

Central Nervous System

January 7, 2016

Anatomy of a neuron

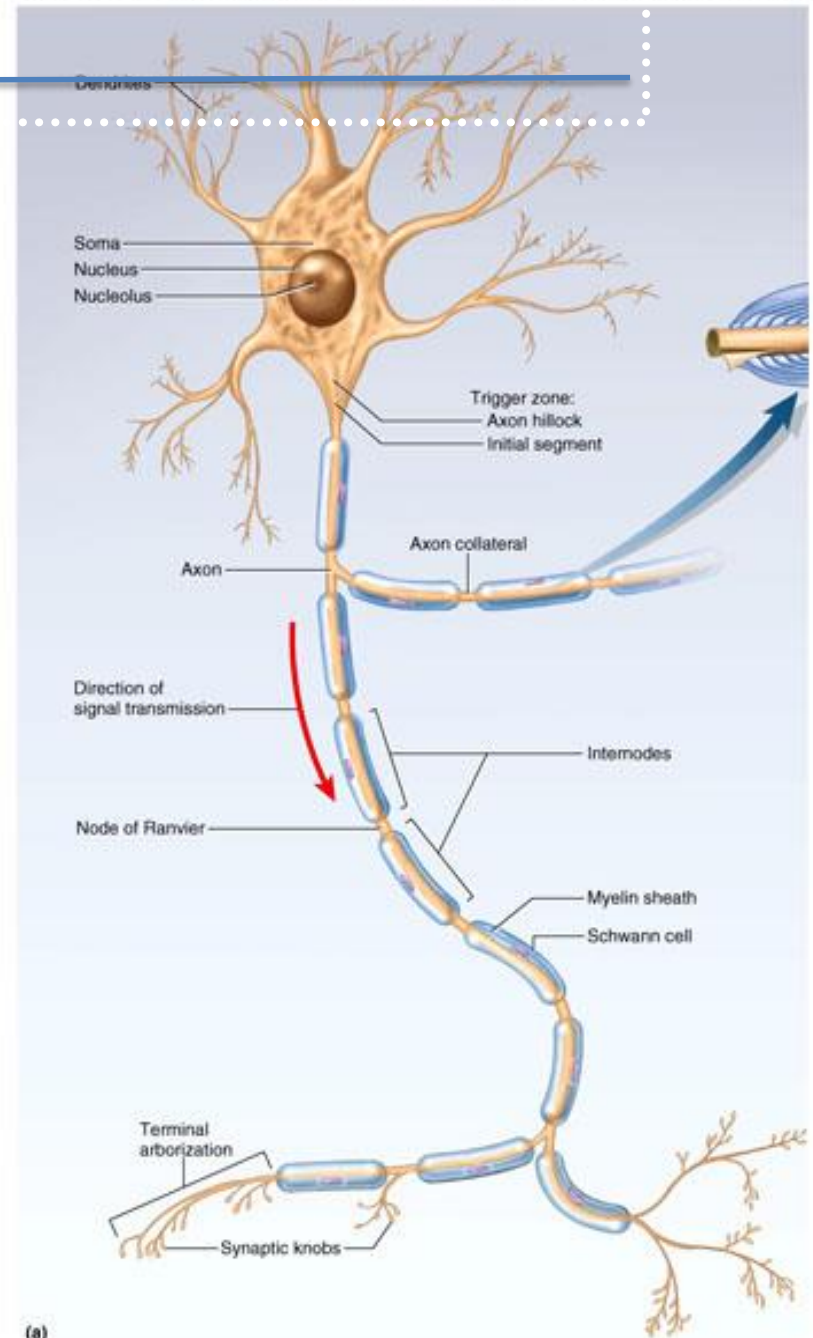
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Cell Body (soma)

- **Receives** information from the soma's extensions (**dendrites**)
- **Passes on** information away from the soma towards extensions (**axons**)

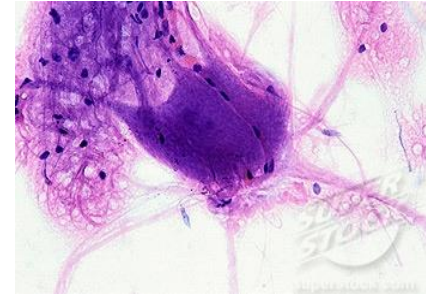
Axon

- Conducts nerve impulses (AP) **away** from soma

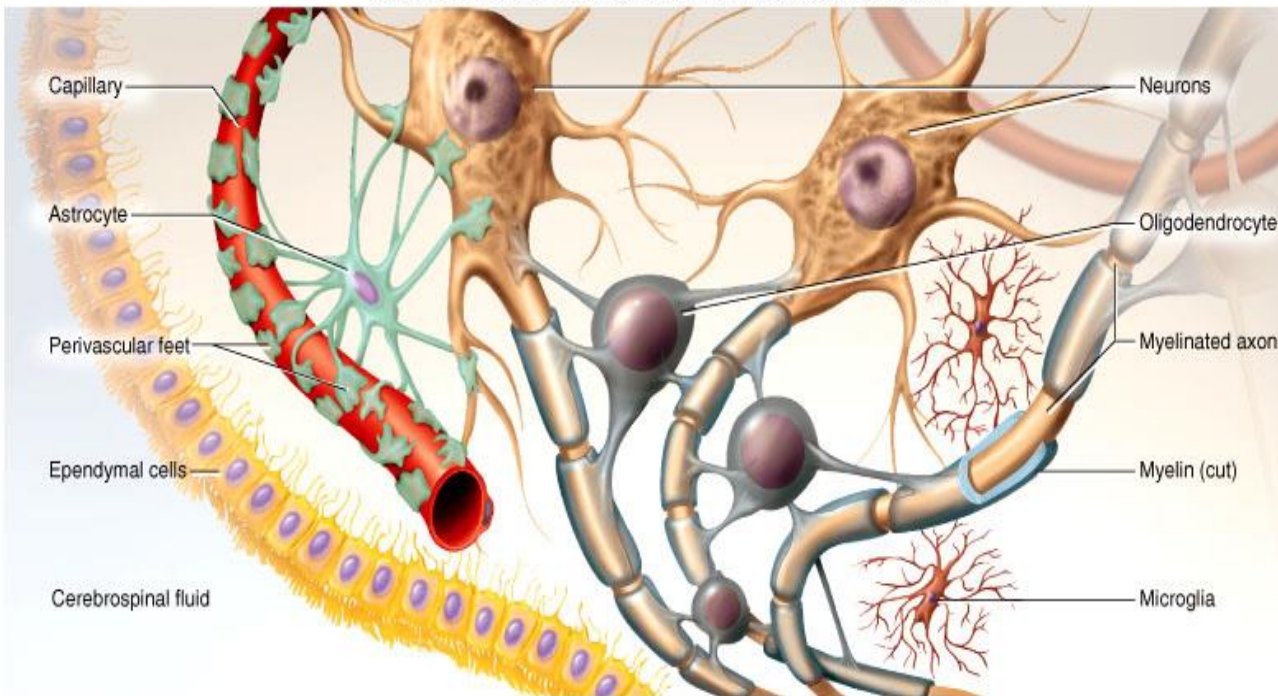


Nervous tissue

- Nervous tissue is specialized tissue for reacting to stimuli and transmitting impulses.
- The nervous tissue/system is made up of two main cell types:
 1. **Neurons** – excitable cells that transmit electrical signals
 2. **Support cells (glia)** – cells that surround and assist neurons



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Microglia:

Specialized macrophages, ~15%

Macroglia

Oligodendrocytes
(coat axons in CNS)
(~Schwann cells in PNS)

Astrocytes

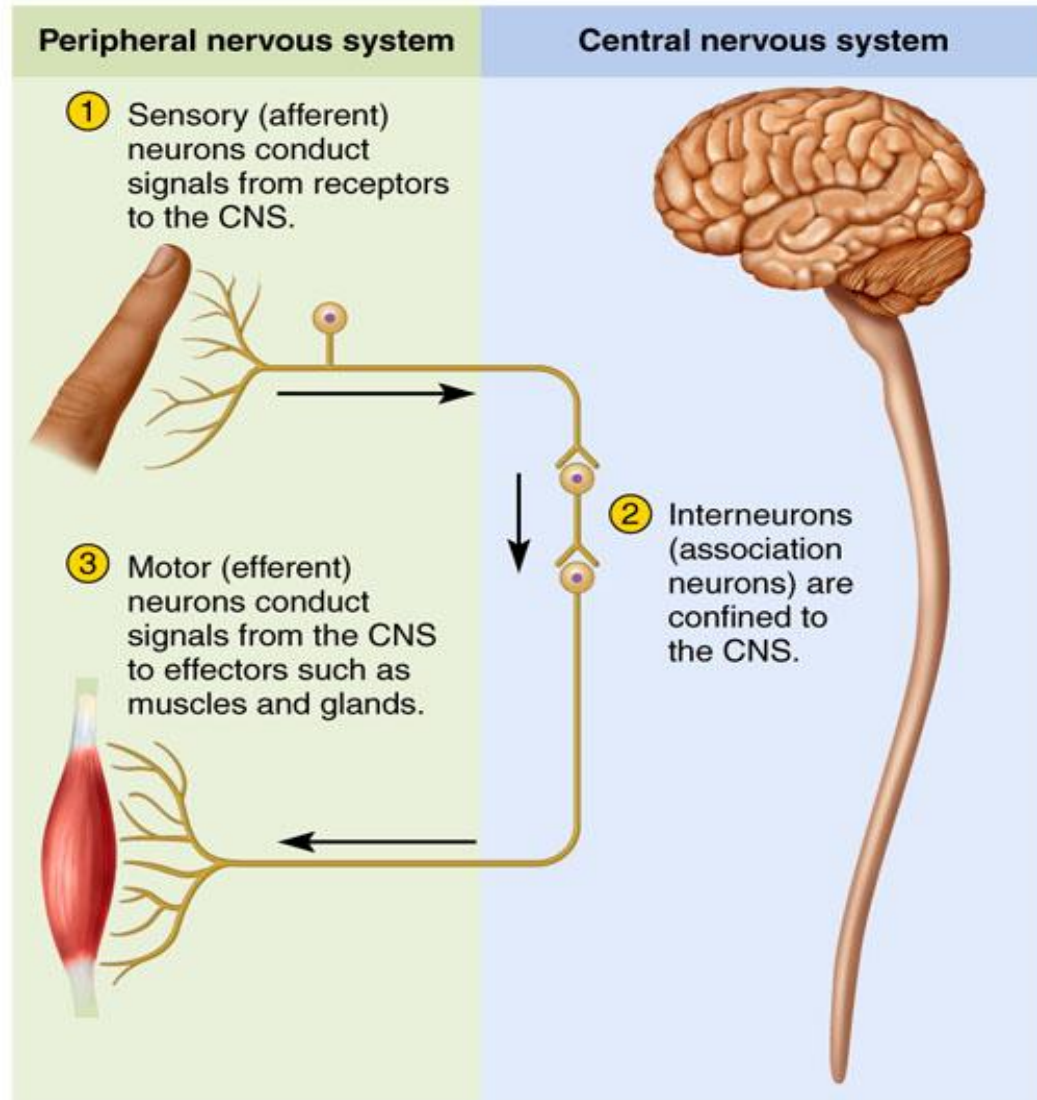
(control external chemical environment)
(~satellite cells of PNS)

Ependymal Cells:

Coat cavities (ventricles)

Neuronal circuitry

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Classification

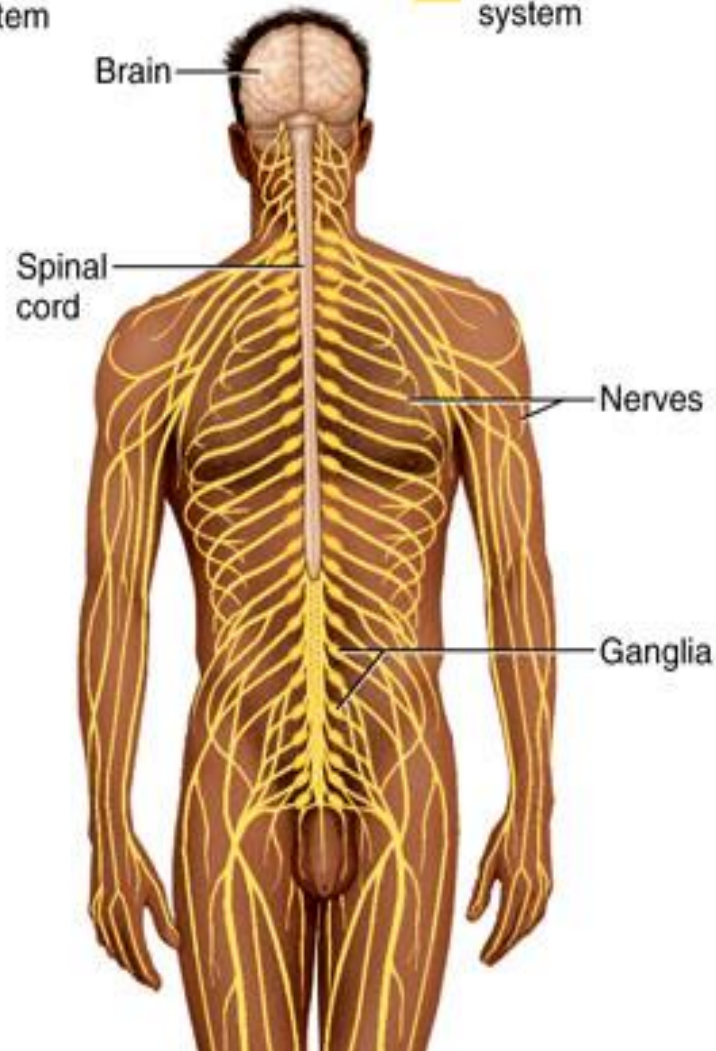
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Central nervous system

