

Central Nervous System

January 7, 2016

Anatomy of a neuron

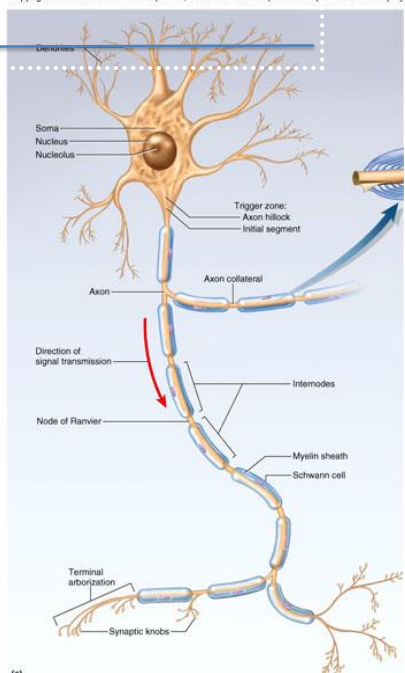
Cell Body (soma)

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

Axon

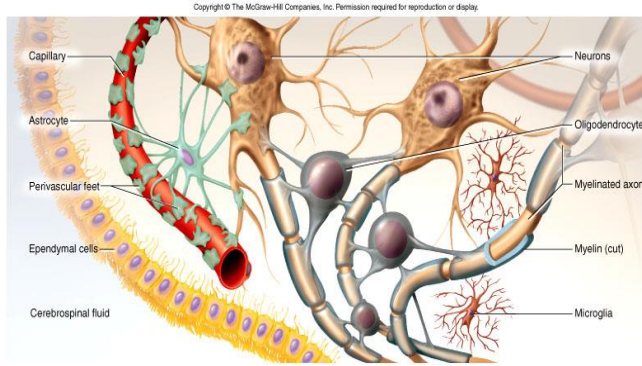
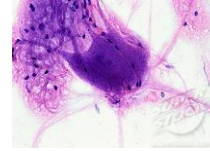
- Conducts nerve impulses (AP) **away** from soma

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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:
 - Neurons** – excitable cells that transmit electrical signals
 - Support cells (glia)** – cells that surround and assist neurons



Microglia:
Specialized macrophages, ~15%

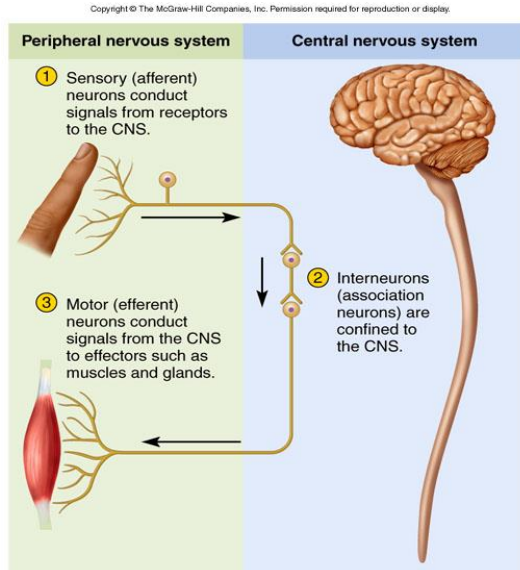
Macroglia
Oligodendrocytes
(coat axons in CNS)
(~Schwann cells in PNS)

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

Ependymal Cells:
Coat cavities (ventricles)

Lalo et al. *J. Neurosci* 26:2673–83.

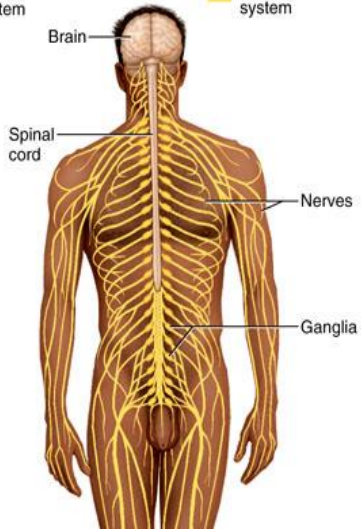
Neuronal circuitry



Classification

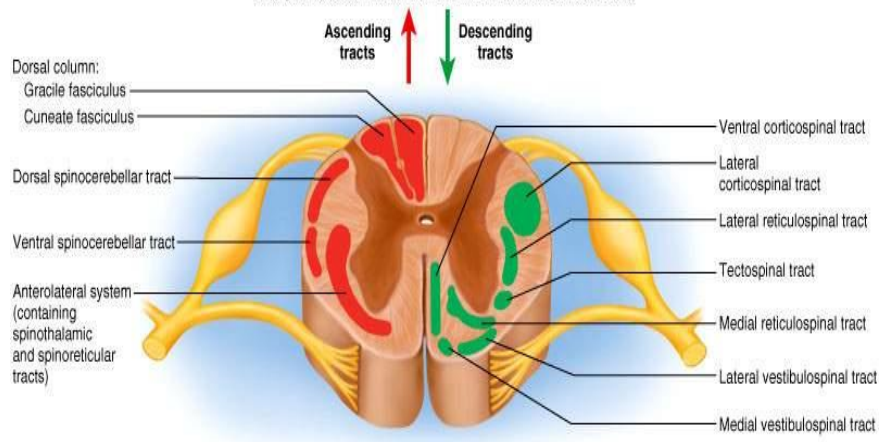
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Central nervous system Peripheral nervous system



