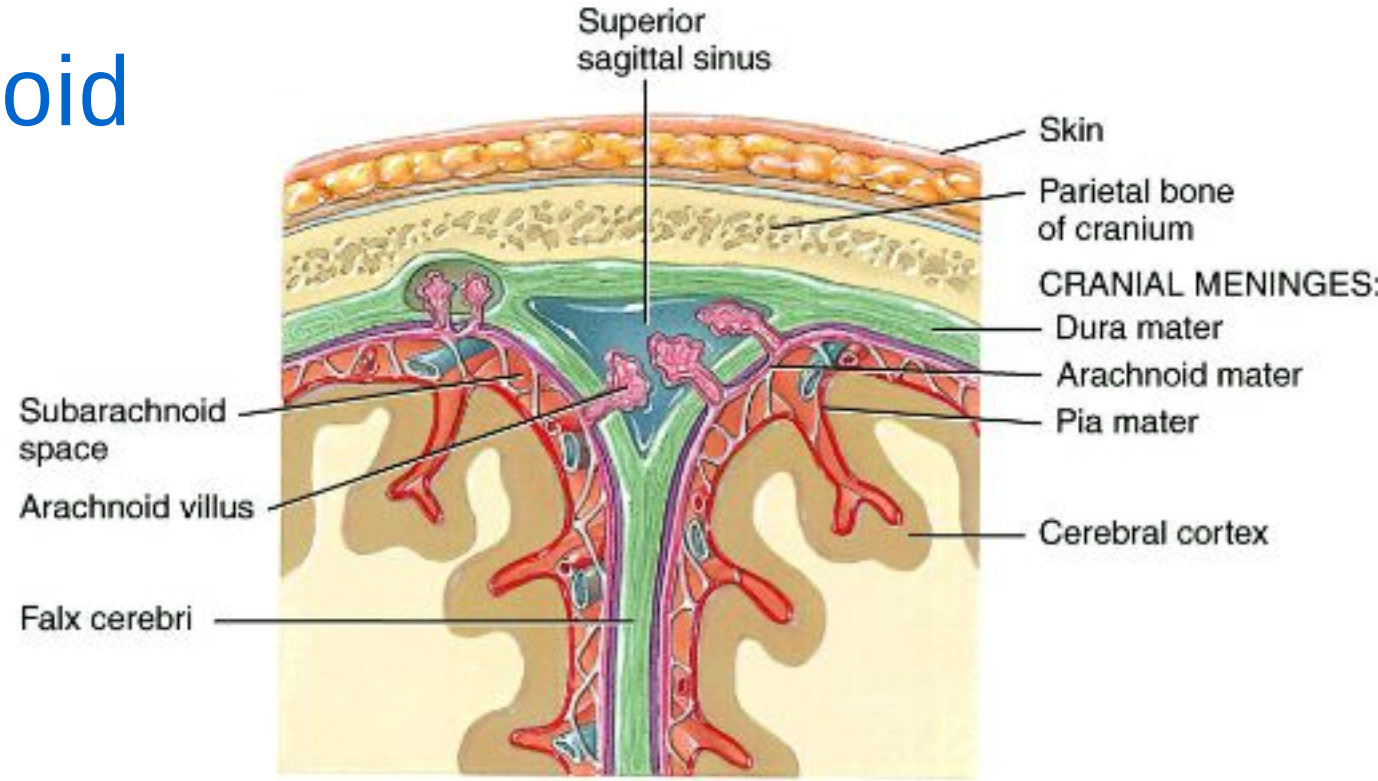
Cerebellum
- Coordinates subconscious movements
- Contributes to muscle tone, posture, and balance

Brain stem
- Origin of many cranial nerves
- Reflex center for movements of eyeballs, head, and trunk
- Regulates heartbeat and breathing
- Plays a role in consciousness
- Transmits impulses between brain and spinal cord

The cranial meninges are continuous with the spinal meninges and mirror their structure and function –they also bear the same names:

- a tough outer dura mater
- a spidery arachnoid mater
- and a thin, delicate pia mater





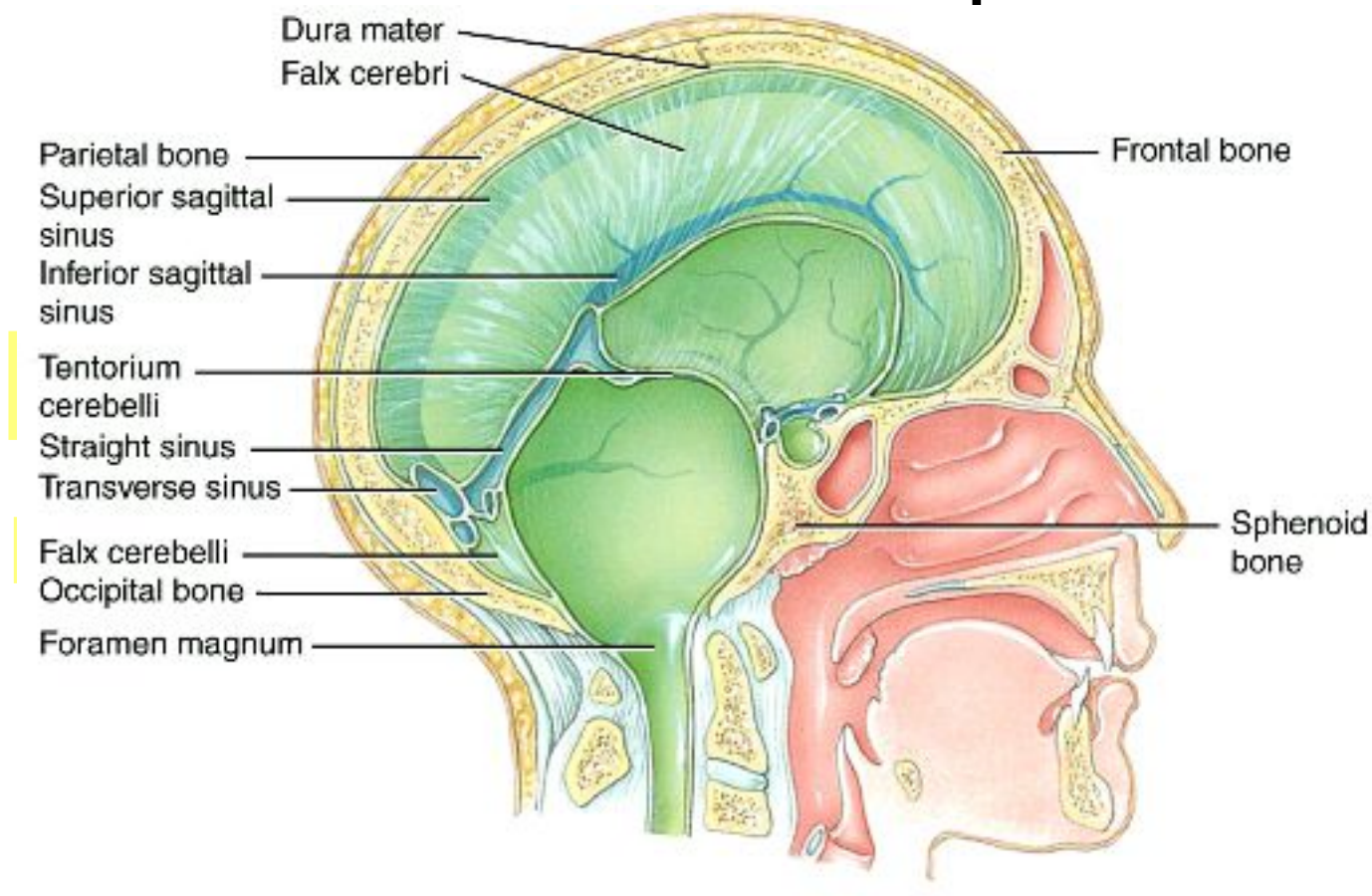
Anterior view of frontal section through skull showing the cranial meninges

In the brain, extensions of the dura mater form hard, non-compliant membranes that divide the intracranial vault in various ways:

- The 3 important dural extensions are the falx cerebri, the falx cerebelli, and the tentorium cerebelli.

- The falx cerebri is a strong sickle-shaped fold of dura mater which descends vertically in the longitudinal fissure and separates the two cerebral hemispheres.

- The falx cerebelli is a small triangular process that separates the two cerebellar hemispheres.