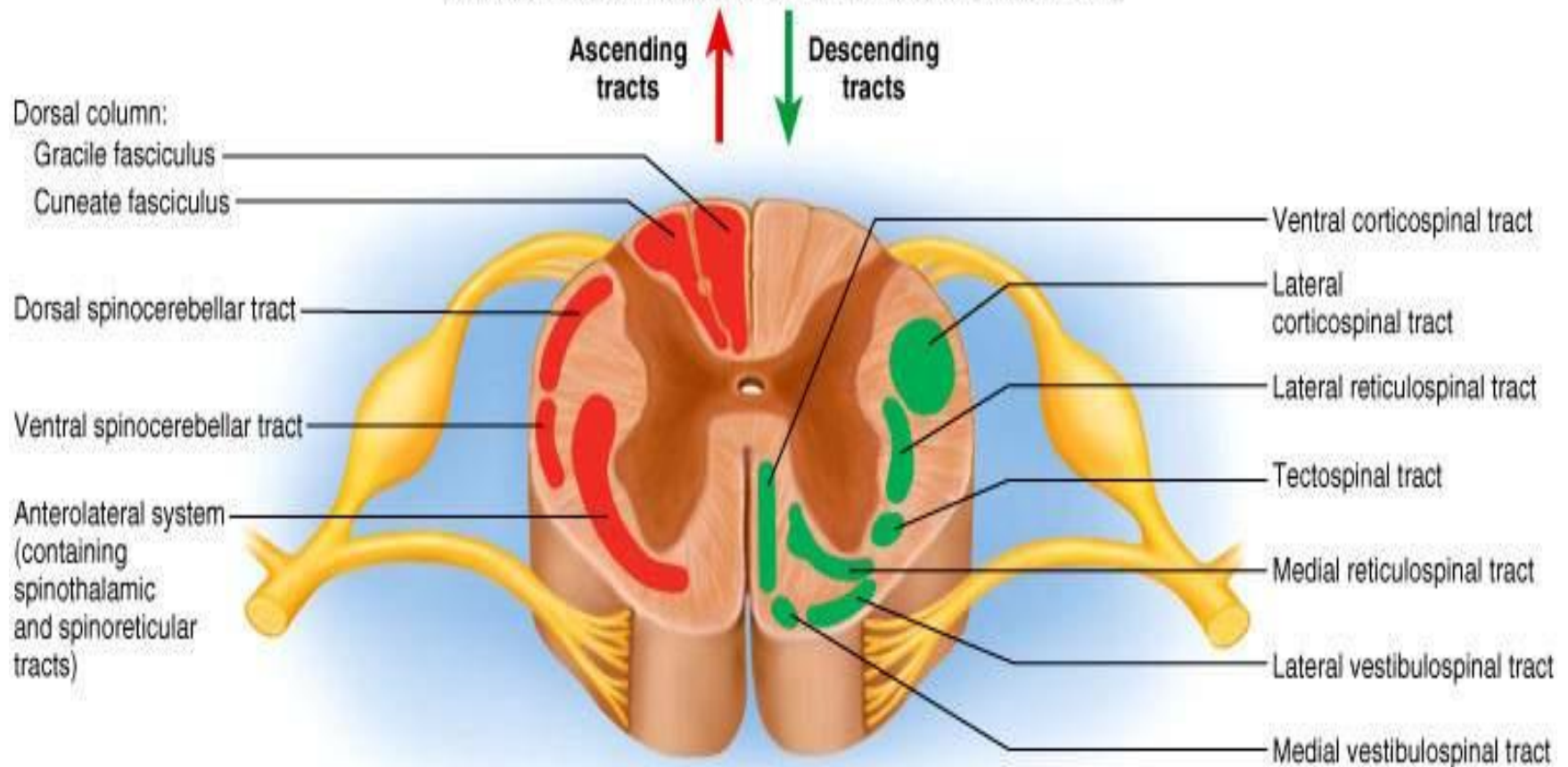


Peripheral nervous system



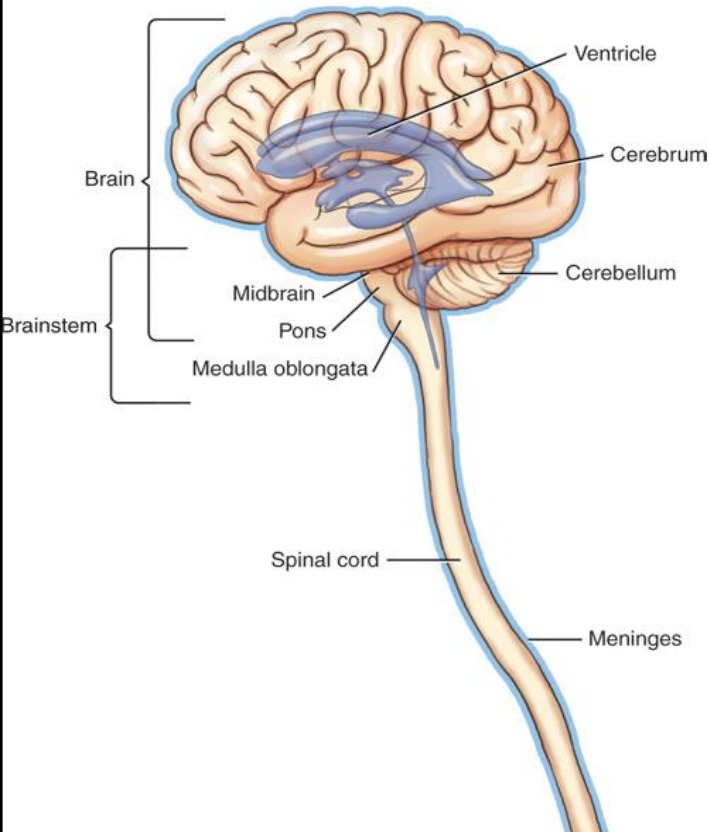
Spinal cord: spinal tracts

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Classification

CNS: “Processing center”



PNS:

- 12 pairs of cranial nerves
- 31 pairs of spinal nerves

Sensory (afferent) division

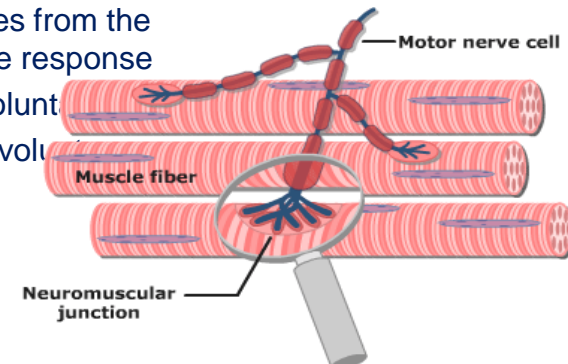
carries sensory information from the body to the CNS;

- Somatosomatic
- Visceral
- Nociception
- Proprioceptors

Motor (efferent) division

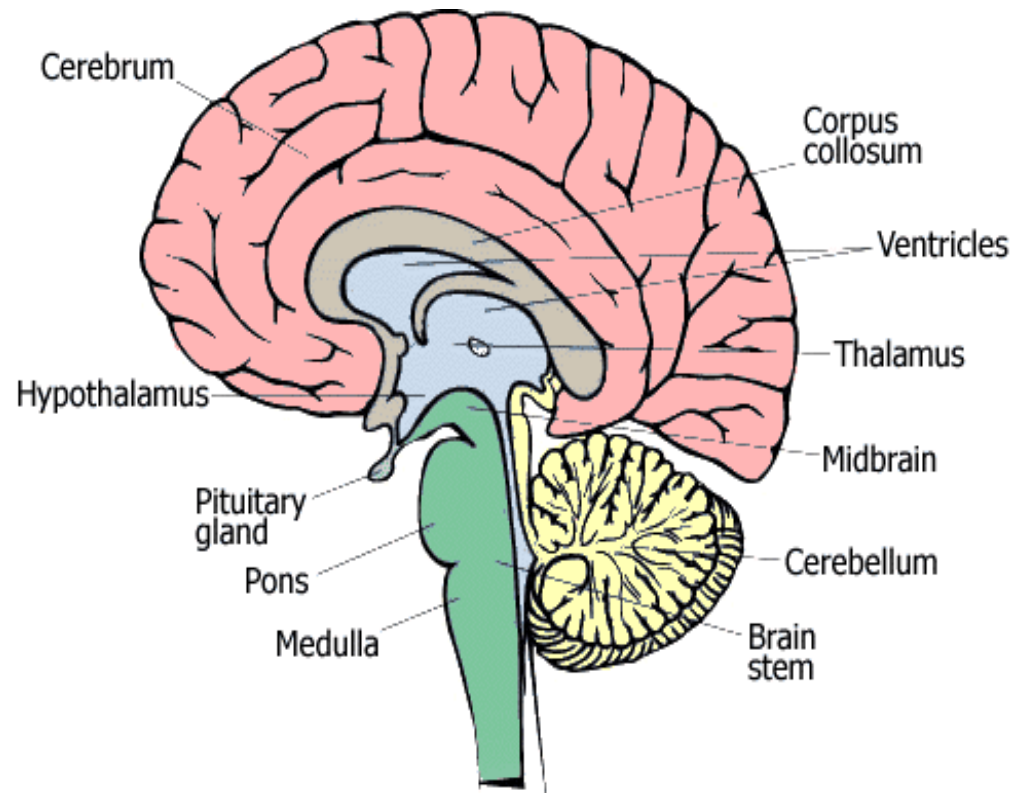
Response: Transmits impulses from the CNS to organs involved in the response

- Striated muscle cells: voluntary
- Smooth muscle cells: involuntary
- glands

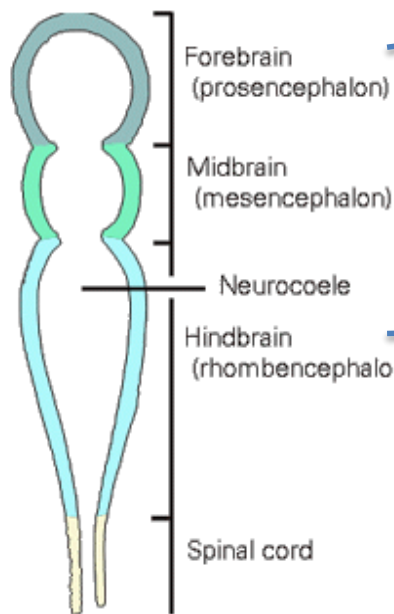


Central Nervous System

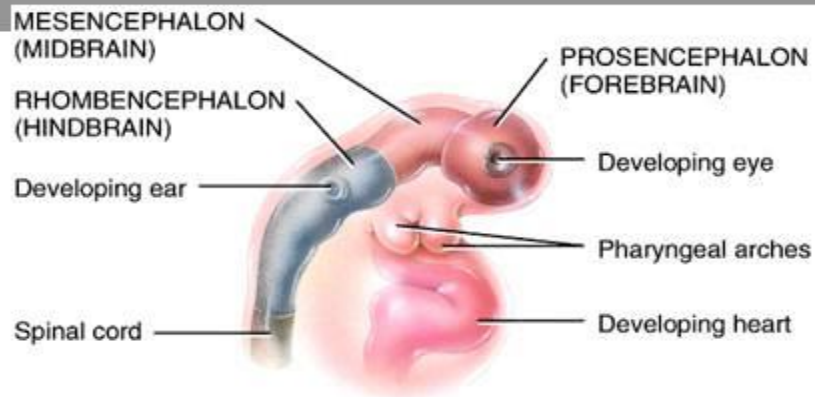
- **brain:** major portion of the central nervous system
 - **Cerebrum:**



Embryology of CNS:Ventricular System

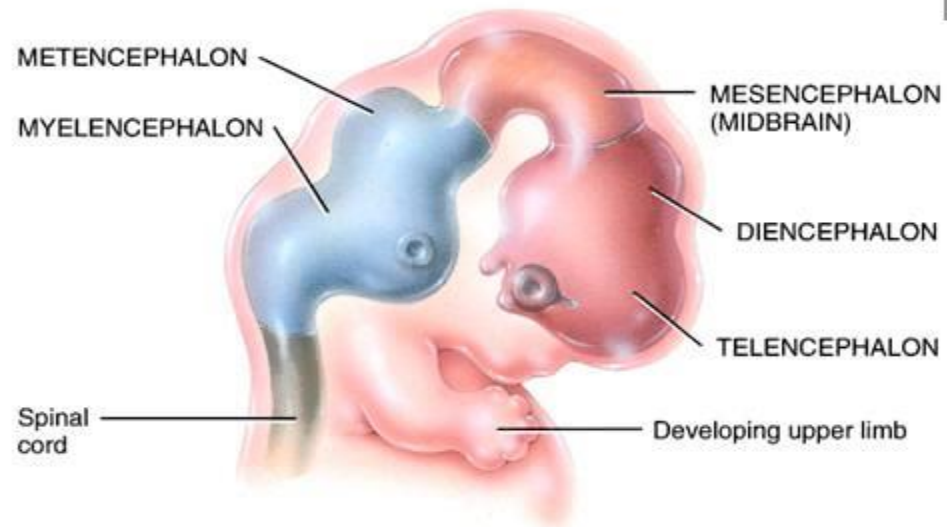


nervous system	Brain	Telencephalon	Rhinencephalon, Amygdala, Hippocampus, Neocortex, Basal ganglia, Lateral ventricles
		Diencephalon	Epithalamus, Thalamus, Hypothalamus, Subthalamus, Pituitary gland, Pineal gland, Third ventricle
		Mesencephalon	Tectum, Cerebral peduncle, Pretectum, Mesencephalic duct
	Brain stem	Metencephalon	Pons, Cerebellum
		Myelencephalon	Medulla oblongata
Spinal cord			