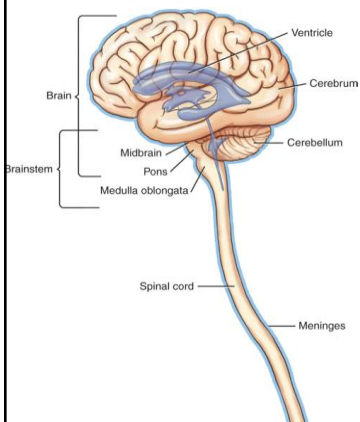
Spinal cord: spinal tracts

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Classification

CNS: "Processing center"



PNS:

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

Sensory (afferent) division

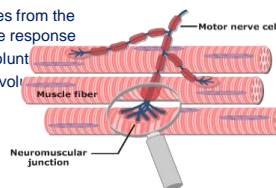
carries sensory information from the body to the CNS;

- Somatosomatic
- Visceral
- Nociception
- Proprioceptors

Motor (efferent) division

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

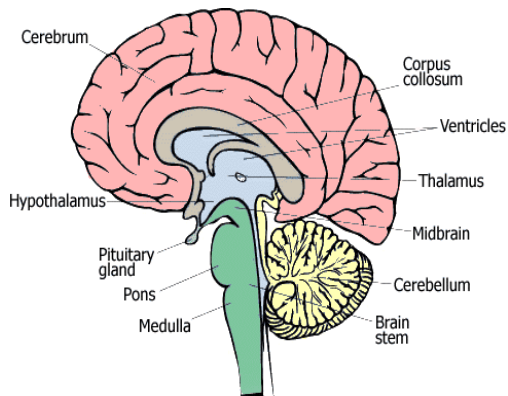
- Striated muscle cells: volunt
- Smooth muscle cells: invol
- glands



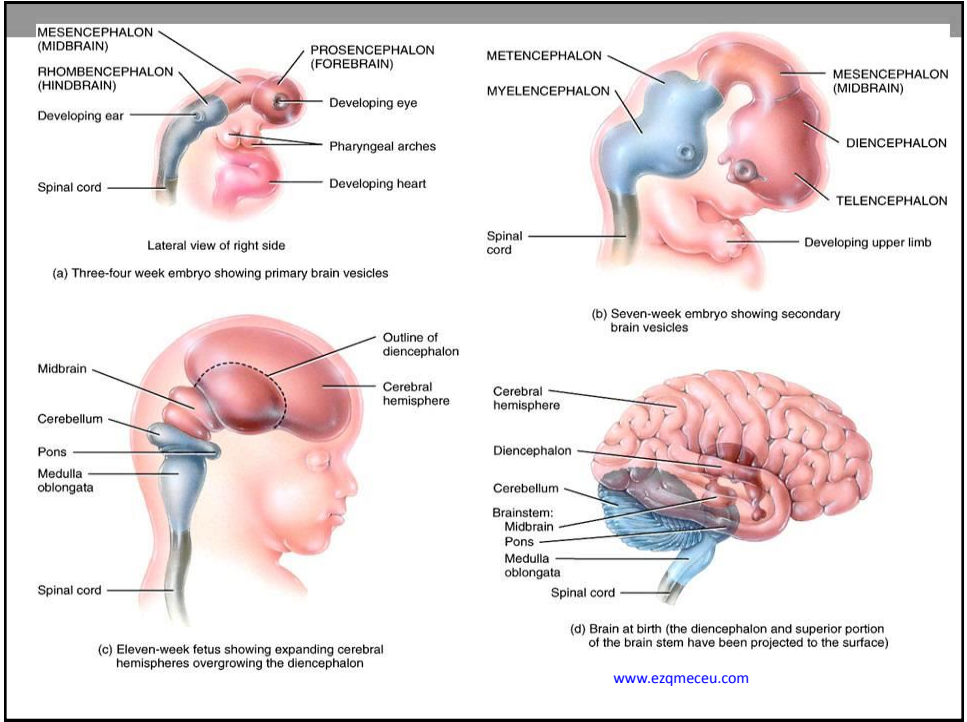
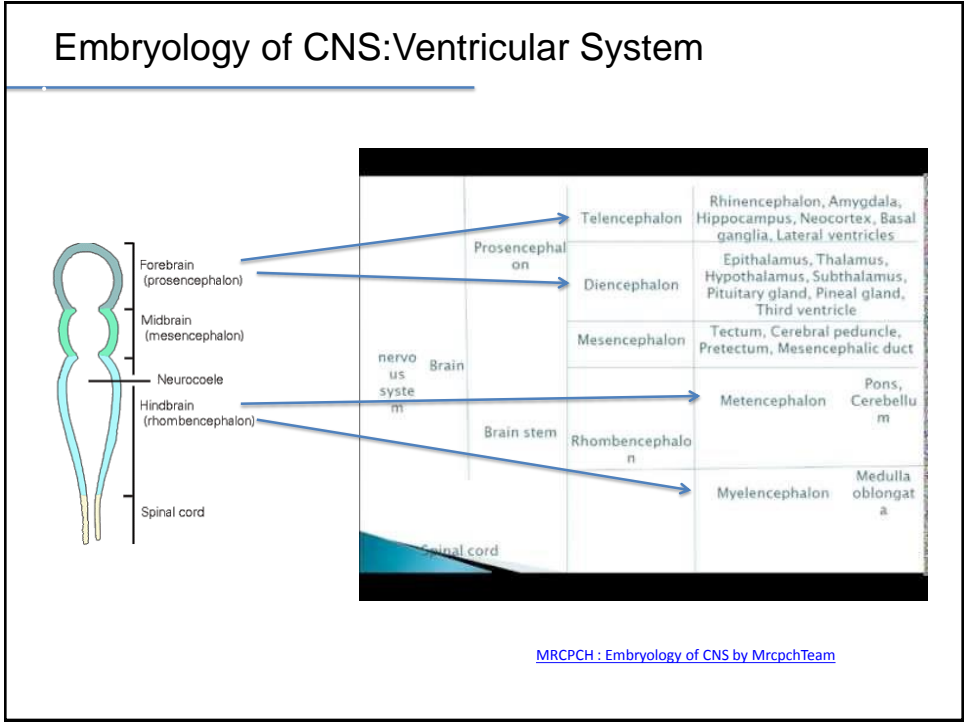
Central Nervous System

