Overview of the Nervous System

- Peripheral nervous system-PNS
  - cranial nerves
  - spinal nerves
  - ganglia
  - peripheral nerves
  - enteric plexuses
  - sensory receptors
Overview of the Nervous System

- Central nervous system-CNS
  - Brain & Spinal cord
Organization of nervous system

- PNS
  - somatic nervous system
  - sensory and motor functions of voluntary skeletal muscle
  - autonomic nervous system
  - involuntary sensory and motor functions
  - branches into sympathetic and parasympathetic nervous systems
  - enteric nervous system
  - also involuntary
  - innervates the G.I. tract
Nervous Tissue

- Nervous tissue consists of neurons and neuroglia cells
- Neurons are responsible for most of the unique functions that we associate with the nervous system.
  - For example thinking, feeling, remembering and controlling our movements
- Neuroglia cells function to support neurons
Types of Neurons

Unipolar neurons consists of one continuous process that branches off the cell body and includes both the axon and dendrite.
Types of Neurons

Bipolar neurons consists of two separate processes that branch off the cell body, the dendrite and the axon.
Types of Neurons

Multipolar neurons have many processes that branch from the cell body.
Structures of the neuron

- Cell body – contains the nucleus and organelles
- Dendrites – receive impulses from other neurons and carry them to the cell body
- Axon – carry impulses away from cell body and toward another neuron.
- Axon hillock – first part of axon that branches off cell body and is referred to as the trigger zone
Structures of the neuron

- Axon terminals – fine branches of an axon that lead to the synaptic end bulb
- Synaptic end bulb - contains neurotransmitters to be released
- Myelin sheath – electrically insulates the axon of a neuron and speeds the conduction of action potentials
- Node of Ranvier – gaps in the myelin sheath that surrounds the axon
Neuroglia cells

The neuroglia cells can be found in both the PNS and CNS where their function is to support neurons.
Neuroglial cells of the CNS

Astrocyte – star shaped cells which are the most numerous of the glial cells. Provide support for neurons.

Blood brain barrier – restricts flow of substances between the blood and interstitial fluid of the CNS.

Maintain the ionic composition of the cerebral spinal fluid.
Neuroglial cells of the CNS

- **Oligodendrocytes** – form the myelin sheaths around axons in the CNS.
- **Microglial cells** – Function as phagocytes that remove debris and phagocytize microbes and damaged nervous tissue.
- **Ependymal cells** – Possess microvilli and cilia, line the ventricles and central canal produce and assist in the circulation of Cerebral Spinal Fluid.
- Also they form the blood-cerebral-spinal-fluid-barrier.
Neuroglia cells of the PNS

Schwann cells – form the myelin sheaths around axons of the PNS.

Satellite cells – provide structural support and regulate the exchange of materials between neuronal cell bodies and interstitial fluid.
Myelination

Neural impulses travel faster along the axons of myelinated axons in comparison to unmyelinated axons.
Grey matter and White matter

The presence of white and grey matter is reversed in the brain and spinal cord. The spinal cord has grey matter on the inside and white matter on the outside. The Brain has grey matter on the outside and white matter on the inside.
White matter and Grey matter

- White matter contains myelinated axons and unmyelinated axons.
- Grey matter contains the dendrites, cell bodies, neuroglia cells, unmyelinated axons and axon terminals.
- Nucleus - a cluster of neuronal cell bodies in the CNS.
- Ganglion – cluster of neuronal cell bodies in the PNS.
Sensory and Motor Pathways

Impulses traveling in the peripheral nervous system can be traveling in one of two directions. They can be traveling toward the central nervous system as sensory information. Or they can be traveling away from the central nervous system as motor impulses.
Sensory Pathways

Sensory information enters the spinal cord through the posterior root. These nerves are referred to as afferent nerves.
Sensory Pathways

- Motor information exits the spinal cord through the anterior roots.
- These nerves are referred to as efferent.
Types of sensory pathways

A sensory pathway is divided into three sections. First order neuron – carries the sensory impulse from the sensory receptor to the central nervous system. Second order neuron – carries the information from the central nervous system to the thalamus.

Information traveling along second order neurons deccussates from one side of the CNS to the other side of the CNS.

Third order neuron – carries sensory information from the thalamus to the cerebral cortex.
Sensory Pathways

- Information that is relayed to the brain can be coded in several ways.
- The strength of the stimulus can be coded for by the number of sensory receptors stimulated.
- The type of receptor activated. For example chemoreceptors for levels of oxygen in the blood.
- Or thermoreceptors for thermal sensations such as hot or cold.
Sensory Pathways

- Spinothalamic pathway.
- There are actually two spinothalamic pathways. The lateral spinothalamic and the anterior spinothalamic pathways.
- The lateral spinothalamic pathway relays the sensations of pain and temperature.
- The anterior spinothalamic pathway carries the sensations of crude touch, pressure, tickling and itching.
Spinothalamic Pathway

- First order neuron – Start at the sensory receptor and synapse with second order neurons in the dorsal horn of the spinal cord.
- Second order neuron – Start at the dorsal horn of the spinal cord and synapse with third order neurons in the thalamus.
- Third order neuron – Start at the thalamus and terminate in the primary somatosensory area of the cortex.
Spinothalamic Pathway
Posterior Column Medial Lemniscus Pathway

- This sensory pathway relays the sensations of fine touch, proprioception, vibration and stereogenisis.
- Proprioception is the awareness of the bodies position. For example the position of your limbs.
- Stereogenisis is the ability to identify an object by touching it and not actually seeing it. For example reading braille or identifying a fork by holding it.
Posterior Column Medial Lemniscus Pathway

First order neuron – Impulse starts at the sensory receptor and synapses with the second order neuron in the medulla.

