

Anatomy and Physiology 121: The Nervous System

- General Functions of the Nervous System

- Terms and Topics
 - Neural tissue (neurons and neuroglial cells)
 - Nerves!
 - Nerve impulses (bio-electrochemical)
 - Synapses and neurotransmitters
 - Sensory neurons and motor neurons
 - Receive and respond to stimuli

General Divisions of the Nervous System

- Central Nervous System (brain and spinal cord)
- Peripheral Nervous System (cranial and spinal nerves)
 - Sensory Division (sensory receptors)
 - Motor Division (effectors)
 - Somatic Nervous System (voluntary)
 - Autonomic Nervous System (involuntary)

Structure of a Neuron

- Cell Body
- Dendrites (cellular processes)
- Axon (cellular processes)
- Neurilemma
- Nodes of Ranvier
- Schwann Cells (peripheral nervous system)
- Myelin and the *Myelin Sheath*
- Synaptic cleft (synapses)
- Neurofibrils
- Nissl Bodies (chromatophilic substance)

Classification of Neurons

- Structural
 - Bipolar neurons
 - Unipolar neurons
 - Multipolar neurons

- Functional
 - Sensory neurons
 - Interneurons
 - Motor neurons

Classification of Neuroglial Cells

- Astrocytes
- Oligodendrocytes (central nervous system) & Schwann Cells (peripheral nervous system)
- Microglia
- Ependyma

Regeneration of a Nerve Fiber

- If a cell body is injured, the neuron is likely to die
- If a peripheral nerve is severed, its distal portion may regenerate and reestablish its former connections
- Significant regeneration is unlikely in the CNS

Cell Membrane Potential

- Distribution of Ions
- Membrane Potential
- Resting Potential
- Local Changes and the Threshold Potential
- Summation and Action Potentials
- Refractory Period
- All or None Response
- Impulse Conduction

Synapses

- Synapse
- Synaptic cleft
- Presynaptic neuron
- Postsynaptic neuron
- Neurotransmitters

Classification of Synapses

- Axosomatic
- Axoaxonic
- Axodendritic
- ~ 100,000 presynaptic terminals lie on dendrites of a cell

Synaptic Transmission

- Impulses travel from dendrite on cell body through axon to presynaptic terminal
- Axons secrete neurotransmitter from synaptic vesicles in knobs on axon when receives an impulse
- When transmitter reaches postsynaptic neuron it triggers an synaptic potential

Neurotransmitter Substances

- ~ 50 neurotransmitters identified
- Neurotransmitters are quickly removed or decomposed from synaptic clefts
- Some transmitters cause action potentials, excitatory postsynaptic potential (EPSP)
- Others can inhibit action impulses, inhibitory postsynaptic potential (IPSP)

Processing of Impulses

- Neuronal pools
- Facilitation
- Convergence
- Divergence

The Brain

- Brain structure reflects the way it was formed
- Brain develops from a tube with 3 cavities: forebrain, midbrain, hindbrain
- The cavities persist as ventricles
- Brain Structure

- The brain has three major parts to it:
 - The cerebrum
 - The cerebellum
 - The brain stem

Structure of the Cerebrum

- Consists of two hemispheres
- Surface is marked by ridges and grooves as a result of rapid nerve growth
- Cerebral cortex is a thin layer of gray matter near the surface
- White matter
- Basal ganglia

Functions of the Cerebrum

- Higher brain function
- Sensory, motor and association areas
- Primary motor region in Precentral gyri
- Primary sensory region in Postcentral gyri
- Association areas analyze and interpret sensory impulses that are involved in memory, reasoning, verbalizing, judgment and emotions

Basal Ganglia

- Are masses of gray matter located deep within cerebral hemispheres
- Function as relay stations for motor impulses that originate in the motor cortex
- Aid in control of motor activities
- Putamen, caudate nucleus, substantia nigra, globus pallidus

Ventricles

- Are interconnected fluid filled cavities within the brain
- Filled with CSF
- CSF circulate through ventricles and is reabsorbed into the blood in the dural sinuses
- There are four ventricles

The Cerebellum

- Consists of two hemispheres connected by the vermis
- Composed of white matter surrounded by a thin cortex of gray matter
- Functions primarily as a reflex center in coordination and maintains equilibrium

The Brain Stem

- Extends from base of cerebrum to spinal cord
- Consists of diencephalon, midbrain, pons, medulla oblongata
- Diencephalon consists of thalamus, hypothalamus and epithalamus
- Midbrain contains reflex centers for eye and head movements
- Pons relays impulses between cerebrum and other parts of the nervous system
- Medulla oblongata transmits all ascending and descending impulses, reflex areas
- Reticular formations filter incoming impulses, collates, arouses cerebral cortex to wakefulness
- Normal sleep results from decreased activity of reticular formation

Regional Names for the Brain

- Diencephalon
- Mesencephalon
- Metencephalon
- Myelencephalon
- Telencephalon

Structure of the Spinal Cord

- Composed of 31 segments, each gives rise to a pair of spinal nerves
- Cervical and lumbar enlargements
- Right and left halves
- Central core of gray matter surrounded by white matter
- White matter composed of myelinated nerve fibers

Functions of the Spinal Cord

- Communication between brain and rest of body
- Ascending and descending tracts
- Most tracts cross over in brain stem or brain (i.e. left side of brain controls right side of body)

Meninges

- Dura mater: outer layer, many blood vessels and nerves, forms partitions in brain
- Arachnoid mater: net-like middle membrane, no blood vessels, between arachnoid and pia is the subarachnoid space filled with CSF
- Pia mater: thin, blood vessels, contacts surface of brain

Peripheral Nervous System

- Peripheral Nerve Structure (no distinction between sizes of nerves)
- Bundle of nerves surrounded by connective tissue
- Epineurium, perineurium, endoneurium

Cranial Nerves

- Twelve pairs connect brain to head, neck and trunk
- Most are mixed nerves, some are sensory only
- Names of cranial nerves indicate their primary function
- Some are somatic, some are autonomic
- The Twelve Cranial Nerves
- I. Olfactory
- II. Optic
- III. Oculomotor
- IV. Trochlear
- V. Trigeminal
- VI. Abducens
- VII. Facial
- VIII. Auditory
- IX. Glossopharyngeal
- X. Vagus
- XI. Accessory
- XII. Hypoglossal

Spinal Nerves

- 31 pairs: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral, 1 coccal
- Mixed nerves, 2-way communication
- Dorsal and ventral root
- Dorsal root for sensory fibers, dorsal root ganglion
- Ventral root for motor fibers
- Most spinal nerves form plexuses

Classification of Nerves Based on Function

- General efferent somatic: brain to skeletal muscle
- General afferent somatic: muscle/skin to CNS
- General efferent visceral: CNS to organs
- General afferent visceral: organs to CNS
- Special visceral efferent: CNS to muscles of speech, chewing, swallowing
- Special visceral afferent: olfactory and taste to CNS
- Special somatic afferent: sight and hearing to CNS

Autonomic Nervous System

- No conscious effort
- Independent and autonomous
- Always efferent or motor neurons
- Two divisions
 - Sympathetic Division
 - Parasympathetic Division