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

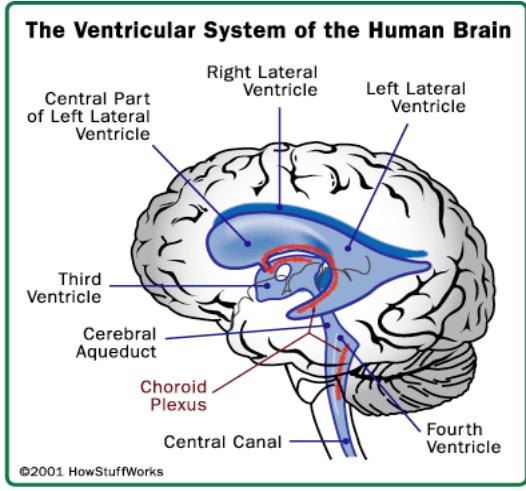
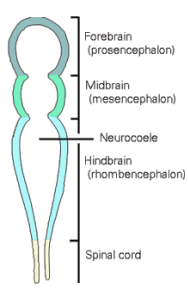
– Cerebrum:



15-8

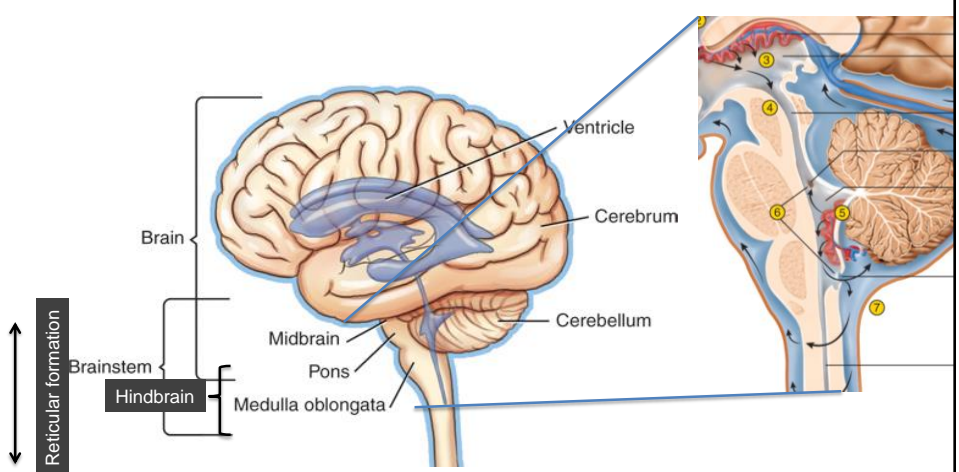


Embryology of CNS: Ventricular System



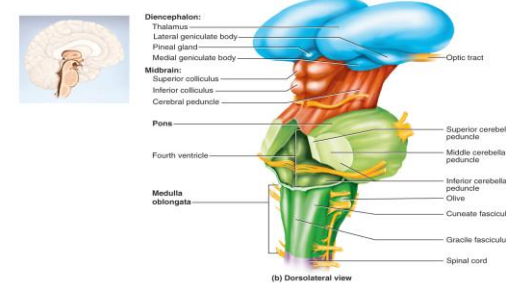
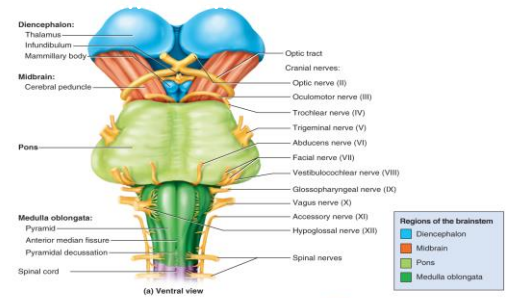
http://drugster.info/img/term/cerebral-ventricle-2808_2.gif

Anatomical elements of the brain

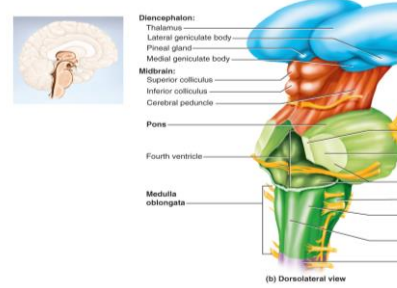
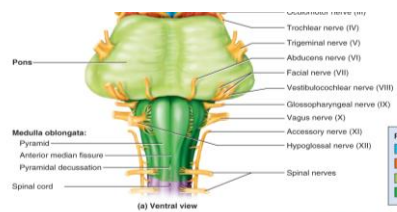
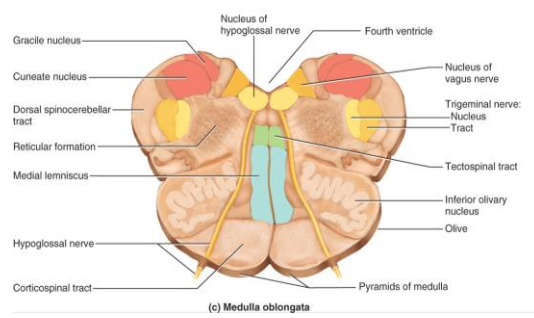
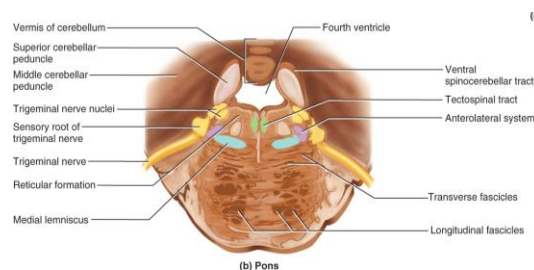


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Brainstem and diencephalon: overview



Brainstem: Pons and Medulla Oblongata



Anatomical elements of the brain: midbrain

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Posterior view (a) MI:

- Tectum
- Reticular formation
- Cerebral peduncle: Tegmentum
- Substantia nigra
- Cerebral crus
