Foundations of Psychophysiology

Part 2.3: The central nervous system

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NEUROADAPTIVE
HUMAN-COMPUTER
INTERACTION

Brandenburg
University of Technology
Cottbus - Senftenberg

Central nervous system

Anatomical terminology

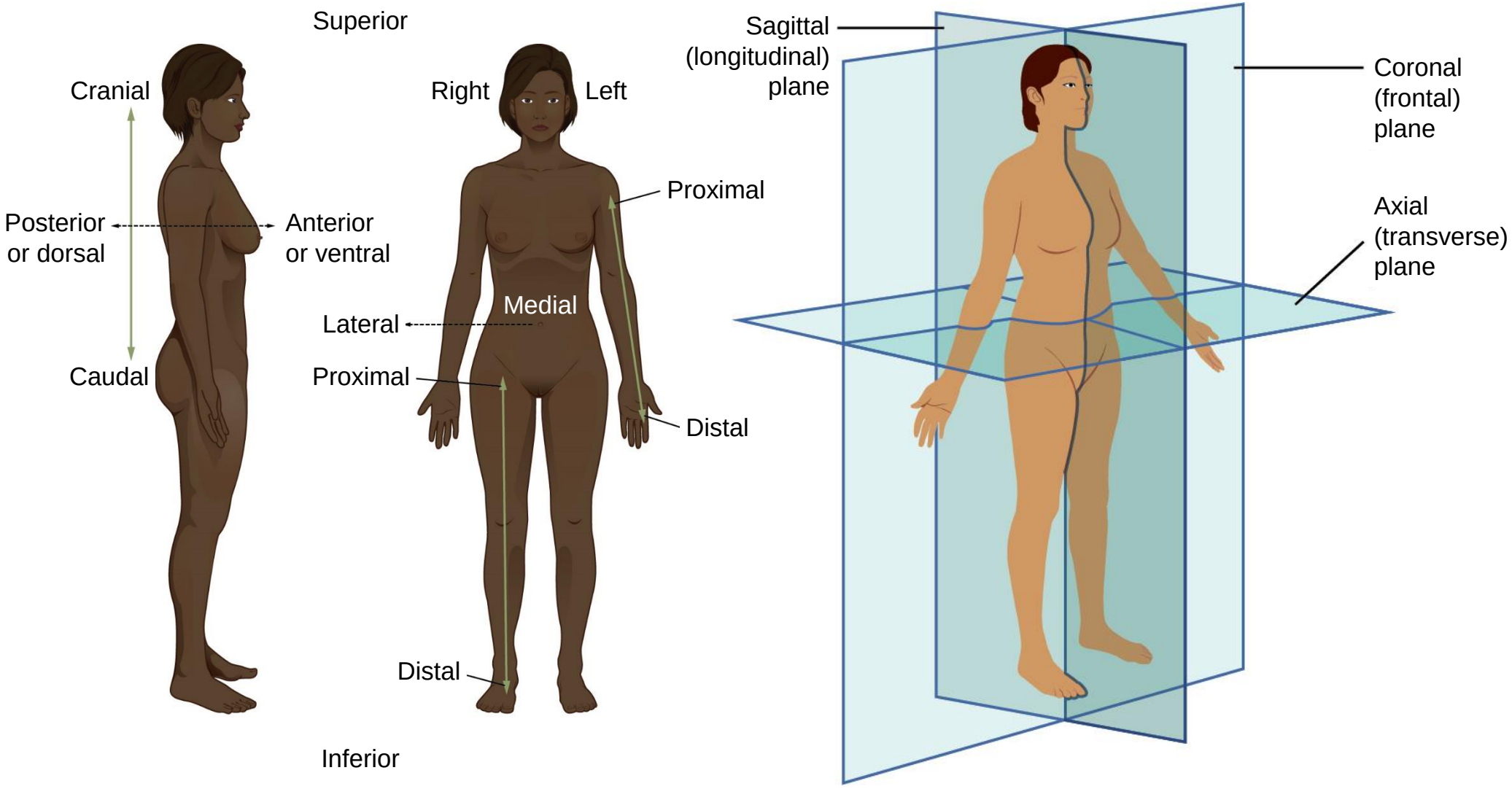
Spinal cord

Brain

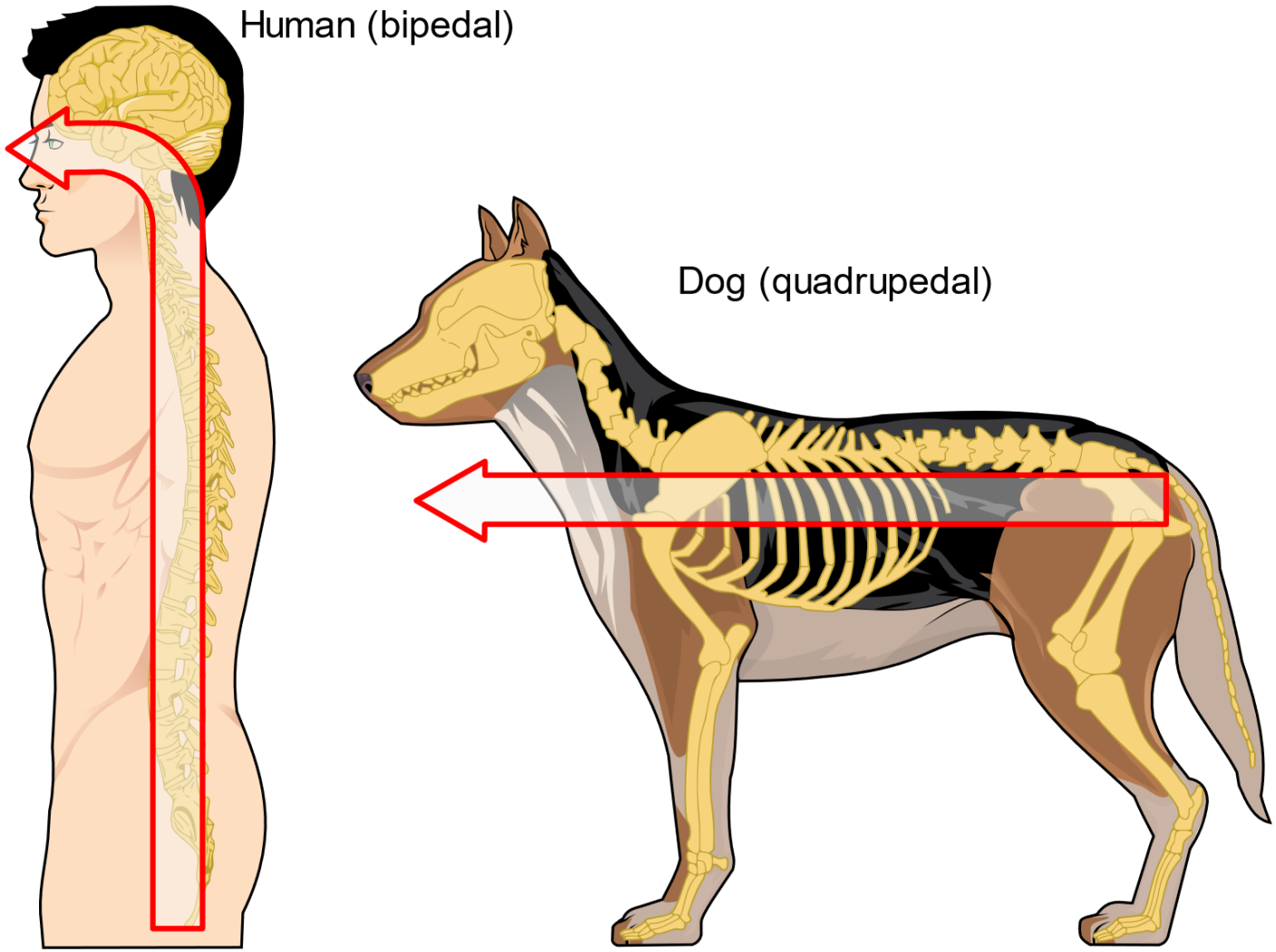
Psychophysiology

Anatomical terminology

Anatomical terminology



Different neuroaxis requires different terms



Some other terms

A **nerve** is a bundle of axons in the PNS. In the CNS, this is called a **tract**.

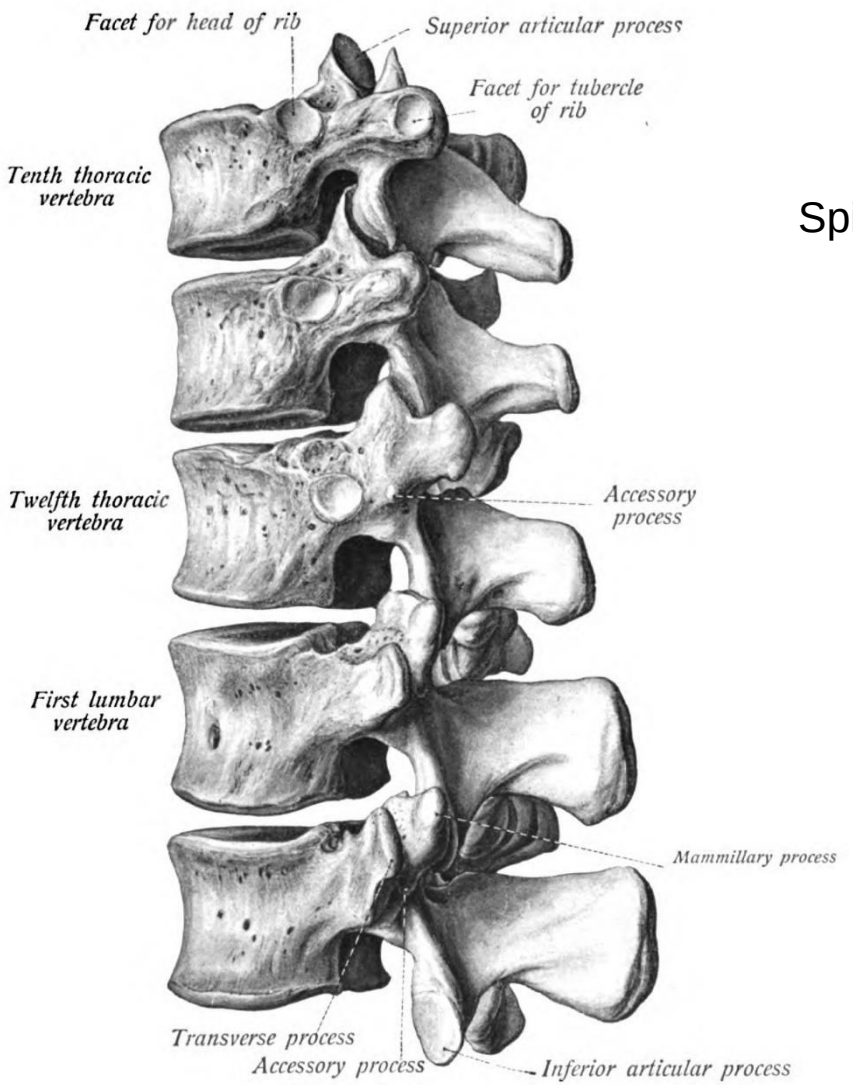
Similarly, a **ganglion** is a group of neuron cell bodies in the PNS. In the CNS, this is called a **nucleus**.

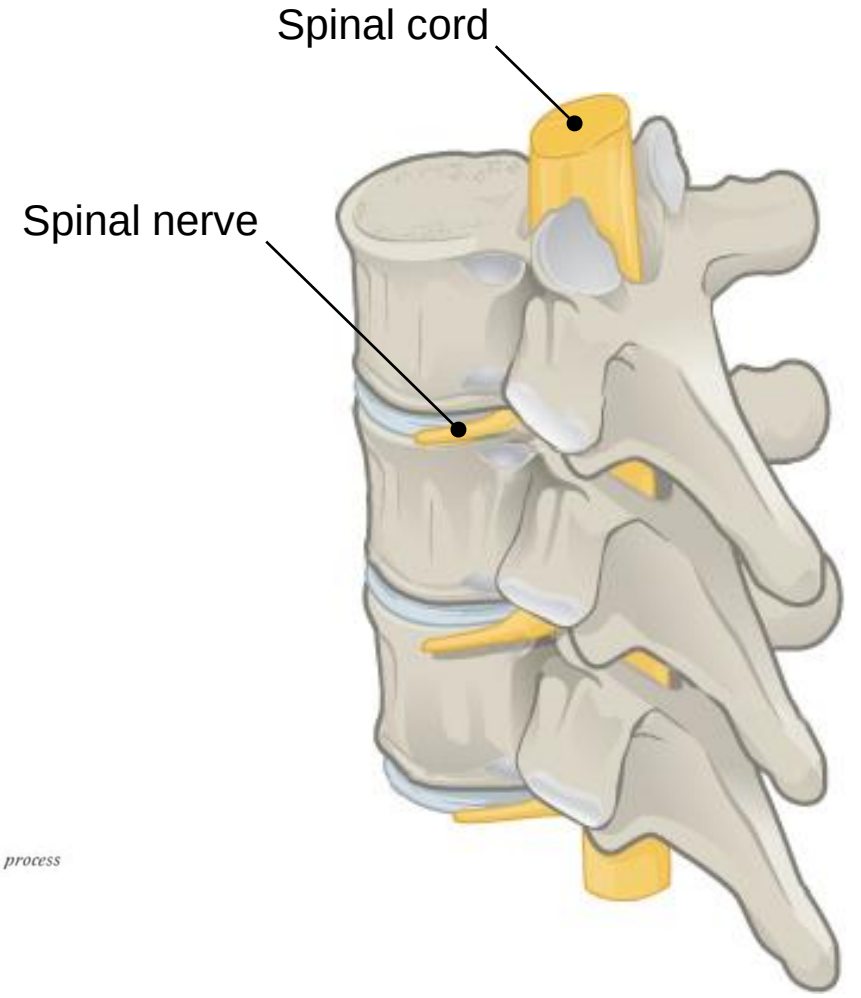
Afferent nerves conduct signals towards the CNS. The opposite are **efferent** nerves.

