

Chapter 11

Nervous System II: Divisions of the Nervous System

1. Name the layers of the meninges and explain their functions.

The layers of the **meninges** surround the brain and spinal cord. They are, from the outermost to the innermost layers:

Dura mater—The dura mater is a tough, fibrous connective tissue layer containing many blood vessels and nerves. It functions as a protective layer, surrounding the brain and spinal cord.

Arachnoid mater—The arachnoid mater is a thin weblike membrane that lacks blood vessels and nerves. It is attached to the pia mater by thin strands.

Pia mater—The pia mater is a thin membrane containing many nerves and blood vessels that provide nourishment to the underlying brain cells and spinal cord. It is attached directly to the surface of the brain and spinal cord.

2. Describe the location of cerebrospinal fluid within the meninges.

Cerebrospinal fluid (CSF) is found between the arachnoid and pia mater of the brain and spinal cord in the space called the subarachnoid space.

3. Describe the location of the ventricles of the brain.

The **lateral ventricles** (*first and second ventricles*) extend into the cerebra hemispheres and occupy part of the frontal, temporal, and occipital lobes. The **third ventricle** is found in the midline of the brain, below the corpus callosum, and connects the lateral ventricles through openings in the anterior ends. The **fourth ventricle** is found in the brain stem in front of the cerebellum. The cerebral aqueduct connects openings in its roof that lead into the subarachnoid space of the meninges.

4. Explain how cerebrospinal fluid is produced and how it functions.

Cerebrospinal fluid (CSF) is secreted by tiny reddish cauliflower-like masses of specialized capillaries in the pia mater called choroid plexuses that project into the ventricles. CSF is important in the protection and support of the CNS by absorbing the forces of impact, maintaining a stable ion concentration, and providing a route for waste products to be removed.

5. Describe the structure of the spinal cord.

The **spinal cord** is a long slender column of nerve fibers that begins at the foramen magnum of the skull and extends downward to a point near the first and second lumbar vertebrae. The cord is actually a group of thirty-one segments that give rise to pairs of *spinal nerves*. These nerves connect all of the body to the CNS.

A thickening in the neck region, called the *cervical enlargement*, supplies the nerves to the arms and a similar thickening, the *lumbar enlargement*, supplies the nerves to the legs. Inferior to the lumbar enlargement, the spinal cord tapers into a structure (*conus medullaris*) that is connected to the coccyx by a thin cord of connective tissue (*filum terminale*).

Along the length of the cord are two grooves, the anterior median fissure and posterior median sulcus, which divide the cord into left and right halves. A cross section of the cord shows a gray matter core surrounded by white matter. The gray matter resembles a butterfly. The upper wings are called the *posterior horns* and the lower wings are called the *anterior horns*. Between these horns is a small protuberance called the *lateral horn*. A horizontal bar of gray matter surrounds the central canal and connects the wings on both sides. The white matter is divided on each side into three regions, the *anterior, lateral, and posterior funiculi*.

6. Describe a reflex arc.

A **reflex arc** is the simplest response to a stimulus. It begins with a receptor at the end of sensor nerve fibers. It travels to a reflex center in the CNS and an impulse is sent to an effector along a motor nerve fiber.

7. Define reflex.

A **reflex** is an automatic, subconscious response to stimuli inside or outside the body.

8. Describe a withdrawal reflex.

When a person touches something painful, receptors in the skin send impulses to interneurons in a reflex center in the spinal cord. The reflex center sends impulses to the flexor muscles of the affected part causing the part to be moved away. At the same time this is happening, impulses to the extensor muscles of the affected part are inhibited, so that the flexors can work more effectively. A phenomenon, called a crossed extensor reflex, occurs simultaneously with the initial reflex that causes the extensors of the opposite limb to contract.

9. Name the major ascending and descending tracts of the spinal cord, and list the functions of each.

The major ascending tracts are:

Fasiculus gracilis and **fasiculus cuneatus**—These tracts are found in the posterior funiculi and conduct sensory impulses from the skin, muscles, tendons, and joints. Most of the nerve fibers cross over in the medulla oblongata to their opposite sides.

Lateral and **anterior spinothalamic**—These tracts are located in the lateral and anterior funiculi. The lateral tracts conduct pain and temperature sensations from the body. The anterior tract conducts touch and pressure sensations from the body.

Posterior and **anterior spinocerebellar**—Both tracts are located near the surface of the lateral funiculi. The anterior tracts cross over in the spinal cord, while the posterior tracts do not. Both tracts conduct impulses from the legs and trunk to the cerebellum and aid in muscle coordination.