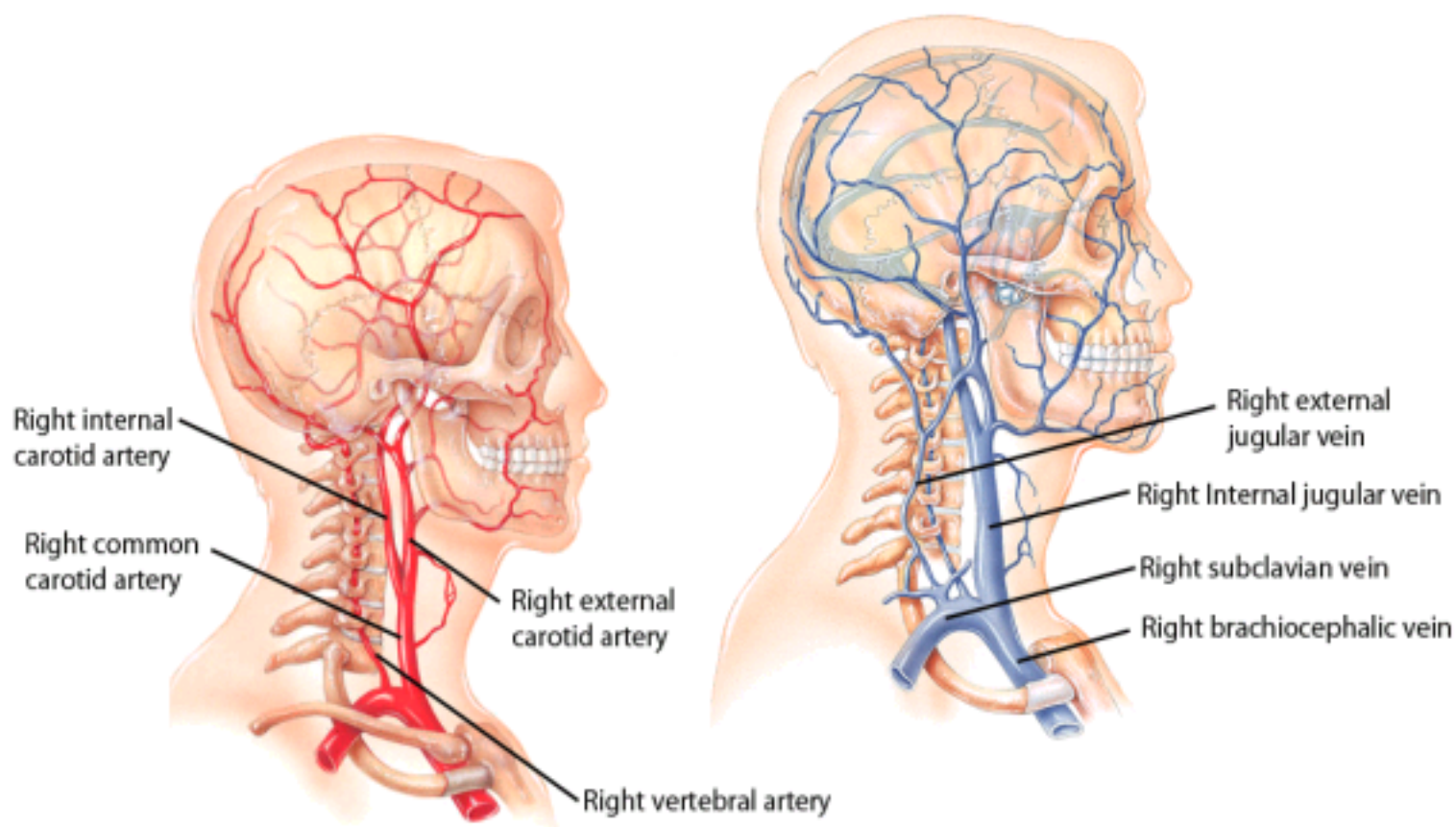


Sagittal section of extensions of the dura mater

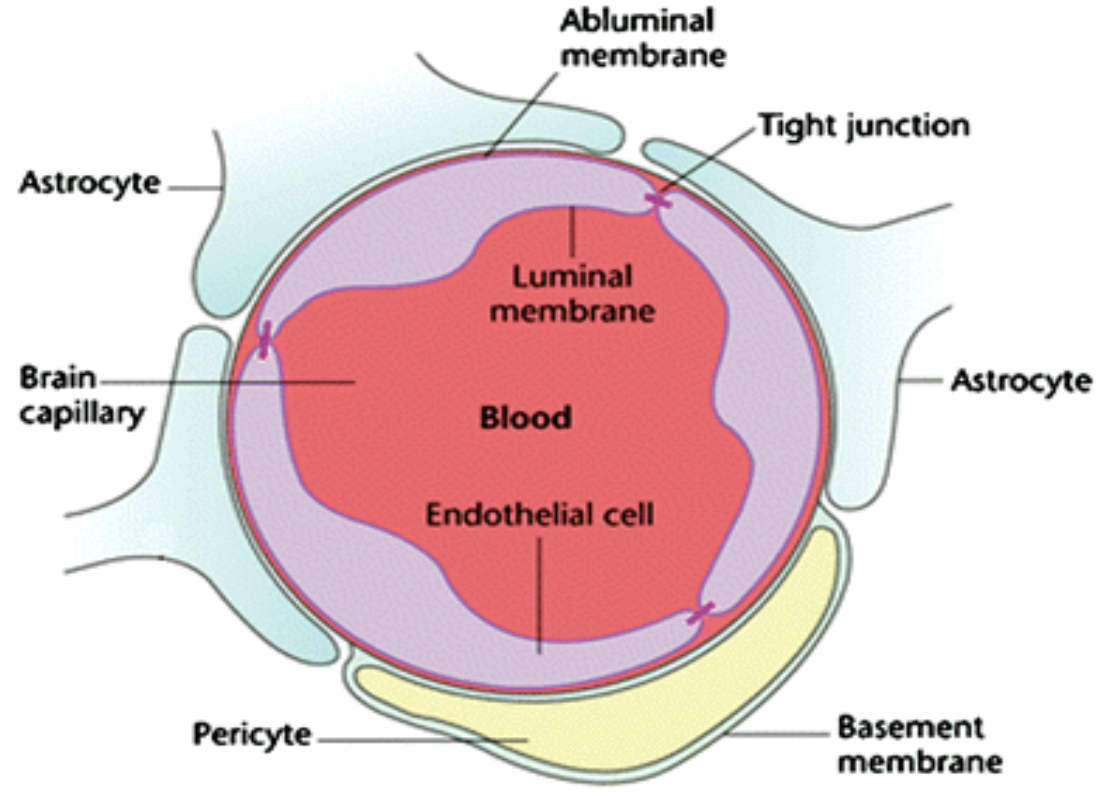
Brain Blood Flow

Anteriorly, the internal carotid arteries supply blood to the brain; the posterior blood supply is via the vertebral arteries.

- The internal jugular veins are the venous return



- The vascular endothelium around brain capillaries differs from most other organs of the body in that it forms tight junctions with the end-feet of nearby astrocytes.
  - As a result of this unusual architecture, a blood brain barrier (BBB) is formed.

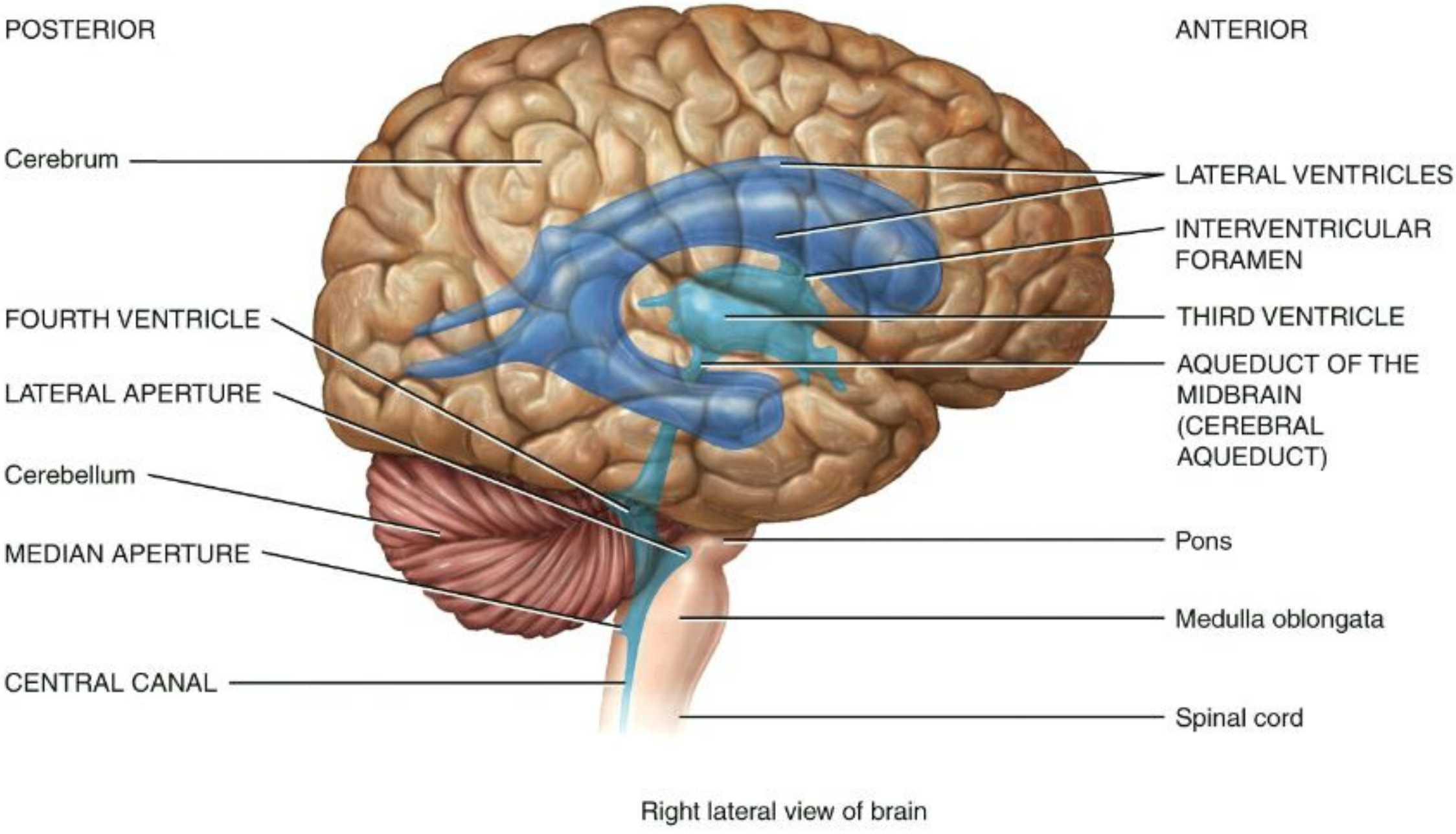


Production and Flow of CSF

- Cerebral spinal fluid is a clear fluid that circulates through the internal cavities in the brain and spinal cord and also flows over and around the brain and cord in the subarachnoid space. The brain "floats" in it.