Psychophysiology

Spinal cord

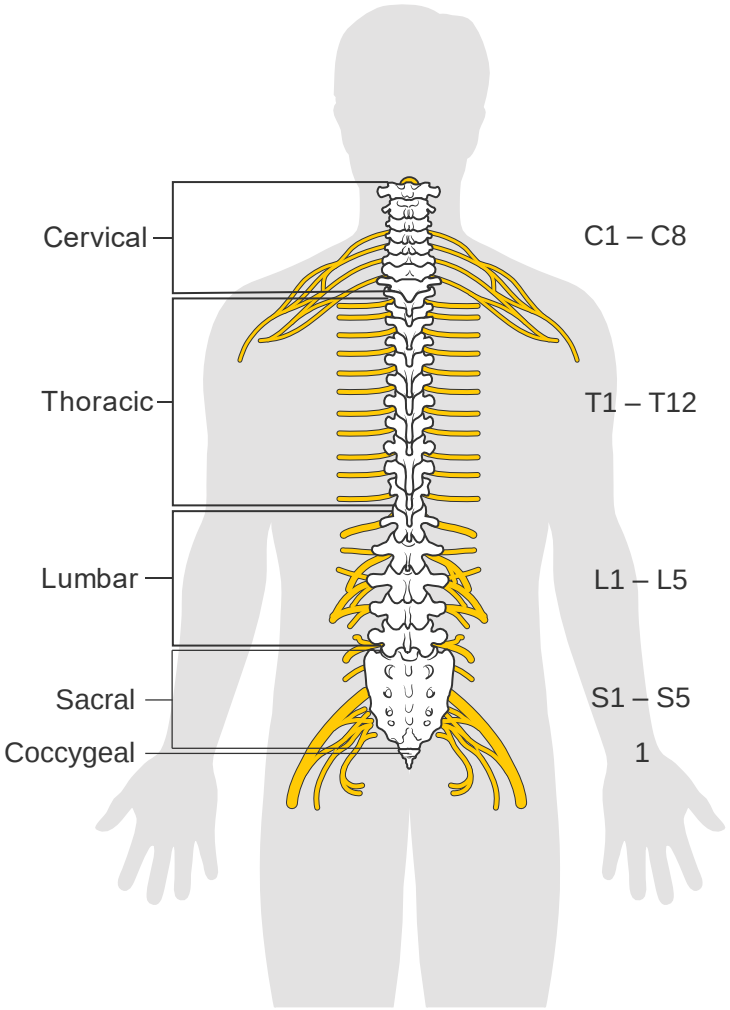
Spine and the spinal cord

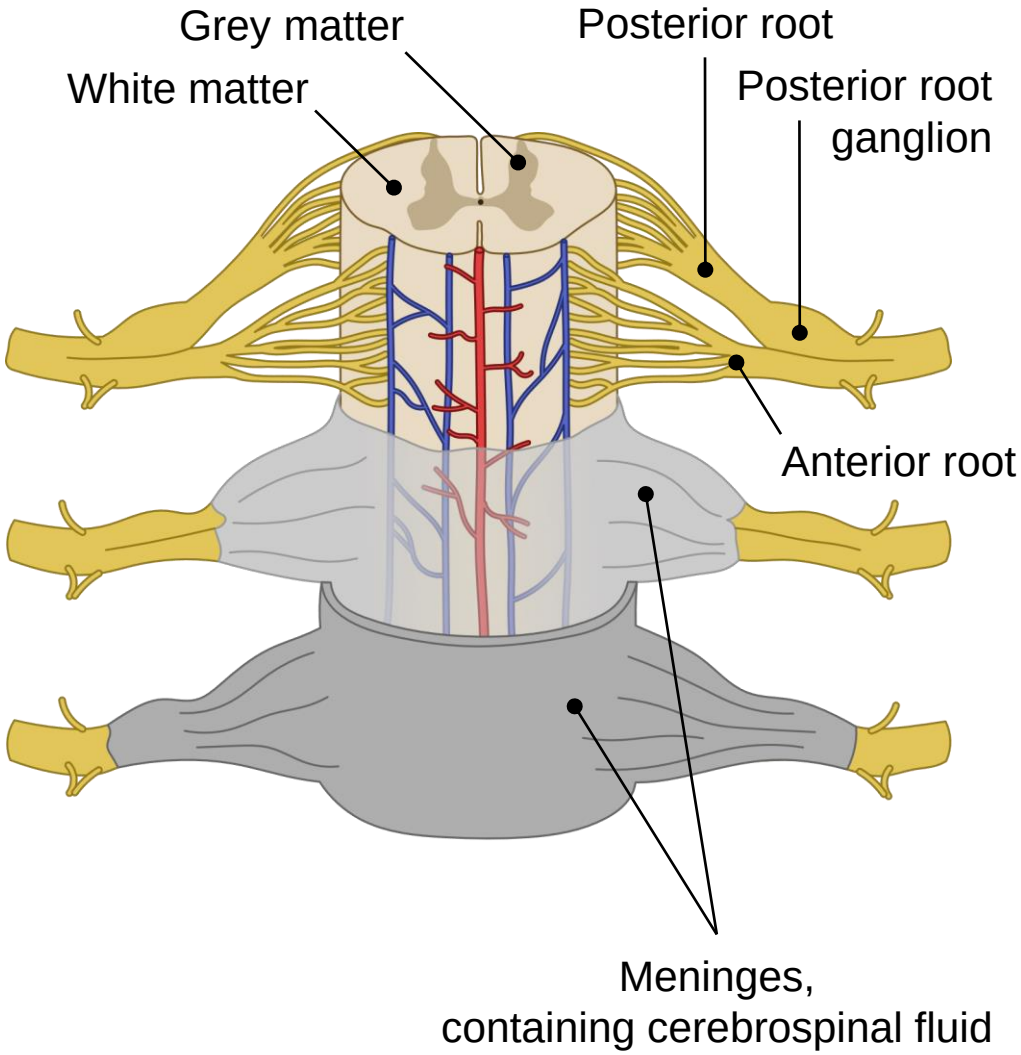




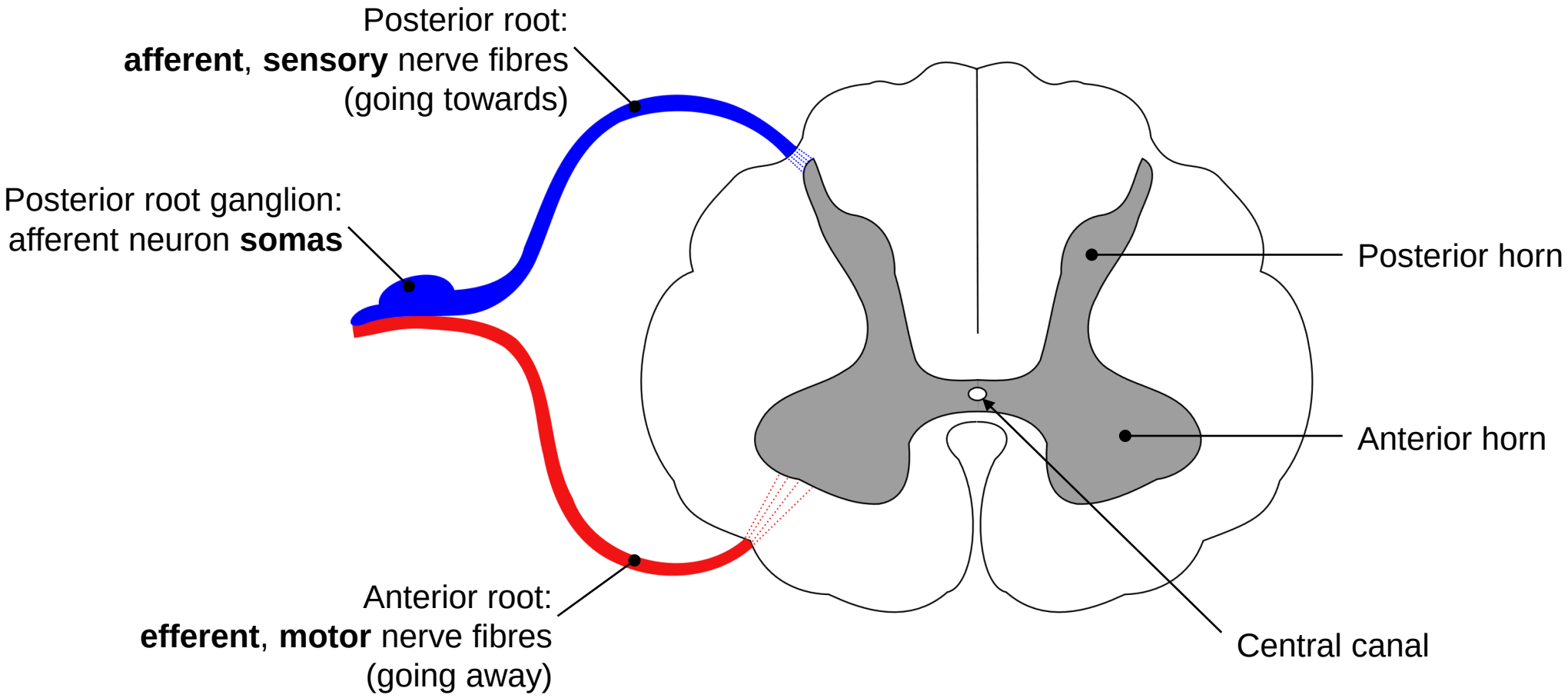
Left posterolateral view

Spinal nerves

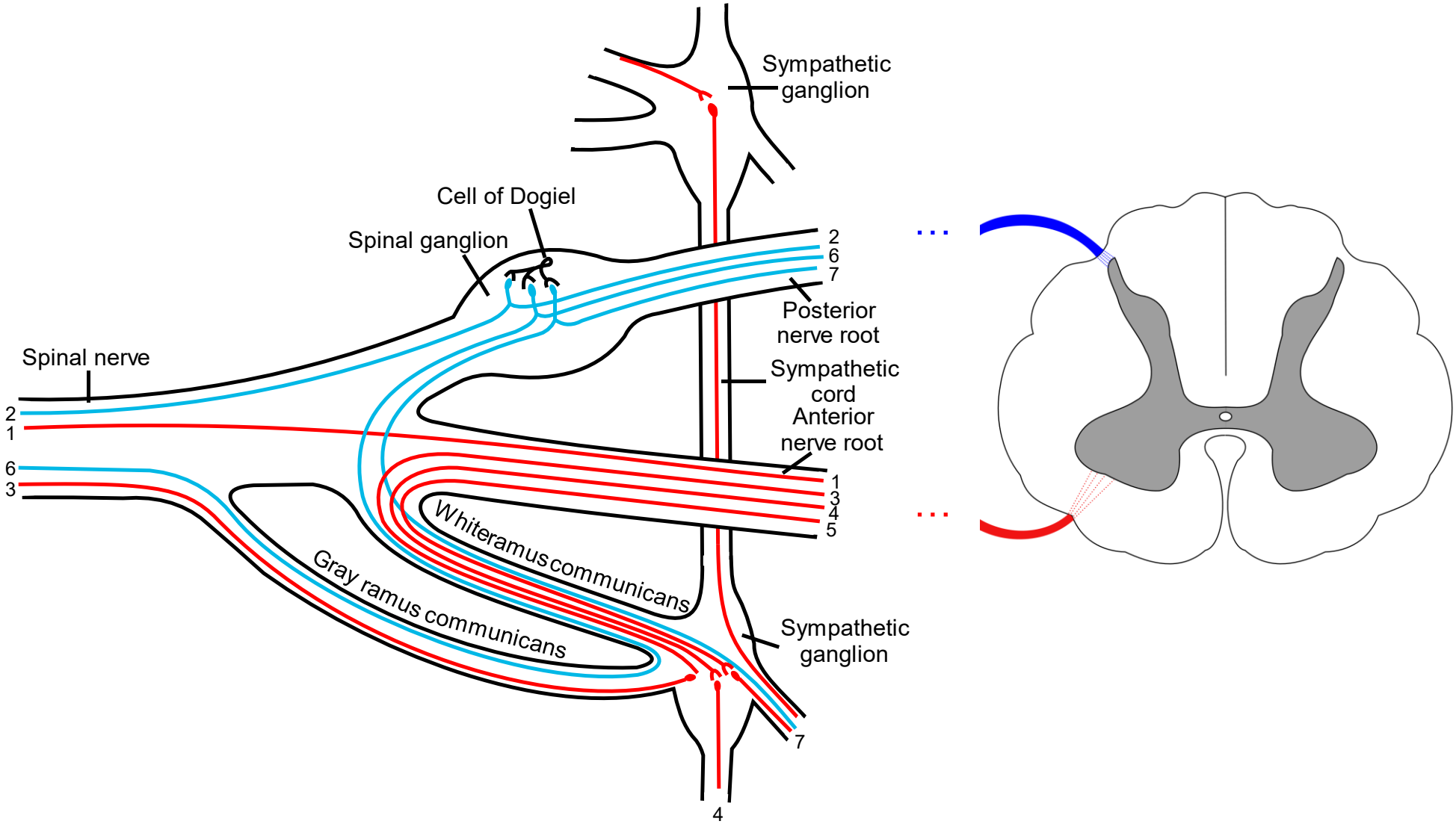




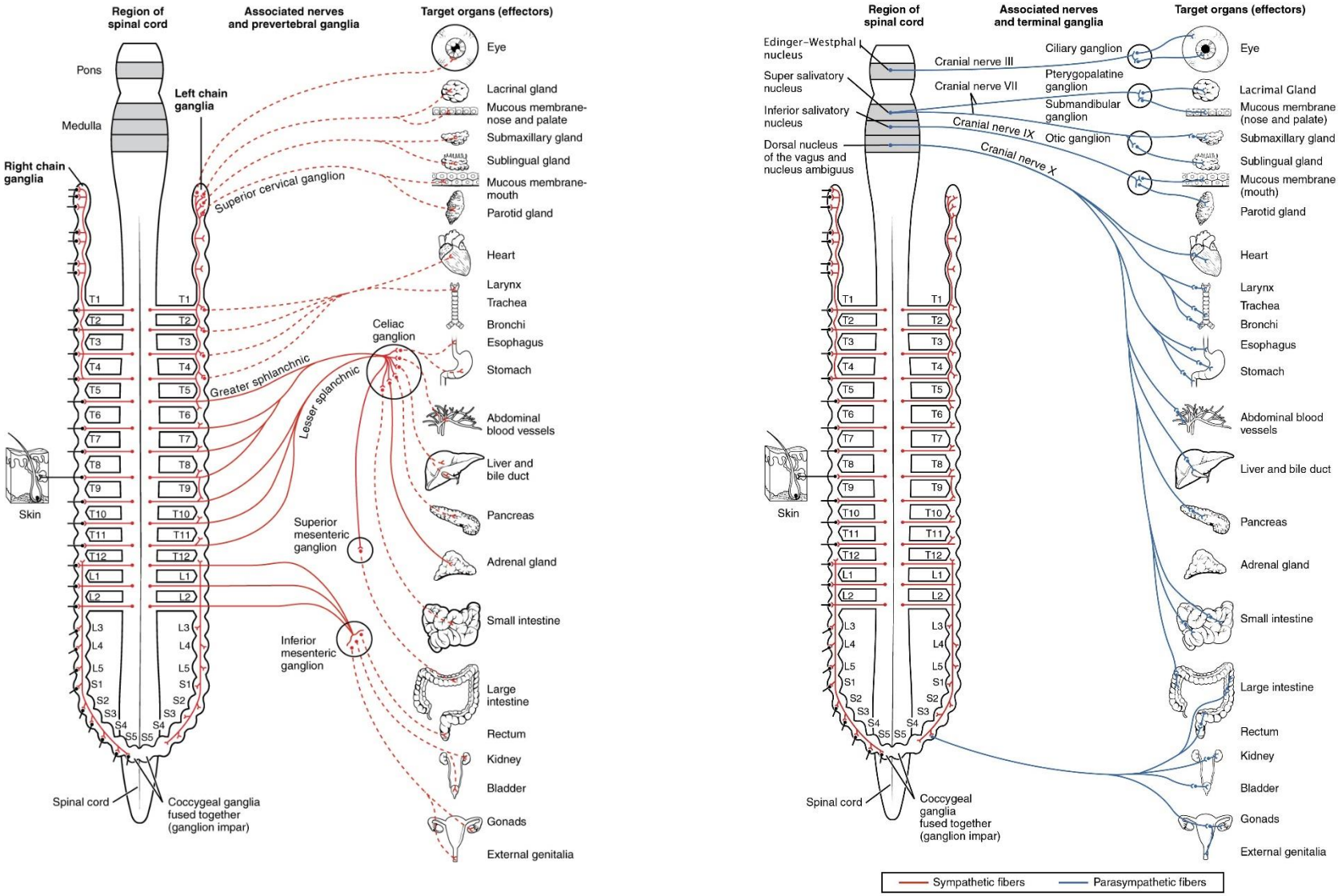
Spinal cord



Spinal cord



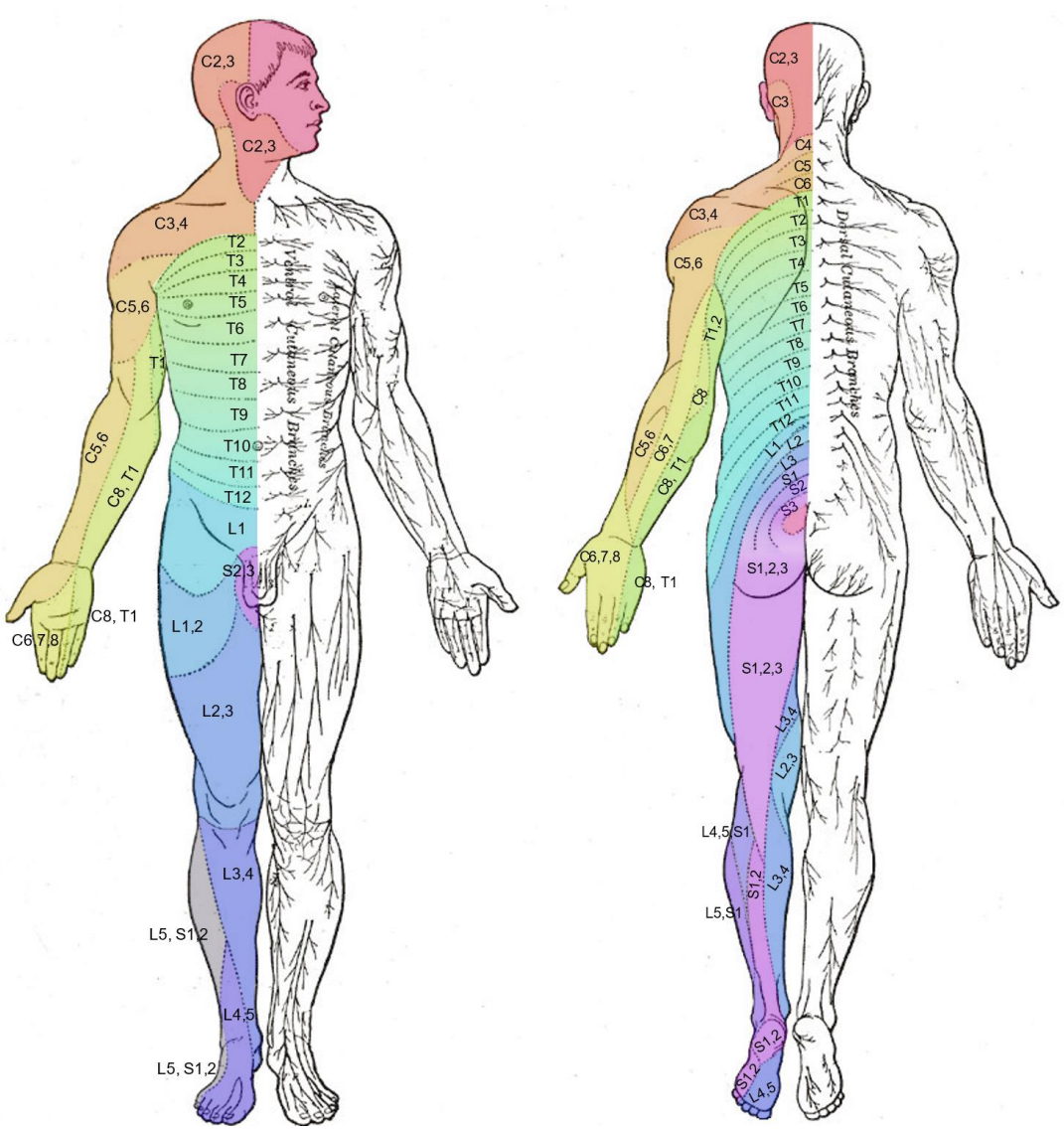
