


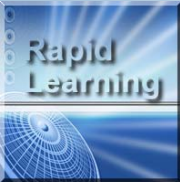
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 **Control of the Human Body:
The Peripheral Nervous System**

Rapid Learning Medical Series

Wayne Huang, PhD
Andrew Graham, PhD
Terri Gilbert, PhD
Jessica Habashi, PhD
Sara Olson, PhD
Jessica Barnes, PhD
Shabir Bhimji, MD

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Learning Objectives

By completing this tutorial, you will learn about:



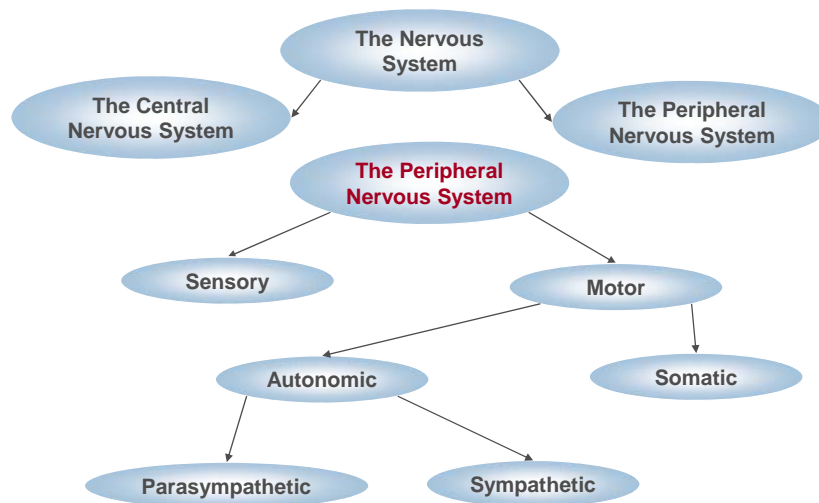
The Peripheral Nervous System (PNS)

- Neural Tissue
- Information Processing
- Organization and Integration

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Concept Map




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Introduction To The Peripheral Nervous System



Structures
Function

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Overview: Peripheral Nervous System

Composition

- The peripheral nervous system (PNS) includes all neural tissue, excluding the brain and the spinal cord.


Function

- The PNS is the communication network between the CNS and the rest of the body.



Base diagrammatic view of the brain, spinal cord, and distribution of spinal nerves.

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Review: Nervous System Cells - Neurons

Neurons

Signal Propagation

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Key Concept - Neuron

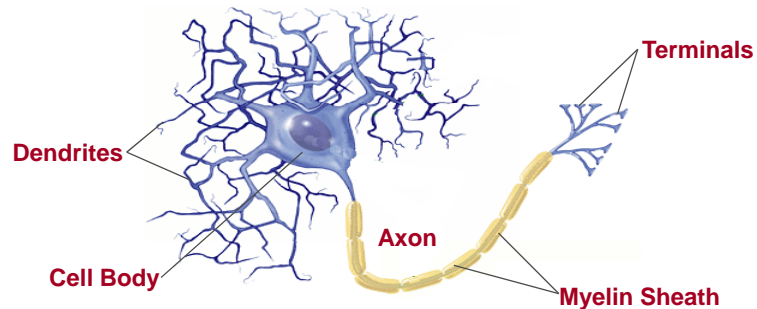
One of the fundamental units of the peripheral nervous system is the **neuron**, which conducts information to and from the brain to the rest of the body.

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Overview: Neurons



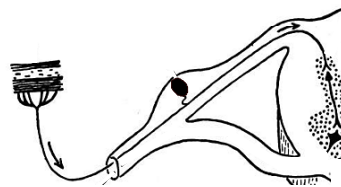
The neuron is a cell that is specially designed for receiving, propagating, and transmitting signals.

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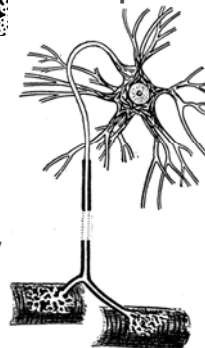
PNS Neurons: Functions

In the Peripheral Nervous System, two type of neurons predominate:



Unipolar Sensory Neurons: large myelinated neurons with the cell body off to one side of the single dendritic-axon process.