Second order neuron – Impulse travels from the medulla to the thalamus. Information decussates right before entering the medial meniscus of the medulla.

Third order neuron – Starts at the thalamus and terminates primary somatosensory area of the cerebral cortex.
Posterior Column Medial Lemniscus Pathway
Patellar Reflex

- Step one – A tap on the patellar tendon activates a specialized SENSORY RECEPTOR called a muscle spindle. This sensory receptor is at the distal end of a sensory neuron.
- Step two – A sensory neuron relays the impulse to the gray matter of the spinal cord referred to as the INTERGRATING CENTER.
- Step three - It is here at the intergrating center that the sensory neuron activates a motor neuron.
- Step four – The motor neuron then carries an impulse to the quadriceps femoris muscle.
- Step five – The quadriceps femoris muscle then contracts causing the leg to extend at the knee.
Patellar Reflex
Motor Pathways

- Motor pathways are efferent and travel from the central nervous system to an effector organ, gland or muscle.
- There are two main types: the pyramidal pathways and the extrapyramidal pathways.
- The pyramidal pathways are considered direct while the extrapyramidal pathways are considered indirect.
Both of these pathways consist of upper motor neurons and lower motor neurons. The upper motor neurons start in the primary area of the motor cortex and synapse with lower motor neurons in the ventral horn of the spinal cord. The upper motor neurons do not innervate the effector organ, gland, or muscle. The lower motor neurons start in the ventral horn of the spinal cord and actually innervate the effector organ, muscle, or gland.
Motor pathways

- The pyramidal pathways are considered direct motor pathways because 90% of the axons cross-over in the medulla.
- The lower motor neurons of the pyramidal pathways innervate the muscles of the limbs, hands and feet.
- The pyramidal pathways control precise motor movements such as buttoning a shirt or playing the piano.
- Examples of pyramidal pathways are the lateral corticospinal tract anterior corticospinal tract and corticobulbar tract.
Extrapyramidal Pathways

- The extrapyramidal pathway is considered indirect because the axons of this pathway do not cross-over uniformly at one level of the CNS.
- Instead the axons cross-over at different levels of the CNS.
- The Extrapyramidal pathways control movements of the trunk and proximal limbs.
- This pathway is responsible for maintaining posture.
- Examples of the extrapyramidal pathways are rubrospinal, tectospinal, vestibulospinal, lateral reticulospinal, medial reticulospinal
Autonomic Nervous System

The ANS is divided into the sympathetic nervous system and the parasympathetic nervous system.

The sympathetic nervous system is used in fight or flight situations

The parasympathetic nervous system is used during “rest and digest”
Autonomic Nervous System

- Both of these pathways contain pre-ganglionic and post-ganglionic neurons.
- The preganglionic and postganglionic neurons of the parasympathetic nervous system both release the neurotransmitter acetylcholine.
- The preganglionic neurons of the sympathetic nervous system release acetylcholine while the postganglionic neurons release norepinephrine.
Sympathetic Nervous System

- One major difference between the sympathetic nervous system and the parasympathetic nervous system is the location of the ganglia.
- The ganglia of the sympathetic nervous system are located just outside the vertebral column and arise from the anterior rami of spinal nerves T1-L2.
- The ganglia of the parasympathetic nervous system are located closely to the organ at which they exert their effects on.
Sympathetic vs Parasympathetic

- The location of the ganglia creates a structural difference between the pre-ganglionic neurons and the post-ganglionic neurons.
- The pre-ganglionic neurons of the sympathetic are short while the pre-ganglionic neurons of the parasympathetic are long.
- The post-ganglionic neurons of the sympathetic are long while the post-ganglionic neurons of the parasympathetic are short.
The sympathetic is referred to as thoracolumbar while the parasympathetic is referred to as the craniosacral sympathetic.
Effects of each division of the ANS

Sympathetic (fight or flight) decreases blood flow to the digestive tract and increases blood flow to the skeletal muscle.

Airways dilate pupils dilate

Liver cells perform glycogenolysis.

Heart rate, force of heart contraction, and blood pressure increase.
Effects of each division of the ANS

- parasympathetic (rest and digest)
- decrease in heart rate, diameter of airways and pupils
- increased SLUDD
- Salvation
- Lacrimation
- Urination
- Digestion
- Defecation