- Superior colliculus
- Cerebral aqueduct
- Medial geniculate nucleus
- Central gray matter
- Oculomotor nucleus
- Medial lemniscus
- Red nucleus

(b) Pons: (Small inset diagram)

(a) MI: (Midbrain section)

(b) Pc: (Pons section)

Caudal view:

- Mammillary body
- Lateral geniculate body
- Pineal gland
- Medial geniculate body
- Midbrain: Superior colliculus, Inferior colliculus, Cerebral peduncle
- Optic tract

Rostral view:

- Infundibulum
- Mammillary body
- Midbrain: Cerebral peduncle
- Optic tract
- Cranial nerves: Optic nerve (II), Oculomotor nerve (III), Trochlear nerve (IV)

15-15

Anatomical elements of the brain: diencephalon

Sagittal view:

- Intermediate mass
- Hypothalamus: Mammillary body, Optic chiasma
- Pituitary gland
- Infundibulum
- Corpus callosum
- Thalamus
- Habenular nucleus
- Pineal body
- Cerebellum
- Subthalamus
- Epithalamus

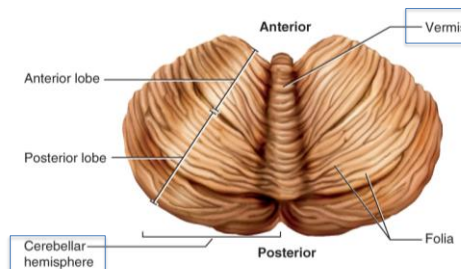
Coronal view:

- Cerebrum
- Corpus callosum
- Lateral ventricle
- Thalamus
- Internal capsule
- Insula
- Third ventricle
- Hypothalamus
- Pituitary gland
- Caudate nucleus
- Putamen
- Globus pallidus
- Subthalamic nucleus
- Optic tract
- Corpus striatum
- Lentiform nucleus

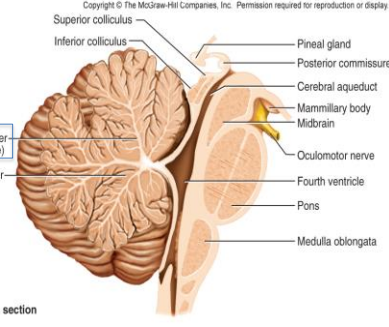
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Todd R. Olson. A.D.A.M. Student atlas of anatomy.

Anatomical elements: Cerebellum



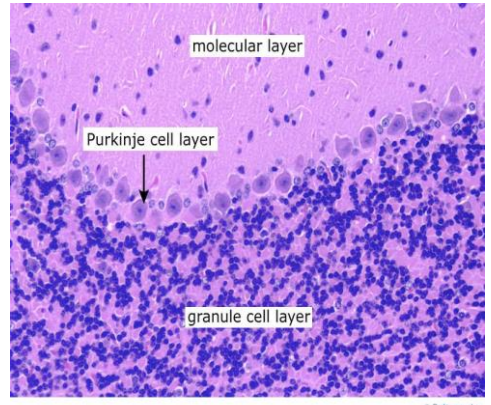
(b) Superior view



(a) Median section

Cortex: input
Deep nuclei: output

Cerebellum histology



Purkinje cells compare information of Intention vs outcome

Opisthotonus in dinosaurs

Posture suggesting of severe spastic distress

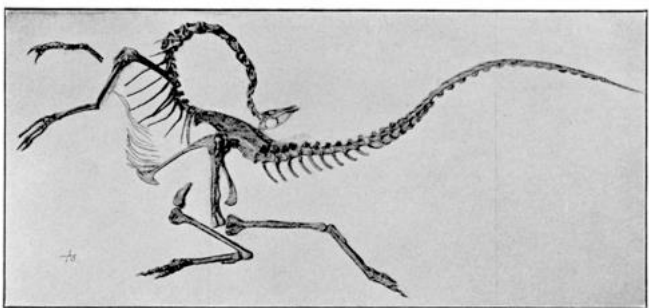
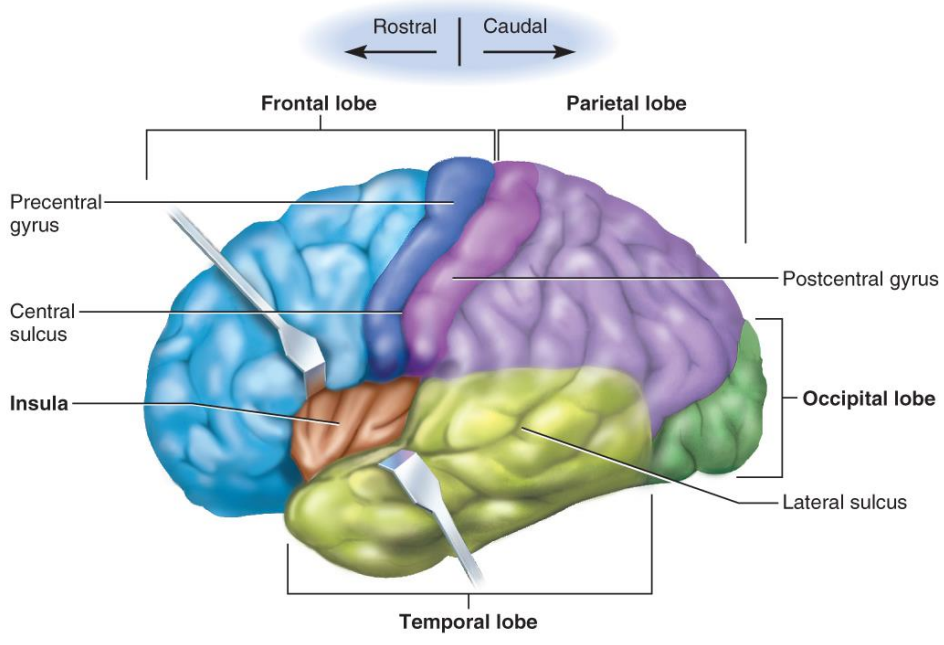


FIG. 4. Skeleton of *Struthiomimus altus*. Genotype specimen, Amer. Mus. 5339. $\frac{1}{30}$ natural size. In this panel mount the animal is placed approximately as found. The attitude is typically opisthotonos. After Osborn.