CSF absorbs shock and protects the brain and the cord. It also helps transport nutrients and wastes between blood and nervous tissues.

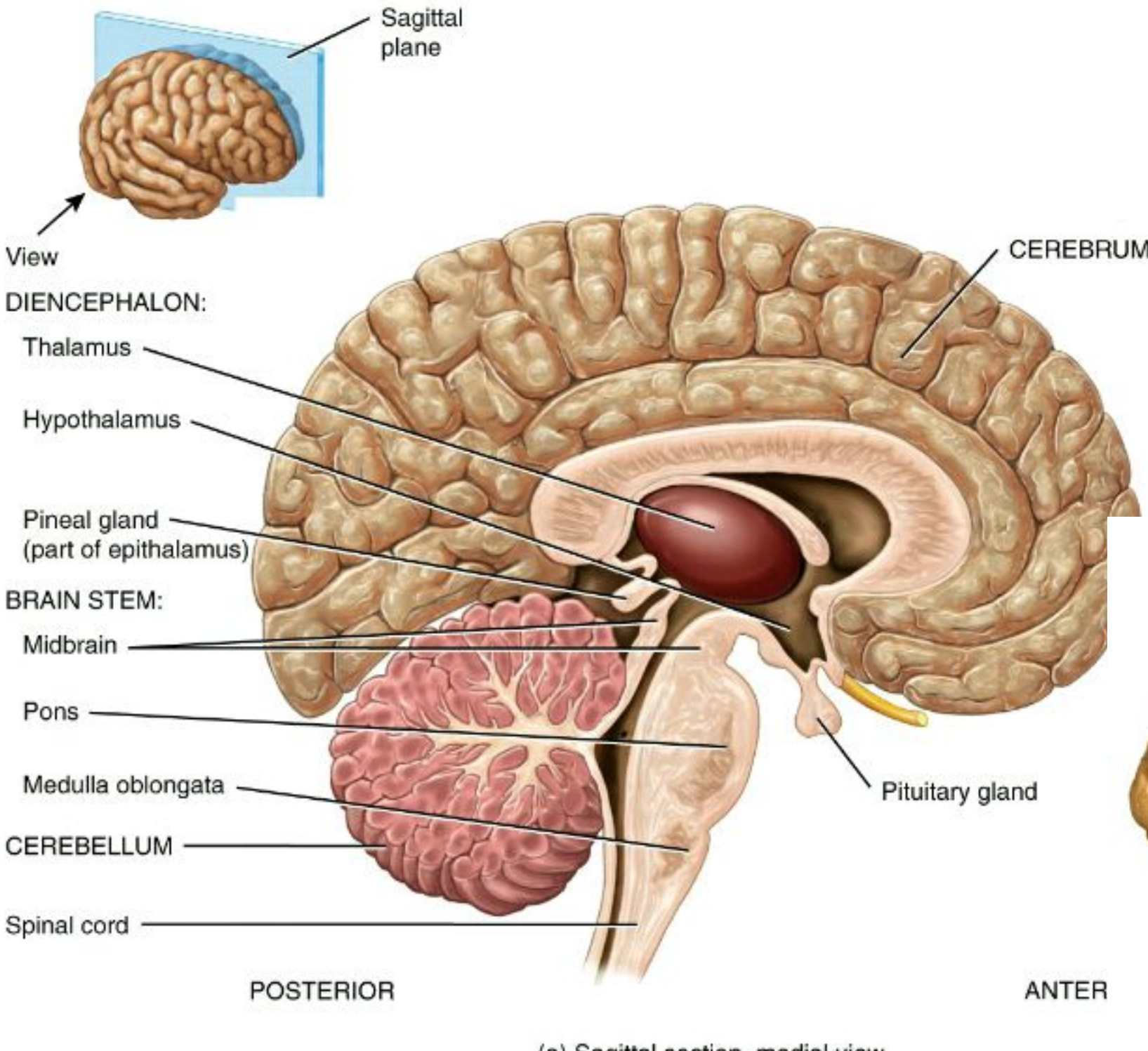
Production and Flow of CSF



Right lateral view of brain

The Irrigation System of the fluid filled brain showing the circulating CSF.