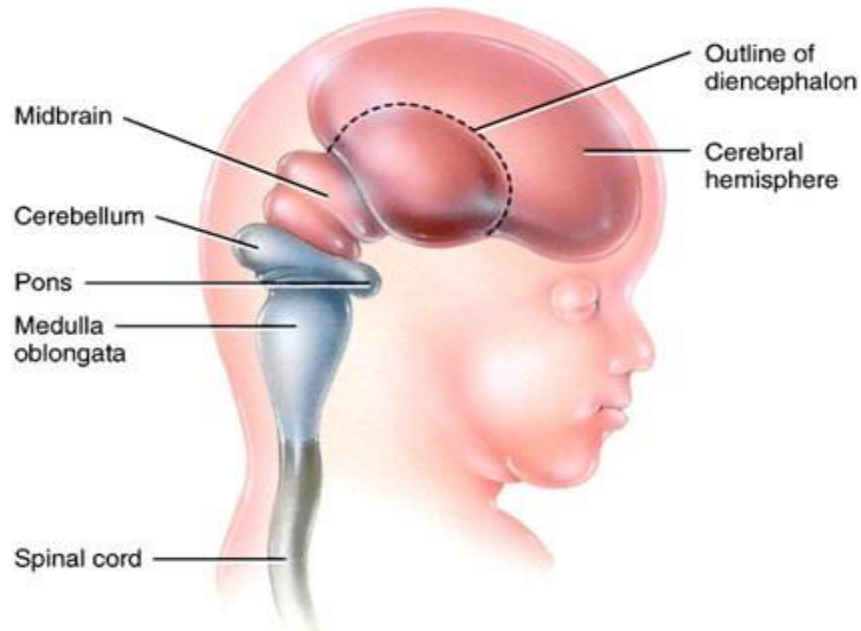


Lateral view of right side

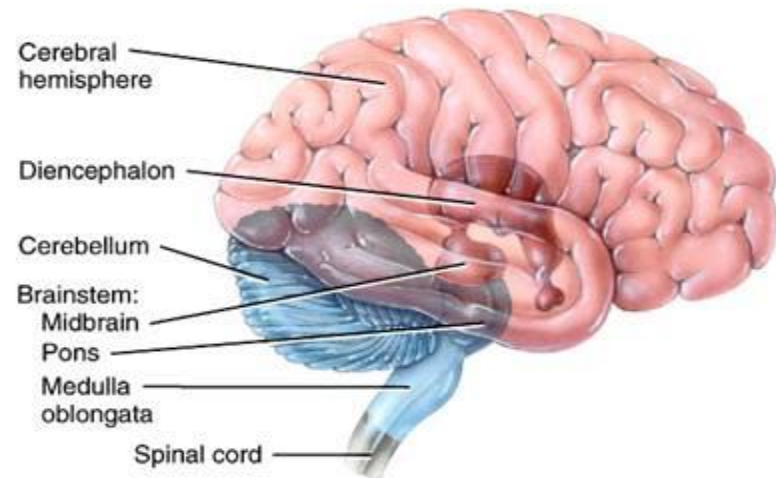
(a) Three-four week embryo showing primary brain vesicles



(b) Seven-week embryo showing secondary brain vesicles

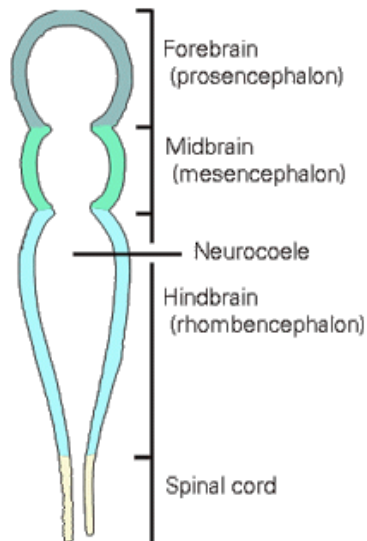


(c) Eleven-week fetus showing expanding cerebral hemispheres overgrowing the diencephalon

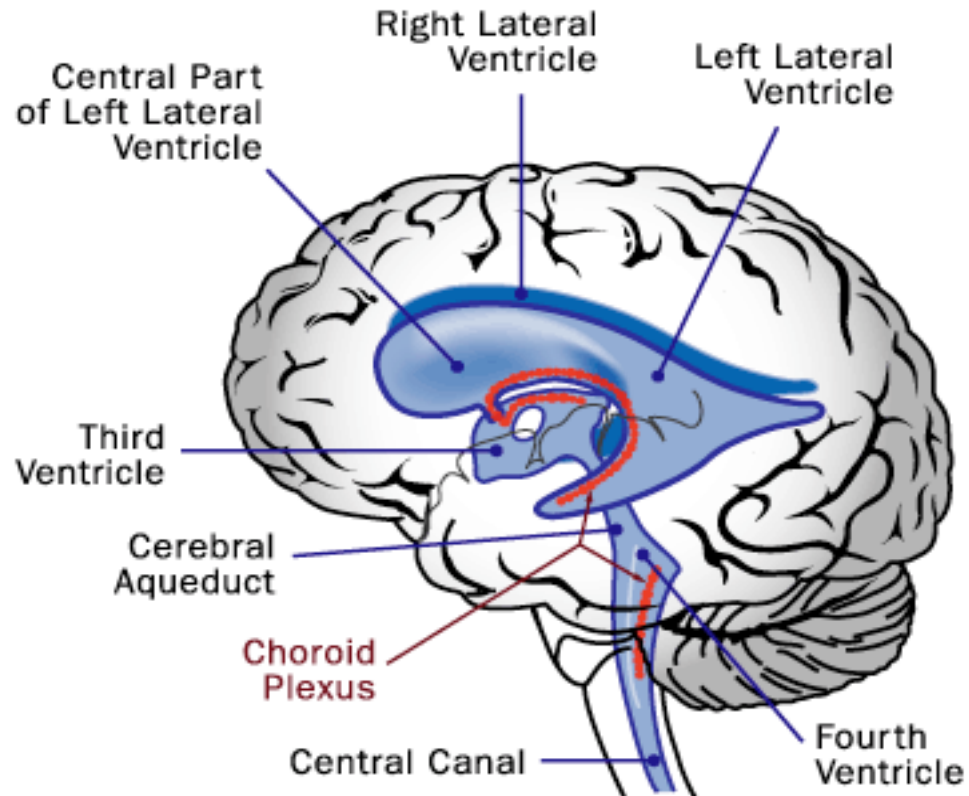


(d) Brain at birth (the diencephalon and superior portion of the brain stem have been projected to the surface)

Embryology of CNS: Ventricular System

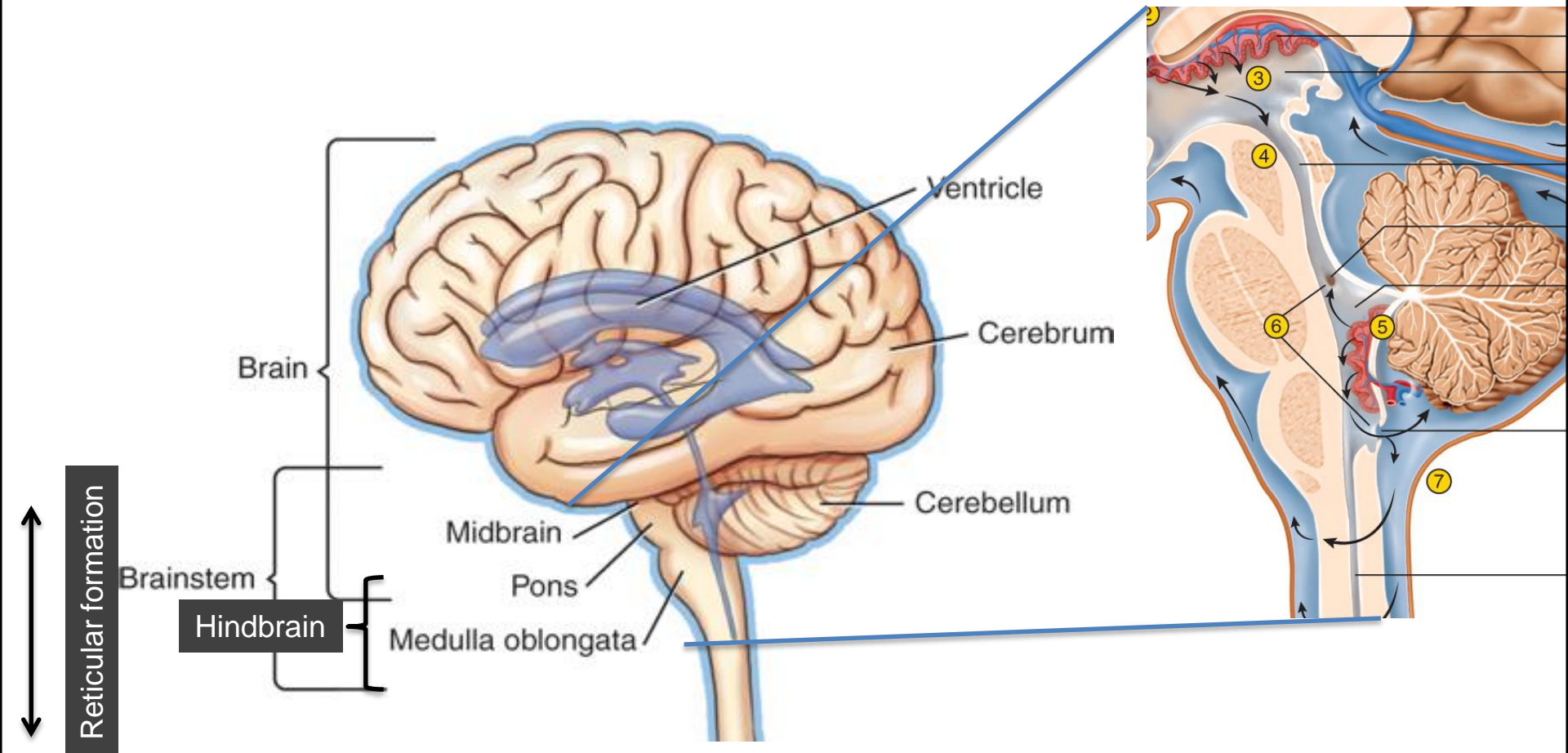


The Ventricular System of the Human Brain



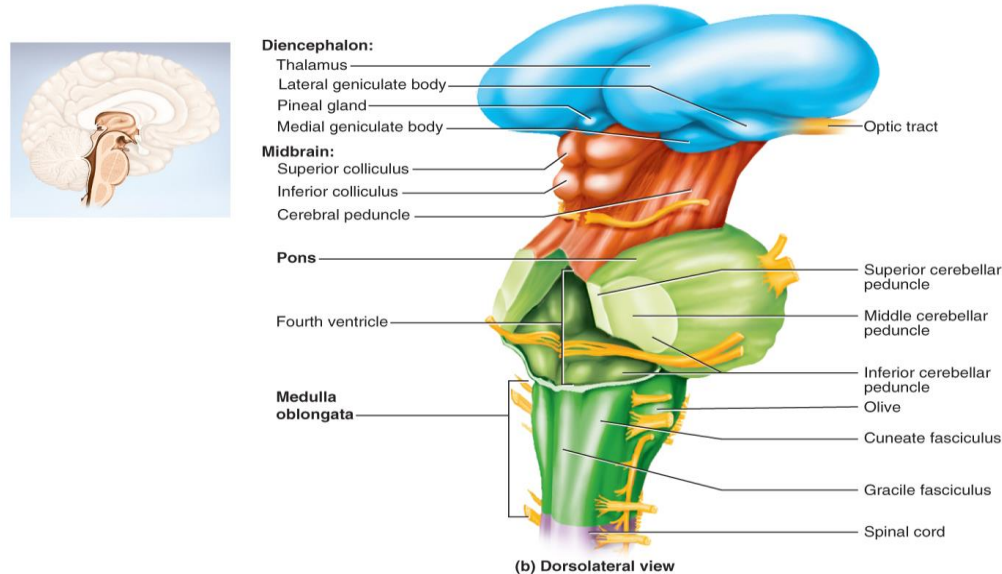
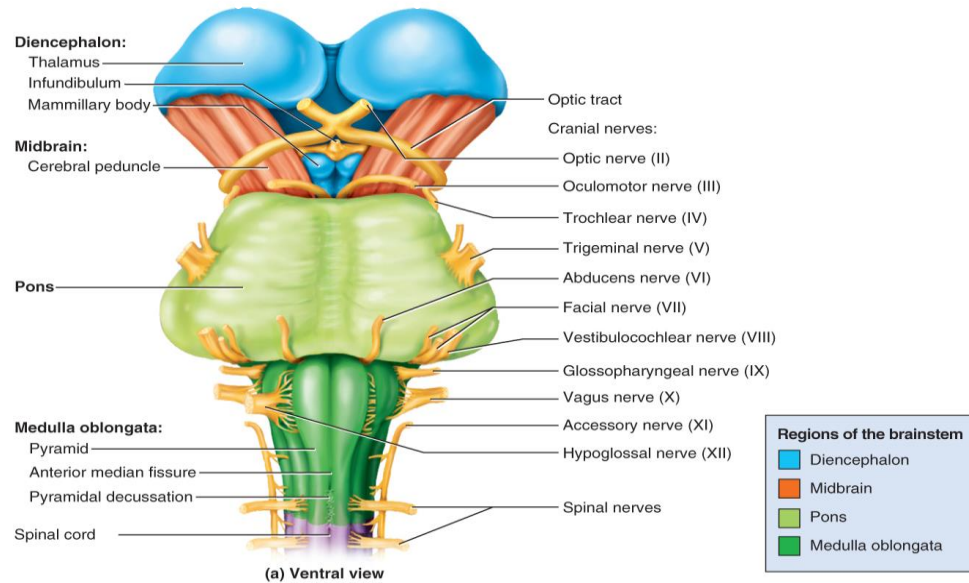
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Anatomical elements of the brain

