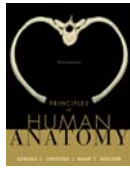


Chapter 17

Nervous Tissue



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Introduction

The nervous system and the endocrine system are the body's major control and integrating centers.

Neurology is the study of the normal functioning and disorders of the nervous system.

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Introduction

- The nervous system include the **brain**, **cranial nerves** (and their branches), **spinal cord**, **spinal nerves** (and their branches), **ganglia**, **enteric plexuses**, and **sensory receptors**
- **A nerve** is a bundle of axons (plus associated connective tissue and blood vessels) located outside the brain and spinal cord
- **Ganglia** are small masses of nervous tissue, consisting primarily of neuron cell bodies, that are located outside the brain and spinal cord
- **Enteric plexuses** are networks of neurons located in the walls of GI tract organs; they help regulate digestive system activities
- **Sensory receptors** are structures that monitor changes in the internal and external environment

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Components of the nervous system and anatomical organization of the nervous system. Figure 17.1

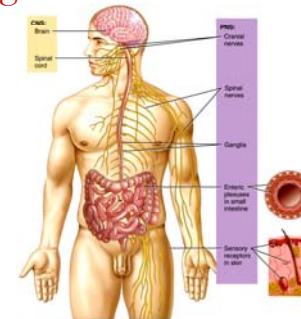


Figure 17.1 Tolosa / Peak 11a
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Organization of the Nervous System

The nervous system consists of two major divisions:

- **Central nervous system (CNS)**, which consists of the **brain** and **spinal cord**.
- **Peripheral nervous system (PNS)**, which consists of [1] **cranial nerves** that emerge from the brain, and [2] **spinal nerves** that emerge from the spinal cord - the PNS contains [a] **sensory or afferent neurons** which transmit nerve impulses from sensory receptors to the CNS, and [b] **motor or efferent neurons** which transmit nerve impulses from the CNS to muscles and glands

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The Function of the Nervous System

- **Sensory function - sensory receptors** detect stimuli in the internal and external environments, resulting in sensory information being transmitted by **sensory or afferent neurons** to the **brain** or **spinal cord**
- **Integrative function - interneurons** play a role in analyzing the sensory information to provide **perception**, storing some of it, and making decisions regarding appropriate behaviors
- **Motor function - motor or efferent neurons** respond to integration decisions by initiating actions in **effectors**, including muscle fibers and glandular cells

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Somatic Nervous System

- The somatic *nervous* system (SNS) of the PNS consists of **sensory and motor neurons**.
- **Somatic sensory neurons** convey information from sensory receptors in the skin, skeletal muscles, joints, and for the special senses (vision, hearing, taste, and smell) to the CNS.
- **Somatic motor neurons** convey information from the CNS to skeletal muscles only, are involved in the output of information from the CNS that results in a muscular contraction.

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Autonomic Nervous System

- **Autonomic nervous system of the PNS also has sensory and motor components.**
- **Sensory neurons**, called autonomic (visceral) sensory neurons, convey information mainly from visceral organs (smooth muscle organs in the thorax, abdomen, and pelvis) to the CNS.
- **Autonomic motor neurons** convey information from the CNS to smooth muscle, cardiac muscle, and glands and cause the muscles to contract and the glands to secrete..

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The Motor Branch of the ANA

- The motor part of the ANS consists of two branches, the **sympathetic division and the parasympathetic division**.
- The sympathetic neurons increase heart rate, support exercise or emergency actions, so-called “fight-or-flight” responses.
- The parasympathetic neurons slow it down and the parasympathetic division takes care of “rest-and-digest” activities.

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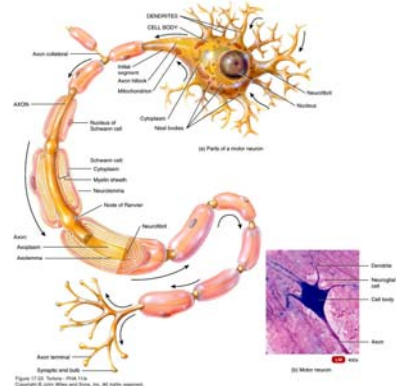
Histology

- Nervous tissue is a vascular tissue comprised of two types of cells - neurons and neuroglia.
- **Neurons** highly specialized cells.
Neurons have lost the ability to undergo mitotic divisions.
- **Neuroglia** are smaller cells but they greatly outnumber neurons.
Neuroglia support, nourish, and protect neurons, and maintain the interstitial fluid that bathes them. Unlike neurons, neuroglia continue to divide throughout an individual's lifetime.

