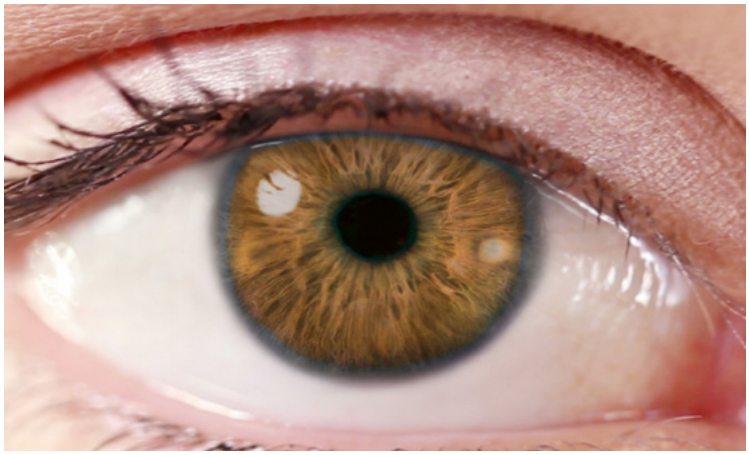
Chapter 12

The Nervous System



Summary of Terms

- **Action potential** A signal from a neuron or other cell that occurs when the cell's membrane potential becomes positive.
- **Axon** The part of a neuron that transmits information to other neurons or cells.
- **Autonomic nervous system** The motor neurons that control involuntary actions in the body.
- **Brainstem** The part of the brain that connects the spinal cord to the rest of the brain and controls many of the body's basic involuntary activities such as heartbeat, respiration, and digestion.
- **Central nervous system** The brain and spinal cord.
- **Cerebellum** The part of the brain that controls balance, posture, coordination, and fine movements.
- **Cerebrum** The largest part of the brain, which is responsible for high-level functions such as reasoning, problem-solving, and language, as well as collecting information from the senses and controlling the voluntary activities of the body.
- **Chemoreception** A way of sensing that occurs when chemicals bind to receptors on sensory cells, initiating action potentials.
- **Dendrites** The parts of a neuron that receive information from other neurons or cells.
- **Homeostasis** The maintenance of a relatively stable internal environment.
- **Hypothalamus** The part of the brain that is responsible for emotions and bodily drives as well as regulating the hormones of the endocrine system.
- **Interneurons** Neurons that connect one neuron to another neuron.
- **Motor neurons** Neurons that carry instructions from the central nervous system to muscles or organs.
- **Neuron** A cell that receives and transmits electrical signals from one part of the body to another.
- **Neurotransmitter** Molecules used by a neuron to communicate with another neuron at a chemical synapse.

- **Organ** A structure in the body that has a specific function.
- **Organ of Corti** The structure in the ear that contains the sensory cells responsible for hearing.
- **Organ system** A set of organs that work together to perform a particular bodily function.
- **Parasympathetic nervous system** The division of the autonomic nervous system that calms your body; its effects are the opposite of those of the sympathetic nervous system.
- **Peripheral nervous system** All the nerves in the body that are not found in the brain or spinal cord.
- **Retina** The structure at the back of the eyeball that contains the rods and cones, the light-sensitive cells of the eye.
- **Sensory neurons** Neurons that carry information from the senses to the central nervous system.
- **Somatic nervous system** The motor neurons that control the voluntary actions of the body.
- **Sympathetic nervous system** The division of the autonomic nervous system that prepares your body for danger, also known as the "fight or flight" response.
- **Synapse** A connection between a neuron and a target cell.
- **Thalamus** A major part of the brain that functions in collecting information from other parts of the brain, which it then sorts and filters to pass to the cerebrum
- **Tissue** A group of similar cells that performs a certain function.

Detailed Chapter Summary

A tissue is a group of similar cells that performs a certain function. The four major types of tissue in the body are epithelial, connective, muscle, and nervous tissue. Multiple tissues combine to form an organ, a structure in the body that has a specific function. The heart, stomach, and brain are organs. Multiple organs make up an organ system, which is responsible for a particular bodily function.

Homeostasis is the maintenance of a relatively stable internal environment. Body temperature and blood oxygen levels are examples of variables for which the body maintains homeostasis. Feedback regulation, in which changes in one variable affect a second variable, and changes in the second variable in turn affect the first variable, is an important mechanism for maintaining homeostasis.