Sympathetic and parasympathetic innervation



Dermatomes

Each spinal nerve can be associated with a specific area on the skin.

Each area is served by at least two spinal nerves.



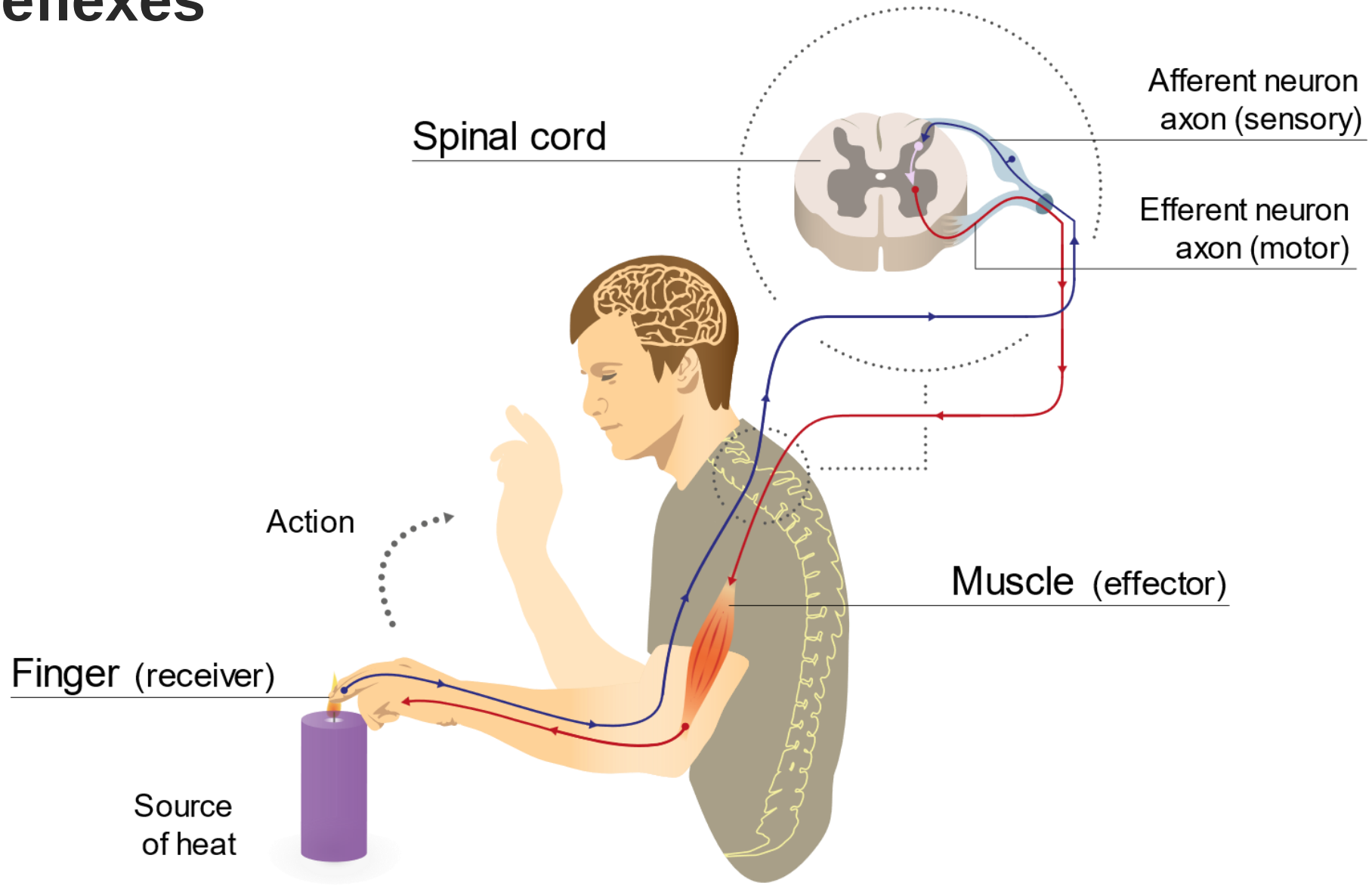
Functional description

The spinal cord transports afferent and efferent signals between the CNS and the PNS.

It also processes reflexes.

