

Central Nervous System

January 7, 2016

Anatomy of a neuron

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

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:
 - 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

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Peripheral nervous system **Central nervous system**

- Sensory (afferent) neurons conduct signals from receptors to the CNS.
- Interneurons (association neurons) are confined to the CNS.
- Motor (efferent) neurons conduct signals from the CNS to effectors such as muscles and glands.

Classification

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Legend:
■ Central nervous system
■ Peripheral nervous system

Labels: Brain, Spinal cord, Nerves, Ganglia.

Spinal cord: spinal tracts

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Ascending tracts (red):
 Gracile fasciculus, Cuneate fasciculus, Dorsal spino cerebellar tract, Ventral spino cerebellar tract, Anterolateral system (containing somatosensory and spinothalamic tracts).

Descending tracts (green):
 Ventral corticospinal tract, Lateral corticospinal tract, Lateral reticulospinal tract, Tectospinal tract, Medial reticulospinal tract, Lateral vestibulospinal tract, Medial vestibulospinal tract.

13-6

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

Forebrain (prosencephalon)	Prosencephalon	Telencephalon	Epineurion, Amygdala, Hippocampus, Neocortex, Basal ganglia, Lateral ventricles
Midbrain (mesencephalon)	Diencephalon	Diencephalon	Epithalamus, Thalamus, Hypothalamus, Subthalamus, Pituitary gland, Pineal gland, Third ventricle
Hindbrain (rhombencephalon)	Brain stem	Metencephalon	Pons, Cerebellum
		Myelencephalon	Medulla oblongata