The brain controls most all bodily activities. The brainstem connects to the spinal cord and is responsible for basic involuntary activities such as heartbeat, respiration, and digestion. The cerebellum controls balance, posture, coordination, and fine motor movements. The cerebrum is the largest part of the brain and is responsible for high-level functions such as reasoning, problem solving, language, and creativity. The cerebrum also receives information from the senses and controls voluntary actions. Each cerebral hemisphere consists of four lobes. The frontal lobes deal with reasoning, voluntary movements, and speech. The parietal lobes deal with sensory information such as temperature, touch, taste, and pain. The occipital lobes deal with sight. The temporal lobes deal with sound and language comprehension. The thalamus sorts and filters information headed to the cerebrum. The hypothalamus is responsible for emotions such as pleasure and rage as well as bodily drives.

The central nervous system (CNS) includes the brain and spinal cord, and the peripheral nervous system includes all other nerves in the body. The nervous system has two types of cells, neurons and glial cells.

Neurons are signaling cells and have dendrites, a cell body, and an axon. Glial cells support and protect neurons. The three types of neurons are sensory neurons, interneurons, and motor neurons. Sensory neurons carry information from the senses to the CNS. Interneurons connect neurons to other neurons. Motor neurons carry directions from the CNS to muscles or organs. Motor neurons belong to either the somatic nervous system (controlling voluntary actions) or the autonomic nervous system (controlling involuntary actions). The autonomic nervous system has two divisions. The sympathetic division is responsible for the "fight or flight" response and is active during danger. The parasympathetic division works during times of calm.

A neuron fires during a sequence of events called an action potential. A neuron's membrane potential is normally negative -- this is called its resting potential. Stimulation increases the membrane potential. If the membrane potential reaches a value known as the threshold, an action potential occurs -- sodium channels in the membrane open, sodium ions enter the neuron, and the membrane potential spikes. Potassium channels in the membrane open, potassium ions exit the neuron, and the membrane potential returns to resting potential. An action potential is an all-or-nothing event.

Once a neuron fires, the action potential is propagated down its axon. This happens as sodium ions entering the neuron diffuse down the axon and cause successive parts of the axon to reach the threshold, initiating action potentials in a kind of domino effect. Some axons are enclosed by a myelin sheath that allows an action potential to jump from one gap in the sheath to the next, greatly increasing the speed of propagation.

At the end of an axon, a neuron connects with one or more target cells. The connection is called a synapse. In an electrical synapse, ions move directly from the signaling neuron to the target cell, allowing for rapid signal transmission. Electrical synapses are responsible for the simultaneous muscle contractions that produce the heartbeat. In a chemical synapse, a signaling neuron releases neurotransmitter molecules that bind to receptors in the cell membrane of the target cell. This leads to changes in the membrane potential of the target cell that can be either excitatory or inhibitory. Target cells may receive signals from many neurons, and the sum of their effects determines whether the target cell fires. Chemical synapses allow for a finer degree of control and are much more common than electrical synapses.

Our senses allow us to obtain information about our environment. Our eyes allow us to see. Important structures of the eye include the cornea, pupil, iris, lens, and retina. Light enters the eyes and stimulates the sensory cells of the retina—rods and cones. Rods and cones send information to the brain via the optic nerve. Rods are more sensitive to light but offer grainy black-and-white vision. Cones detect color.

Sound enters through the pinna of the ear and reaches the eardrum, where waves are transmitted via the middle ear bones (hammer, anvil, and stirrup) to the fluid-filled inner ear. The sensory cells for sound are found in the organ of Corti in the cochlea. The bending of "hairs" found on these sensory cells causes action potentials to be transmitted to the brain via the auditory nerve.

Smell and taste occur through chemoreception. Action potentials are initiated when chemicals bind to receptors in the cell membrane of chemosensory cells. Humans have more than 1,000 different kinds of chemosensory cells for smell. Chemosensory cells in the taste buds distinguish five basic tastes – sweet, sour, salty, bitter, and umami. Much of our sense of "taste" actually relies on our sense of smell.

The sense of touch is actually multiple senses that respond to pressure, temperature, and pain. Other senses include proprioceptors that tell us where different parts of our body are and vestibular senses that tell us about body rotation and movement.