<https://laelaps.wordpress.com/2007/06/11/opisthotonus-in-dinosaurs/>

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Cerebrum: Somatosensory perception

Input from general senses
→
Gracile fasciculi
Cuneate faciculi
Spinothalamic tract
→
Thalamus
→
Postcentral gyrus

(a)

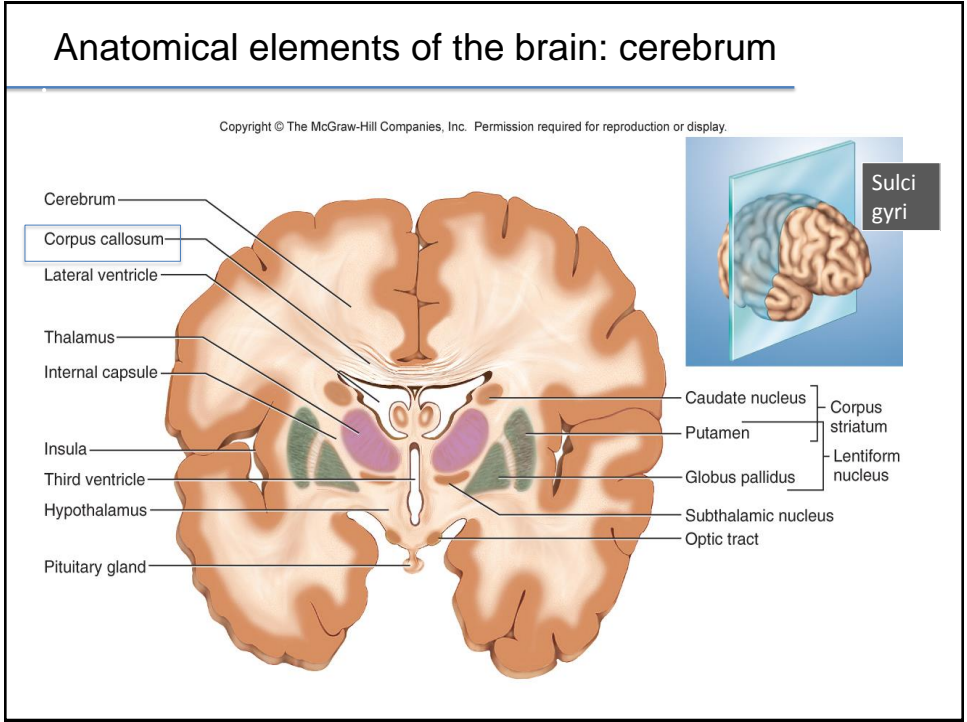
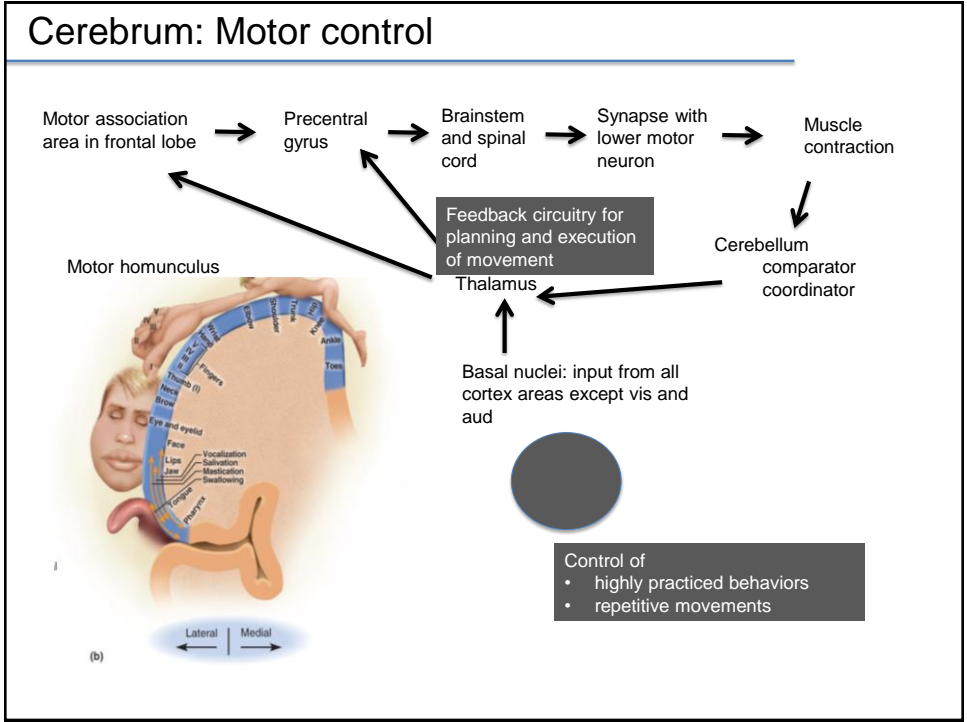
Sensory cortex