Multipolar Motor Neurons: large myelinated neurons that have many dendrites off the cell body and an axon that may branch to affect many effectors.

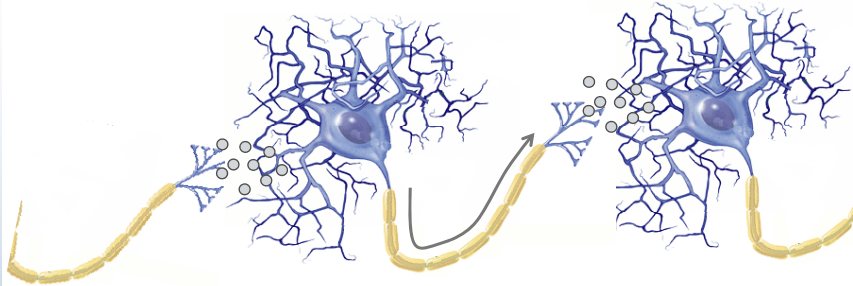


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Signal Transmission



Neurotransmitters released from one neuron bind to and activate the dendrites of the next neuron.

This causes the release of neurotransmitters from that neuron.

If the signal is strong enough, an action potential is propagated down the axon.

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Key Concept – Action Potential

How do neurons, which are just biological cells, transmit electrical signals?

The Action Potential.

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The Action Potential

Resting Potential

Action Potential

Synapse

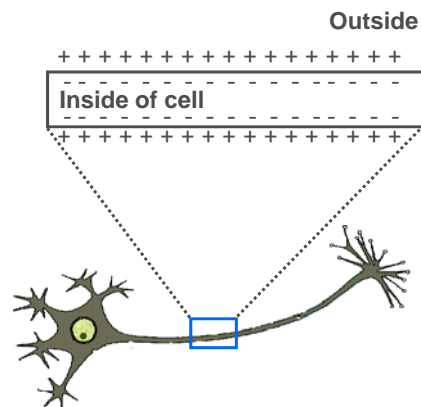
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The Resting Potential

Resting Potential

- Before the neuron is excited, the inside of the cell has a negative charge and the outside has a positive charge.
- The charge is carried by positively and negatively charged atoms, called **ions**.
- A separation of ions across the cell membrane creates the **electrical potential**, and it enables the transmission of electricity.



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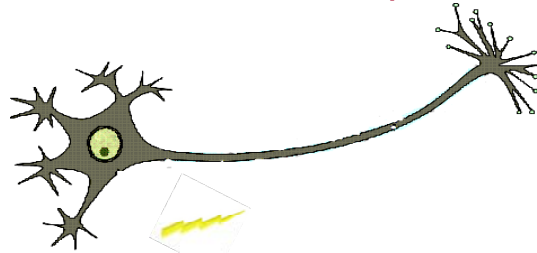




The Action Potential

The action potential sends electricity.

When another neuron sends a sufficiently strong signal to the next neuron, the neuron excites to a **threshold potential**.



Transporters on the cell membrane let positive ions into the cell, causing a change in potential, which spreads down the axon. This electrical propagation is called the **action potential**.

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Question: Neurons

Which part of the neuron is covered by myelin?

▶ Axon

What potential does a neuron need to reach in order to fire an action potential?

▶ Threshold

What is released from terminal branches of neurons?

▶ Neurotransmitter

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Nervous System Cells: Glial Cells

PNS Glial Cell Types
Functions

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Peripheral Nervous System: Glial Cells



- Neurons are not the only cells in the Peripheral Nervous System
- Glial cells provide structural and environmental support that allows for neurons to function
- There are two types of glial cells in the peripheral nervous system.

