

Biopsychology
Chapter 3: Structure of the
Nervous System

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Neuroanatomy Terms

- The **neuraxis** is an imaginary line drawn through the spinal cord up to the front of the brain
- Anatomical directions are understood relative to the neuraxis
 - **Anterior** (rostral): toward the head
 - **Posterior** (caudal): toward the tail
 - **Dorsal** (superior): toward the back (top of head)
 - **Ventral** (inferior): toward the "belly"
- Location in brain:
 - **Ipsilateral**: same side of brain
 - **Contralateral**: opposite side of brain
 - **Unilateral**: one side of brain
 - **Bilateral**: both sides of brain

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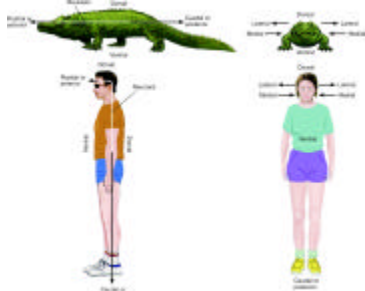
Neuroanatomy Terms (cont.)

- Anatomical directions with varying reference points
 - **Medial**: towards the center (e.g., neuroaxis, midline)
 - **Lateral**: towards the side
 - **Proximal**: close to
 - **Distal**: away from
 - **Afferent**: towards the reference point (e.g., towards the brain)
 - **Efferent**: away from the reference point (e.g., away from the brain)

*One neuron's efferent is another
neuron's afferent*

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Anatomical Directions Are Relative to the Neuraxis

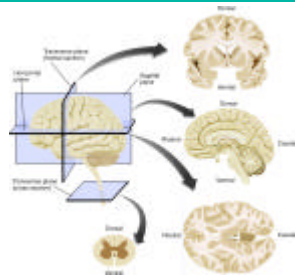


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Planes of Sectioning

- The brain can be sectioned in three planes
- Each section provides a different view of the internal anatomy of the brain
 - Sagittal
 - Coronal (or transverse)
 - Horizontal



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Major Divisions of the Nervous System

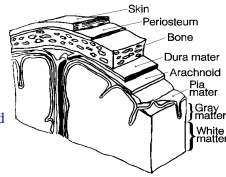
- Central Nervous System (CNS)
 - Brain
 - Spinal cord (often considered an extension of the brain)
- Peripheral Nervous System (PNS)
 - Somatic nervous system (connects to skin & musculoskeletal system)
 - ◆ sensory nerves (afferent) and motor nerves (efferent)
 - ◆ cranial nerves (12) and spinal nerves (31)
 - Autonomic nervous system (connects to viscera, glands & blood vessels)
 - ◆ sympathetic nervous system
 - ◆ parasympathetic nervous system

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The Meninges

■ The brain and spinal cord are protected by a series of membranes termed **meninges**

- **Dura mater**-outer (thick) layer
- **Arachnoid**-middle layer
 - ◆ Overlies the arachnoid space (CSF)
 - ◆ Blood vessels run through the arachnoid layer
- **Pia mater**- inner layer
 - ◆ Overlies every detail of the outer brain



Source: Brain Tumor Foundation of Canada. <http://www.bfnc.org/>

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Cerebrospinal Fluid

- The brain floats in a pool of **cerebrospinal fluid (CSF)** which reduces its net weight from 1400 g --> 80 g
- CSF is also contained within four brain ventricles



- CSF is produced by the **choroid plexus** of each ventricle
- The brain ventricles are an access point for drug studies
- The brain ventricles can expand when brain cells are lost (as in alcoholism or certain diseases)

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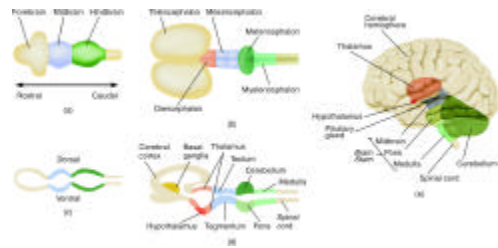
Brain Development

- The nervous system develops from **ectoderm** (outer layer) which forms a plate (~day 18)
 - The edges of the plate curl and eventually fuse together forming a **neural tube**
 - By ~day 28, the rostral end of the neural tube has formed the ventricles and the tissue that surrounds these hollow chambers has formed three major divisions of the brain
 - ◆ Forebrain, midbrain, and hindbrain

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Overview of Brain Development



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Overview of the CNS

Forebrain	Lateral	Telencephalon	Cerebral cortex Basal ganglia Limbic system
	Third	Diencephalon	Thalamus Hypothalamus
Midbrain	Cerebral aqueduct	Mesencephalon	Tectum Tegmentum
Hindbrain	Fourth	Metencephalon	Cerebellum Pons
		Myelencephalon	Medulla oblongata