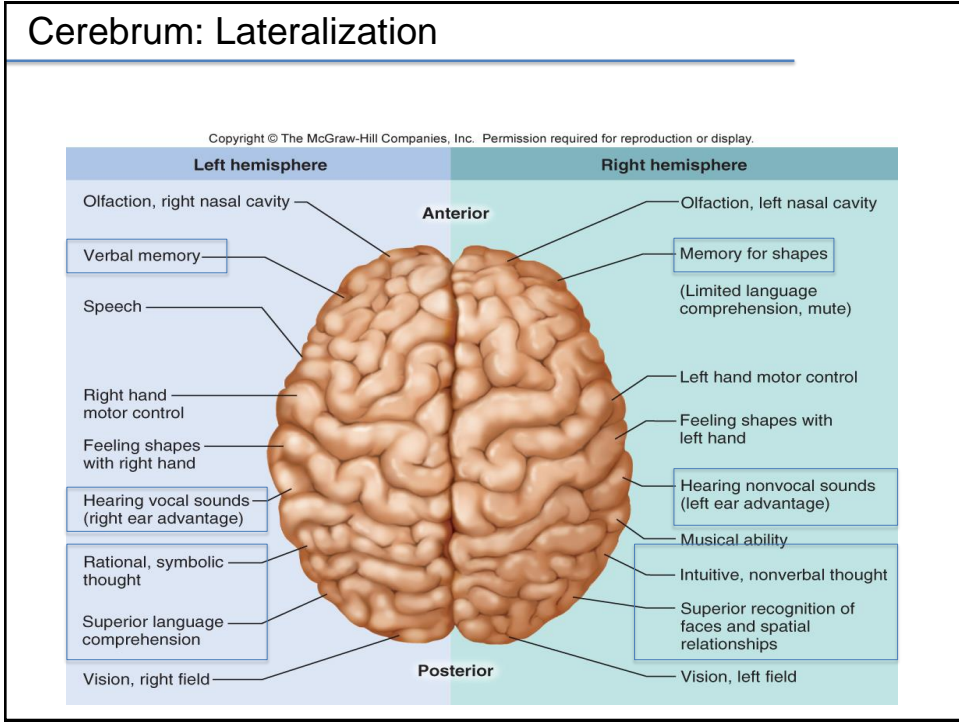
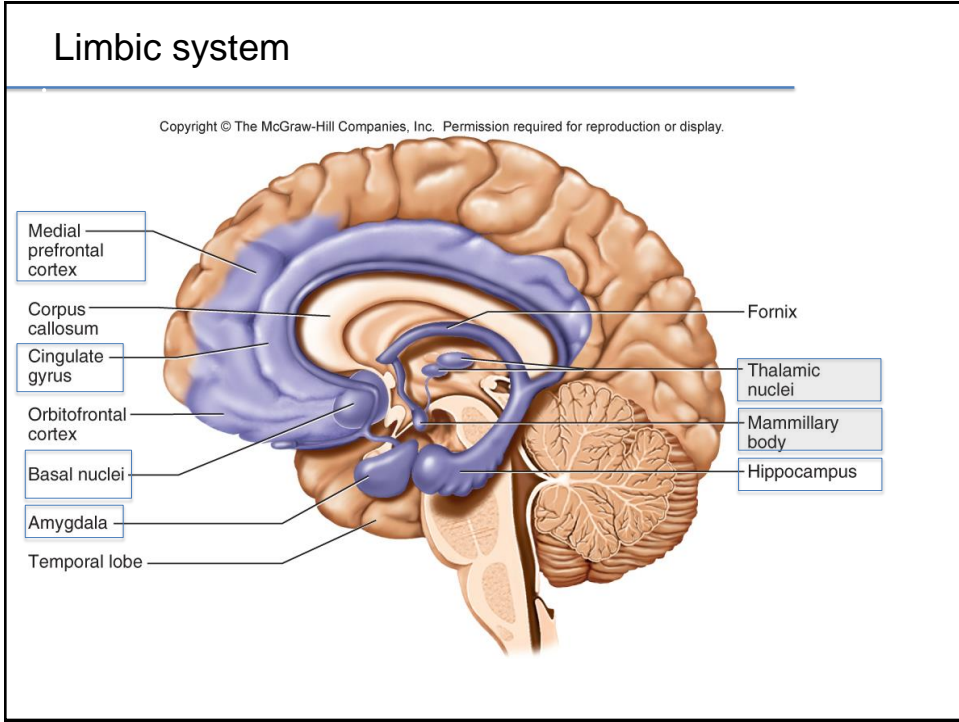
Figure 11.8