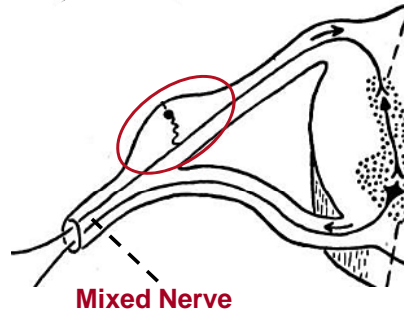
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Satellite Cells

In the PNS, every neuron is insulated. The nerves that exit and enter the spinal cord are bundles of neurons held together by glial cells.



The cell bodies of several sensory neurons form structures called **Ganglia**.

Satellite cells are the glial cells that surround each ganglion.

Nerves that contain both sensory and motor neurons are called “mixed nerves”.

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Schwann Cells

Schwann Cells



Axon

Unlike Oligodendrocytes, which myelinate several neurons, a single Schwann cell forms a segment of myelin sheath.

Like Oligodendrocytes in the CNS, Schwann cells wrap themselves around neurons in the PNS to form the myelin sheath.

Schwann cells also act to remove debris (similar to microglia in the CNS) and direct the growth of PNS neurons.

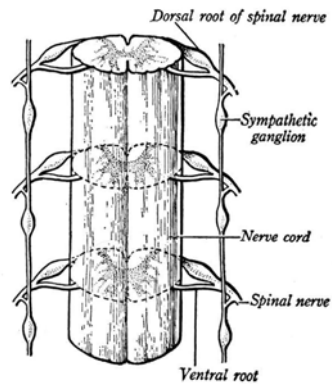
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Question: PNS Anatomy

What is the enlarged area at the **root** of the **dorsal** side of the spinal cord called?



Dorsal Root Ganglion

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Peripheral Nervous System

Overview

Sensory Nervous System

Motor Nervous System

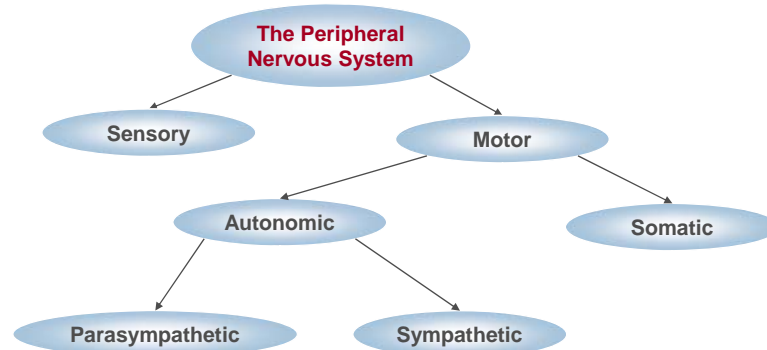
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Overview: The PNS

The PNS includes the nerves, which receive input from internal and external senses and send commands to the body.



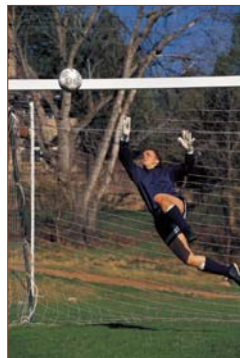
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Proprioception

The sensory nervous system includes internal monitoring systems that allow us to coordinate movement.

- **Proprioception:** Sensors that keep track of where the body is in space.



Proprioceptors are mechanoreceptors, receptors that respond to mechanical stimuli such as tension, pressure or displacement.

These receptors are located in the joints and muscles.

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The Five Senses

The sensory nervous system includes sensory organs, which receive information from the environment and send it to the CNS.

- **Skin:** detects temperature, touch, and painful stimuli.
- **Nose:** detects aromatic molecules
- **Tongue:** taste buds detect salty, bitter, sweet, and sour information
- **Ears:** detect sound waves with mechanical receptors.
- **Eyes:** detect photons or light.