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Cerebral Cortex

- The **cerebral cortex** forms the outer surface of the cerebral hemispheres
- Cortex surface is convoluted by grooves
 - **Sulci** (small grooves)
 - **Fissures** (large grooves)
- The bulges in cortex are termed **gyri**
- The cortex is primarily composed of cells, giving it a gray appearance
 - The cortex is formed from 6 layers of cells
- Cortex can be divided into 4 lobes: frontal, parietal, occipital, and temporal

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Your Folded Cortex: Sulci & Gyri



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Cerebral Lobes

■ Frontal Lobe

- anterior to the central sulcus & dorsal-medial to the lateral fissure
- includes precentral gyrus (primary motor cortex)

■ Parietal Lobe

- posterior to the central sulcus, anterior to the occipital lobe, & dorsal-medial to the lateral fissure
- includes postcentral gyrus (primary somatosensory cortex)



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Cerebral Lobes (cont.)

■ Temporal Lobe

- ventral to the lateral fissure and rostral to the occipital lobe
- includes the primary auditory cortex

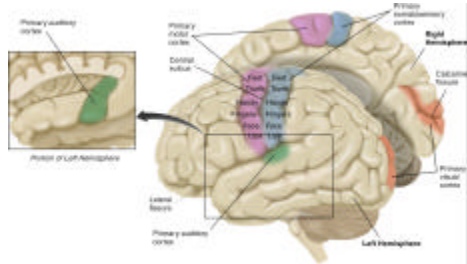
■ Occipital Cortex

- caudal to the parietal & temporal lobes
- includes the primary visual cortex



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Primary Sensory and Motor Cortex



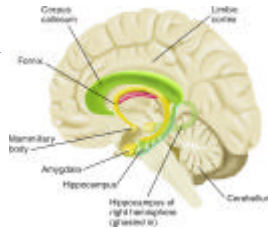
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Limbic System

■ The limbic system is comprised of

- **Hippocampus:** involved in learning and memory
- **Amygdala:** involved in emotion
- **Mammillary Bodies**
 - ◆ The **fornix** is a fiber bundle that interconnects the hippocampus with the mammillary bodies



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Basal Ganglia

■ The basal ganglia are a collection of subcortical nuclei that lie just under the anterior aspect of the lateral ventricles

- “Ganglia” is a misnomer (term refers to collections of cell bodies in periphery)

■ Basal ganglia consist of:

- Globus pallidus
- Caudate nucleus
- Putamen

■ Basal ganglia are involved in the control of movement

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Diencephalon

■ Diencephalon consists of

- **Thalamus:** contains nuclei that receive sensory information and transmit it to cortex
- **Hypothalamus:** contains nuclei involved in integration of species-typical behaviors, control of the autonomic nervous system and pituitary



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Mesencephalon

■ The mesencephalon (midbrain) consists of

- **Tectum** is the dorsal portion of midbrain
 - ◆ Superior and inferior colliculi are involved in the visual and auditory systems
- **Tegmentum** is the portion of the midbrain located under the tectum and consists of the
 - ◆ Rostral end of the reticular formation
 - ◆ Periaqueductal gray
 - ◆ Red nucleus
 - ◆ Substantia nigra
 - ◆ Ventral tegmental area



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Metencephalon

■ Metencephalon consists of the

- **Pons**
 - ◆ Contains the core of the reticular formation
 - ◆ The pons is involved in the control of sleep and arousal
- **Cerebellum** is involved in motor control

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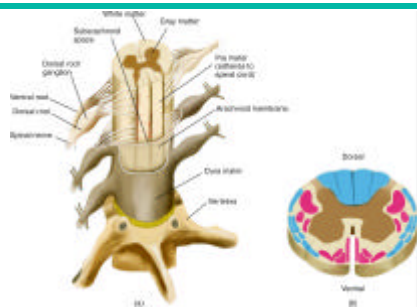
Myelencephalon

- The **myelencephalon** consists of the
 - Medulla oblongata
 - The medulla is the most caudal portion of brain and is rostral to the spinal cord
 - The medulla contains part of the reticular formation
 - The nuclei of the medulla control vital functions such as regulation of the cardiovascular system, breathing, and skeletal muscle tone

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The Spinal Cord



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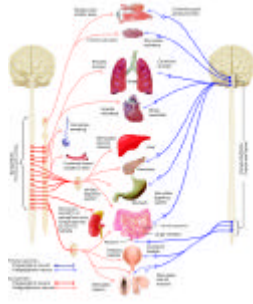
The Peripheral Nervous System

- **Somatic** division of PNS is comprised by nerves that control muscle action and that carry sensory information back to the CNS
 - ◆ Cranial nerves (12)
 - ◆ Spinal nerves (31)
- **Autonomic** division of PNS governs smooth muscle and gland secretion
 - **Parasympathetic**: supports activities that increase energy
 - **Sympathetic**: arousal and the expenditure of energy

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Overview of the ANS



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