MRCPCB - Embryology of CNS by MrcpcbTeam

(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

www.ezgmecce.com

Embryology of CNS: Ventricular System

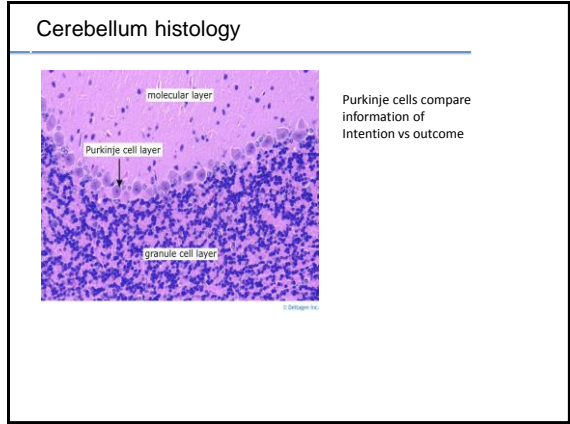
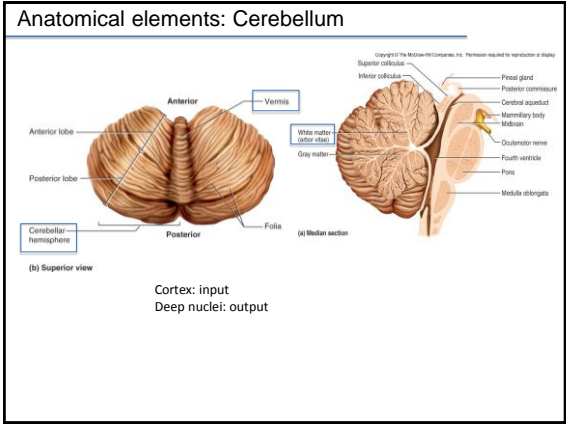
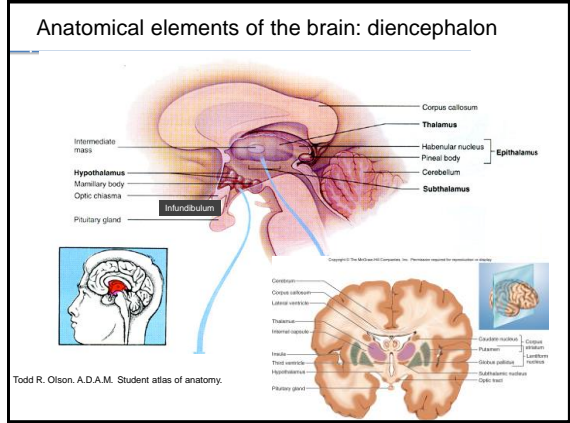
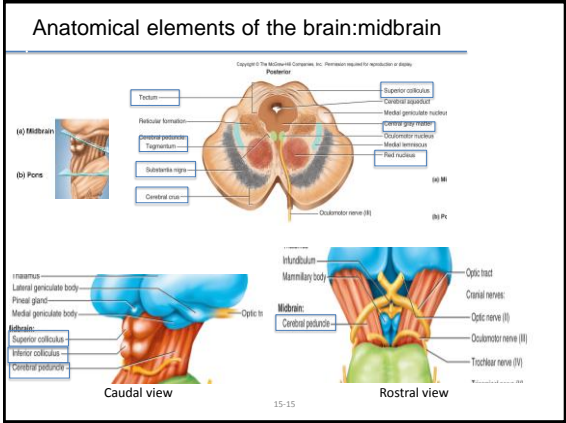
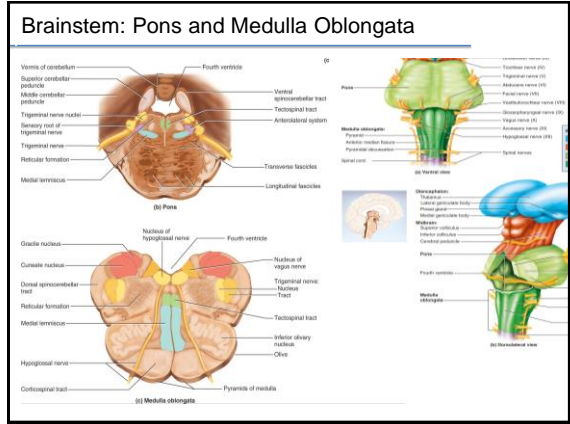
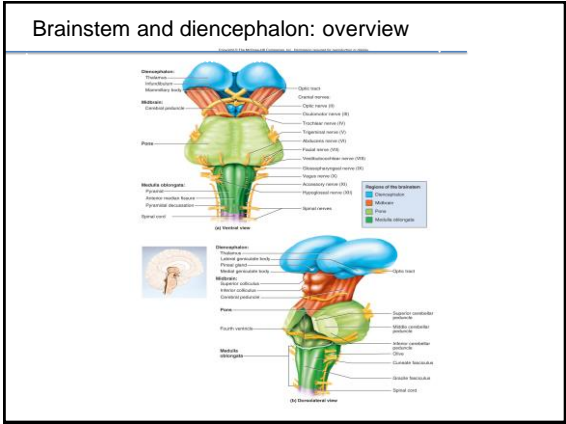
The Ventricular System of the Human Brain

©2001. NewStufWorks

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

Anatomical elements of the brain

15-12



Opisthotonus in dinosaurs

Posture suggesting of severe spastic distiss

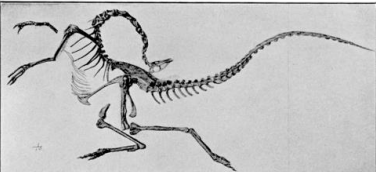
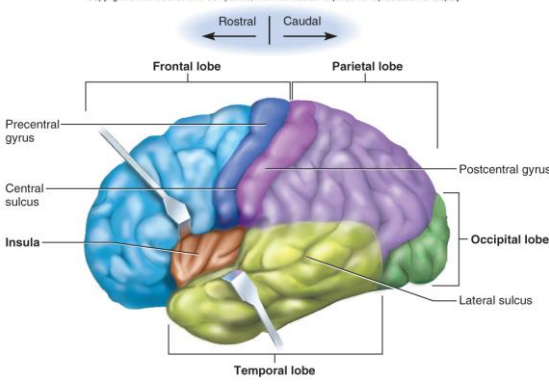


FIG. 4. Skeleton of *Struthiomimus altus*. Genotype specimen, Amer. Mus. 5339. 1/2 natural size. In this panel mount the animal is placed approximately as found. The attitude is typically opisthotonus. After Osborn.

