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

Neuroanatomy Terms (cont.)

- Anatomical directions with varying reference points:
  - Medial: towards the center (e.g., neuraxis, 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
Anatomical Directions Are Relative to the Neuraxis

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

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
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.btf.org/

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)

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
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.
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)

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
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

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
**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**: involved in motor control
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

The Spinal Cord

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
More Neuroanatomy Terms

- **Nerve**: collection of axons outside CNS
- **Tract**: collection of axons inside CNS
- **Nucleus**: collection of cell bodies inside CNS
- **Ganglion**: collection of cell bodies outside CNS

Somatic Nervous System:

Cranial Nerve Division

- **Cranial Nerves (12)**
  - Motor (red)
  - Sensory (blue)

Somatic Nervous System:

Spinal Nerve Division

- **Spinal Nerves (31 pair)**
  - 8 Cervical
  - 12 Thoracic
  - 5 Lumbar
  - 5 Sacral
  - 1 Coccygeal
Somatic Nervous System:
Spinal Nerve Division—Dermatomes

- Dermatomes are the areas of skin supplied with nerve fibers by a single spinal nerve root
  - There are 8 nerve roots for the 7 cervical vertebrae
  - One for each of the
    - 12 thoracic
    - 5 lumbar
  - 5 sacral vertebrae have a single spinal nerve root

From http://www.merck.com/pubs/mmanual_home/illus/69i1.htm

Effects of Spinal Injury

- Damage to different levels of the spinal cord are associated with specific pathologies
- Complete transection at any level would disrupt functions associated with all segments below the transected level

From http://www.merck.com/pubs/mmanual_home/illus/69i1.htm

The Autonomic Nervous System

- Sympathetic division
  - Associated with energy expenditure
  - Derives from thoracic andolumbar levels of the spinal cord
- Parasympathetic division
  - Associated with energy conservation
  - Derives from cranial and sacral levels of the spinal cord

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Overview of the ANS