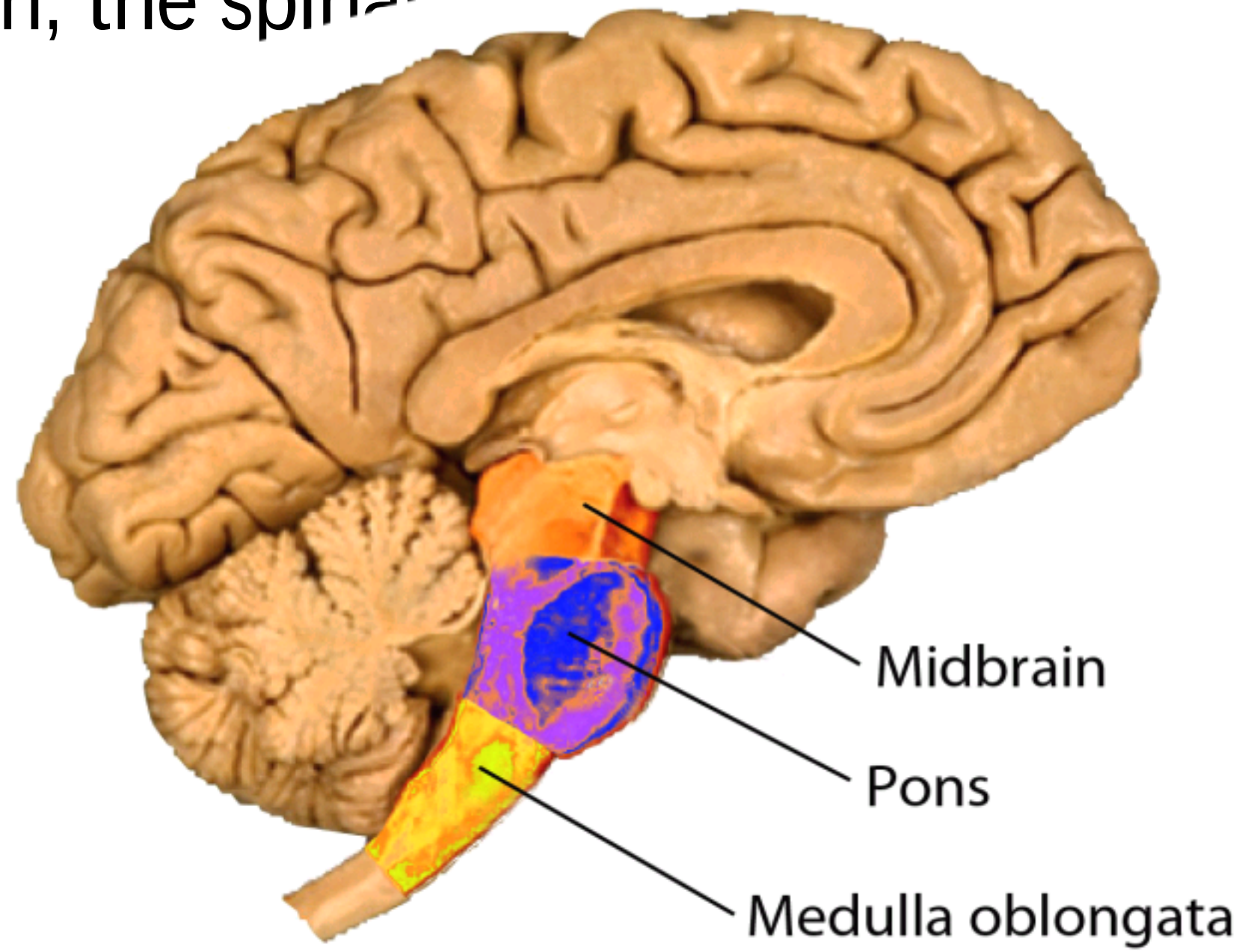
Parts of the Brain



(a) Sagittal section, medial view

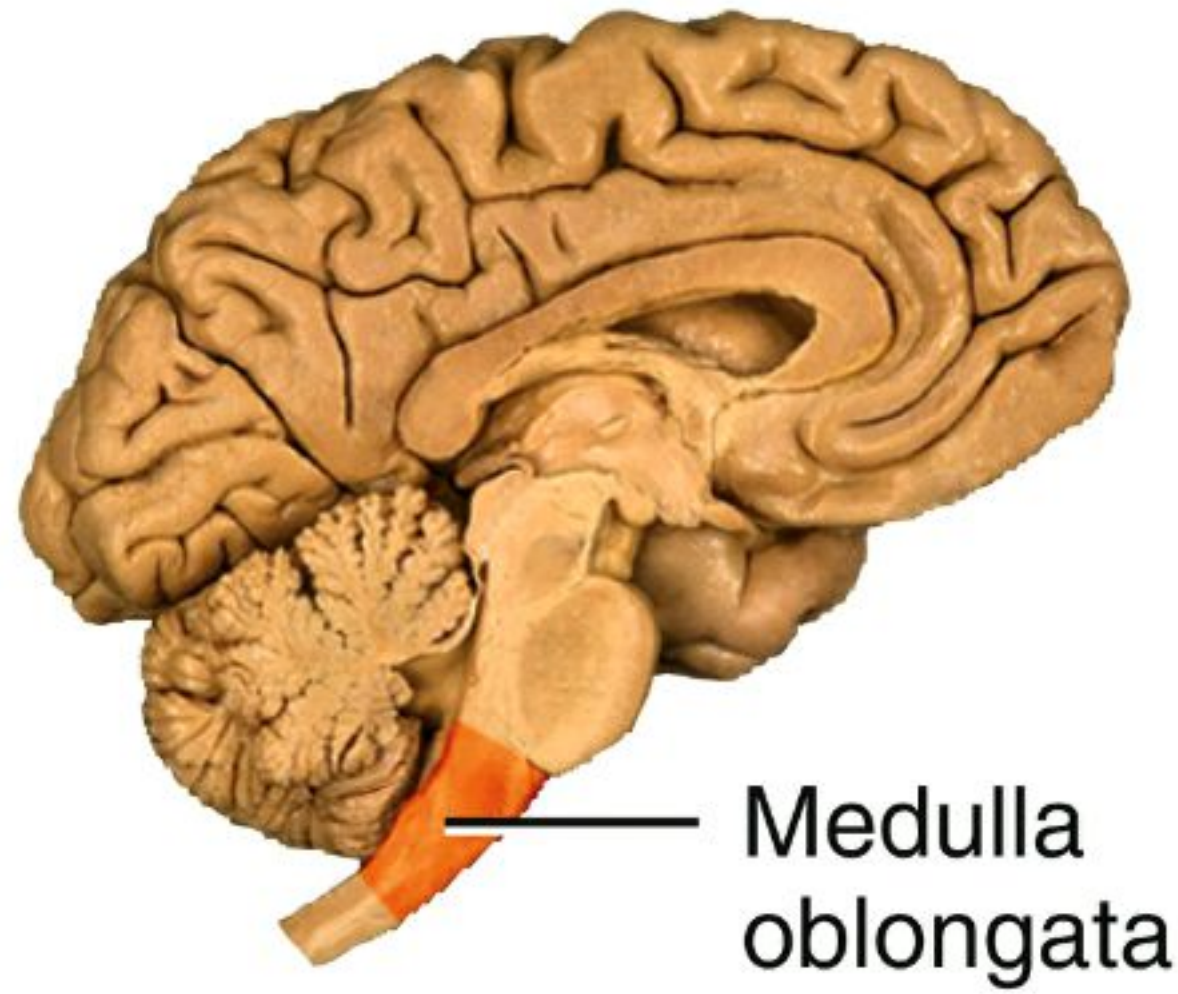
The Brain Stem

- The brain stem is superior to, but continuous with, the spinal cord



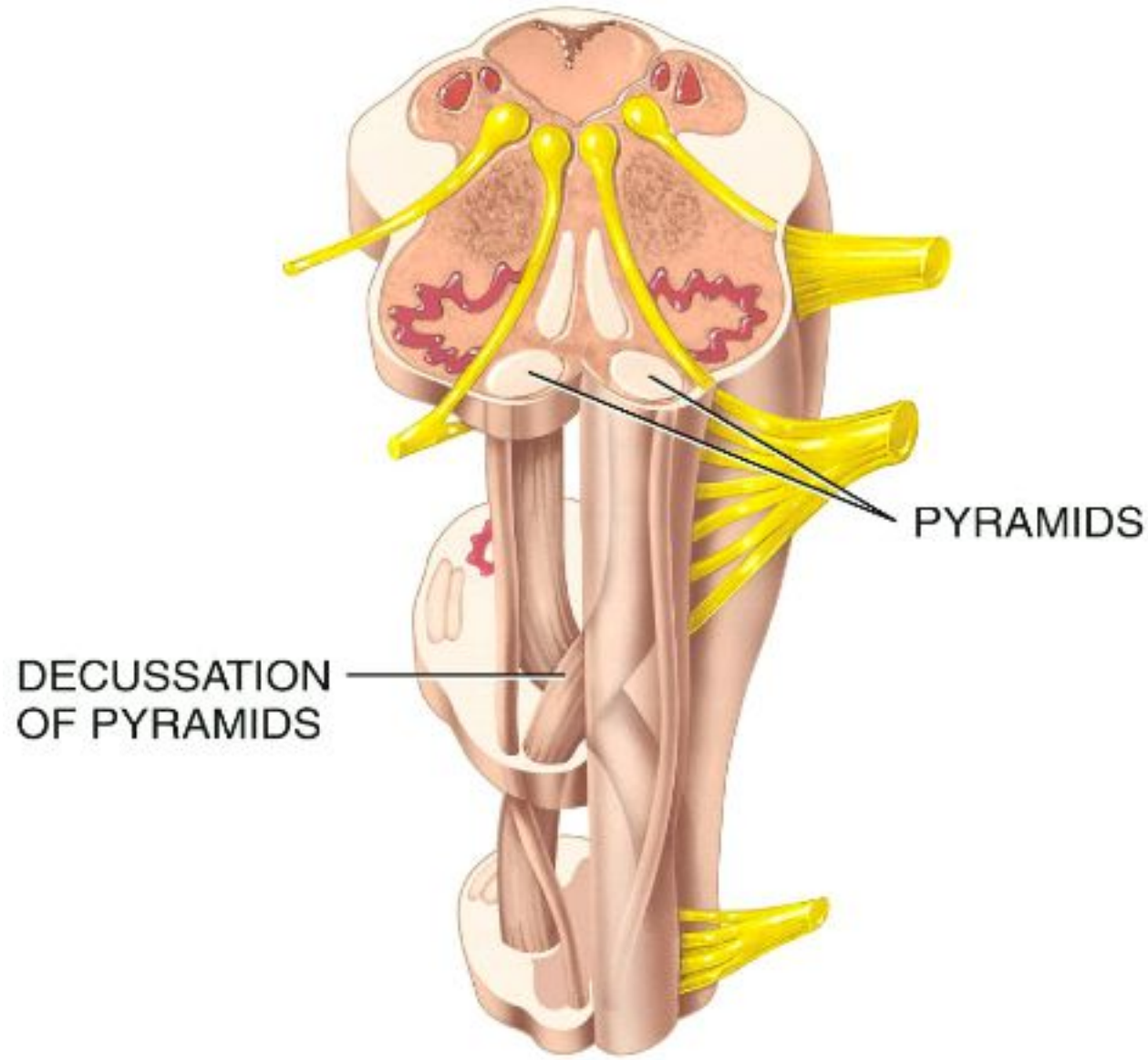
The Medulla Oblongata

- The **medulla** begins at the inferior border of the pons and extends to the foramen magnum (~3 cm). It contains **all ascending and descending tracts** extending between the spin cord and cerebrum
  - The medulla contains nuclei which are regulators for various vital body functions



The Medulla Oblongata

- It has two pyramids formed by the largest motor tracts in the body. Axons from the left pyramid cross over to the right and axons on the right cross over to the left (decussation of pyramids)