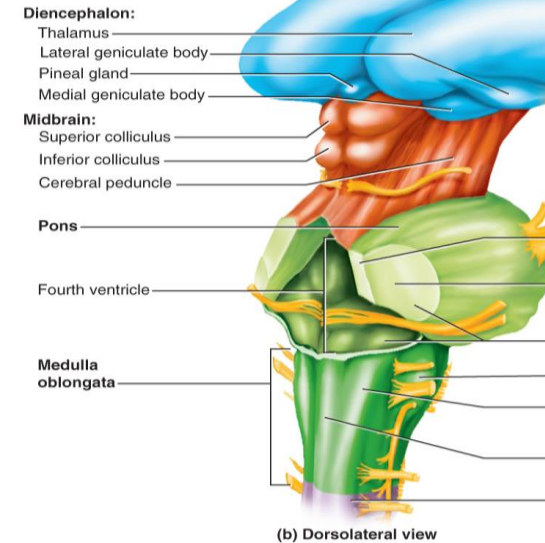
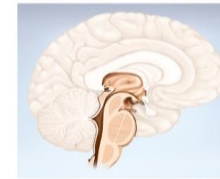
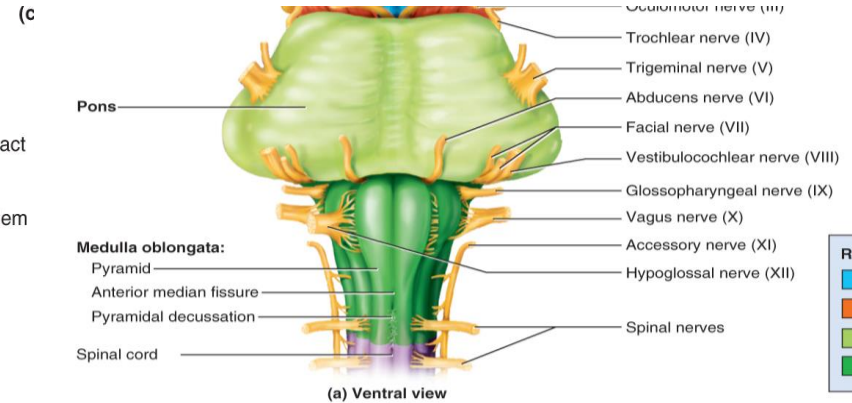
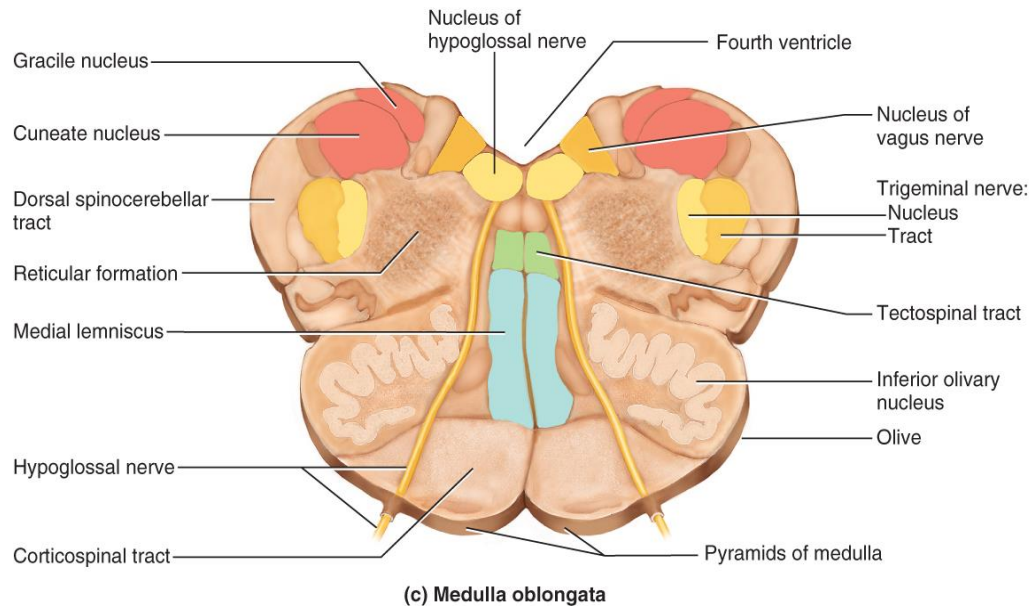
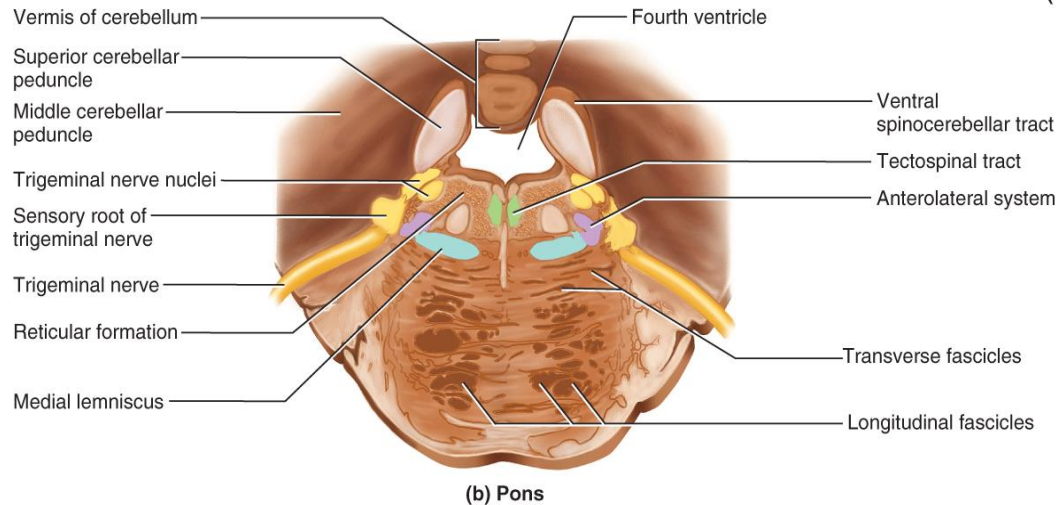


Brainstem and diencephalon: overview

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Brainstem: Pons and Medulla Oblongata



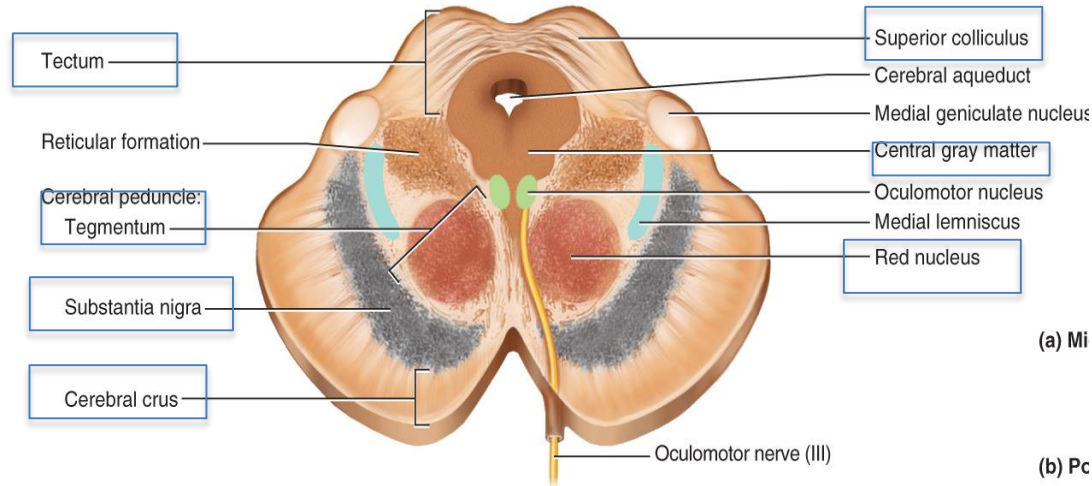
Anatomical elements of the brain:midbrain

