**The Human Nervous System**

In this chapter, we will go in depth over the topic of the human nervous system. By the end of this chapter, you will be able to understand the basics of the anatomy and physiology of the human body’s nervous system, and disorders to the system. This introductory chapter will prepare you for college sciences and psychology. The nervous system is in charge of coordinating the body’s activities, ranging from just a simple heartbeat to emotional reactions. This system receives information from other systems in the body, decides what to do with it, and causes a reaction.

* 1. **Neuronal Structure and Function**

Neurons are another type of cell that the body possesses; however, these cells are specialized to transmit and process all types of information from one part of the body to another. These neurons communicate over long distances by making and sending an electrical signal called an **action potential**. Action potential, or nerve impulse, is a quick process lasting only about one-thousandth of a second. During action potential, there is a reversal of electric polarization of a neuron’s membrane and causes it to travel in a wave-like manner along an **axon**. Humans have axons that may be more than a meter long, but it takes action potential only milliseconds to travel along one. Think of it as “action potential” being a airplane backed full of suitcases, or “information”. This airplane full of suitcases travels across a runway, or an “axon”.

When an action potenetional reaches the end of the axon at a synapse, the information is transformed into a chemical signal with the releases of neurotransmitter into the synaptic clef. This action is referred to as **synaptic transmission.** This end point of an axon is like the end of the runway, and the airplane must take off. The information of the many synaptic clefs coming into a neuron is processed to determine whether that specific neuron will trigger an action potential. All of these actions work together to form the nervous system as a whole.

**Structure of the Neuron**

The neuron is the simplest team member of the entire nervous system. These cells are structured in a special way to be able to process and transmit action potentials. The neuron has a central cell body called the **soma**. The soma is where the nucleus is located, causing this site to be the main center of activity. The **axons** and **dendrites** branch out from the soma. A neuron only possesses one axon, but has multiple dendrites. The dendrites receive signals and the axons carry the action potentials away from the soma. The axons terminate in a **synaptic knob** that forms connections with target cells. This is just where the cell begins to come to an end. At this end point after the action potentials travel all the way down from the axon and reaches the synaptic knob, tiny chemical messengers are released. These chemical messengers travel across an extremely small gap, called the **synaptic cleft**, to the target cell.

**The Action Potential**

The electric potential across the plasma membrane is called its **resting membrane potential**. This potential is measured using millivolts (mV). The inside of the neuron is negatively charged at this time. Two primary membrane proteins are involved to create this resting membrane potential: the Na+/K+ ATPase and the potassium leak channels. You will learn about this process more in advanced classes, but for now we will just briefly explain it. The Na+/K+ ATPase pumps ions out of the cell through leak channels. Potassium leak channels only allow potassium to flow down their gradient and go out of the cell. This flow of ions and potassium causes a negative charge along the interior of axons, making it reach its resting membrane potential state. The cell is now labeled as **polarized**. When an action potential disturbs this membrane potential, a wave of depolarization of the plasma membrane travels along an axon. During **depolarization**, voltage-gated sodium channels open to allow sodium ions to pass. However, these gates only open fully when a threshold potential is reached. After the wave of depolarization has pasted, the membrane potential returns to its normal state of **repolarization**. The change in the plasma membrane is caused by the ions producing movement as they travel through the ion channels.

This barely scrapes the surface on the process of action potential. Each step has a long list of activity occurring to make this process complete. In future college classes, each step will be fully explained in great detail.

**1.2 Organization of the Nervous System**

The nervous system has three main priorities: receive information, decide what to do with the information, and cause muscles or glands to react. By receiving information, a sensory function occurs using the **peripheral nervous system**. By deciding what to do with the information, the integrative function is carried out by the **central nervous system**. By finally acting upon the information, a motor function is resulted from the peripheral nervous system. All of this important information from the nervous system to organs is carried by **motor neurons**. Motor neurons can be called the nervous system’s “mailman” delivering information to the **effectors**. Efferent neurons carry information away from the central nervous system. Afferent neurons, or sensory neurons, carry information toward the central nervous system. All of these members work together to complete the tasks of the nervous system.

**Reflexes**

Whenever you go to the doctor, he or she taps you on the knee and your leg flies up without you trying to even move it. The doctor is checking your **reflexes**. Reflexes are simply an action of the nervous system. The doctor is testing the direct motor responding to sensory input. Whenever the reflex happens, it feels as if you never even thought about doing that action. This is true, because reflexes occur without any help from the brain. Instead of processing the information in the brain, the motor neuron in the spinal cord is stimulated. Also, two actions are happening at the same time. Our hamstring relaxes, while the quadriceps contracts. The sensory neuron that has been stimulated by the stretch, affects the quadriceps motor neuron and hamstring motor neuron. This relaxation and contraction is an example of **reciprocal inhibition**.

**Functional Organization**

The nervous system can be broken up into smaller categories. The nervous system can divide into two divisions: the central nervous system and the peripheral nervous system. The central nervous system includes the functions of the brain and spinal cord only. On the other hand, the peripheral nervous system includes all the nerves and sensory structures outside of the brain and spinal cord. The peripheral nervous system is then divided into two more divisions: **somatic** and **autonomic**. The somatic division consists of conscious sensation and all voluntary movement of skeletal muscles. The autonomic division is associated with digestion, metabolism, circulation, perspiration, and other involuntary processes. Finally, autonomic division is separated into sympathetic and parasympathetic. Sympathetic system is activated, causing the body to prepare for the “flight or flight” mode. When in parasympathetic system is activated, the body is in the “rest and digest” state.