Psychophysiology: CNS: Spinal cord

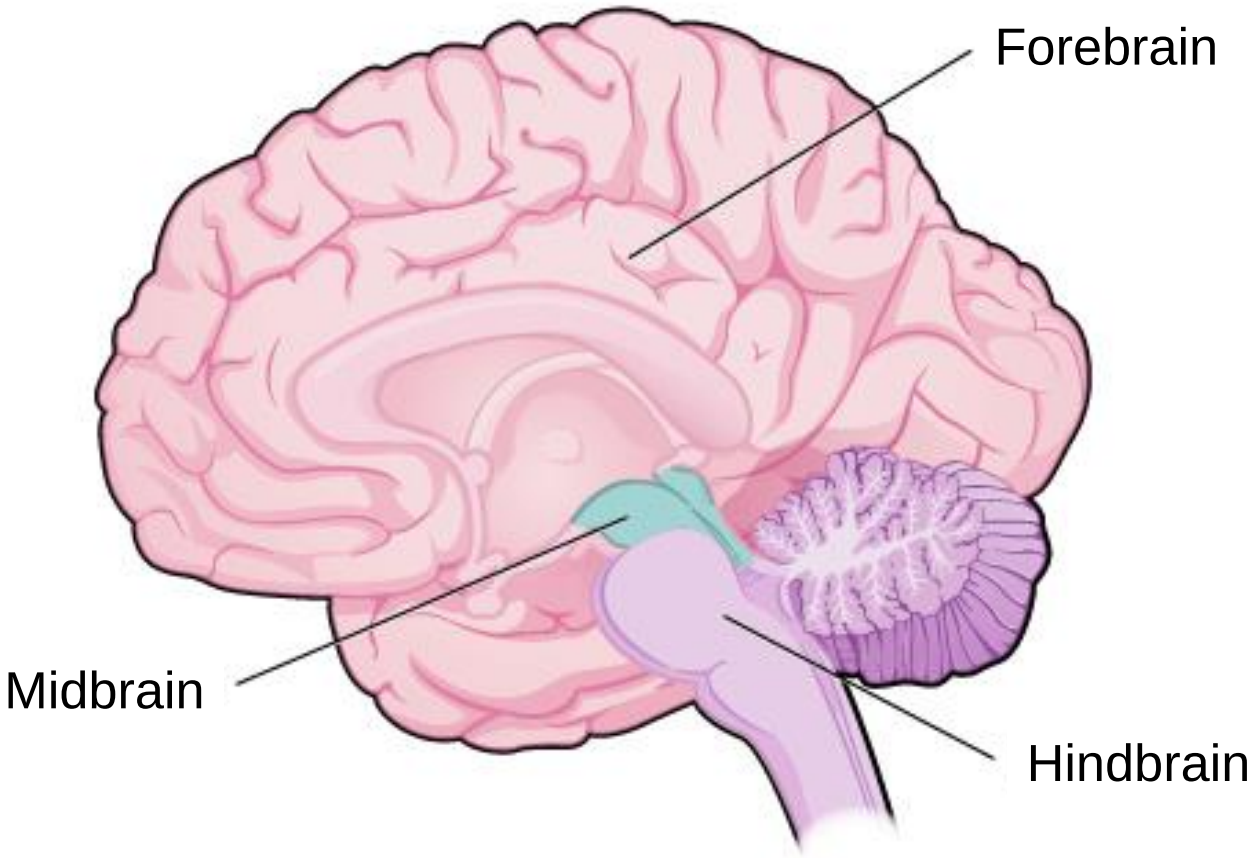
Reflexes



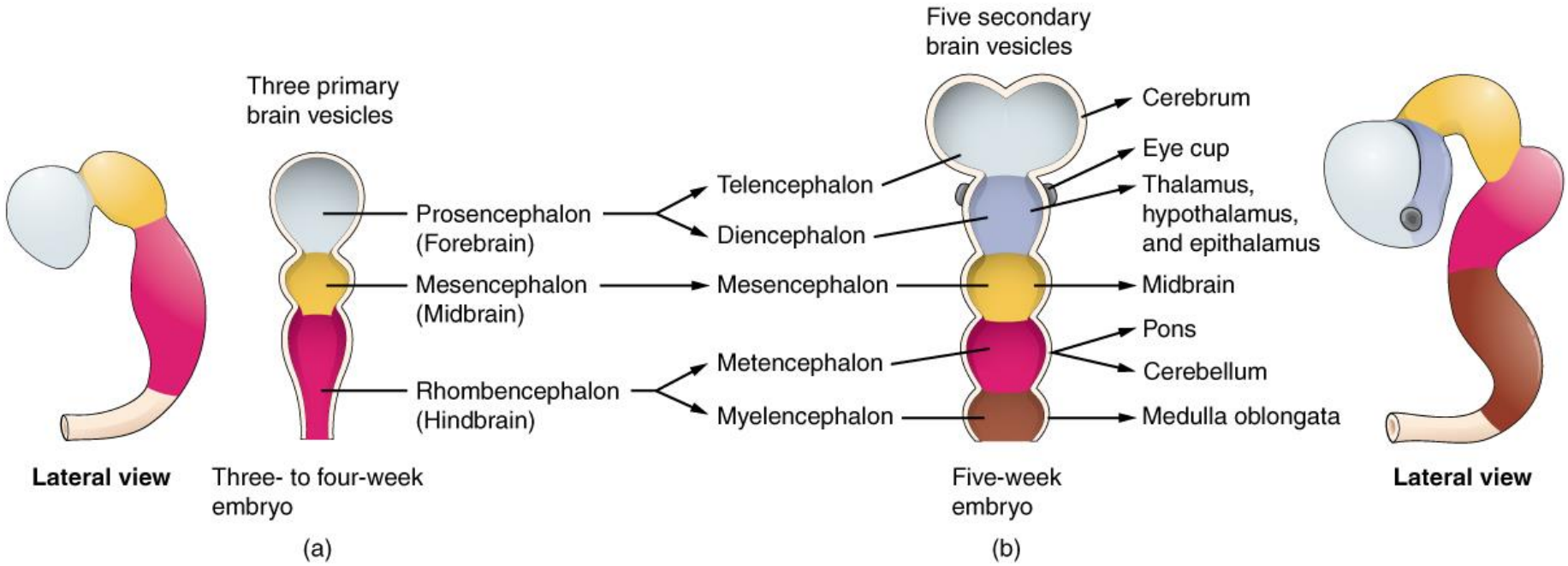
Psychophysiology

Brain

Brain



Brain

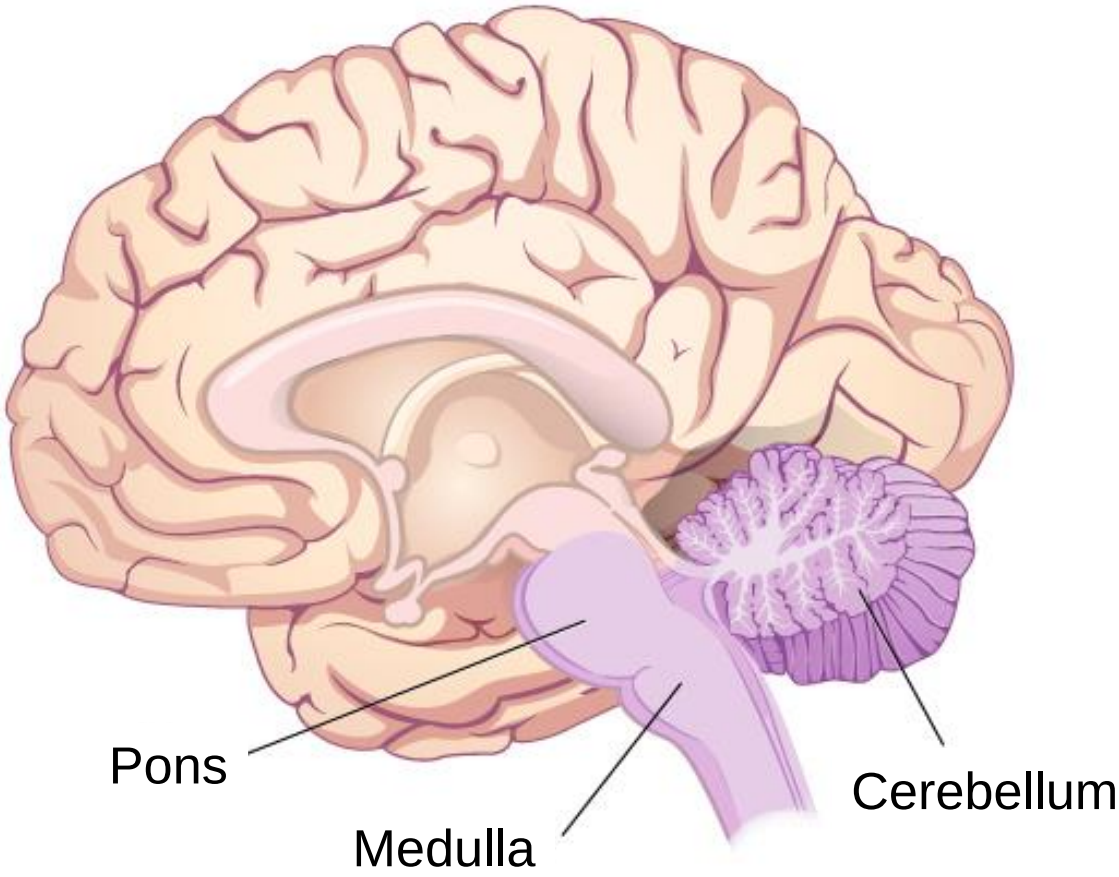


Hindbrain

The **medulla (oblongata)** controls autonomic functions like breathing, heartbeat, swallowing, vomiting, and sneezing.

The **pons** also controls some autonomic functions, and interfaces the hindbrain with the midbrain.

The **cerebellum** primarily coordinates (but does not initiate) motor control.