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Sensory Organ: Skin

- **Skin:** Three separate kinds of nerves detect sensation on the skin.
 1. **Mechanoreceptors:** Detect pressure and tension on the skin
 2. **Thermoreceptors:** Detect the temperature of the stimulus
 3. **Nociceptors:** Detect painful stimuli



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Sensory Organs: Nose and Tongue

■ Olfaction and Taste



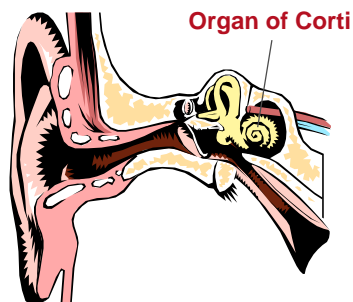
- Thousands of chemicals can be detected by our olfactory and taste receptors and sorted into “pleasant”, “toxic”, etc.
- Seven transmembrane receptors (7TMR) are important for this kind of sensory signaling.

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Sensory Organ: Ear

■ Ears: Detect sounds and air pressure.



- Fluctuations in air pressure move a membrane attached to **hair cells** in the Organ of Corti.
- These motions open ion channels in neurons, sending the signal to the CNS.

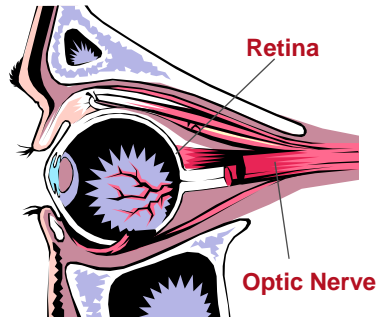
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Sensory Organ: Eye

■ Eyes: Vision



- The **retina** is the neural portion of the eye.
- Photons (light) activate receptors on the retina and the signal is transported to the CNS via the **optic nerve**.
- There are two major kinds of light receptors or **photoreceptors**: cones and rods.

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Question: Sensory Receptors

If you were to touch a steaming hot cup of coffee, which receptors would register that sensation?



Thermoreceptors and,
Possibly, **Nociceptors**

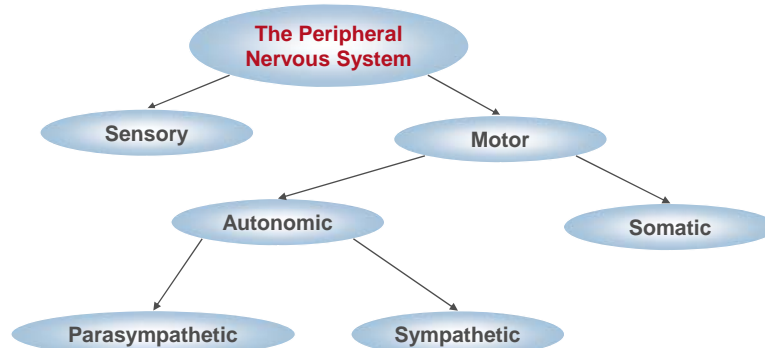
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The Motor Nervous Systems

The CNS sends commands to the body through the motor nervous system.



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The Motor Nervous System: Somatic

The somatic system directly controls voluntary movement.

When you want to jump (or run), your CNS sends the command to your PNS, which goes through the **somatic nervous system** to execute the movement of your leg muscles.



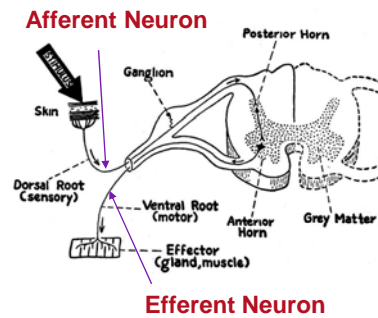
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Spinal Nerve Anatomy

There are 31 nerves exiting the spinal cord. Dorsal connections bring sensory information to the CNS; ventral motor connections send commands to the periphery.



- Each nerve includes afferent sensory neurons from the periphery, and efferent motor neurons to the periphery.
- Signals from the CNS, incorporating sensory input, excite specific motor neurons, resulting in the intended motion.

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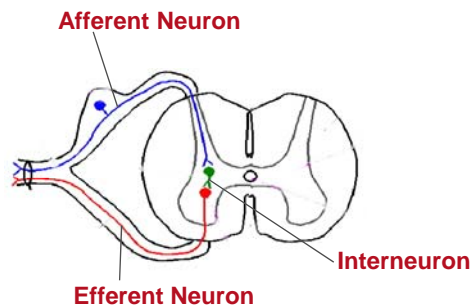
Reflexes: Efferent Regulation

- For painful stimuli, involuntary withdrawal (like a hand from a flame) occurs without input from the brain.
- This very simple nervous pathway is call a reflex arc.