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Posterior

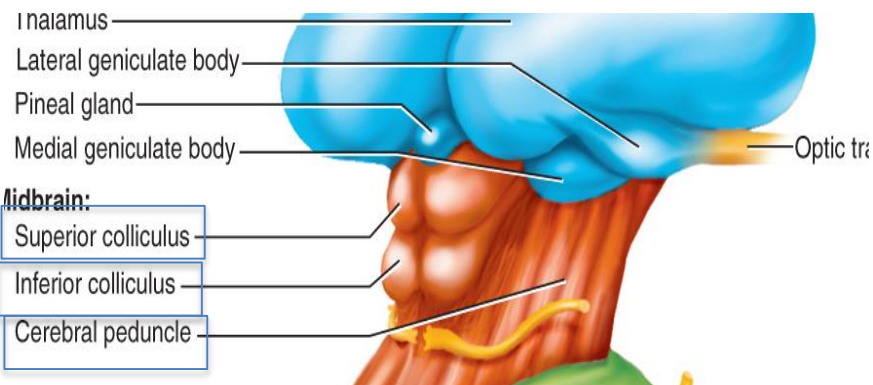
(a) Midbrain

(b) Pons

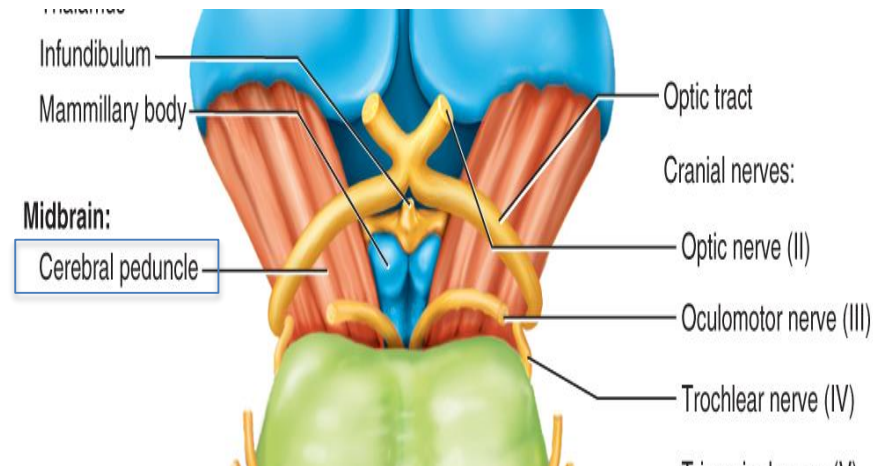


(a) Mi

(b) Pc

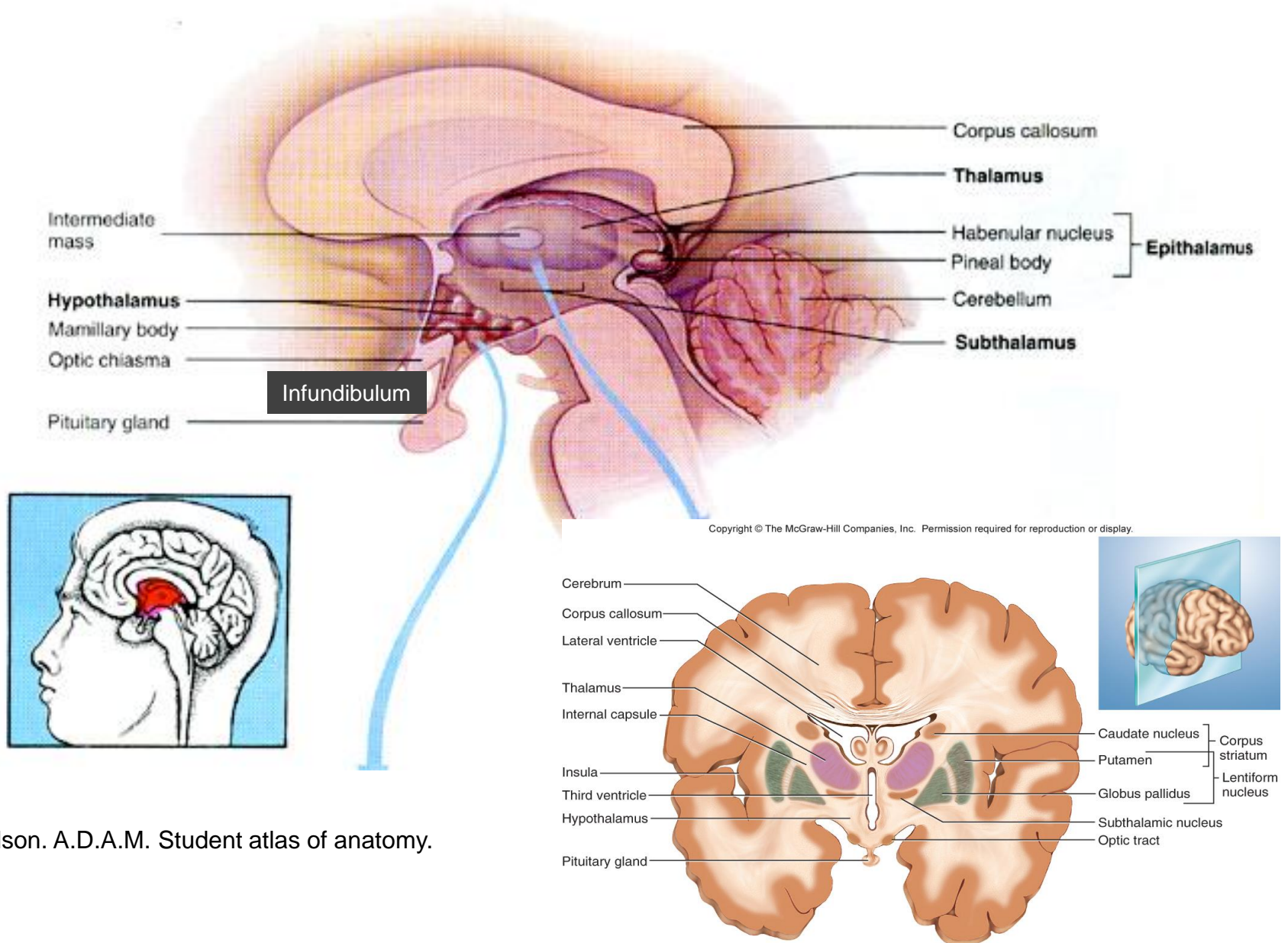


Caudal view



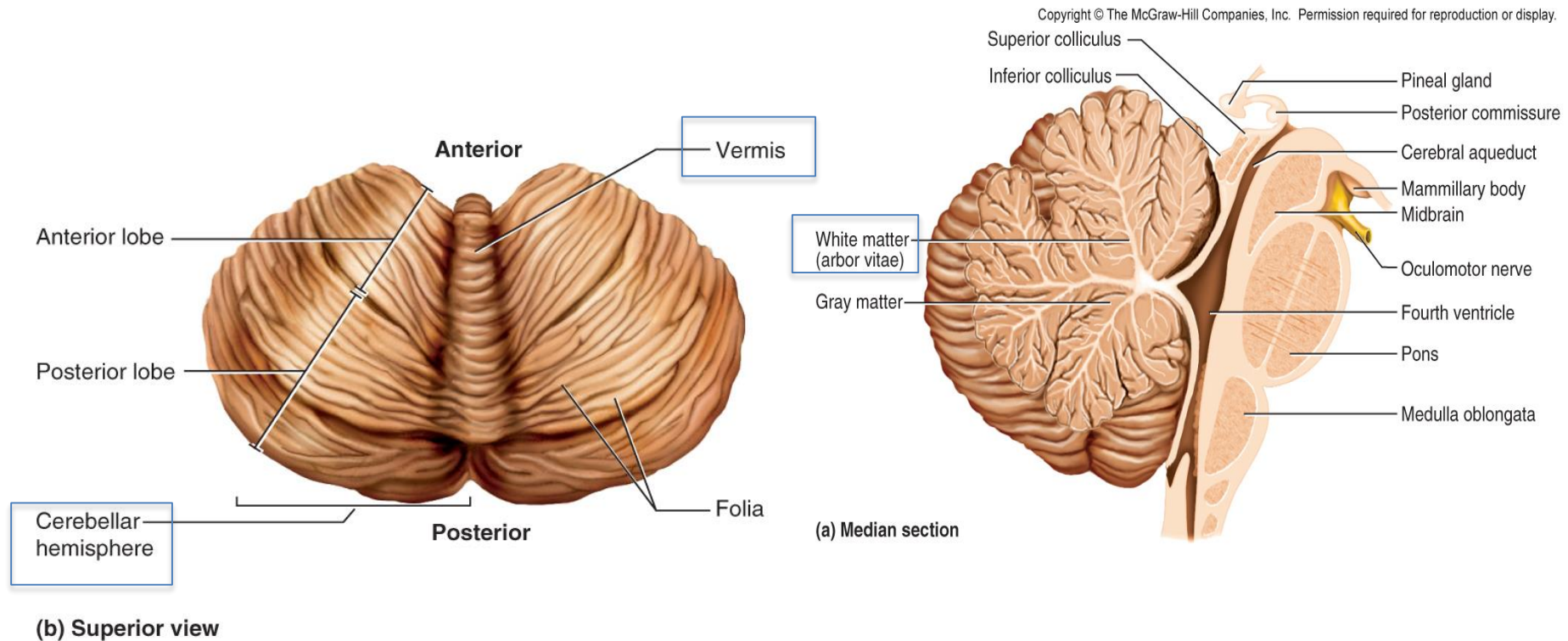
Rostral view

Anatomical elements of the brain: diencephalon



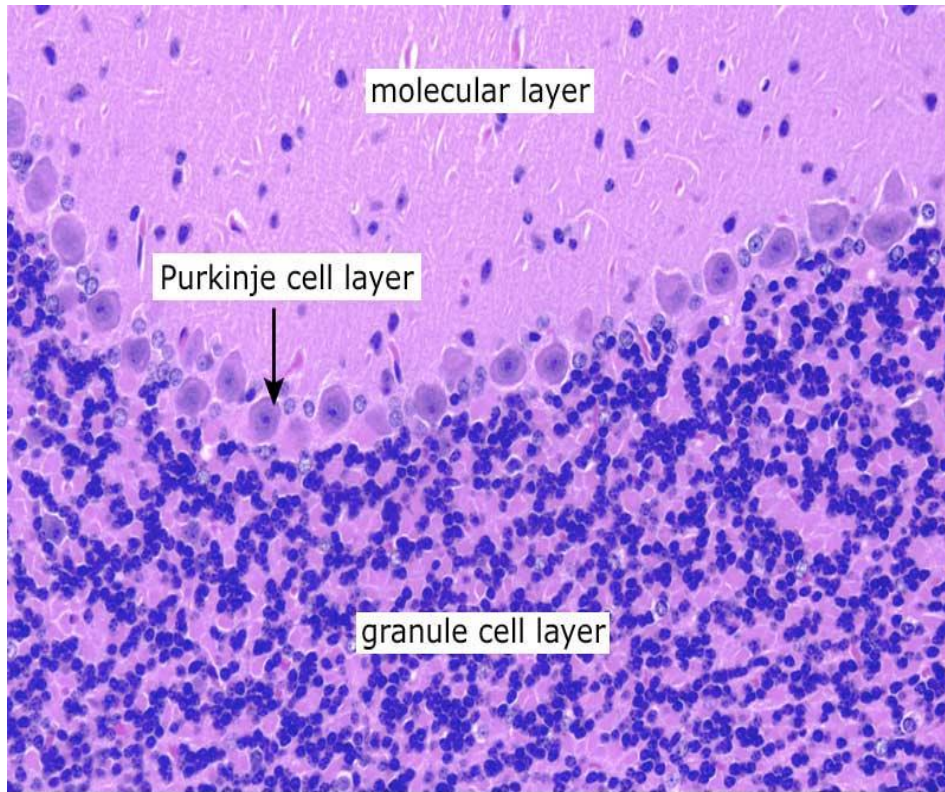
Todd R. Olson. A.D.A.M. Student atlas of anatomy.

Anatomical elements: Cerebellum



Cortex: input
Deep nuclei: output

Cerebellum histology



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Purkinje cells compare
information of
Intention vs outcome

Opisthotonus in dinosaurs

Posture suggesting of severe spastic distress

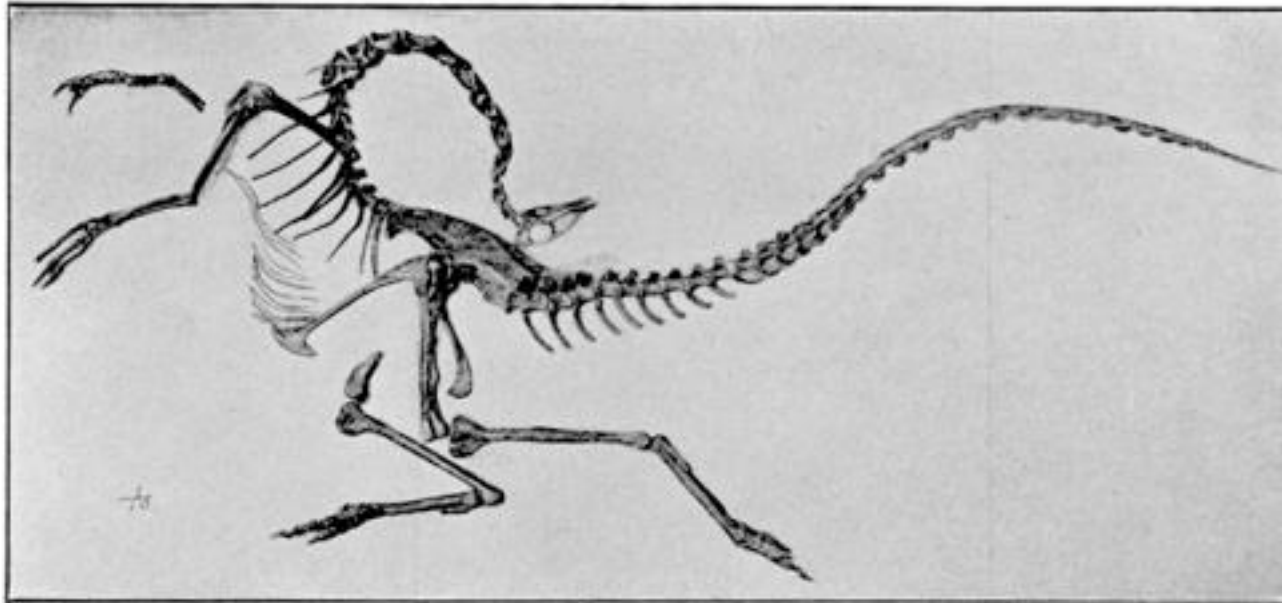
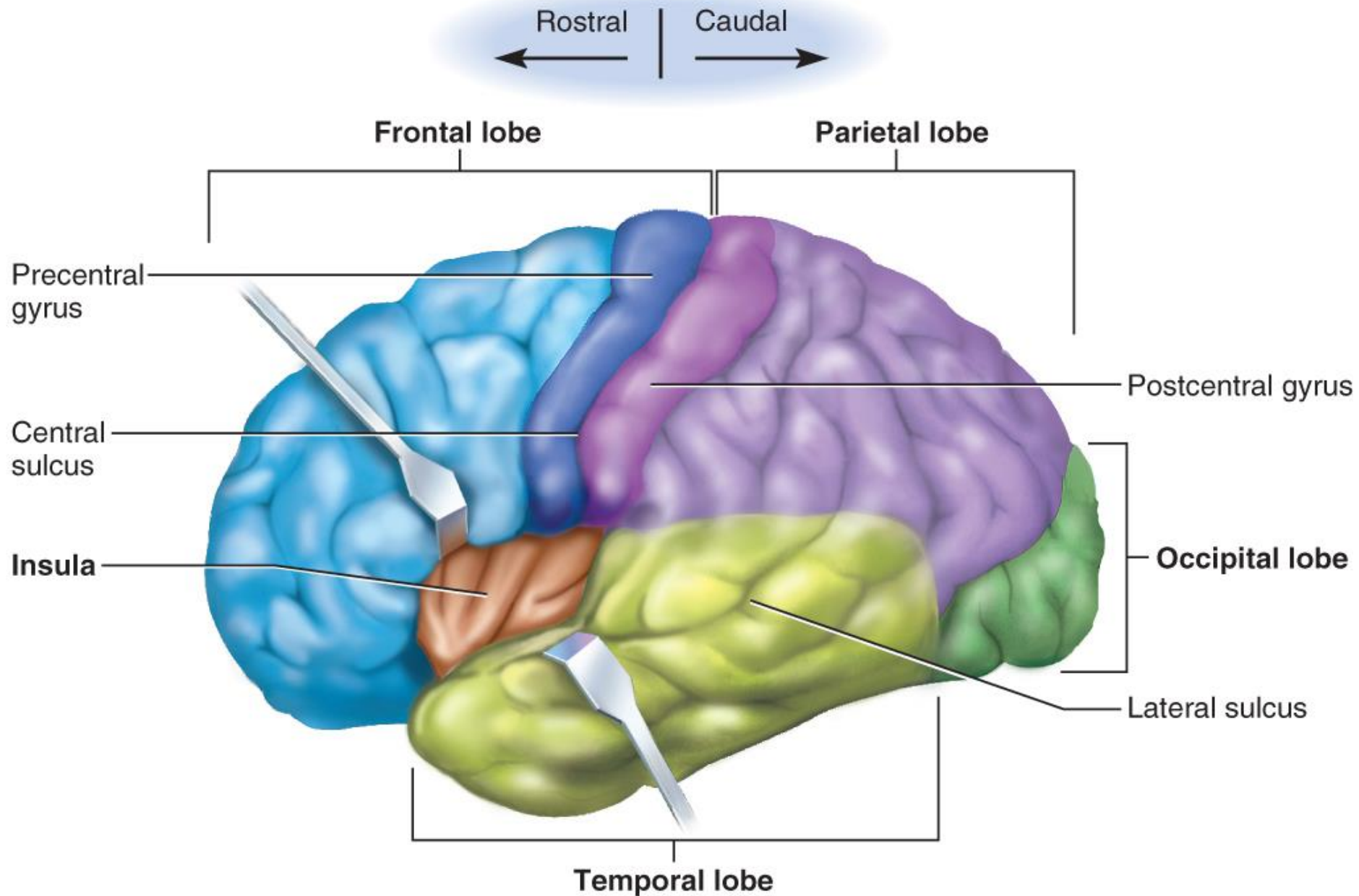
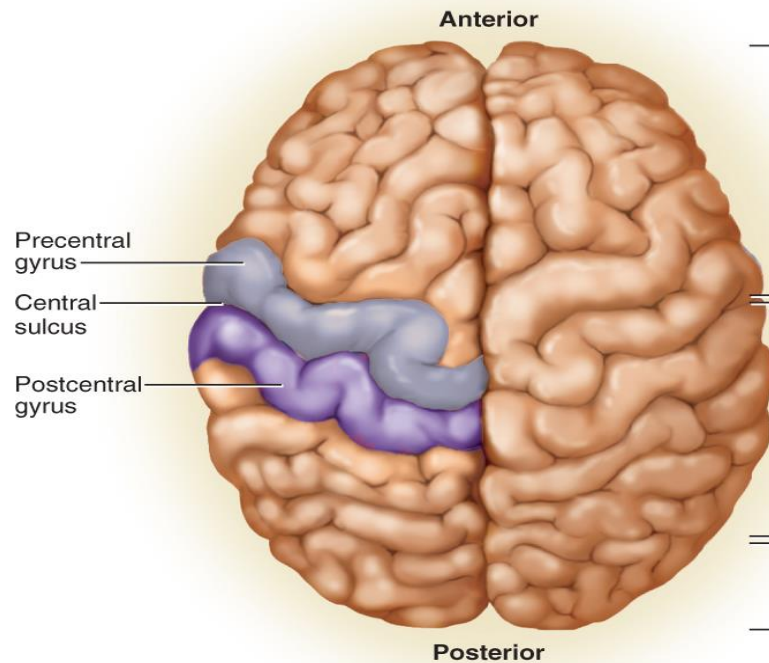
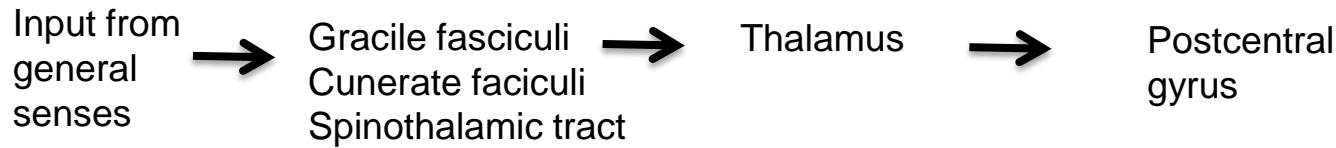


FIG. 4. Skeleton of *Struthiomimus altus*. Genotype specimen, Amer. Mus. 5339. $\frac{1}{20}$ natural size. In this panel mount the animal is placed approximately as found. The attitude is typically opisthotonos. After Osborn.