(association a. for taste and smell)

addictivebehaviors.wordpress.com

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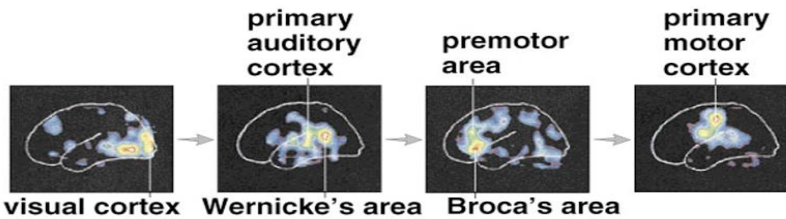




Cerebrum: language production

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

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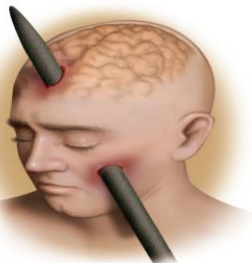
Malfuncions



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

Somatic efferent innervation

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Myelinated fiber

ACh

Somatic effectors (skeletal muscles)

Autonomic efferent innervation

Myelinated preganglionic fiber

ACh

Unmyelinated postganglionic fiber

ACh or NE

Autonomic ganglion

Visceral effectors (cardiac muscle, smooth muscle, glands)

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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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Axon of sensory neuron

Cell body of sensory neuron

Effector (quadriceps femoris muscle)

Dendrite of sensory neuron

Patellar ligament

Tibia

Cell body of motor neuron

Axon of motor neuron

Spinal cord

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1 Baroreceptors sense increased blood pressure

2 Glossopharyngeal nerve transmits signals to medulla oblongata

3 Vagus nerve transmits inhibitory signals to cardiac pacemaker

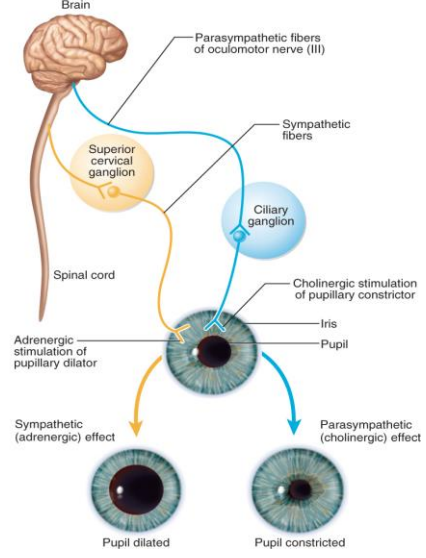
4 Heart rate decreases

Common carotid artery

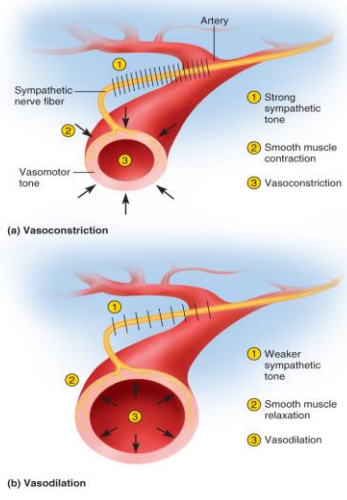
Terminal ganglion

Dual innervation and autonomic tone

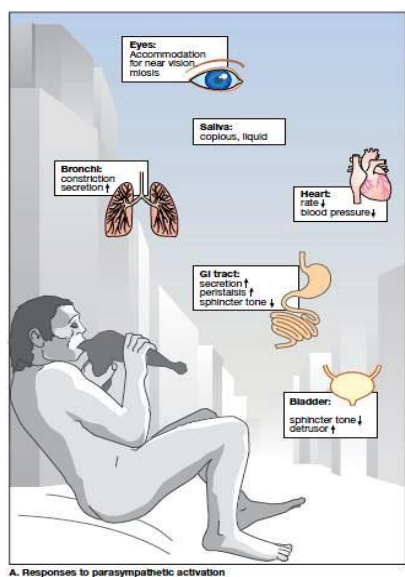
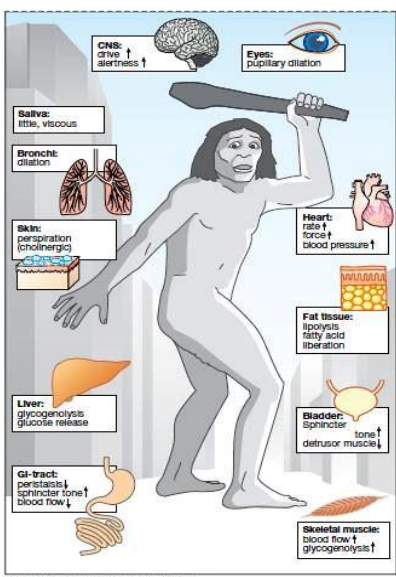
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“Fight or flight” vs “Relaxing over a meal”



<http://human-anatomyphysiology.blogspot.com/2010/03/fight-or-flight-sympathetic-nervous.html>