The major descending tracts are:

Lateral and **anterior corticospinal**—These tracts are found in the lateral and anterior funiculi. Most of the fibers in the lateral tracts cross over in the spinal cord, while the anterior tracts' fibers do not. Both of these tracts conduct impulses through the spinal nerves to various skeletal muscles to control voluntary movements. These tracts are also called pyramidal tracts because they pass through pyramid-shaped regions in the medulla oblongata.

Lateral, anterior, and **medial reticulospinal**—The lateral tracts are found in the lateral funiculi and the anterior and medial tracts are found in the anterior funiculi. Some of the nerve fibers in the lateral tracts are the only ones that cross over. None of the other tracts do. These tracts conduct impulses that control muscle tone and sweat gland activity.

Rubrospinal—These fibers are found in the lateral funiculi and cross over in the brain. These fibers conduct impulses to skeletal muscles to aid in muscle coordination and control posture.

10. Explain the consequences of nerve fibers crossing over.

Crossing over causes the impulses from one side of the body to be received and controlled by the opposite side of the brain.

11. Describe how the brain develops.

During embryonic development, the brain begins as a neural tube that gives rise to the CNS. At one end there are three major cavities or vesicles: the forebrain (prosencephalon), midbrain (mesencephalon), and hindbrain (rhombencephalon). The forebrain divides into the anterior (telencephalon) and posterior (diencephalon) portions. The hindbrain partially divides into the metencephalon and myelencephalon. These five cavities in the mature brain become the ventricles and the tubes that connect them. The tissue of the telencephalon becomes the cerebrum and basal ganglia while the diencephalon remains unchanged. The midbrain continues to mature and is still called the midbrain in the adult structure. The hindbrain matures into the cerebella, pons, and medulla oblongata. The brain stem is comprised of the midbrain, pons, and medulla oblongata and connects the brain to the spinal cord.

12. Describe the structure of the cerebrum.

The **cerebrum** consists of two cerebral hemispheres separated by a layer of dura mater called the falx cerebri and connected deeply by a nerve fiber bundle called the corpus callosum. The hemispheres are marked by many convolutions separated by shallow grooves called sulci (sing. sulcus) and deep grooves called fissures. These grooves form distinct patterns. For instance, the longitudinal fissure

separates left and right hemispheres, and the transverse fissure separates the cerebrum from the cerebellum.

Various sulci divide each hemisphere into lobes names after the skull bones they underlie. They are:

Frontal lobe—The frontal lobe forms the anterior portion of each cerebral hemisphere, and lies in front of the central sulcus (fissure of Rolando) and above the lateral sulcus (fissure of Sylvius).

Parietal lobe—The parietal lobe lies behind the central sulcus and frontal lobe.

Temporal lobe—The temporal lobe lies below the frontal and parietal lobes, separated by the lateral sulcus.

Occipital lobe—The occipital lobe is the posterior portion of each hemisphere separated from the cerebellum by the tentorium cerebelli. There is no clear boundary between the temporal, parietal, and occipital lobes.

Insula—The insula (island of Reil) is found deep in the lateral sulcus and is separated from the frontal, parietal, and temporal lobes by a circular sulcus.

13. Define cerebral cortex.

The **cerebral cortex** is the outermost layer of the cerebrum and is a layer of gray matter that contains 75 percent of all neuron bodies in the nervous system.

14. Describe the location and function of the primary motor areas of the cortex.

The primary motor areas of the cerebral cortex lie in the frontal lobes along the anterior wall of the central gyrus. Large pyramidal cells are responsible for nerve impulses sent through the corticospinal tracts to voluntary muscles. Impulses from the upper parts of the motor areas control muscles in the legs and thighs; the middle portion control muscles in the shoulders and arms; and the lower portions control the muscles of the head, face, and tongue.

15. Describe the location and function of Broca's area.

Broca's area is found just anterior to the primary motor cortex usually in the left hemisphere. It is responsible for complex muscular coordination of the mouth, tongue, and larynx, which make speech possible.

16. Describe the location and function of the sensory areas of the cortex.

The sensory areas for temperature, touch, pressure, and pain in the skin are found in the anterior portion of the parietal lobes along the central sulcus. Vision sensory areas are found in the posterior portion of the occipital lobes. The sensory areas for hearing are found in the dorsal posterior portion of the temporal lobes. The sensory areas for taste are found near the base of the central sulci along the lateral sulci and the sense of smell arises from deep in the cerebrum.