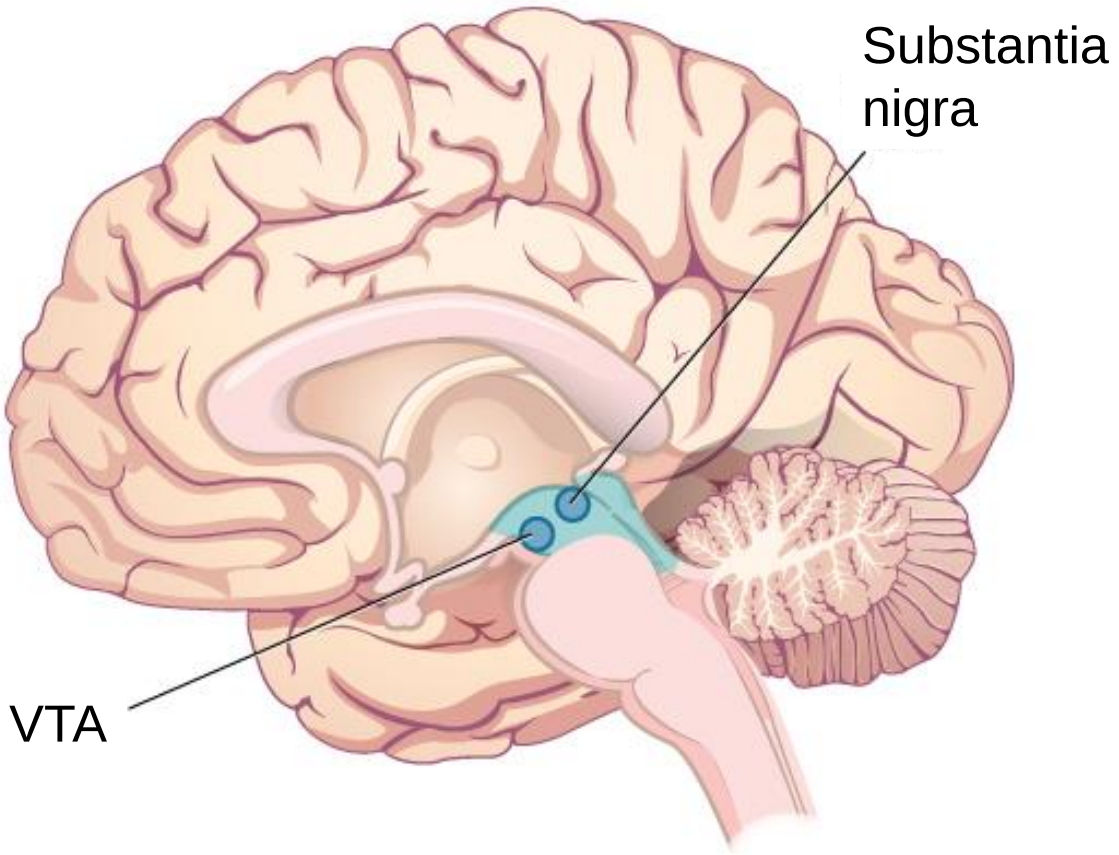


Midbrain

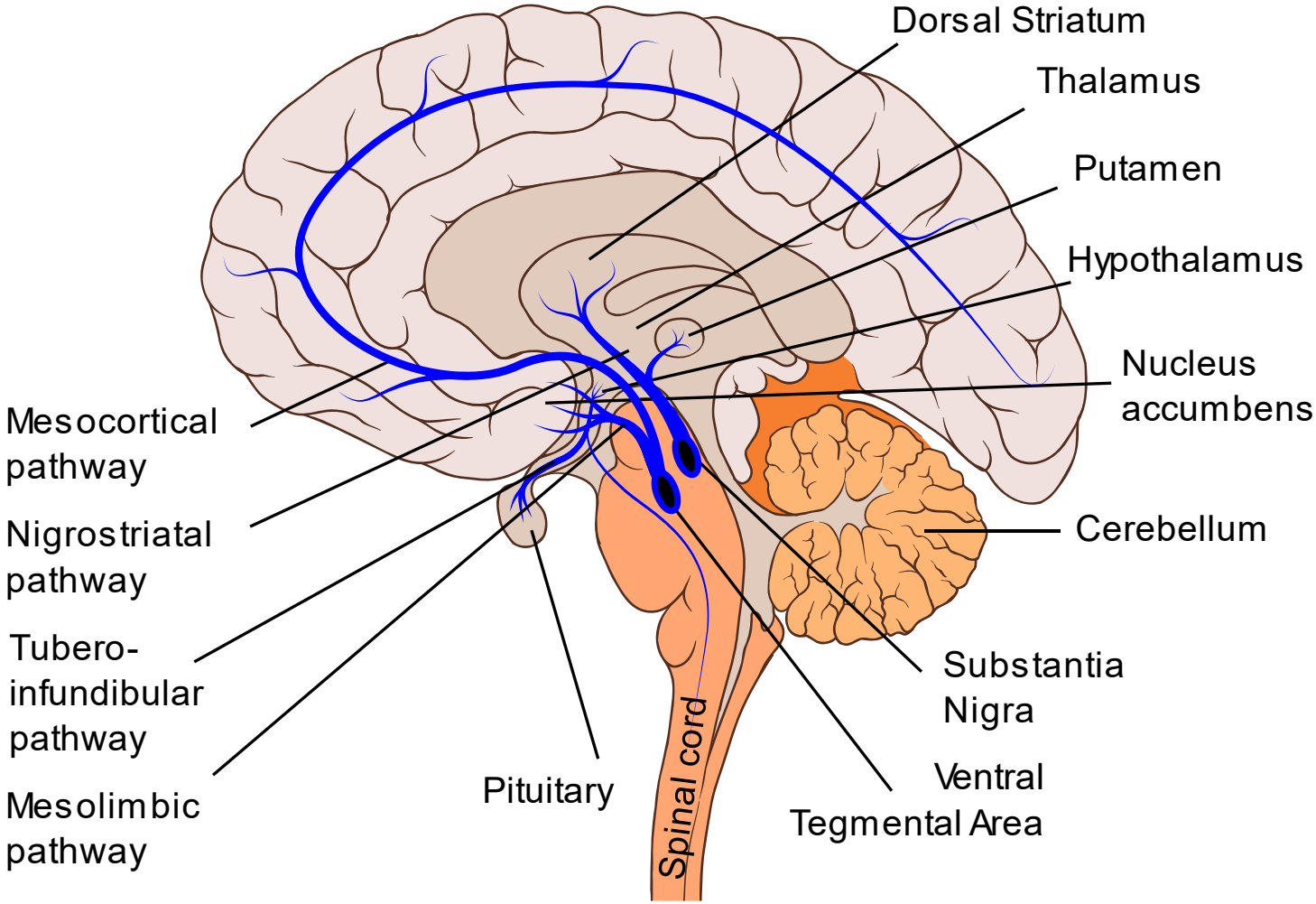
The **substantia nigra** is involved in the planning and maintenance of voluntary movements (damage ~ Parkinson's).

The **ventral tegmental area** primarily contains dopaminergic neurons.

These two structures are not always differentiated and have largely overlapping functions.



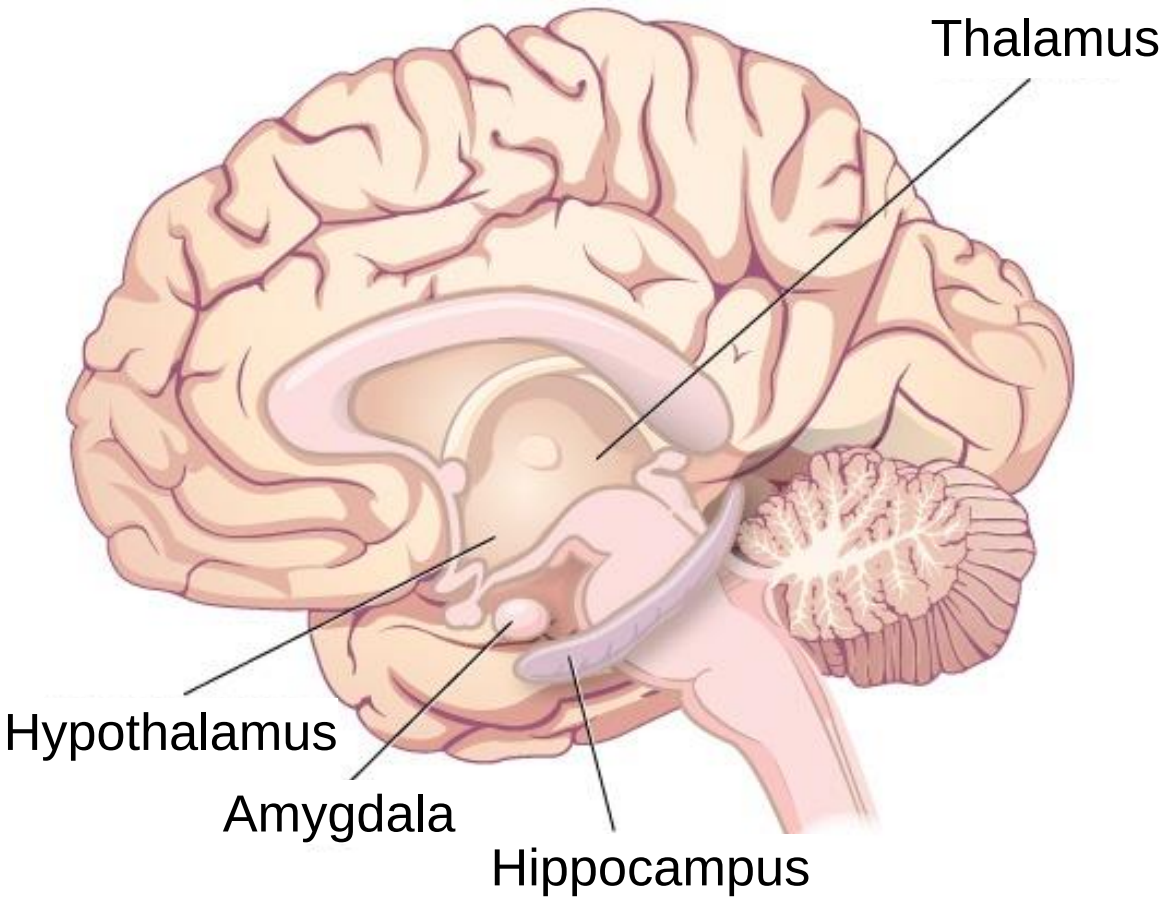
Dopaminergic pathways



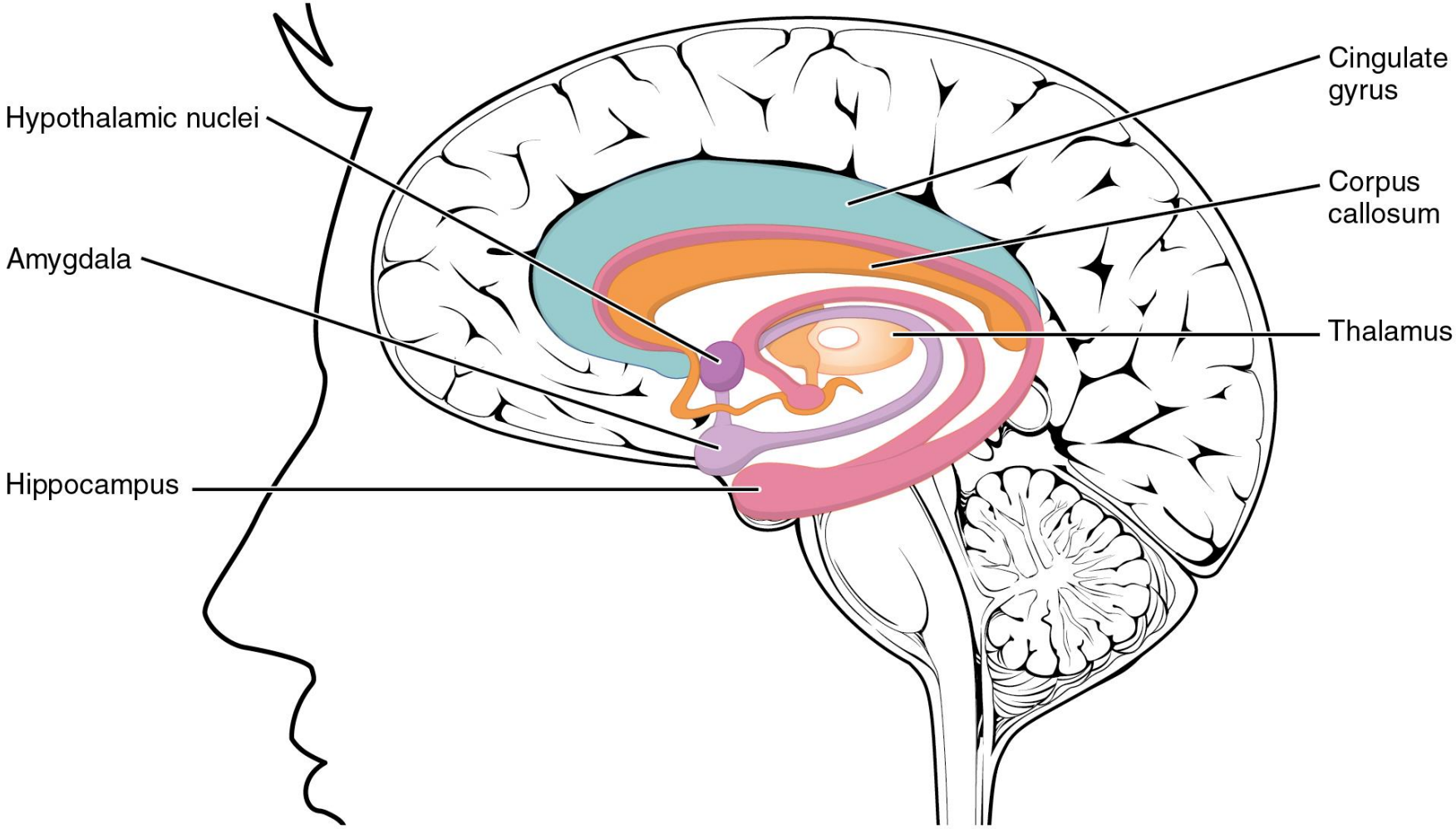
Forebrain

The **thalamus** is a “relay station” for all sensory (except olfactory) information.