* 1. **Anatomy of the Nervous System**

**The Central Nervous System**

As previously stated, the central nervous system includes the spinal cord and the brain. The spinal cord is protected by CSF and vertebral column to prevent any damage. The spinal cord is connected to the brain, and it is the pathway for information to and from the brain. The spinal cord is responsible for simple spinal reflexes. Also, it is involved in primitive processes. Examples of primitive processes are walking and sex organ functions.

The brain has three divisions: the hindbrain (or the rhombencephalon), the midbrain (or the mesencephalon), and the forebrain (or the prosencephalon).

The **hindbrain** consists of the **medulla**, **pons**, and the **cerebellum**. The medulla (or the medulla oblongata) is located just under the pons and is the area that meets the spinal cord. The medulla sends information to other parts of the brain, and it is in charge of vital autonomic functions. The pons is just above the medulla oblongata and below the midbrain. This area of the brain connects the brain stem to the cerebellum. The pons is the location for some autonomic functions. It is in control of movement, balance, and posture. The cerebellum is behind the pons and below the cerebral hemispheres. The cerebellum is at the back of our head. It is sometimes known as the “little brain” because it looks similar to cerebral cortex. Complex movements are controlled in the cerebellum. If any damage to this part of the brain happens, there will be a lack of normal hand-eye coordination and balance.

The **midbrain** is a place to process visual and auditory information, arousal, and wakefulness.

The **forebrain** includes the **diencephalon** and the **telencephalon**. The diencephalon consists of the **thalamus** and the **hypothalamus**. The thalamus is in the middle of the brain above the midbrain. Its main role is to process sensory information. The hypothalamus is an important part of the brain having multiple roles. It directly communicates with many parts of the brain. Controlling emotions and hormone production is just two things the hypothalamus is responsible for. The hypothalamus brings the nervous system and the endocrine system together by working with both simultaneously. It also controls the pituitary gland that is in control of the endocrine system.

Another region of the brain is the **cerebrum**. This is the largest portion of the brain and it consists of two hemispheres paired together. These hemispheres have the cerebral cortex, which is an outer layer of grey matter. Grey matter is full of countless somas. The other part of the cerebrum is an inner core of white matter. White matter contains myelinated axons. The two hemispheres is were all of our thought processes occur. Our intellectual functions depend on the two hemispheres performance. Also the hemispheres process somatic sensory and motor information.

The cerebral cortex is separated into four parts and each of the parts has a specific duty.

The four parts are called lobes. The **frontal** lobe is in charge of reasoning skills and problem solving. The **parietal** lobes consist of our sensations. The **temporal** lobes process auditory and olfactory sensation. Also, these lobes help with short-term memory, language, and emotion. Lastly, the **occipital** lobes process only visual sensations.

The **limbic** **system** of the brain involves the control of emotion, memory, and learning. The basal nuclei of the brain are focused only on controlling movement.

**Sensory Receptors**

Sensory receptors only detect one certain type of stimulus from the interior body or exterior activity. Sensory receptors can only understand one kind of information, and then takes that information and sends it to sensory neurons. If a stimulus happens from the outside world it is to be called **exteroceptors**. Internal stimulation is known as **interoceptors**. A few types of common sensory receptors are mechanoreceptors, chemoreceptors, nociceptors, thermoreceptors, and electromagnetic receptors. Mechanoreceptors stimulate from mechanical disturbances. Chemoreceptors respond to certain chemicals. Nociceptors are pain receptors, and stimulates whenever an injury to the skin tissue happens. Theremoreceptors recognize the changes in temperature. Electromagnetic receptors are stimulated by electromagnetic waves.

**1.4 Problems related to the Nervous System**

As you may have picked up from the first of the chapter, the nervous system has many jobs that make it run smoothly. The nervous system is a delicate system and injury can cause a wave of bad events to the body. It can be damaged by infections, trauma, tumors, autoimmune disorders, degeneration, blood flow disruption, and much more.

**Disorders of the Nervous System**

Doctors who help people with nervous system disorders are called a neurologist. These medical healthcare providers can preform neurological surgery to help with certain disorders or prescribe medicines to help pain.

**Infections**

Infections to the nervous system can result in death and should be taken seriously. Meningitis is an example of an infection that causes inflammation of the brain and spinal cord membranes. This airborne infection causes one to have a fever, headache, and a stiff neck. This is because the small area between the skull and the brain gets inflamed. Another infection to the nervous system is Polio. This infection can cause paralysis, but luckily today we have a vaccination to prevent the infections.

**Vascular Disorders**

An example of a vascular disorder is a stroke. During a stroke, the brain’s blood supply is interrupted and it can cause permeate damage to the brain. When a stroke begins, the person may have trouble walking or speaking. Parts of the body can become numb and this can be seen as an obvious stroke sign. The elderly are at the highest risks for strokes. During a Ischemic stroke, there is a clot in the brain’s artery. During a Hemorrhagic stroke, the artery actually ruptures.

**Structural Disorders**

Sometimes, damage to the nervous system can be because of an injury to either the spinal cord or the brain. Bell’s palsy, which is weakness to half of the face, usually can resolve on its own within six months. Unfortunately, muscles can permanently remain contracted.

**Functional Disorders**

Just a simple headache is considered a disorder of the nervous system. Dizziness and epilepsy are two more examples of a functional disorder. These may not be as serious as previously stated problems, but they do still matter.

**Degeneration**

Multiple sclerosis is a disease in which the immune system eats away at the protective covering of the nerves. If nerves become damaged, it can cause a list of reaction problems. The symptoms are extreme fatigue, pain, vision loss, and impaired coordination. Amyotrophic lateral sclerosis, or commonly known as ALS, is also a nervous system disease that weakens the muscles and consequently ruins physical function.

**References**

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