12.4A: Structure of a Nerve

A nerve is the primary structure of the peripheral nervous system and is composed of bundles of axons.

Learning Objectives

• Describe the structure of nerves

Key Points

• A nerve is the primary structure of the peripheral nervous system (PNS) that encloses the axons of peripheral neurons.
• A nerve provides a structured pathway that supports neuron function.
• A nerve consists of many structures including axons, glycocalyx, endoneurial fluid, endoneurium, perineurium, and epineurium.
• The axons are bundled together into groups called fascicles, and each fascicle is wrapped in a layer of connective tissue called the perineurium.
• Magnetic resonance neurography is a technology used to detect nerve damage.

Key Terms

• **endoneurial fluid**: A low protein liquid that is the peripheral nervous system equivalent to cerebrospinal fluid in the central nervous system.
• **perineurium**: A protective sheath covering nerve fascicles.
• **glycocalyx**: A glycoprotein-polysaccharide covering that surrounds cell membranes.
- **endoneurium**: A layer of connective tissue that surrounds axons.
- **fascicles**: A small bundle of nerve fibers enclosed by the perineurium.
- **epineurium**: The outermost layer of dense, irregular connective tissue surrounding a peripheral nerve.

## Nerve Anatomy

A nerve is an enclosed, cable-like bundle of axons (the projections of neurons) in the peripheral nervous system (PNS).

**Nerves**: An illustration of the main nerves of the arm.
A nerve provides a structured pathway that supports the electrochemical nerve impulses transmitted along each of the axons.

In the central nervous system, the analogous structures are known as tracts. Neurons are sometimes referred to as nerve cells, although this term is misleading since many neurons do not occupy nerves, and nerves also include non-neuronal support cells (glial cells) that contribute to the health of enclosed neurons.

Each nerve contains many axons that are sometimes referred to as fibers. Within a nerve, each axon is surrounded by a layer of connective tissue called the endoneurium. The axons are bundled together into groups called fasciciles. Each fascicle is wrapped in a layer of connective tissue called the perineurium.

Finally, the entire nerve is wrapped in a layer of connective tissue called the epineurium. See the following illustrations of these structures.

The endoneurium consists of an inner sleeve of material called the glycocalyx and a mesh of collagen. Nerves are bundled along with blood vessels, which provide essential nutrients and energy to the enclosed, and metabolically demanding, neurons.

Within the endoneurium, individual nerve fibers are surrounded by a liquid called the endoneurial fluid. The endoneurium has properties analogous to the blood–brain barrier. It prevents certain molecules from crossing from the blood into the endoneurial fluid.

In this respect, endoneurial fluid is similar to cerebrospinal fluid in the central nervous system. During nerve irritation or injury, the amount of endoneurial fluid may increase at the site of damage. This increase in fluid can be visualized using magnetic resonance neurography to diagnose nerve damage.

(a) Anatomy of a nerve and (b) Cross-section of a nerve: The primary structures of a nerve. An illustration of a cross-section of a nerve highlighting the epineurium and perineurium. Individual axons can also be seen as tiny circles within each perineurium.

### Basic Function

A nerve conveys information in the form of electrochemical impulses (known as nerve impulses or action potentials) carried by the individual neurons that make up the nerve. These impulses are extremely fast, with some myelinated neurons conducting at speeds up to 120 m/s. The impulses travel from one neuron to another by crossing a synapse, and the message is converted from electrical to chemical and then back to electrical.
Nerves can be categorized into two groups based on function:

1. Sensory nerves conduct sensory information from their receptors to the central nervous system, where the information is then processed. Thus they are synonymous with afferent nerves.

2. Motor nerves conduct signals from the central nervous system to muscles. Thus they are synonymous with efferent nerves.

Neurologists usually diagnose disorders of the nerves by a physical examination, including the testing of reflexes, walking and other directed movements, muscle weakness, proprioception, and the sense of touch. This initial exam can be followed with tests such as nerve conduction study, electromyography, or computed tomography.