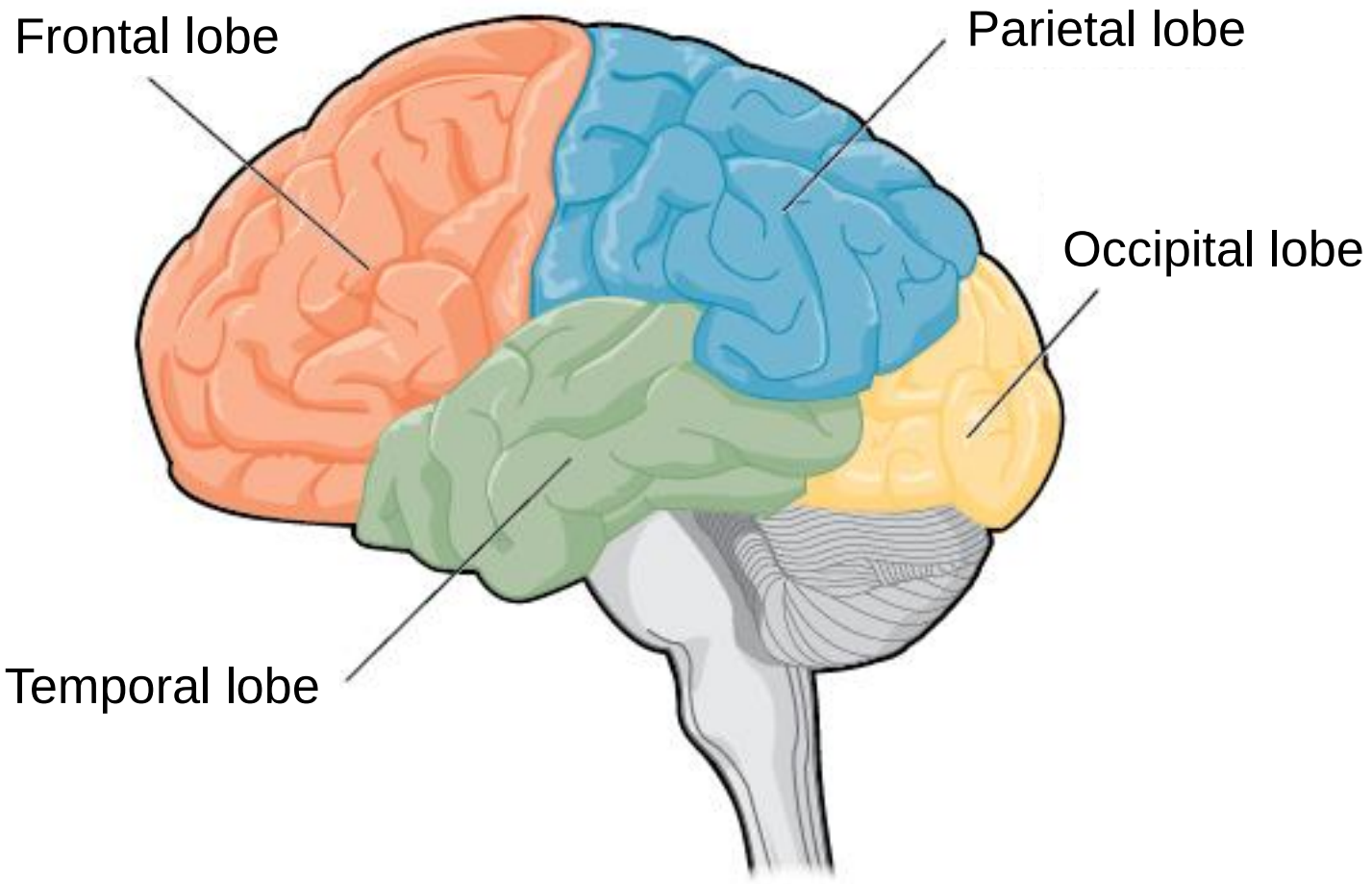
The **limbic system** is associated with emotion and memory, primarily through the **amygdala** and the **hippocampus**, respectively. The **hypothalamus** is primarily responsible for endocrine regulation.



Thalamus and limbic system



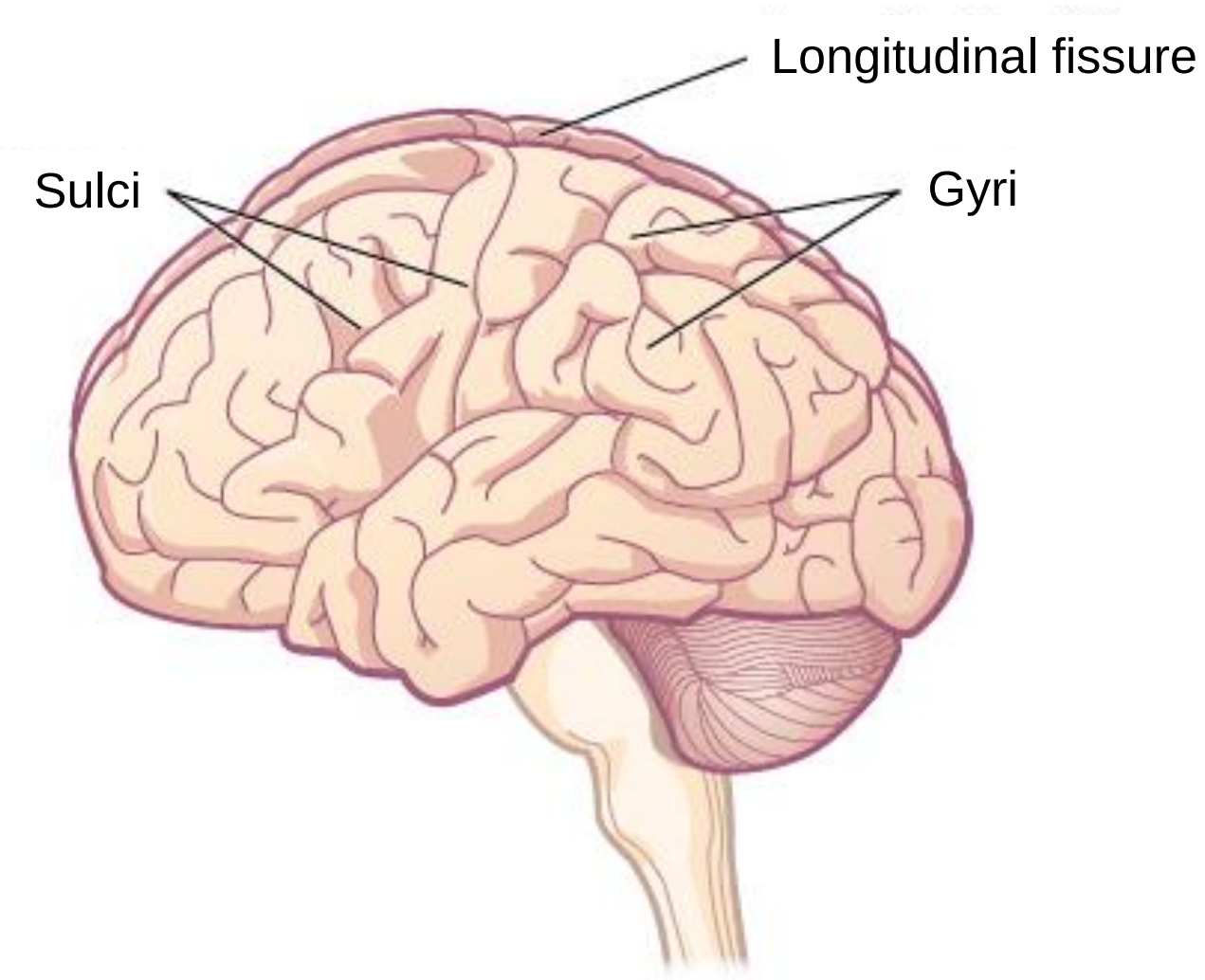
Cerebral cortex



Cerebral cortex

Gyri are the “hills”, sulci the “valleys” of the cerebral cortex.

Deeper sulci are often called fissures.



White and grey matter

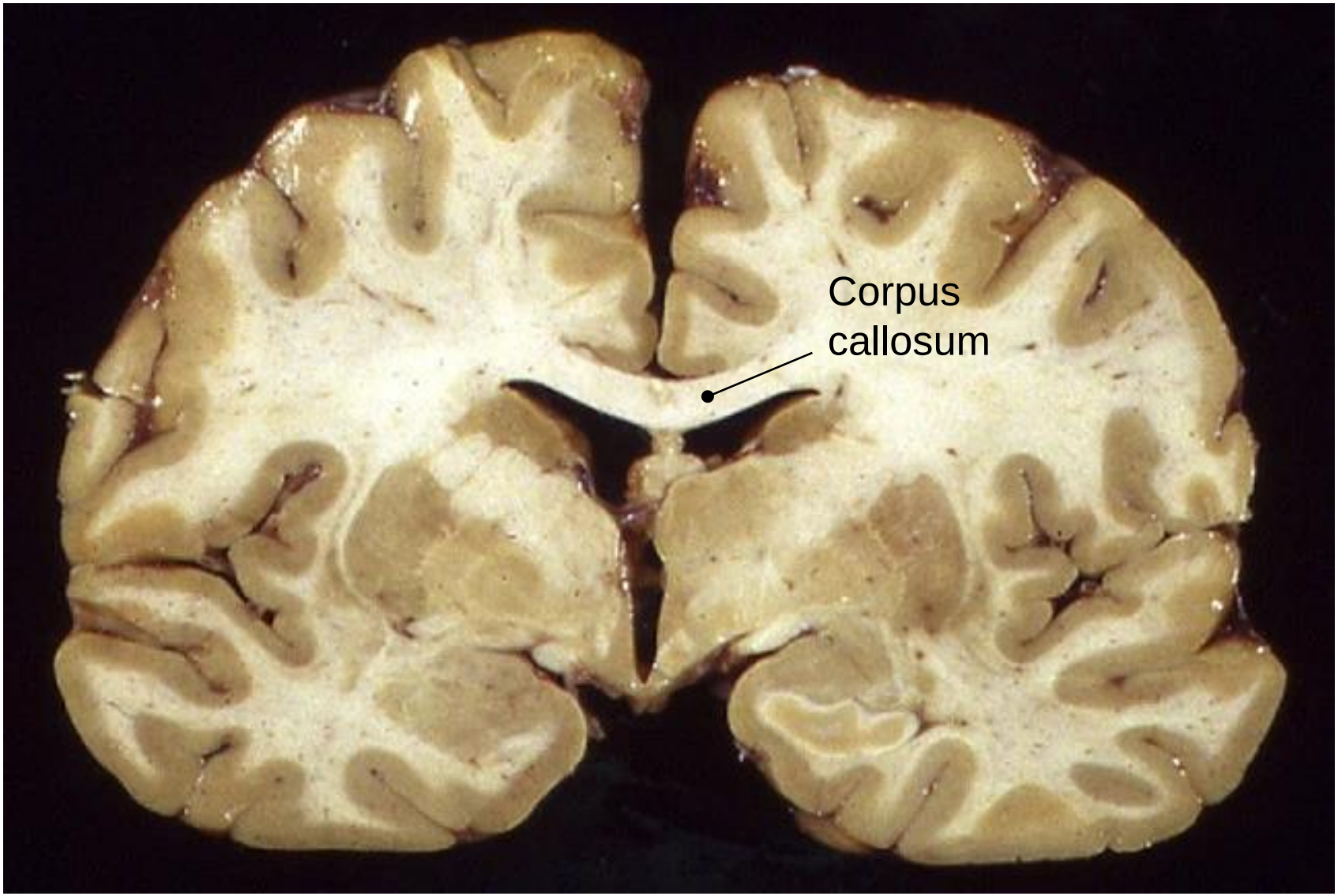
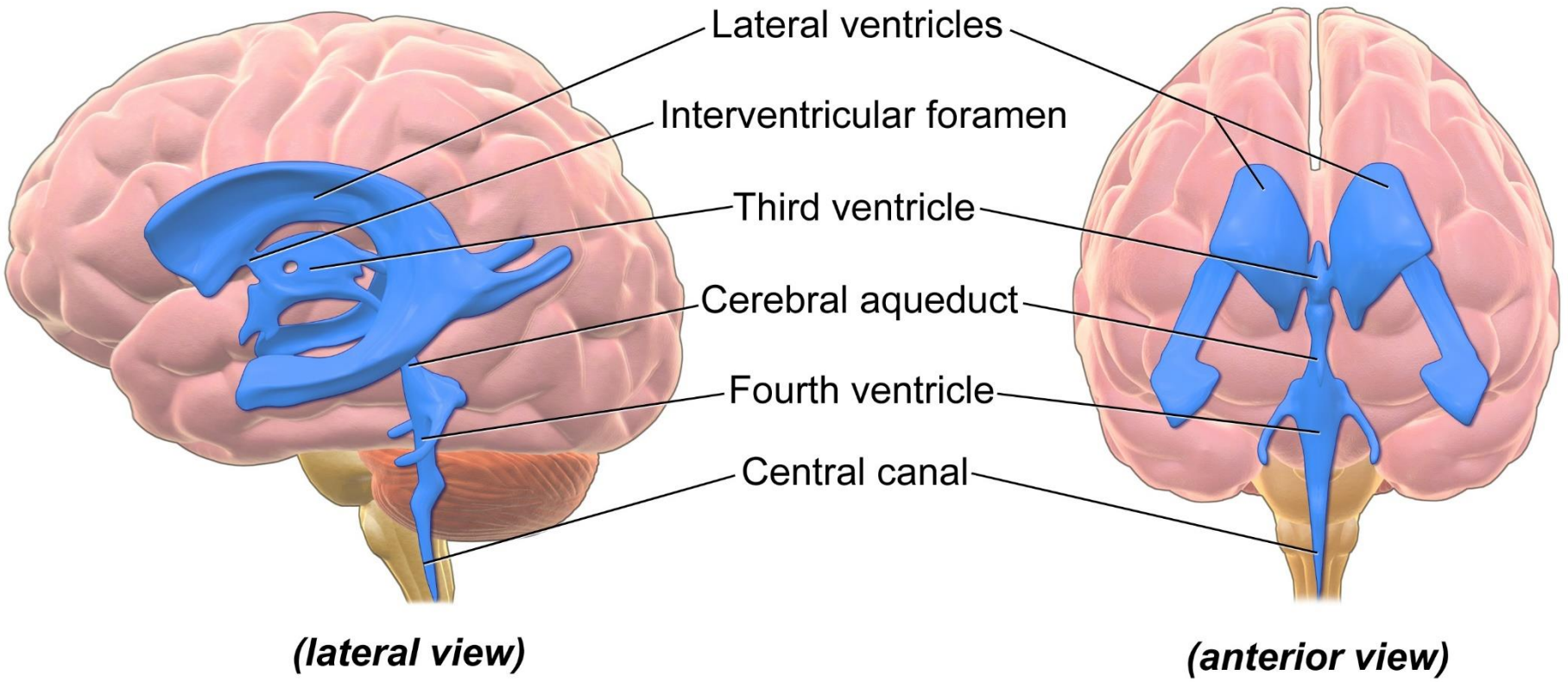