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Structure of a typical neuron

Figure 17.3



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Parts of a Neuron

- The **cell body (perikaryon) contains a nucleus**
- **The Nissl bodies** are responsible for high levels of protein synthesis
- **Dendrites** are the receiving or input portions of a neuron.
- The **axon** of a neuron carries nerve impulses toward another neuron, a muscle fiber, or a gland cell.
- The cylindrical projection that often joins the cell body at a cone-shaped elevation called the **axon hillock**.

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Synapse

- The site of communication between two neurons the **synapse**.
- **The presynaptic neuron** refers to a nerve cell that carries a nerve impulse toward a synapse.
- A **postsynaptic** cell is a nerve cell or effector (muscle or gland) The synapse between a motor neuron and a muscle fiber is called a **neuromuscular junction**.
- A synapses between a muscle and neuron is neuromuscular junction, synaptic vesicles release the neurotransmitter acetylcholine (ACh)

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Neurotransmitters

- About 100 substances are either known or suspected neurotransmitters.
- The presynaptic neuron releases neurotransmitters into the synaptic cleft which act on the postsynaptic cell.
- Neurotransmitters including **acetylcholine (ACh), glutamate, aspartate, GABA, glycine, norepinephrine (NE), dopamine (DA), serotonin, endorphins, nitric oxide (NO)**, etc.

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Structural Diversity in Neurons

- Neurons display great diversity in size and shape.
- Cell bodies range in diameter from 5 micrometers (mm) up to 135 mm.
- The pattern of dendritic branching is varied and distinctive for neurons in different parts.
- A few small neurons lack an axon, and many others have very short axons.

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Structural Diversity in Neurons

- **multipolar neurons** usually have several dendrites and one axon
- **bipolar neurons** have one main dendrite and one axon
- **unipolar neurons** are sensory neurons have just one process extending from the cell body

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Structural classification of neurons

Figure 17.4

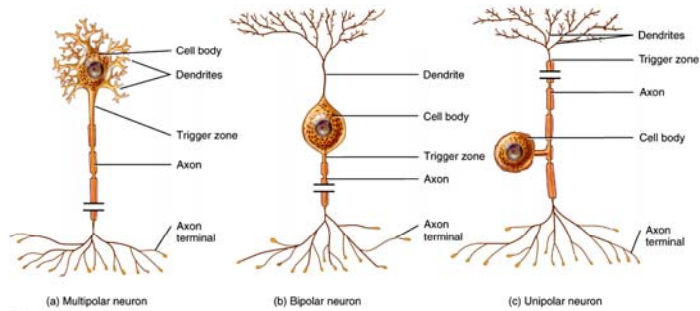


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Neuroglia

- **Neuroglia** or **glia constitute** about half the volume of the CNS.
- Neuroglia are smaller than neurons
- Glia do not generate or propagate nerve impulses
- They have the ability to multiply and divide in the mature nervous system.
- Six types of neuroglia, four:
Astrocytes, oligodendrocytes, microglia, and ependymal cells are found only in the CNS.
Schwann cells (neurolemmocytes) and satellite cells are present in the PNS.

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Neuroglia of the central nervous system

Figure 17.6

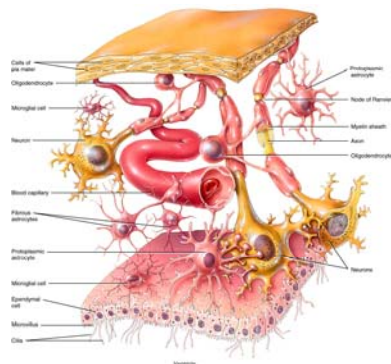


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Astrocytes

- There are two types of astrocytes: *Protoplasmic astrocytes* found in gray matter *Fibrous astrocytes* are located mainly in white matter.
- The processes of astrocytes make contact with blood capillaries, neurons, and the pia mater.