The Medulla Oblongata

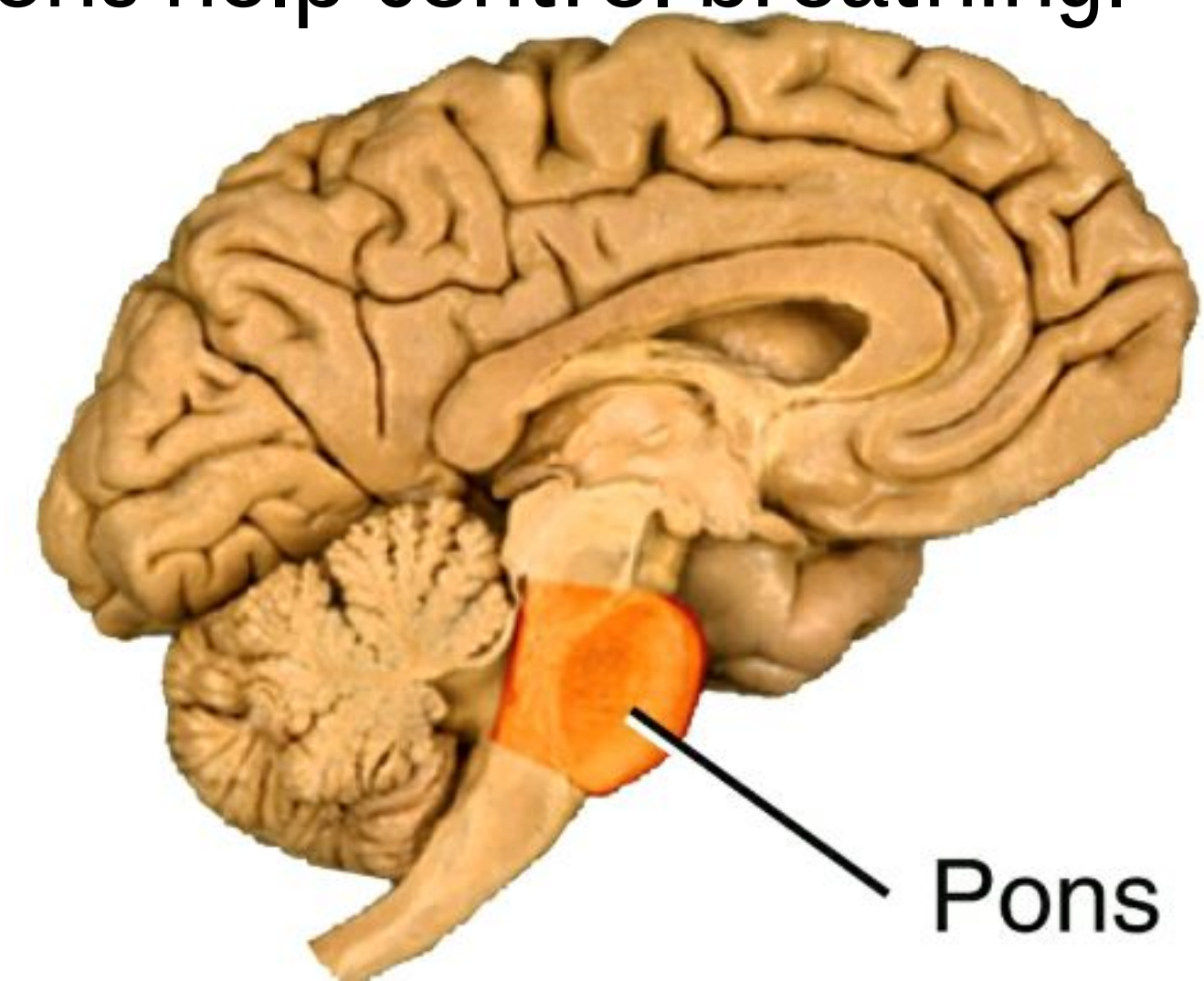
- Vital functional centers regulated by the medulla include:
  - The cardiovascular center –controls the rate and force of heartbeat, and the diameter of blood vessels
  - The respiratory rhythmicity center –controls the rate and rhythm of breathing
  - The vomiting, coughing, and sneezing centers
- The nuclei associated with 5 of the 12 cranial nerves originates in the medulla (CN VIII –XII).

The Pons

The pons lies directly above the medulla and anterior to the cerebellum. Together with the medulla, areas in the pons help control breathing.

The pons contains the

Nuclei of CN: V - VIII



The Midbrain

The midbrain extends from the pons to the diencephalon. Contain axons of the corticospinal, corticobulbar, and corticopontine tracts which conduct nerve impulses from motor areas in the cerebral cortex to the spinal cord, medulla, and pons, respectively.

It is the origin of cranial nerves III and IV.

The Midbrain

- The midbrain contains several other nuclei, including substantia nigra. loss of these neurons is associated with Parkinson disease.
- The red nucleus helps control voluntary movements of the limbs.
- The brain stem consists of a netlike arrangement of neurons & axons known as the reticular formation and reticular activating system (RAS).
- The RAS functions to maintain consciousness

- The cerebellum regulates posture, equilibrium, and balance.
- The thalamus functions as a relay station for all sensory impulses to the cerebral cortex (except smell, which belong to the hypothalamus). Pain, temp, touch, and pressure are all relayed to the thalamus en route to the higher centers of the cerebral cortex. Epithalamus It consists of the pineal gland (secretes melatonin)

- The hypothalamus controls many homeostatic functions:
  - It controls the Autonomic Nervous System (ANS).
  - It coordinates between NS and endocrine systems.
  - It controls body temperature (measured by blood flowing through it).
  - It regulates hunger/thirst and feelings of satiety.
  - It assists with the internal circadian clock by regulating biological activity.

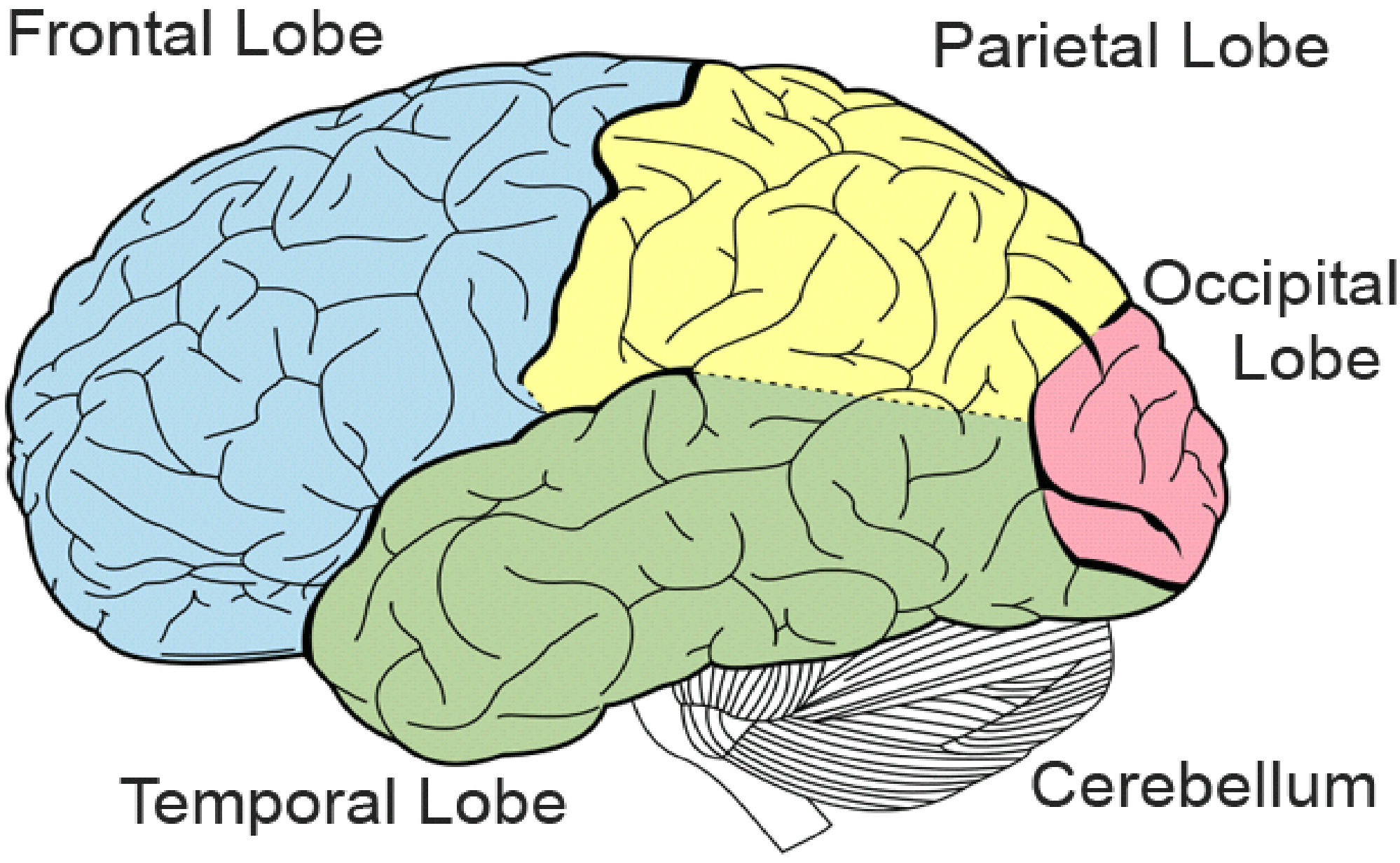
The Cerebrum

- The cerebral cortex is the "seat of our intelligence"—it's because of neurons in the cortex that we are able to read, write, speak, remember, and plan our life. The cerebrum consists of an outer cerebral cortex, an internal region of cerebral white matter, and gray matter nuclei deep within the white matter.

Hemispheric Lateralization

- In most people, the left hemisphere is more important for reasoning, numerical and scientific skills, spoken and written language, and the ability to use and understand sign language.
- Conversely, the right hemisphere is more specialized for musical and artistic awareness; spatial and pattern perception; recognition of faces and emotional content of language; discrimination of different smells; and generating mental images of sight, sound, touch, and taste.

Functional parts of Brain



Functional parts of Brain

FRONTAL LOBE

Located in front of the central sulcus.

Concerned with reasoning, planning, parts of speech and movement (motor cortex), emotions, and problem -solving.

PARIETAL LOBE

Located behind the central sulcus.

Concerned with perception of stimuli related to touch, pressure, temperature and pain.