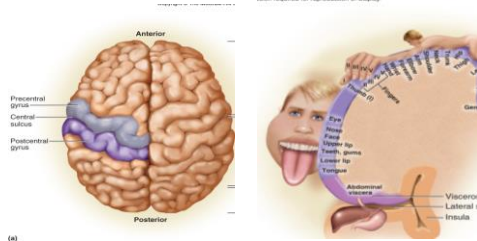
<https://laelaps.wordpress.com/2007/06/11/opisthotonus-in-dinosaurs/>

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display

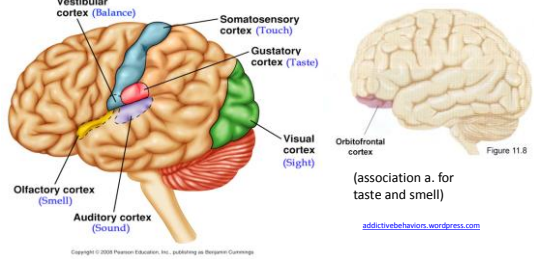


Cerebrum: Somatosensory perception

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



Sensory cortex

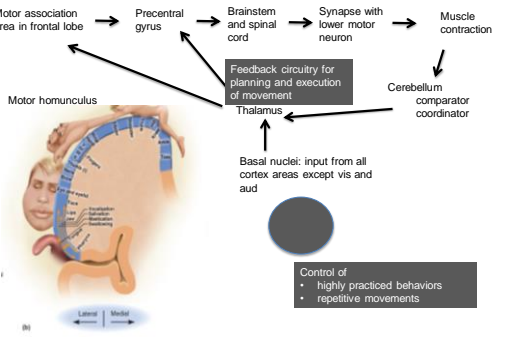


Cerebrum: Motor control

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

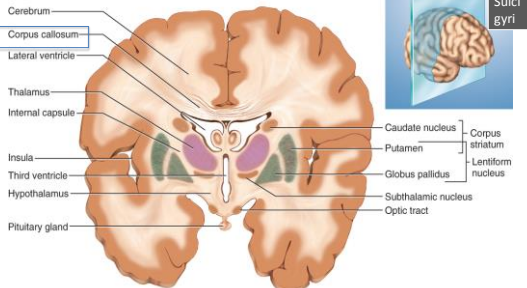
Feedback circuitry for planning and execution of movement: Motor homunculus → Thalamus → Basal nuclei: input from all cortex areas except vis and aud → Cerebellum comparator coordinator → Thalamus

Control of highly practiced behaviors, repetitive movements



Anatomical elements of the brain: cerebrum

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display



Limbic system

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Cerebrum: Lateralization

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

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	

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Malfunctions

Domoic acid poisoning
Marine Animal Center Fort McArthur's slide

Area affected	Pathology
Substantia nigra	Parkinson's disease
Basal nuclei	Dyskinesias • 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

Phineas Gage's 1848 accident

Architecture of autonomic vs motor

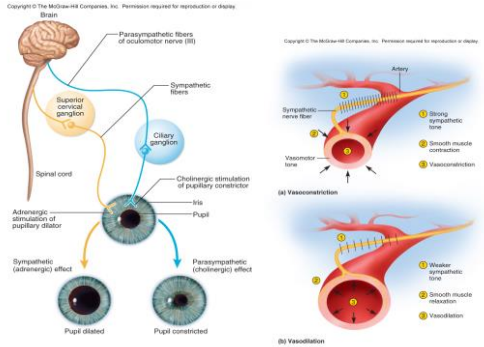
Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

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

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Dual innervation and autonomic tone



"Fight or flight" vs "Relaxing over a meal"