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Oligodendrocytes

- Oligodendrocytes have processes that are responsible for forming the myelin sheath, a lipid and protein covering around some axons that insulates the axon and increases the speed of nerve impulse conduction.

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Microglia

- **Microglia unlike** other neuroglial cells, which develop from the neural tube, microglia originate in red bone marrow and migrate into the CNS as it develops.
- Microglia function as phagocytes and they remove cellular debris, microbes and damaged nervous tissue.

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Ependymal cells

- Ependymal cells line the ventricles of the brain and central canal of the spinal cord
- Functionally, ependymal cells produce, possibly monitor, and assist in the circulation of cerebrospinal fluid. They also form the blood– cerebrospinal fluid barrier.

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Neuroglia of the PNS

Neuroglia of the PNS completely surround axons and cell bodies. The two types of glial cells in the PNS:

- **SCHWANN CELLS** - also called **neurolemmocytes**, encircle PNS axons and form the myelin sheath around axons. Schwann cells participate in axon regeneration, which is more easily accomplished in the PNS.
- **SATELLITE CELLS** - surround the cell bodies of neurons of PNS ganglia. Satellite cells regulate the exchange of materials between neuronal cell bodies and interstitial fluid.

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Neuroglia of the peripheral nervous system (PNS) Figure 17.7

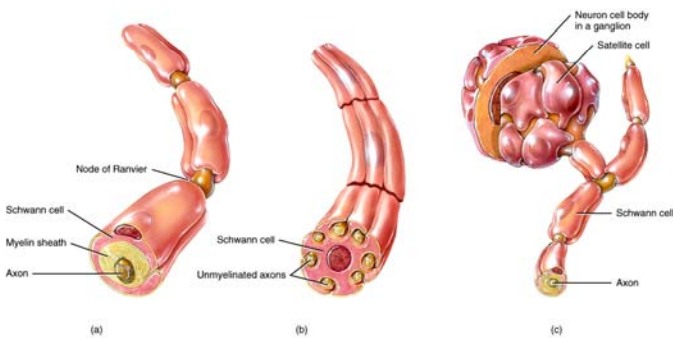


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Myelination

- Axons that are surrounded by a multilayered lipid and protein covering, called the **myelin sheath**, are **myelinated**. Axons without such a covering are **unmyelinated**.
- Two types of neuroglia produce myelin sheaths: Schwann cells (in the PNS) and oligodendrocytes (in the CNS).

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Myelinated and unmyelinated axons Figure 17.8

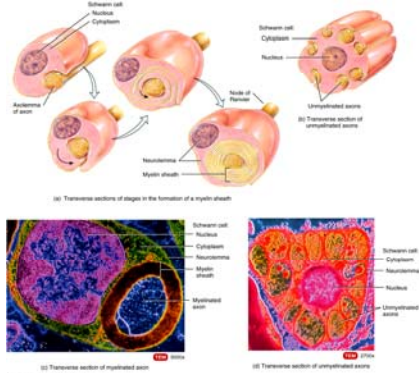


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Distribution of gray matter and white matter in the spinal cord

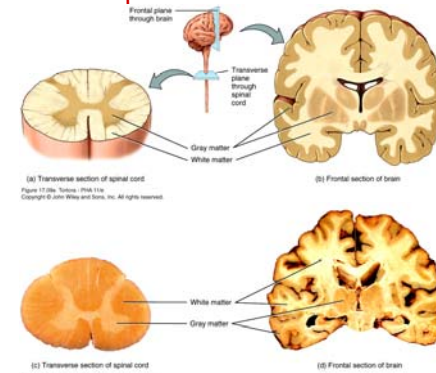


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Gray and White Matter

- The **white matter** is aggregations of myelinated and unmyelinated axons of many neurons.
- The **gray matter** of the nervous system contains neuronal cell bodies, dendrites, unmyelinated axons, axon terminals, and neuroglia.