Functional parts of Brain

TEMPORAL LOBE

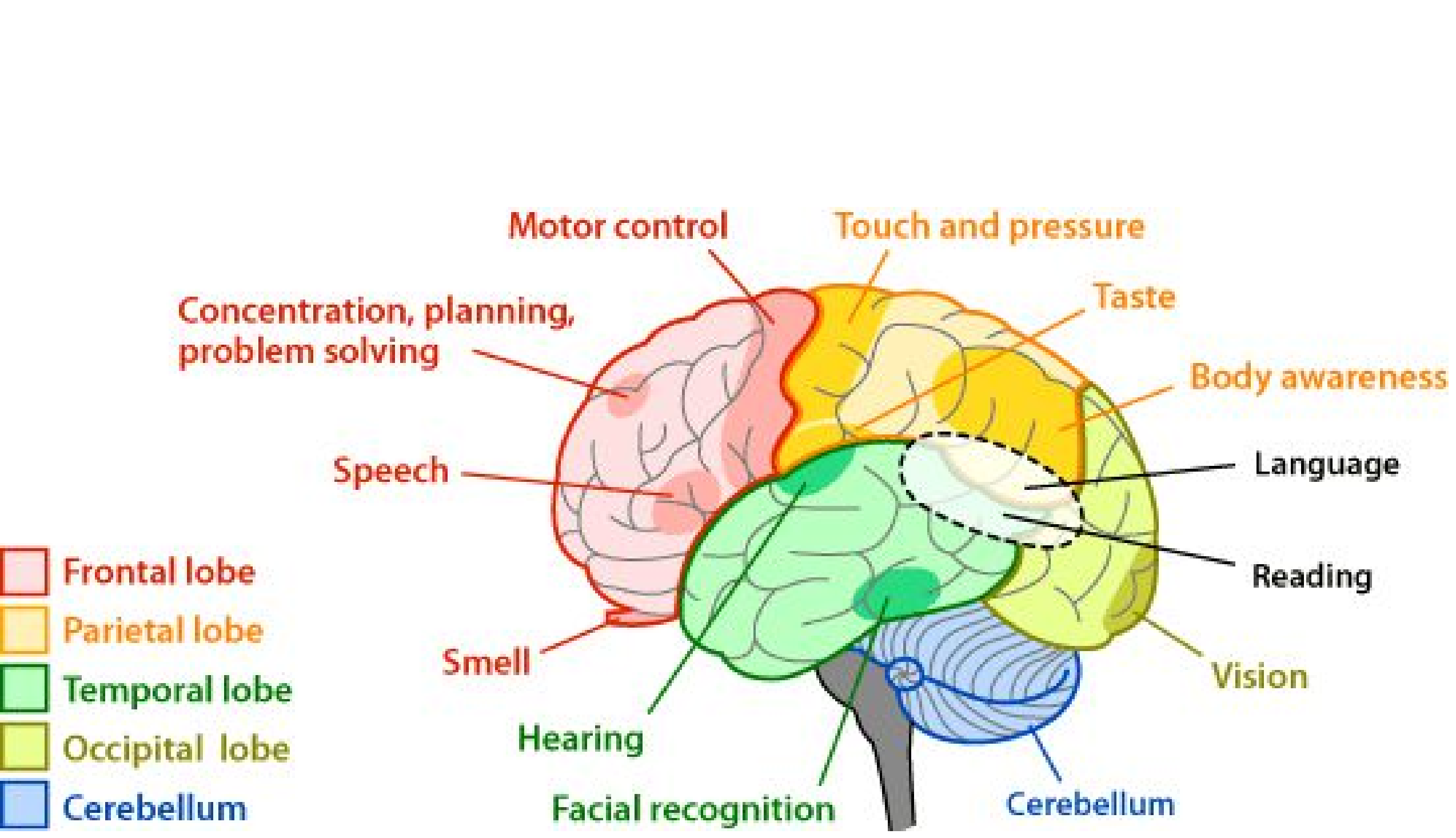
Located below the lateral fissure.

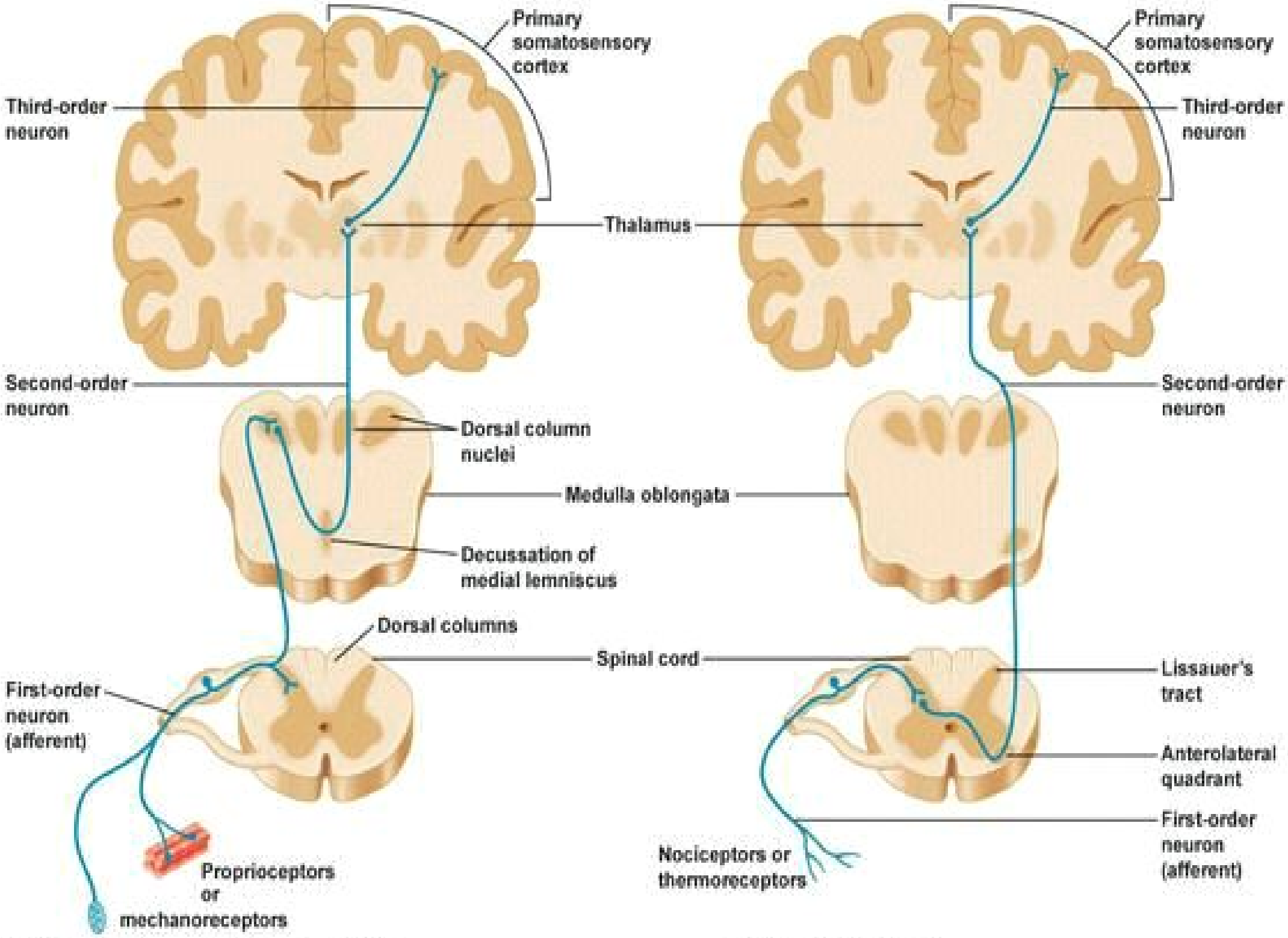
Concerned with perception and recognition of auditory stimuli (hearing) and memory.

OCCIPITAL LOBE

Located at the back of the brain, behind the parietal lobe and temporal lobe.