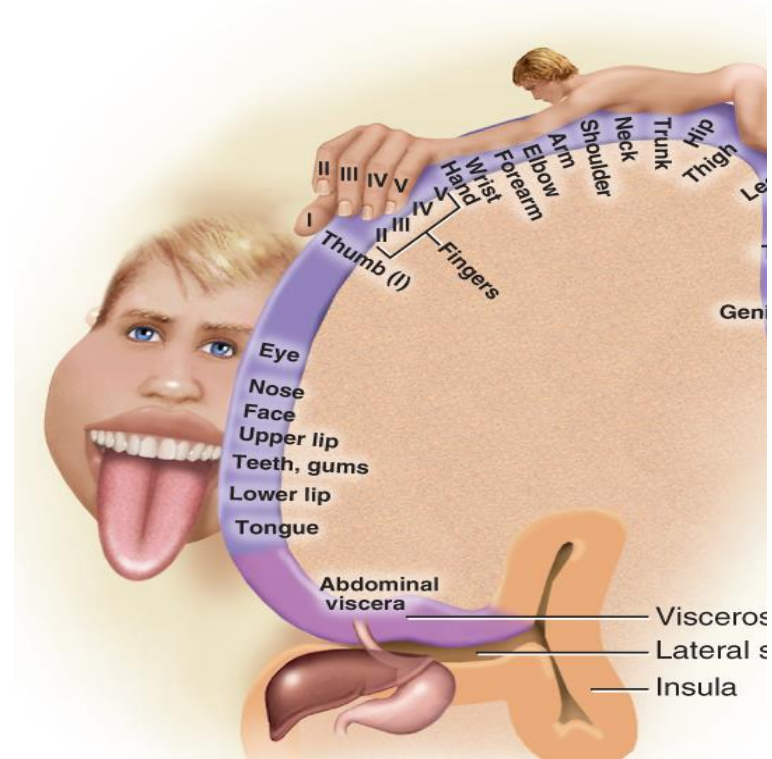


Cerebrum: Somatosensory perception



(a)

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Sensory cortex

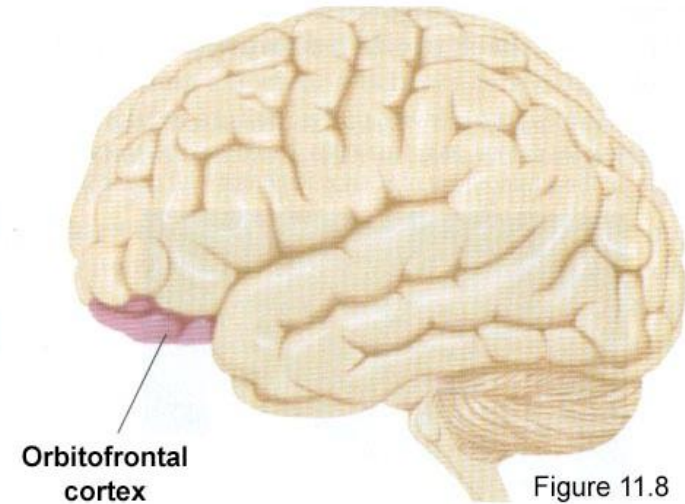
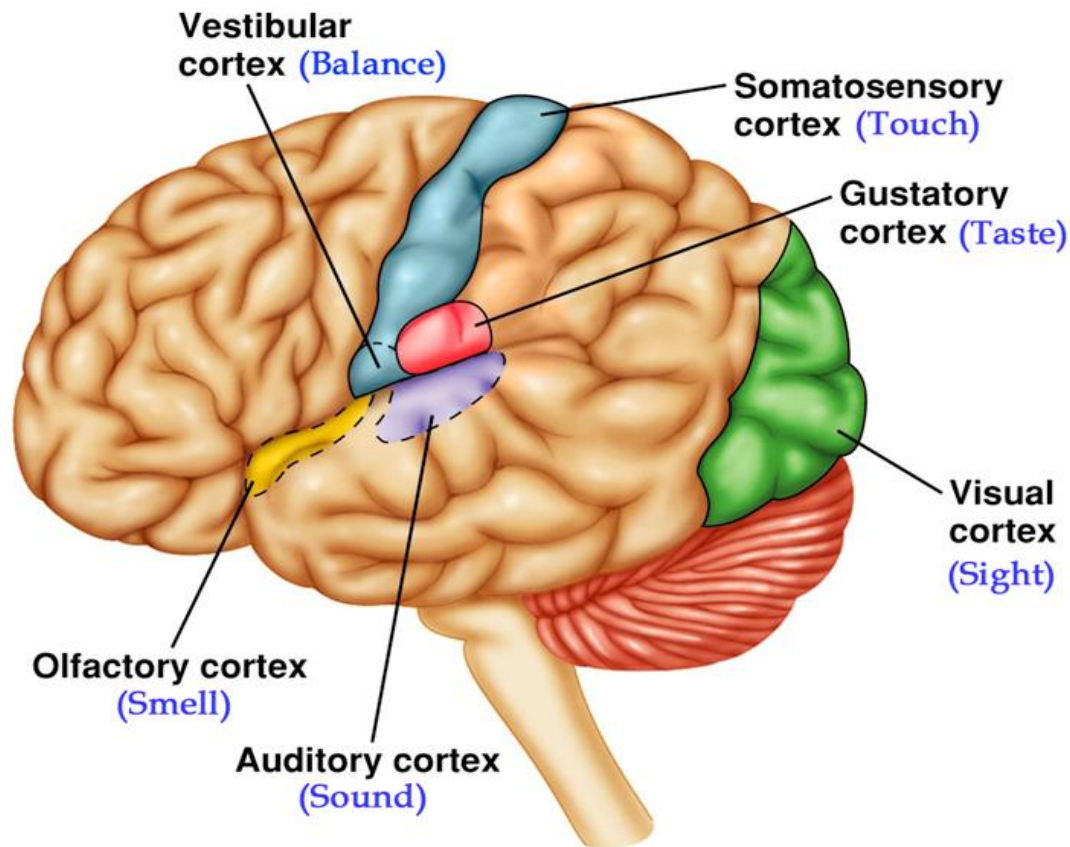


Figure 11.8

(association a. for
taste and smell)

addictivebehaviors.wordpress.com

Cerebrum: Motor control

Motor association area in frontal lobe → Precentral gyrus → Brainstem and spinal cord → Synapse with lower motor neuron → Muscle contraction

Feedback circuitry for planning and execution of movement

Cerebellum
comparator
coordinator

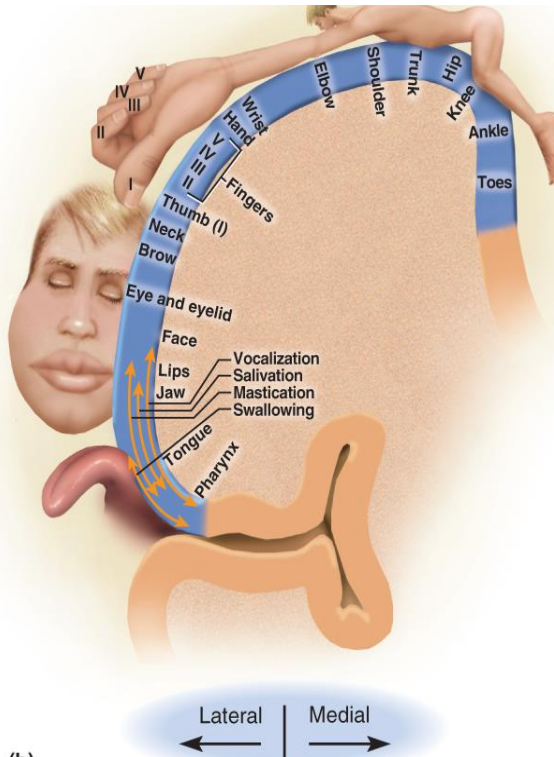
Thalamus

Basal nuclei: input from all
cortex areas except vis and
aud

Control of

- highly practiced behaviors
- repetitive movements

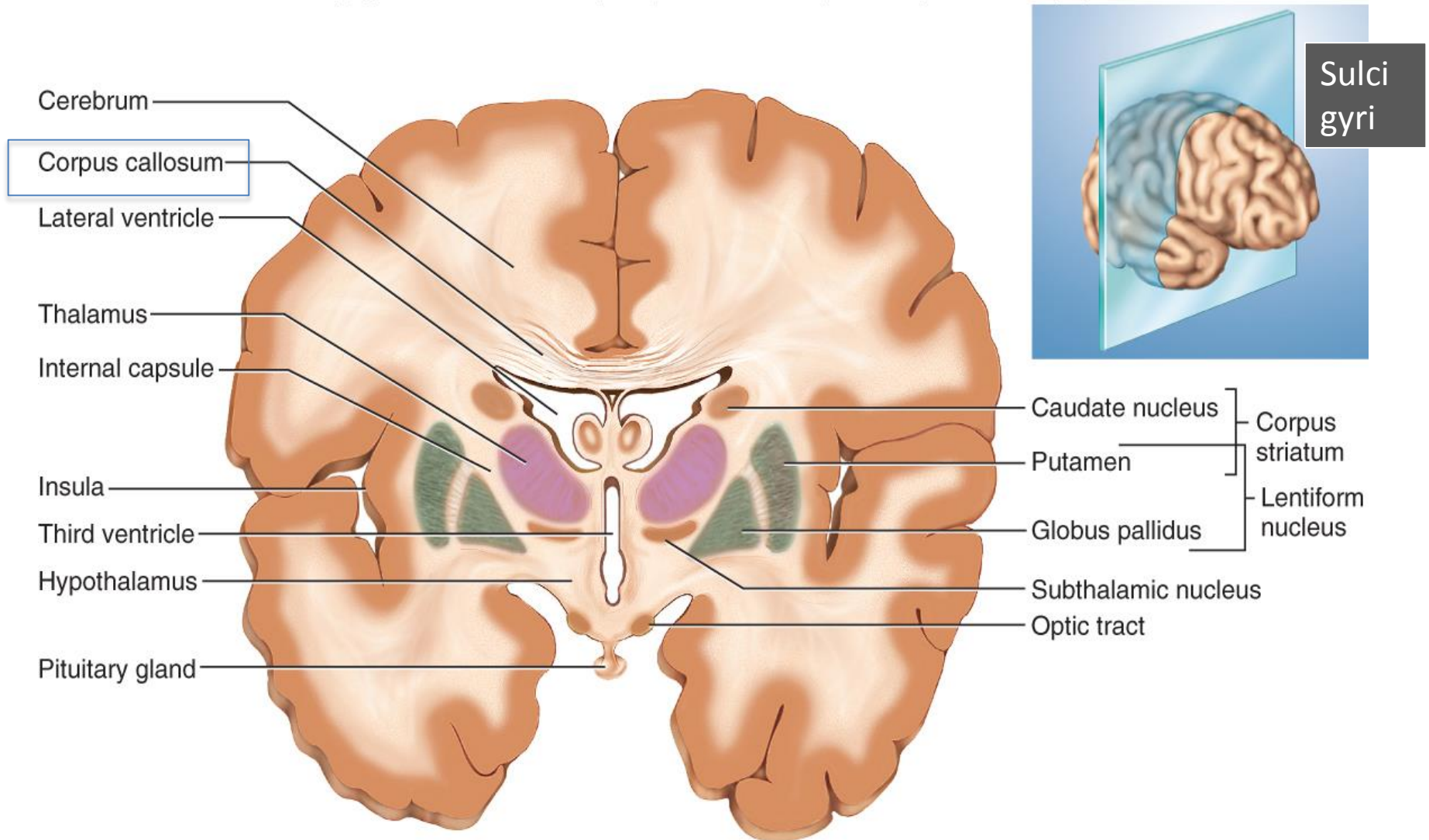
Motor homunculus



(b)

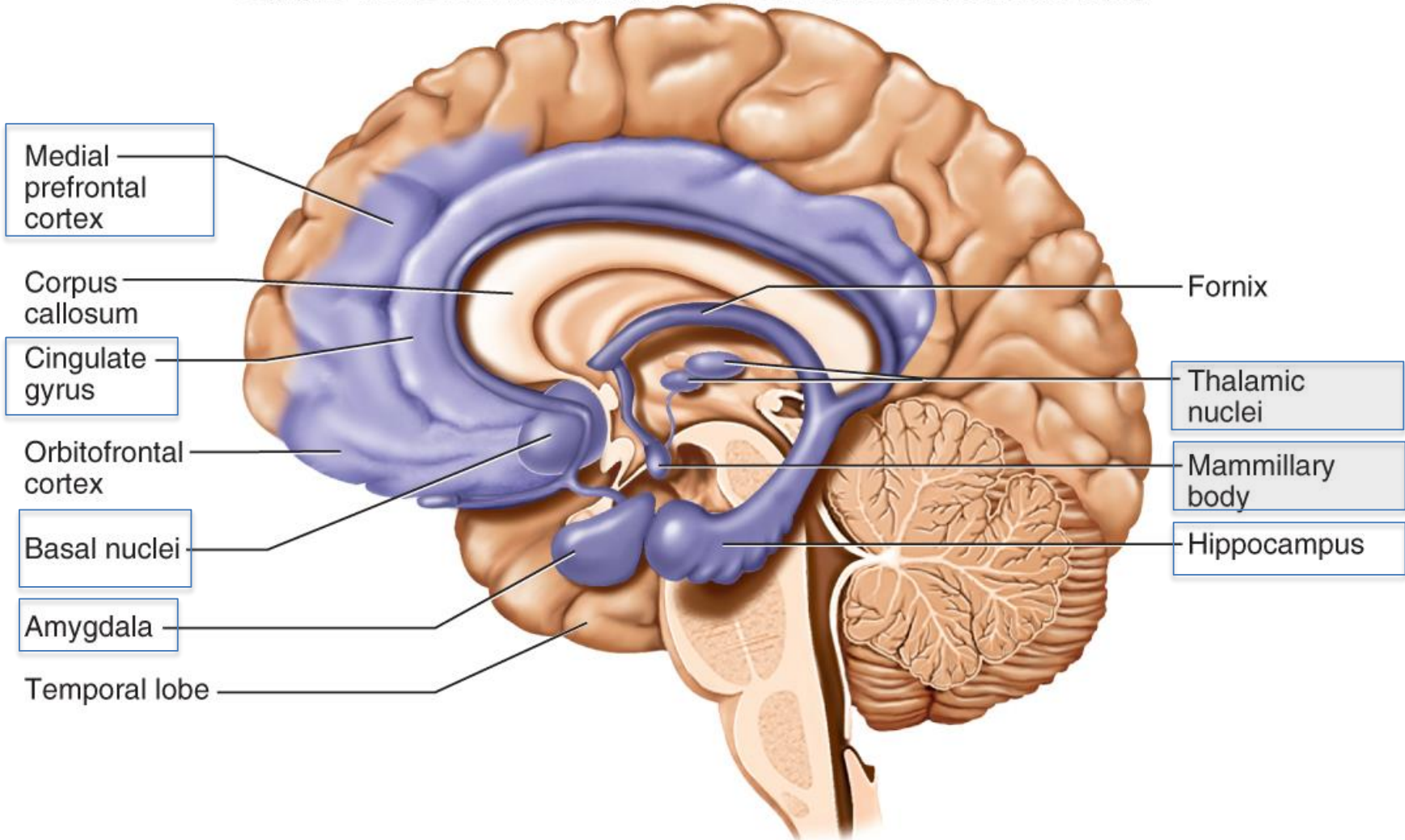
Anatomical elements of the brain: cerebrum