Figure: Lakhan, S.E., Kirchgessner, A. (2012). Chronic traumatic encephalopathy: the dangers of getting "dinged". *SpringerPlus* **1,** 2. doi: 10.1186/2193-1801-1-2. Licensed under CC BY 2.0

Ventricular system

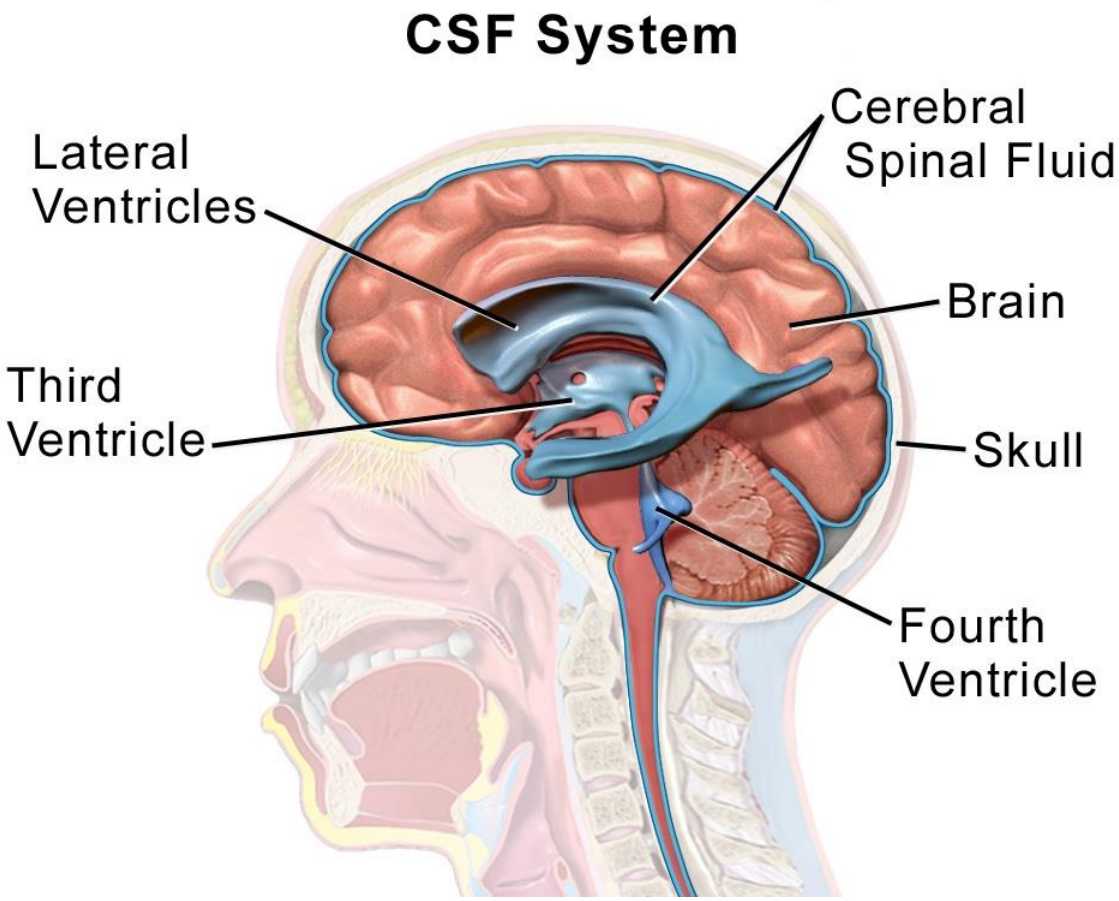


Cerebrospinal fluid

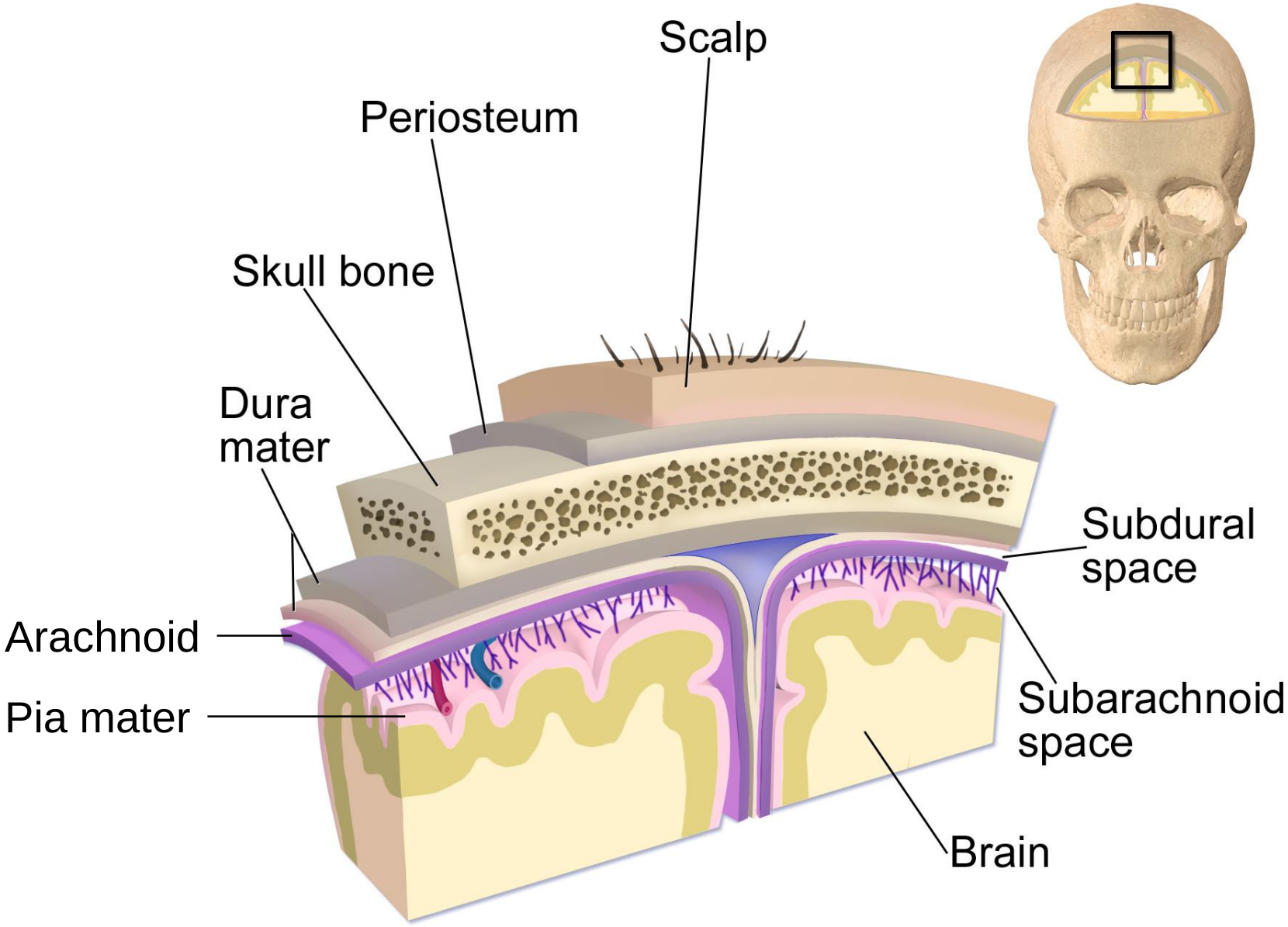
Produced by cells in all four ventricles.

Circulates within the ventricular system and the subarachnoid space surrounding the CNS.

Provides mechanical protection (shock absorption, pressure maintenance) and transports nutrients and waste products.

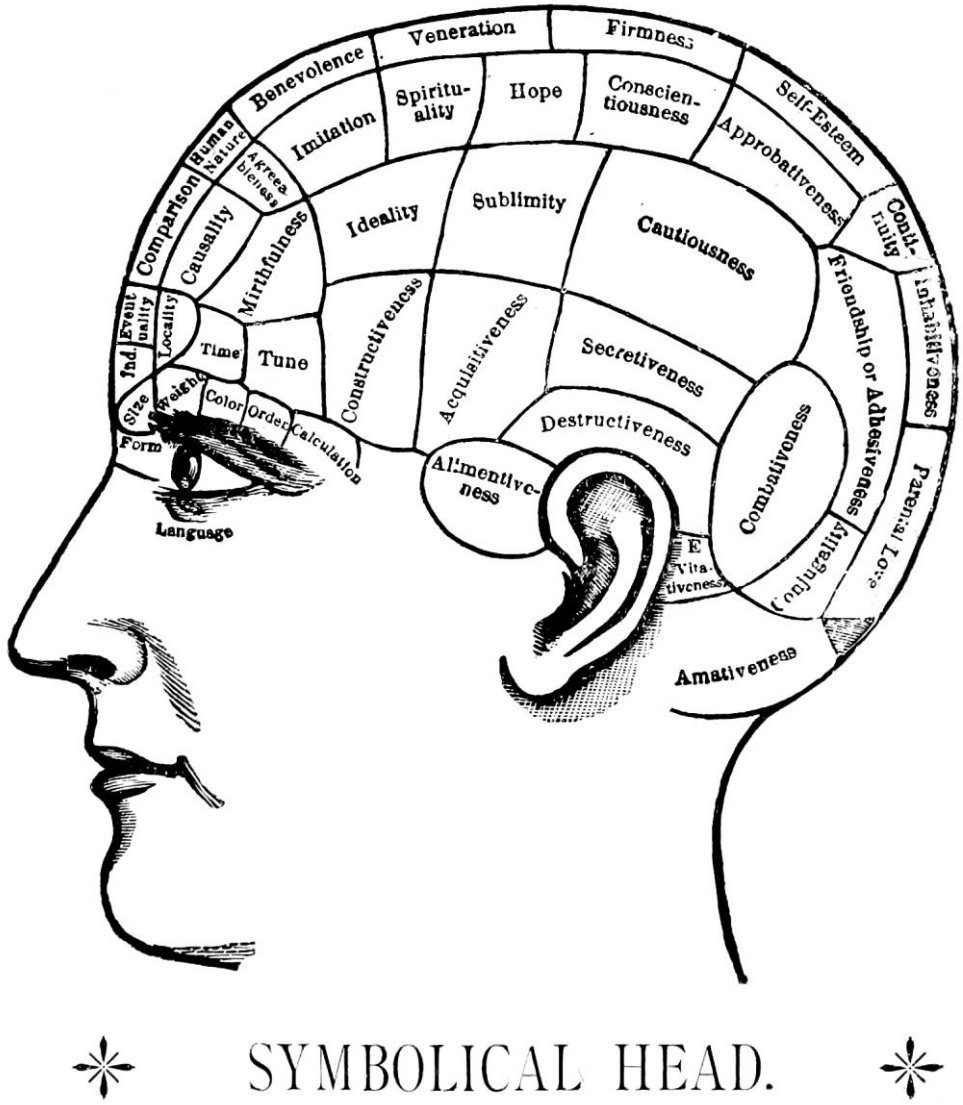


Meninges and the subarachnoid space



Psychophysiology: CNS: Brain: Forebrain: Cerebral cortex

Function

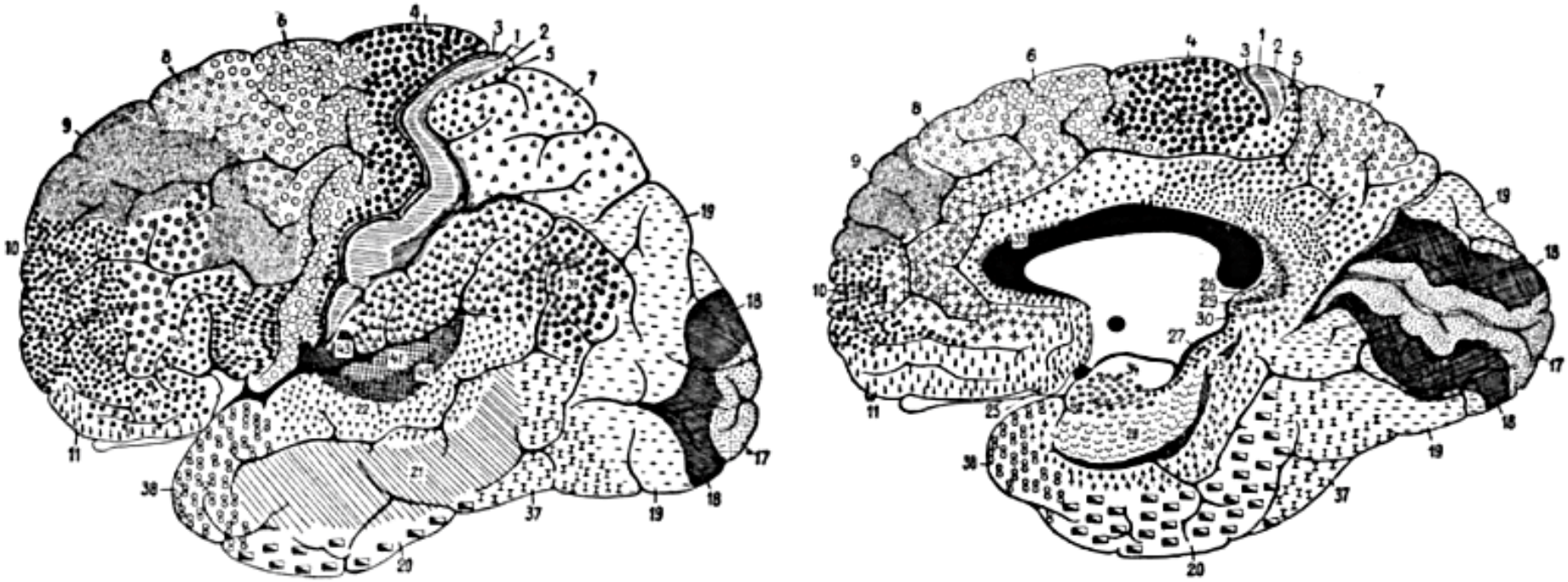


SYMBOLICAL HEAD.