Concerned with many aspects of vision

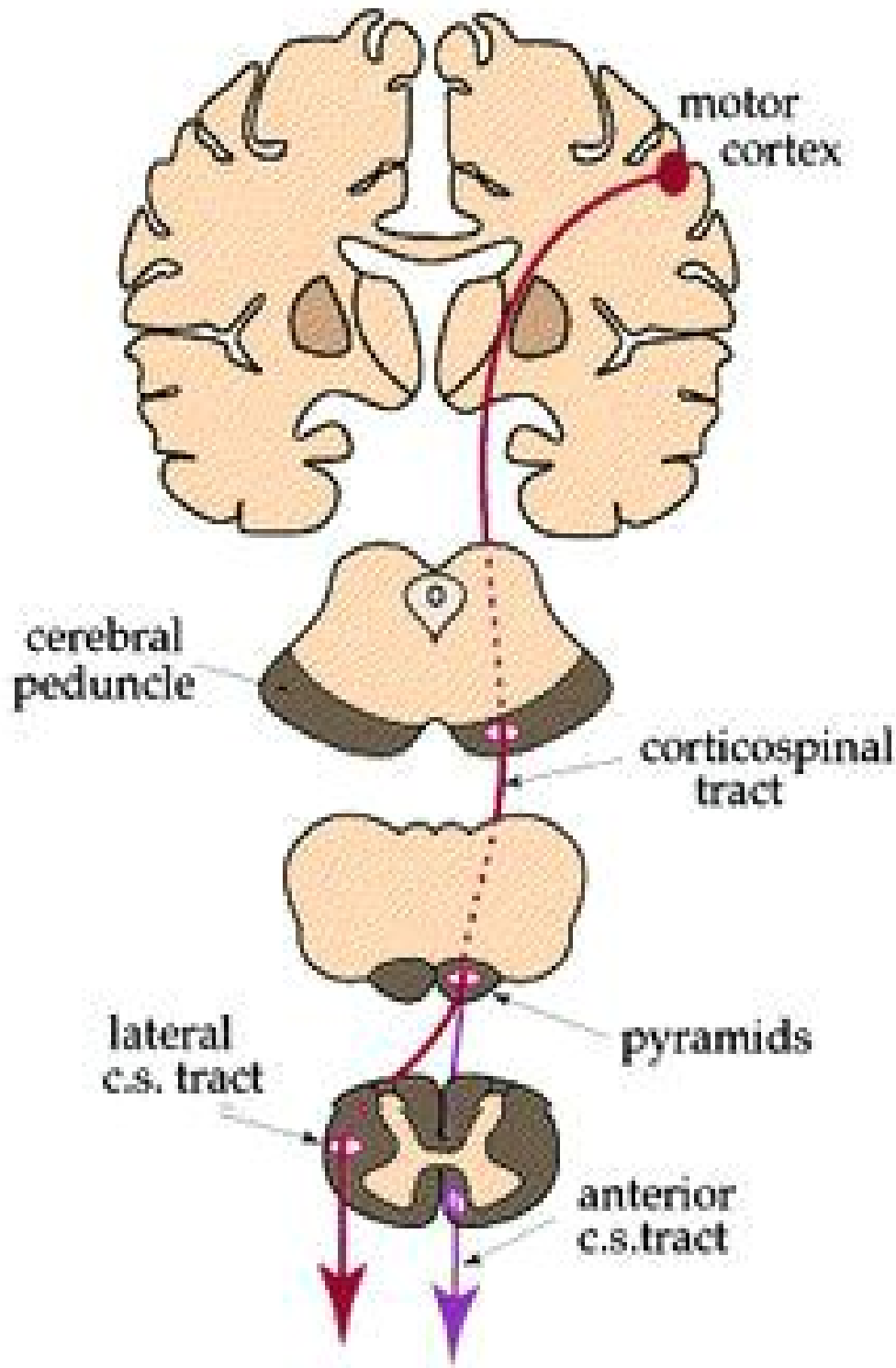

Motor control
Touch and pressure
Concentration, planning, problem solving
Taste
Body awareness
Speech
Language
Reading
Smell
Vision
Hearing
Facial recognition
Cerebellum
Frontal lobe
Parietal lobe
Temporal lobe
Occipital lobe
Cerebellum



(a) Dorsal column–medial lemniscal pathway

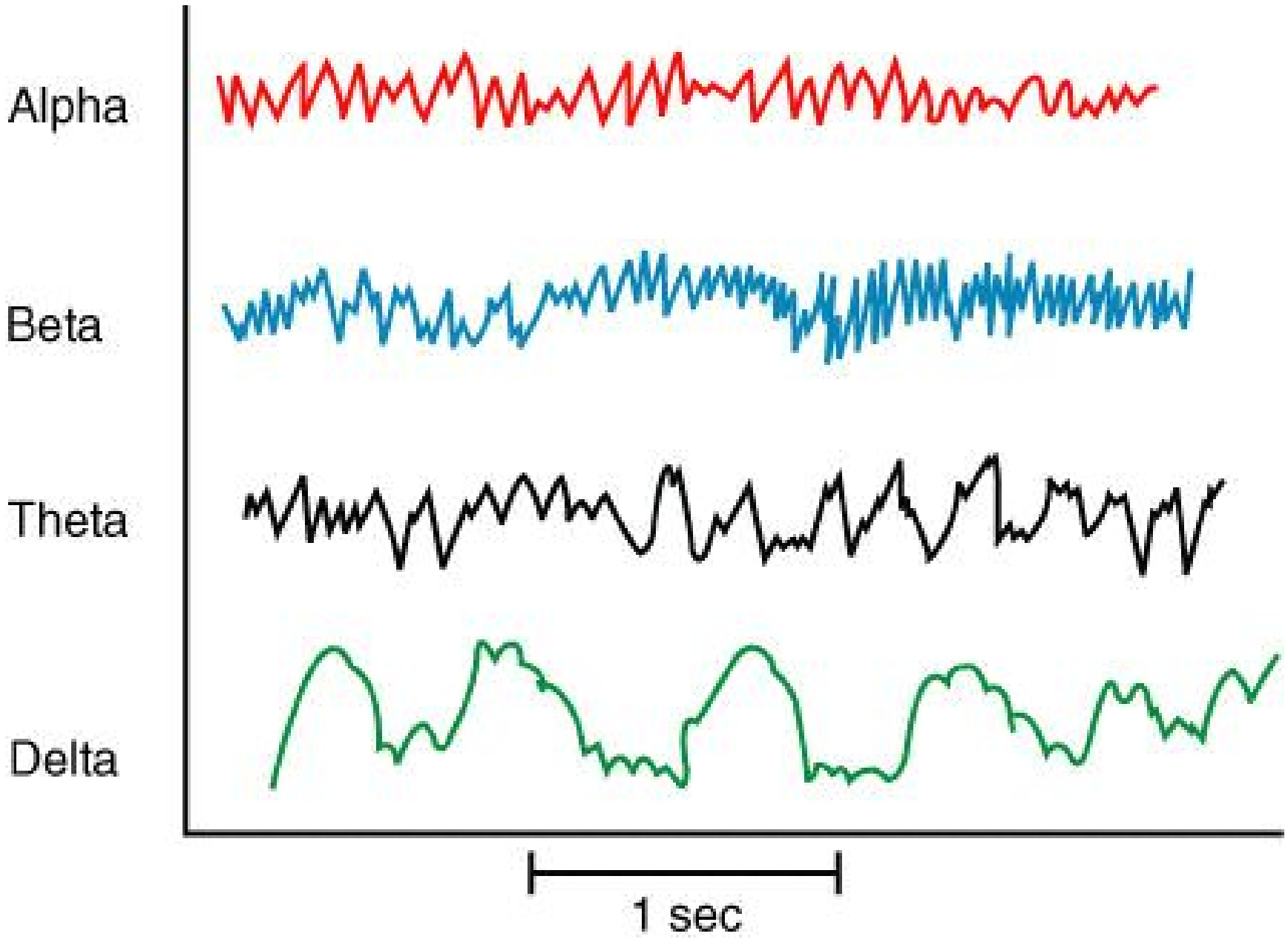
(b) Spinothalamic tract

Motor pathway



Brain Waves

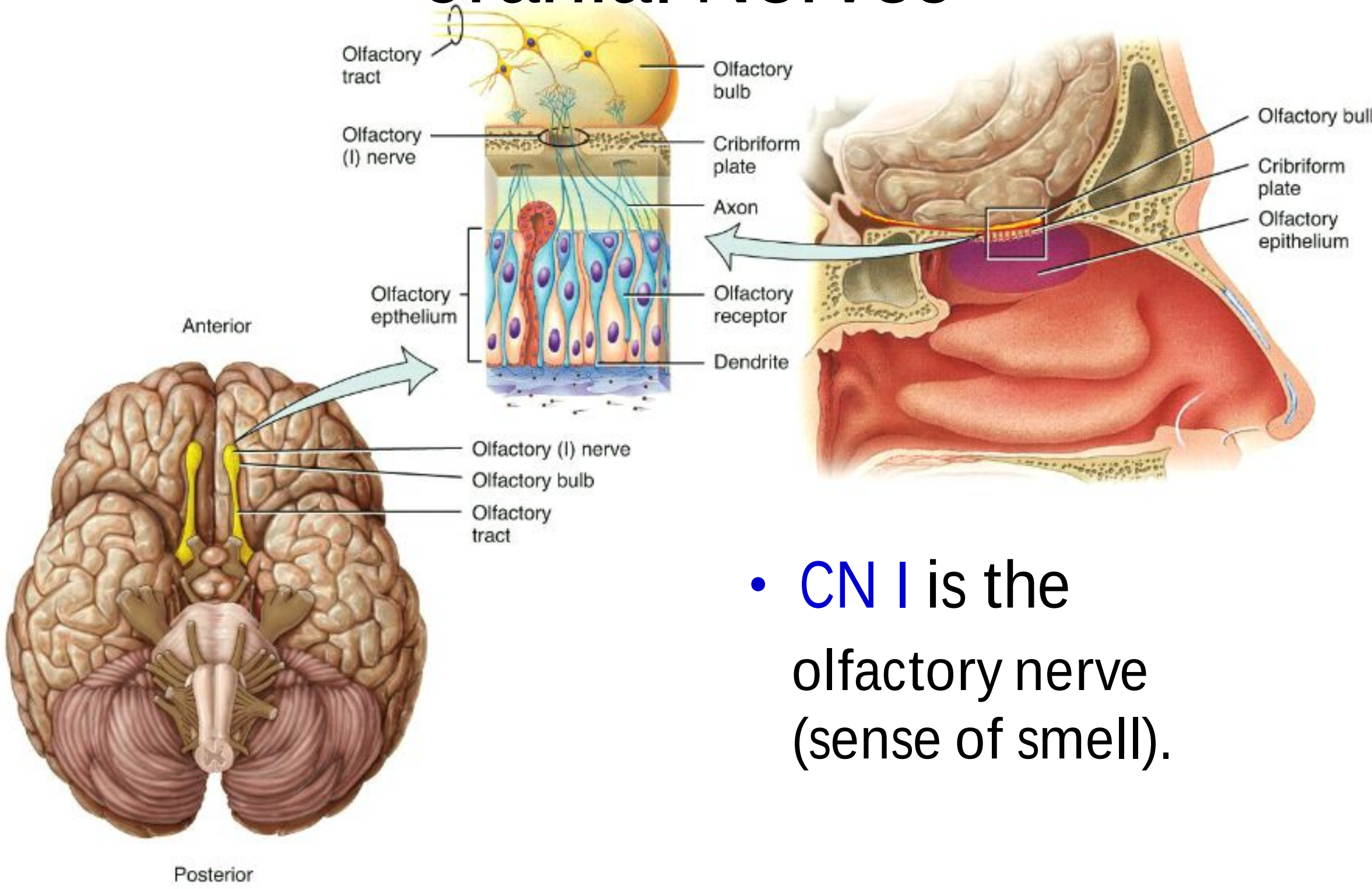
Electroencephalogram(EEG)