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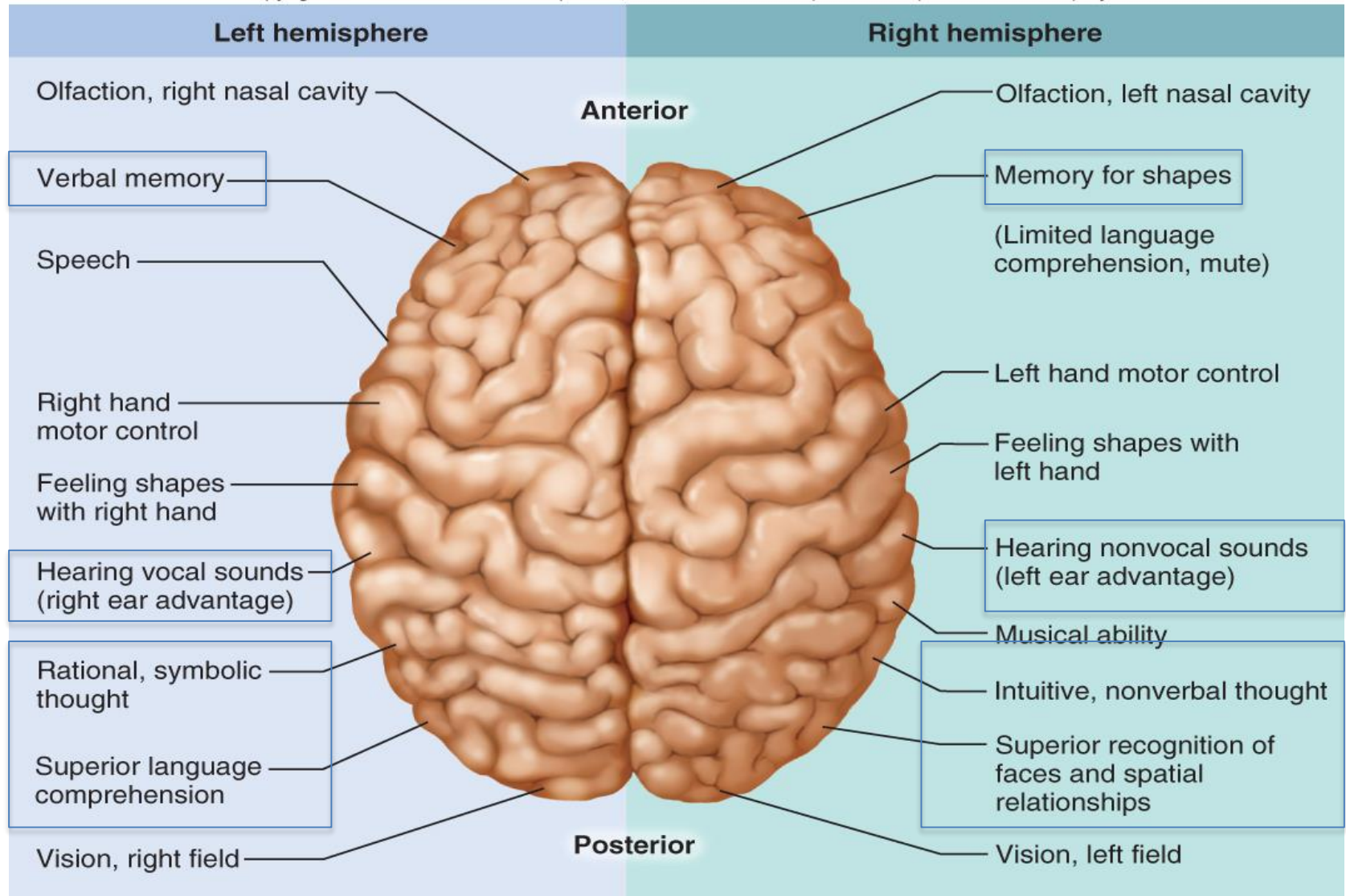
Limbic system

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Cerebrum: Lateralization

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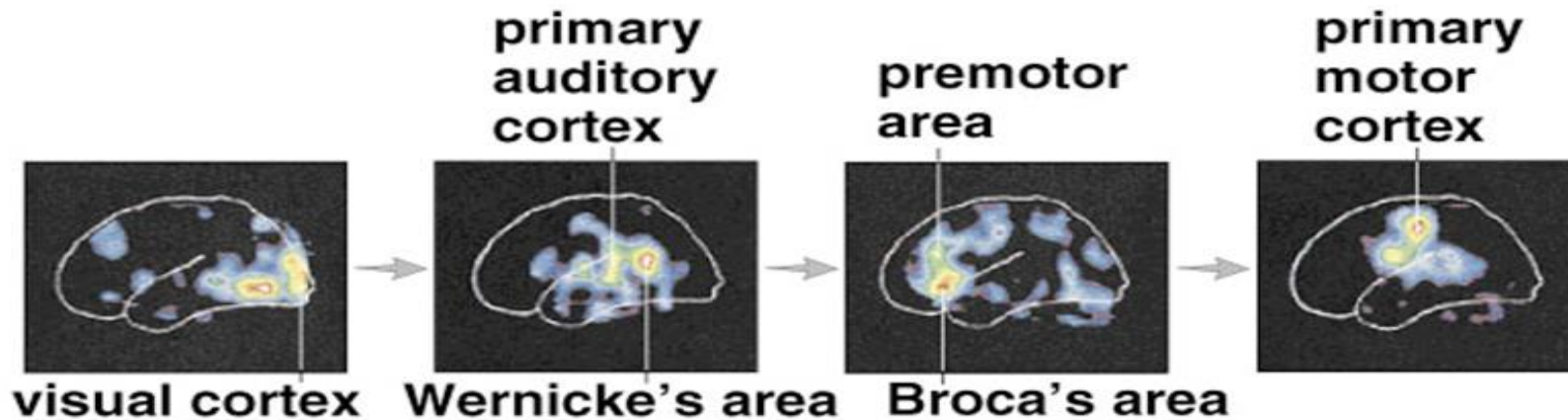


Cerebrum: language production

Area (Left hemisphere)	Role
Wernicke (crossroad between visual, auditory, and somatosensory)	Recognition of spoken and written language
Angular gyrus (posterior and superior)	Reading and writing
Broca	Motor program for speech
Insula	Understanding spoken language

Area (Right hemisphere)
Attention to objects in environment

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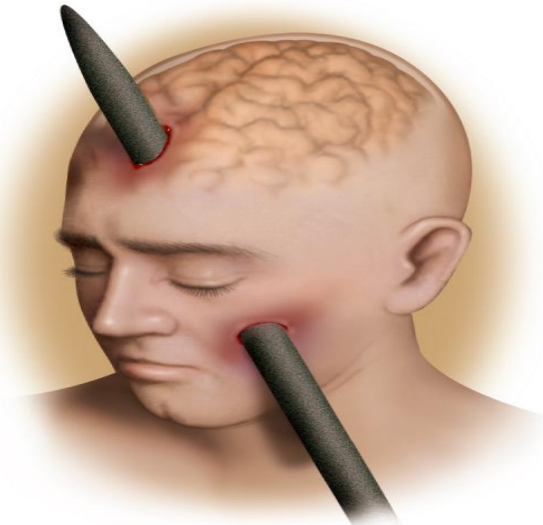
Malfunctions



Domoic acid poisoning

Marine Animal Center Fort McArthur's slide

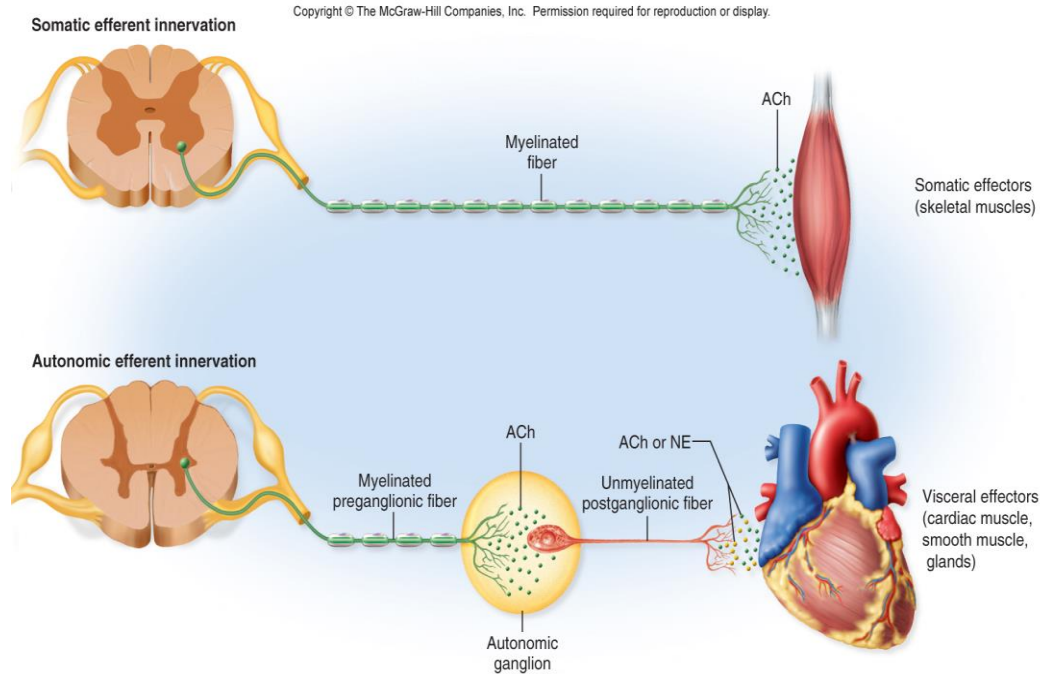
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Phineas Gage's 1848 accident

Area affected	Pathology
Substantia nigra	Parkinson's disease
Basal nuclei	Dyskinesias <ul style="list-style-type: none">• Inhibited movements• Exaggerated movements (ballismus)
Language areas, VII and XII	Aphasias
Cerebellum	ADHD (impulse control problems)
Hippocampus	No new declarative memories
Frontal lobe	Irresponsible behavior, profanity