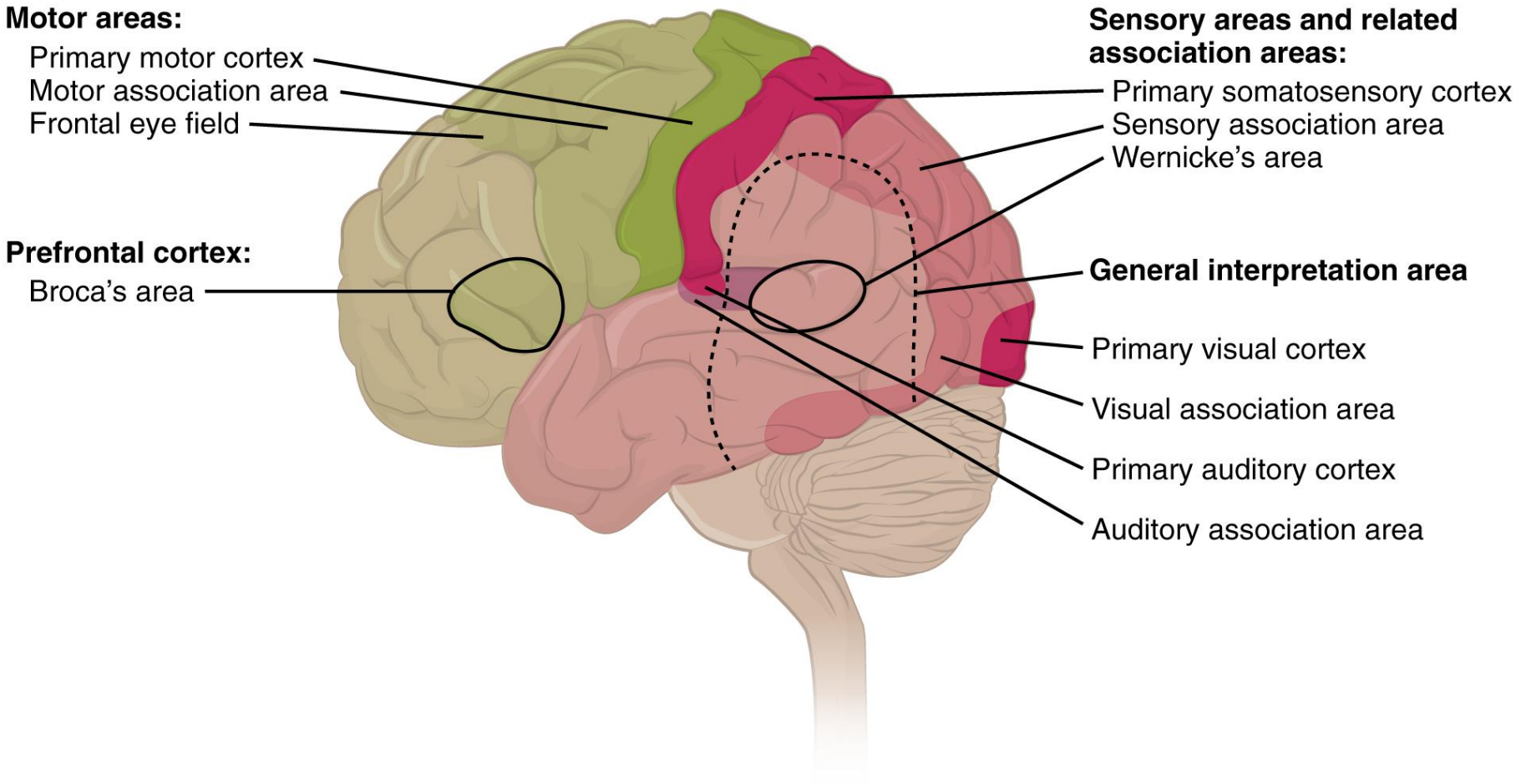
Illustration: Seymour, W. (1890). *Key to phrenology*. Philadelphia, PA, USA: Prof. W. Seymour, & Son.

Brodmann areas

Korbinian Brodmann (1909) identified 52 numbered areas differing based on cellular size, density, and layering.



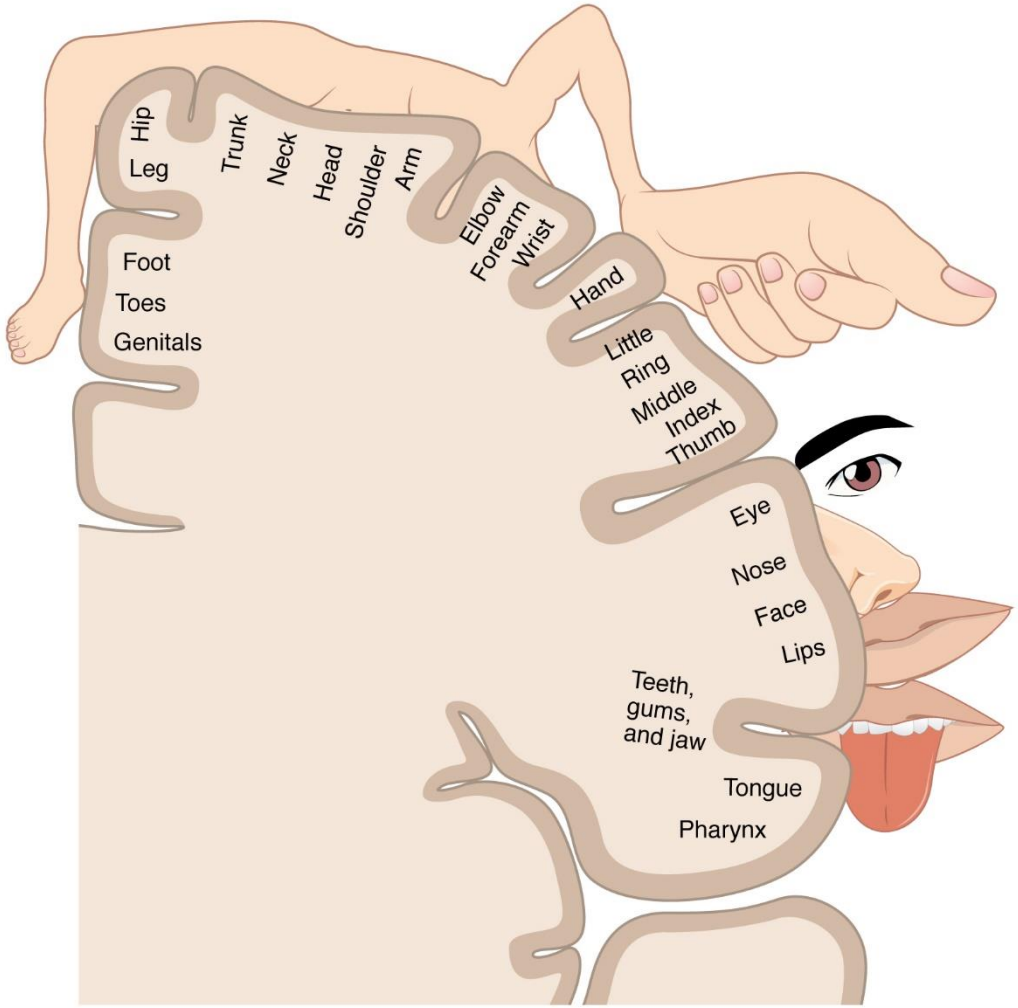
Sensory, motor, and association areas



Topographic organization

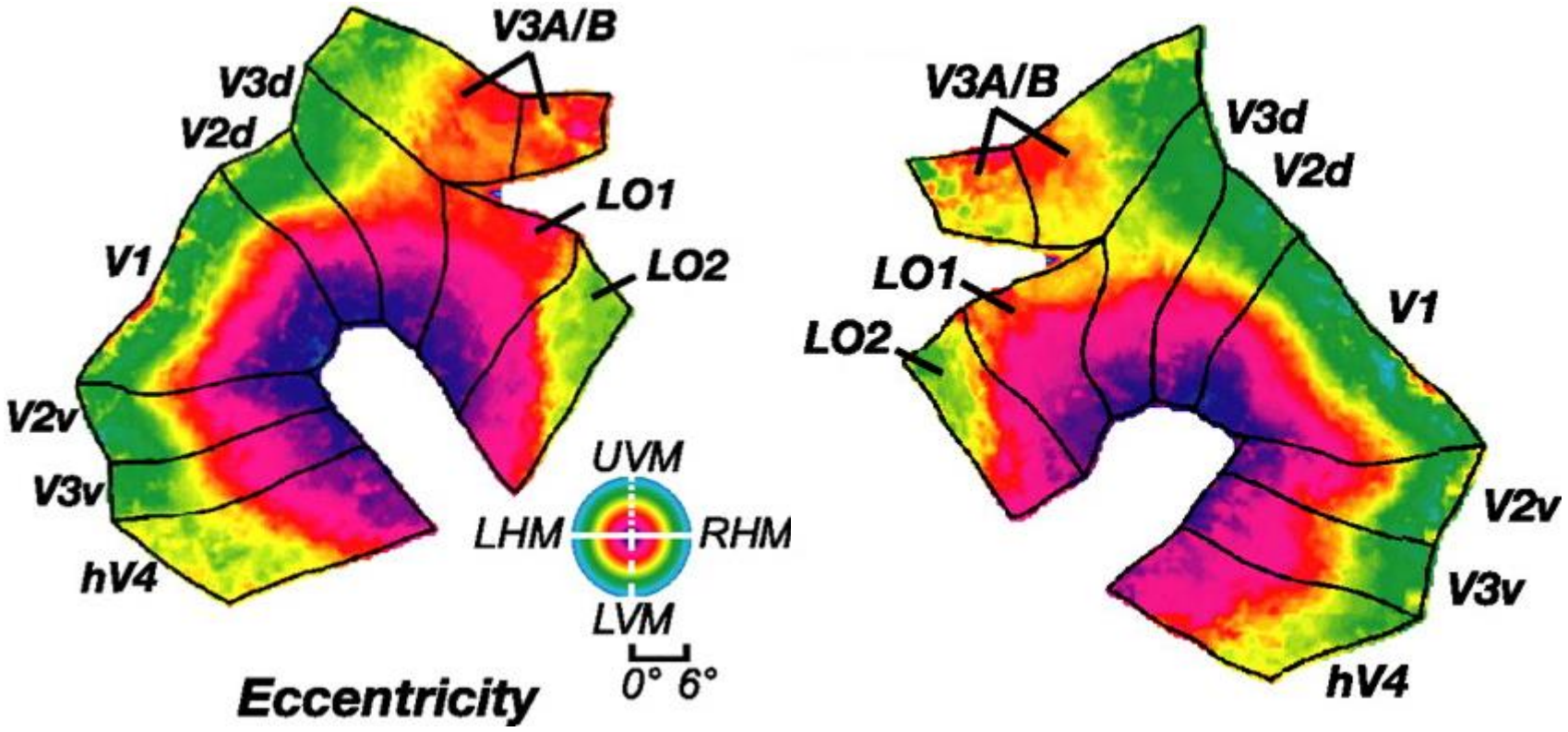
The motor cortex is organised as a somatotopic map of the body, as is the primary samotosensory cortex.

This *somatotopic* organisation is *contralateral*.



Retinotopic organisation

The visual cortex is organised as a map of the retina.



Larsson, J., & Heeger, D. J. (2006). Two retinotopic visual areas in human lateral occipital cortex. *Journal of neuroscience*, *26*(51), 13128-13142. doi: 10.1523/JNEUROSCI.1657-06.2006.

Central nervous system

The spinal cord carries afferent (sensory) and efferent (motor) signals. Through interneurons in its grey matter, it is also responsible for reflexes.

The brain is organised in different evolutionary stages and functional areas, including the sensory, motor, and association areas of the cerebral cortex.

Psychophysiology
Part 2.3: The central nervous system

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