	Spinal	Cranial
Designation	C1-8, T1-12, L1-5, S1-5, Co1	Roman Numerals I – XII
Number	31 pairs	12 pairs
Origin	Spinal cord	Brain
Number of roots	2 - a dorsal and a ventral root	Single root
Contents	Mixed	Most mixed; some sensory only
Target	Limbs/Trunk	All in the Head/Neck (vagus n leaves)

Spinal and cranial nerves are compared in this table.

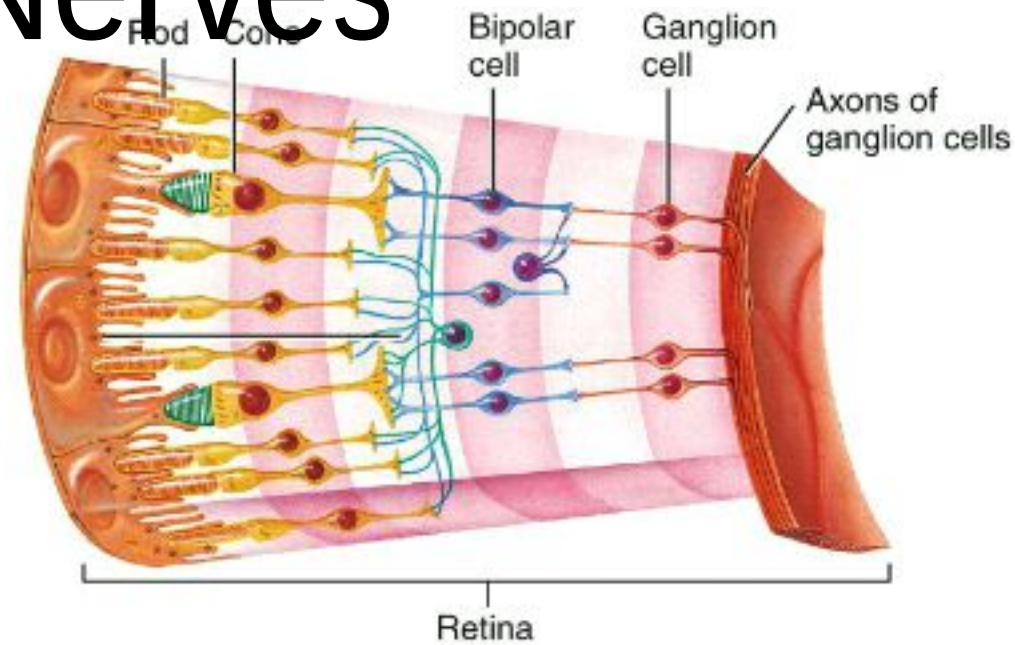
Cranial Nerves

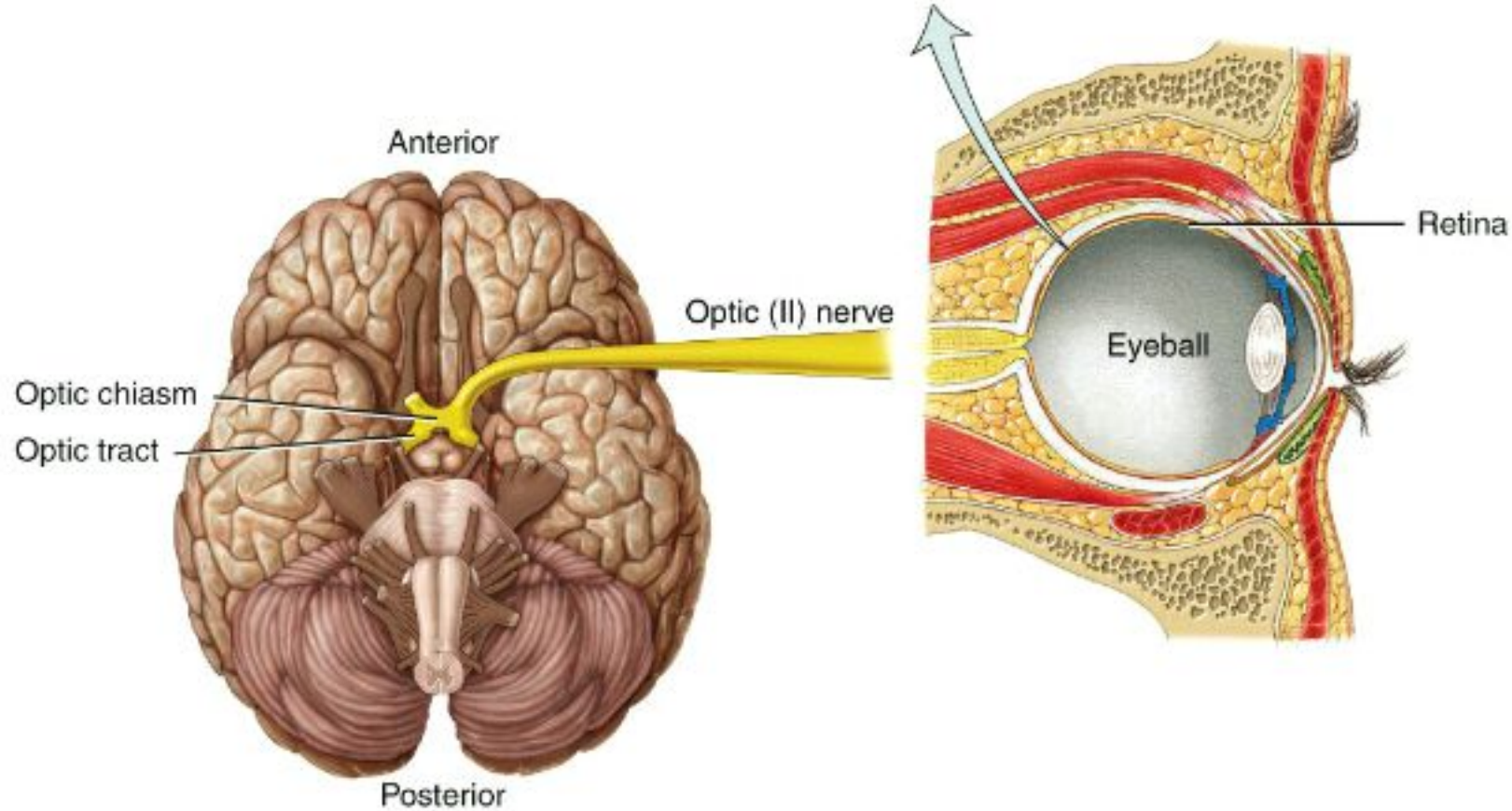


- CN I is the olfactory nerve (sense of smell).

Cranial Nerves

- CN II is the optic nerve (sense of sight).





Cranial Nerves

- CN III, IV, and VI innervate the extraocular muscles that allow us to move our eyes.
  - CN III also supplies motor input to our eyelid muscles and facilitates pupillary constriction.

Cranial Nerves

- CN V is the trigeminal nerve (the major sensory nerve of the face).
  - It has three large branches, each of which supplies an area of the face:
    - ophthalmic
    - maxillary
    - mandibular

Cranial Nerves

- CN VII is the facial nerve. It has 5 large somatic branches which innervate the muscle of facial expression. It also carries some taste sensations

(anterior 2/3 of tongue).

  - Paralysis of CN VII is called Bell's Palsy and leads to loss of ability to close the eyes and impairment of taste and salivation.

Cranial Nerves

- CN VIII is the vestibulocochlear nerve. From the inner ear, the vestibular component carries information on balance, while the cochlear component enables hearing.
  - Damage of CN VIII causes vertigo, ringing in the ears, and/or deafness.

Cranial Nerves

- CN IX is the glossopharyngeal nerve. This nerve carries some taste sensations as well as ANS impulses to salivary glands and the mechanoreceptors of the carotid body and carotid sinus (senses changes in BP).

Cranial Nerves

- CN X is the vagus nerve ("the wanderer "), which carries most of the parasympathetic motor efferents to the organs of the thorax and abdomen.

Cranial Nerves

- CN XI is the spinal accessory nerve. This nerve supplies somatic motor innervation to the Trapezius and Sternocleidomastoid muscles.

Cranial Nerves

- CN XII is the Hypoglossal nerve. This is a very large nerve (a lot of resources) to be devoted solely to the tongue –it takes a lot more coordination than you might guess to chew, talk, and swallow without injuring our tongue.

Thanks