Architecture of autonomic vs motor

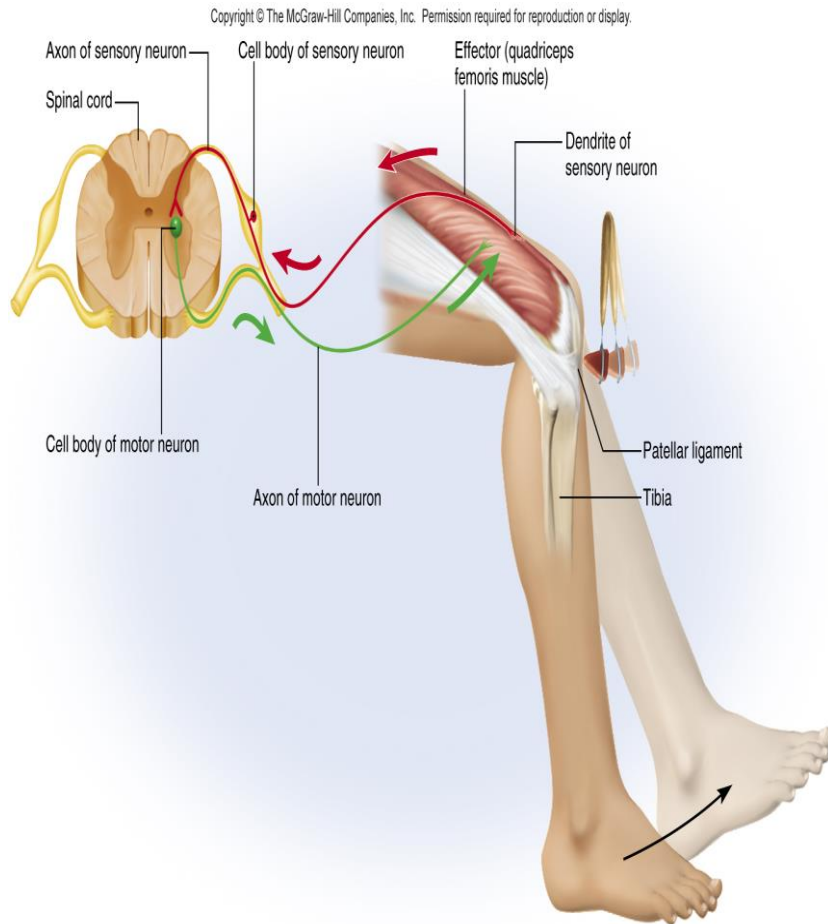


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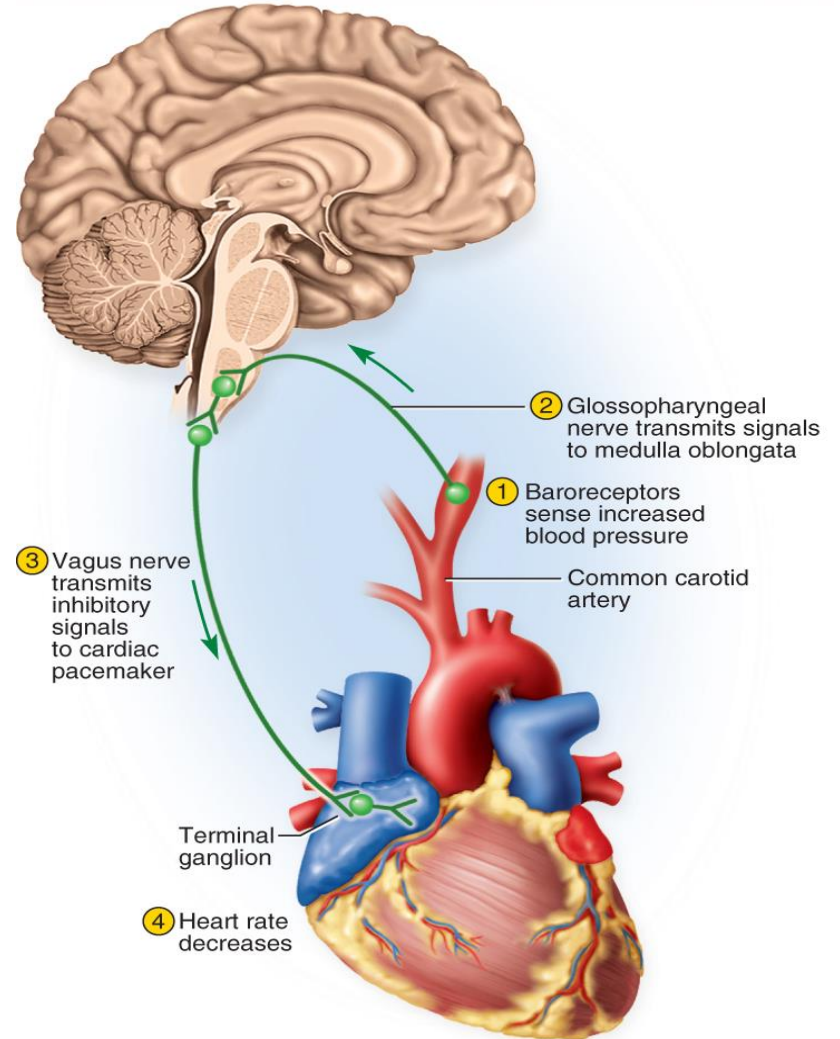
TABLE 16.1 Comparison of the Somatic and Autonomic Nervous Systems

Feature	Somatic	Autonomic
Effectors	Skeletal muscle	Glands, smooth muscle, cardiac muscle
Control	Usually voluntary	Usually involuntary
Efferent pathways	One nerve fiber from CNS to effector; no ganglia	Two nerve fibers from CNS to effector; synapse at a ganglion
Neurotransmitters	Acetylcholine (ACh)	ACh and norepinephrine (NE)
Effect on target cells	Always excitatory	Excitatory or inhibitory
Effect of denervation	Flaccid paralysis	Denervation hypersensitivity

Reflexes: Somatic vs autonomic

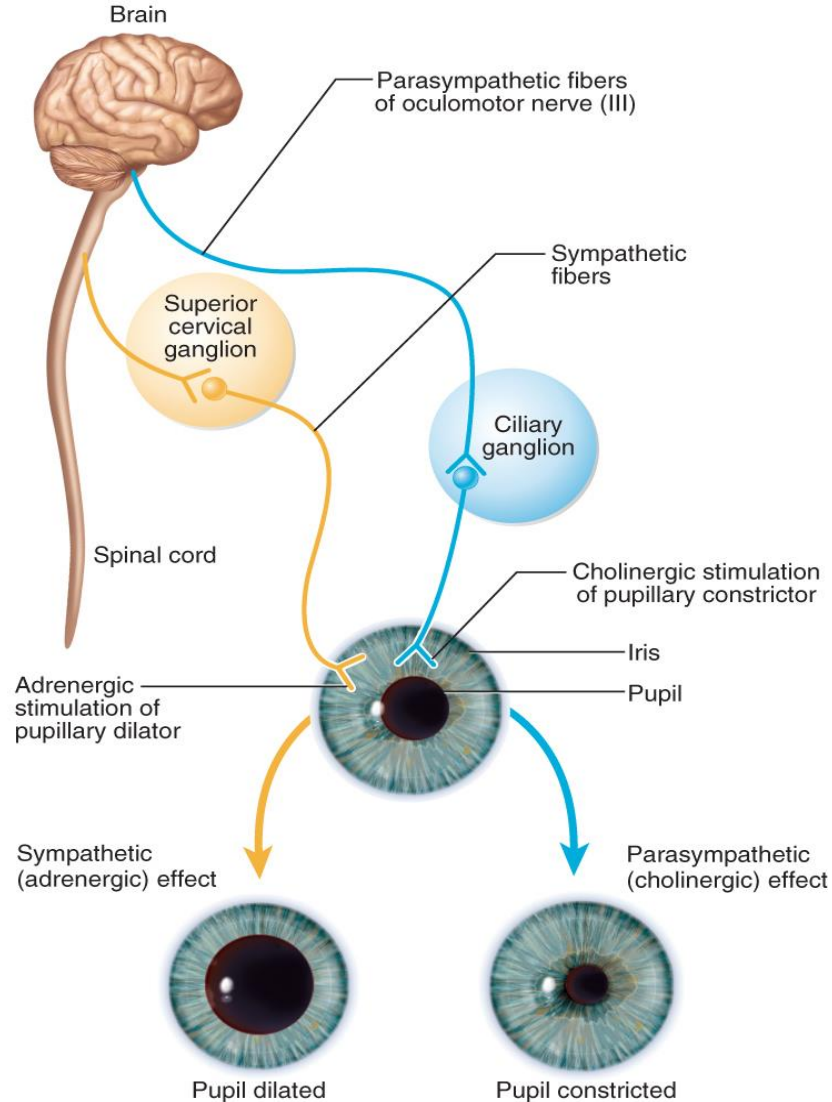


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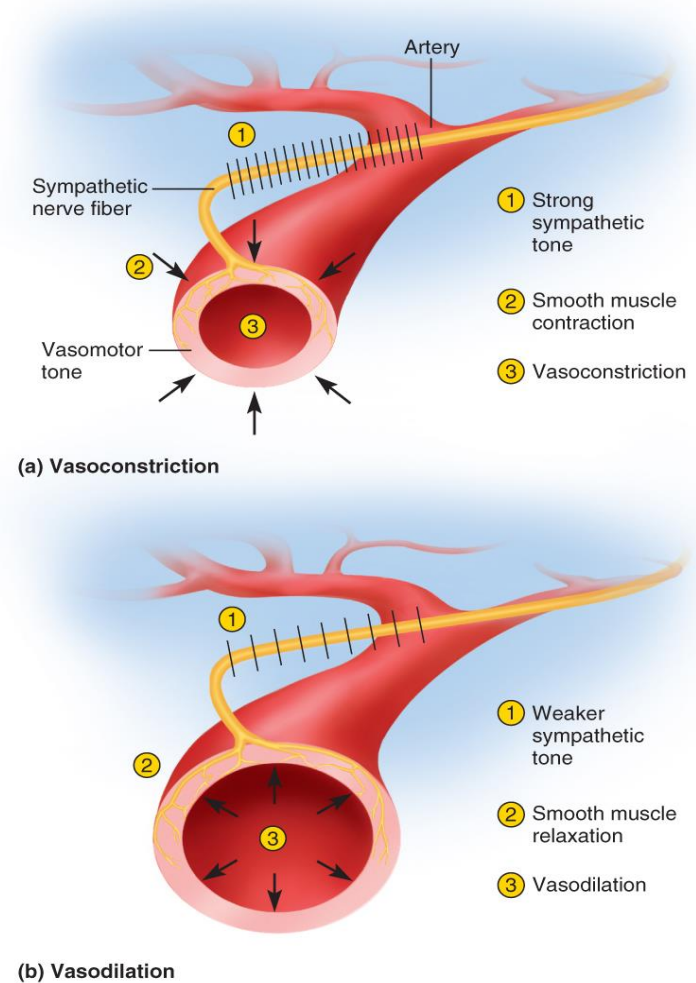


Dual innervation and autonomic tone

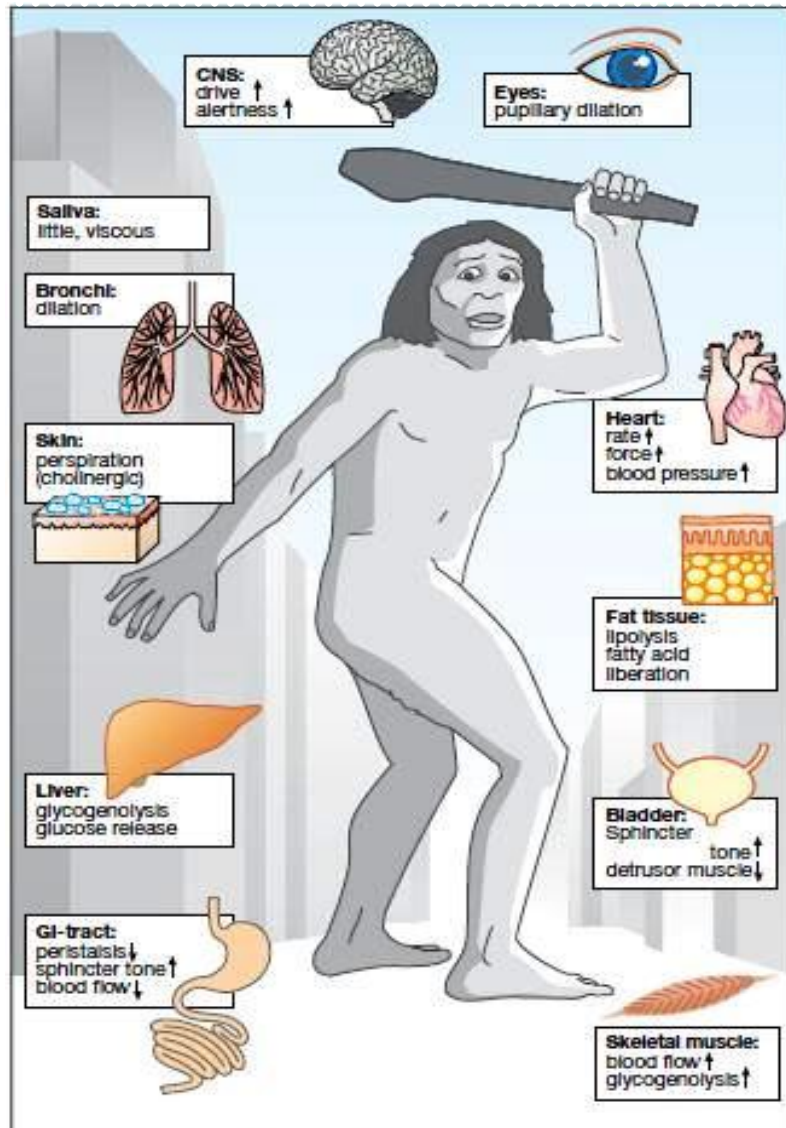
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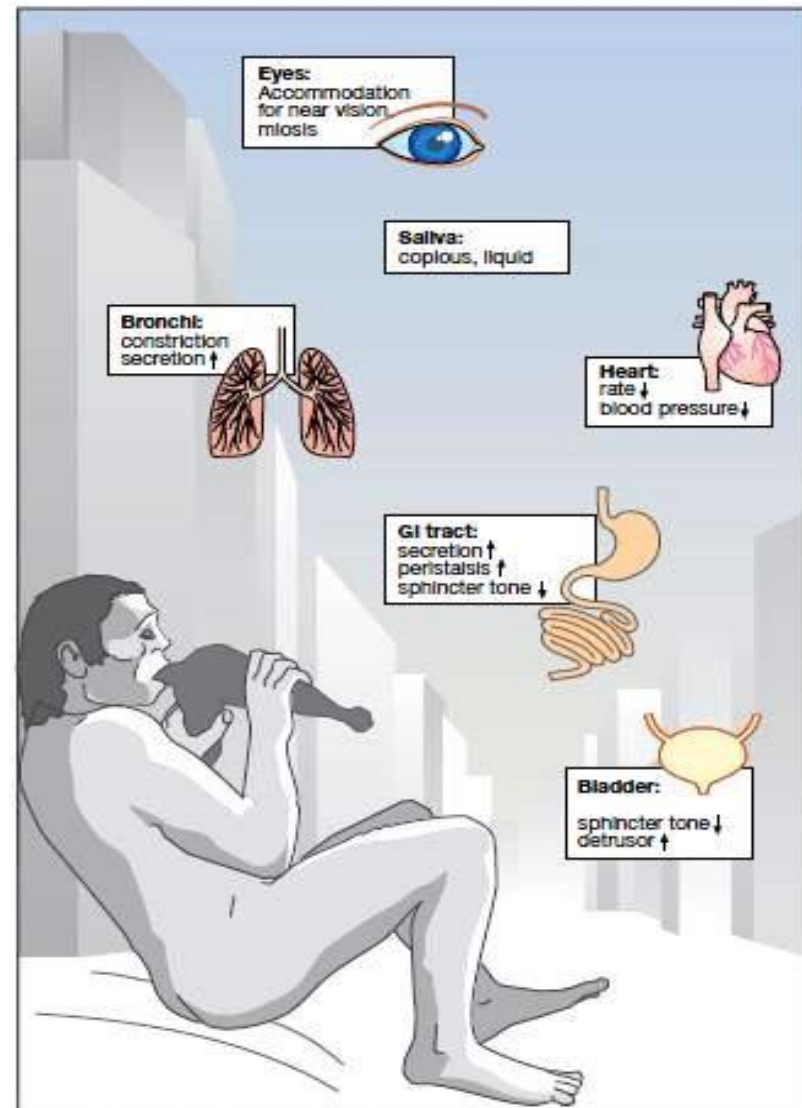
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“Fight or flight” vs “Relaxing over a meal”



A. Responses to sympathetic activation



A. Responses to parasympathetic activation