Chapter 11: Fundamentals of the Nervous System and Nervous Tissue

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11.1 The nervous system receives, integrates, and responds to information

The nervous system has three main functions:

1. Sensory Input: Millions of sensory receptors are used to monitor changes occurring inside and outside of the body, information collected is called sensory output

2. Integration: Nervous system process and interprets sensory input and decides on a course of action

3. Motor Output: Effector organs are activated by the nervous system causing a response

Example: Sensory Input: You are driving and see a red light
Integration: Nervous system integrates information (red light means stop)
Motor Output: Foot hits the break

Central Nervous System

- Composed of the brain and the spinal cord.
- Located in dorsal body cavity
- Integrating and control center
- Interprets sensory input and dictates motor output

Peripheral Nervous System

- Part or the nervous system outside the CNS
- Consists of mainly nerves (bundles of axons) extending from the brain the spinal cord and ganglia (collections of neuron cell bodies)
- Spinal nerves carry impulses to and from spinal curve
- Cranial nerves carry impulses to and from the brain
- Peripheral nerves serve as communication lines that link all parts of the body to

- Peripheral nerves serve as communication lines that link all parts of the body to the CNS

Somatic sensory fibers: convey impulses from the skin, muscles, and joints

Visceral sensory fibers: transmit impulses from the visceral organs (organs in ventral body cavity)

Motor or Efferent division of PNS (carrying away), transmits impulses from CNS to effector organs (muscles contract, glands secrete), effect change in body

The motor division is divided into two main parts:

1. Somatic nervous system (voluntary): composed of somatic motor nerve fibers that conduct impulses from the CNS to skeletal muscles

2. Autonomic nervous system (involuntary): visceral motor nerve fibers regulate the activity of smooth muscles, cardiac muscles, and glands

- Cells are densely packed and tightly intertwined in the CNS

Nervous tissue is made up of just two principal types of cells:

1. Neuroglia (supporting cells): small cells that surround and wrap more delicate neurons

2. Neurons: nerve cells that are excitable (respond to stimuli) and transmit electrical signals

11.2 Neuroglia support and maintain neurons

- There are six types of neuroglia (4 in CNS, 2 in PNS) all with unique functions

Neuroglia in CNS

- Astrocytes, microglial cells, ependymal cells, and oligodendrocytes
- Have branching processes (extensions) and a central cell body
- Differ from neurons due to their smaller size and darker staining nuclei
- Make up half the mass of the brain
- Outnumber neurons by 10 to 1

Astrocytes

- Resemble sea anemones
- Most abundant and versatile glial cell
- Support and brace the neurons and anchor them to their nutrient supply
- Play a role in making the exchange between capillaries and neurons
- Guide migration of young neurons and formation of synapses
- Control chemical environment around neurons
- One of their most important jobs is to clean up leaked K+ ions and recapturing and recycling released neurotransmitters
- Connected by gap junctions, signal each other using calcium waves

Microglial Cells

- Long thorny processes
- Processes touch neurons monitoring their health, injuries, and when they are under attack
- Can transform into a special type of microphage that can phagocytize microorganisms or neuronal debris
- Protective role is important due to the immune systems limited access to the CNS

Ependymal Cells

- Range in shape from squamous to columnar and ciliated
- Line the central cavities of the CNS, form fairly permeable barrier between the cerebrospinal fluid and the tissue fluid
- Beating of cilia help circulate cerebrospinal fluid that cushions the CNS

Oligodendrocytes

- Fewer processes than astrocytes
- Create insulating covers for thicker nerve fibers called a myelin sheath

Neuroglia in the PNS

There are two types of neuroglia in the PNS, which differ mainly in location:

1. Satellite Cells: Surround neuron cell bodies in the PNS, same function as astrocytes in the CNS

2. Schwann Cells: Surround all nerve fibers in the PNS and form myelin sheaths around thicker nerve fibers, vital to the regeneration of damaged peripheral

nerve fibres, similar to oligodendrocytes

11.3 Neurons are the structural units of the nervous system

- Billions of neurons (nerve cells) are the structural units of the nervous system
- Large and highly specialized cells
- Conduct messages in the form of nerve impulses

Three special characteristics of neurons :

1. Extreme longevity: given good nutrition they can function optimally over a lifetime

2. Amitotic: neurons loose their ability to divide due to their roles as communication links, meaning if they are damaged they can't be replaced, some exceptions

3. High metabolic rate: require continuous and abundant supplies of O_2 and glucose

- All neurons have a cell body and one or more slender processes

Neuron Cell Body

- Consists of spherical nucleus, conspicuous nucleolus surrounded by cytoplasm
- Also known as the perikaryon or soma
- Major biosynthetic center of a neuron, consisting of free ribosomes and a Rough ER
- Golgi apparatus forms a complete circle around the nucleus
- Microtubules and neurofibrils, which are bundles of intermediate filaments, are important in maintaining cell shape and integrity
- Plasma membrane acts as part of the receptive region that receives information from other neurons
- Mostly located in the CNS, protected by skull and vertebral column
- Clusters of cell bodies in the CNS are called nuclei, while those in the PNS are called ganglia

Neuron Processes

- Armlike processes extend from the cell bodies
- CNS contain neuron cell bodies and their processes, PNS mainly consists of

- CNS contain neuron cell bodies and their processes, PNS mainly consists of processes
- Bundles are called tracts in the CNS and nerves in the PNS
- Two types of processes, dendrites and axons, differ in structure, and function of plasma membrane

Dendrites

- Dendrites of motor neurons are short, motor neurons have hundreds of twiglike dendrites close to the cell body
- Almost all organelles in cell body can be found in dendrites
- The main receptive/input regions
- Provide large surface area for receiving signals from other neurons
- Finer dendrites are highly specialized for collecting information
- Convey messages towards the cell body (nerve impulses)