Painful Stimulus



Muscle Response



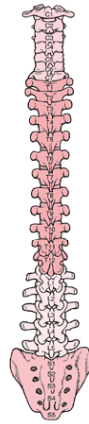
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Question: PNS Signaling

What kind of stimuli bypass the Central Nervous System?



- Tickling
- Chemical Burn
- Hot Stone Massage
- Touching Liquid Nitrogen
- Eating Ice Cream too Fast

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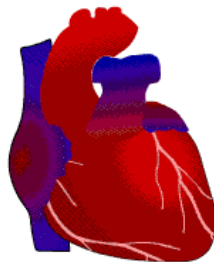


The Motor Nervous System: Autonomic

The autonomic system directly controls automatic body functions (involuntary movements).

Do you have to tell your heart to beat? Do you have to tell yourself to sweat?

No, because your **autonomic nervous system** controls the necessary body parts for you.



The autonomic system has two opposing parts: the **sympathetic** and **parasympathetic** nervous systems.

The sympathetic system increases effects and the parasympathetic system decreases effects (e.g., increase heart beat/decrease heart beat).

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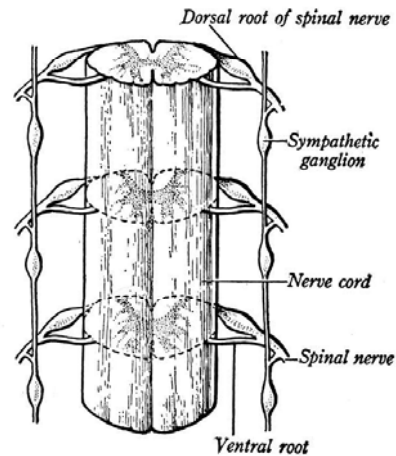




Somatic vs. Autonomic Systems

The somatic nervous system has just a single neuron between the spinal cord and the effector (muscles).

The autonomic system is a two- neuron system; the spinal efferent synapses on another neuron in the **Sympathetic Ganglion** before reaching the effector (gland or organ).



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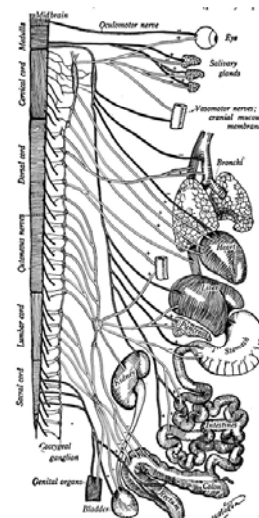


Autonomic Nerves

Our organs operate without any conscious input from us.

Sensory inputs from these organs provide the information for our sympathetic and parasympathetic systems to regulate the organs.

Light lines represent sympathetic nerves; dark lines represent parasympathetic nerves.



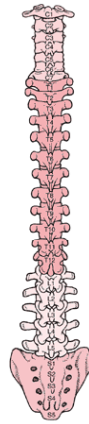
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Question: PNS

What are the two main divisions of the peripheral nervous system?



- Motor Nervous System
- Central Nervous System
- Somatic Nervous System
- Parasympathetic Nervous System
- Sensory Nervous System

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Learning Summary

The autonomic motor system is divided into the sympathetic (increases) and parasympathetic (decreases) systems.

The PNS includes all the nerves outside the CNS. It senses information from the environment and carries out commands sent by the brain.

The Sensory Nervous System includes Sensory Organs and Proprioceptive neurons.

You have learned about the differences between the somatic and autonomic nervous systems.

You have also learned about the cellular and structural anatomy of the PNS.

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Congratulations

You have successfully completed
the core tutorial

**The Peripheral Nervous
System**

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What's Next ...

Step 1: Concepts – Core Tutorial (Just Completed)
→ Step 2: Practice – Interactive Problem Drill
Step 3: Recap – Super Review Cheat Sheet

Go for it!

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