17. Explain the function of the association areas of the lobes of the cerebrum.

The association areas are found in the anterior frontal lobes, and in the lateral areas of the parietal, temporal, and occipital lobes. These function to analyze and interpret sensory experiences involving memory, reasoning, verbalizing, judgement, and emotions. The association areas of the frontal lobes deal with concentration, planning, problem solving, and judging the consequences of behavior. The areas of the parietal lobes deal with the understanding speech and word choice for thought expression. The areas of the temporal lobes deal with complex sensory interpretation, such as reading, music, and memories of visual scenes. The areas of the occipital lobes deal with visual pattern analysis and combining these images with other sensory experiences.

18. Define hemisphere dominance.

Although both hemispheres participate in basic functions, in most people, one hemisphere is dominant over the other. For instance, in over 90 percent of the population, the left hemisphere controls language activities such as reading, speech, and writing as well as complex intellectual functions requiring verbal, analytical, and computational skills. The nondominant hemisphere seems to be more in control of the nonverbal activities such as spacial orientation, interpreting musical patterns, visual experiences, and emotional and intuitive thought.

19. Explain the function of the corpus callosum.

The nerve fibers of the **corpus callosum** allow the dominant hemisphere to receive sensory information sent to the nondominant hemisphere for use in decision making by the general interpretive areas. It also allows the dominant hemisphere to control the motor cortex of the nondominant one.

20. Distinguish between short-term and long-term memory.

Short-term memories are thought to be electrical in nature such that the neurons are connected in a circuit so that the last in the series stimulates the first. As long as the stimulation continues, the thought is remembered. When it ceases, so does the memory, unless it enters long-term memory.

Long-term memories appear to change the structure or function of certain neurons that enhance synaptic transmission. The synaptic patterns must meet two requirements of long-term memory. First, there must be enough synapses to encode an almost infinite number of memories. Second, the pattern of synapses can remain unchanged for years.

21. Describe the location and function of the basal nuclei.

The **basal ganglia** (basal nuclei) are masses of gray matter found deep in the cerebral hemispheres. They are the caudate nucleus, the putamen, and the globus pallidus and are responsible for producing most of the inhibitory neurotransmitter dopamine. Impulses from the basal ganglia inhibit motor functions, controlling certain muscular activities.

22. Name the parts of the diencephalon, and describe the general functions of each.

Diencephalon—The diencephalon contains many parts:

Thalamus—The thalamus serves as a central relay for sensory impulses ascending from other parts of the body. It receives all impulses except for smell, and routes them to the appropriate areas of the cortex. It also interprets general feelings such as pain, touch, and temperature. The thalamus also transmits sensory information by synchronizing action potentials. In this way, it serves as a messenger and an editor.

Hypothalamus—The hypothalamus is interconnected to the cortex and all areas of the brain stem so that it can send and receive impulses to and from these areas. It plays a key role in maintaining homeostasis by regulating visceral activities and serving as a link between the nervous and endocrine system.

Optic tracts and optic chiasma—These are formed as the optic nerve fibers cross over.

Infundibulum—The infundibulum attaches the pituitary gland to the brain stem.

Other parts include the: **posterior pituitary gland, mammillary bodies, and the pineal gland.**

23. Define the limbic system, and explain its functions.

The **limbic system** controls emotional experience and expression. It produces feelings of fear, anger, pleasure, and sorrow. It apparently recognizes upsets in a person's physical or psychological condition that could be life threatening. By relating pleasant or unpleasant feelings about experiences, it guides behaviors that may increase the chance of survival. It also interprets sensory impulses from the olfactory receptors.

24. Name the parts of the midbrain, and describe the general functions of each.

The **midbrain** joins the lower parts of the brain stem and spinal cord with the higher parts of the brain. It also contains certain reflex centers. Two bundles of nerve fibers called the cerebral peduncles lie on the underside of the midbrain and form the corticospinal tracts, which are the main motor pathways between the cerebrum and lower parts of the nervous system. Two pairs of rounded knobs called the corpora quadrigemina provide centers for certain visual reflexes and the auditory reflex centers. In the center of the midbrain is a mass of gray matter called the red nucleus, which provides posture-maintaining reflexes.

25. Describe the pons and its functions.

The **pons** is a rounded bulge on the inferior side of the brain stem where it separates the midbrain from the medulla oblongata. The dorsal portion of the pons relays impulses between the medulla oblongata and the cerebrum. The ventral portion relays impulses from the cerebrum to the cerebellum.

The pons also relays impulses from the peripheral nerves to higher brain centers. It also works with the medulla oblongata to regulate rate and depth of breathing.

26. Describe the medulla oblongata and its functions.

The **medulla oblongata** is an enlarged continuation of the spinal cord at its superior end. It extends from the foramen magnum to the pons. Because of its location, all ascending and descending nerve fibers connecting the brain and the spinal cord must pass through it. Some of the nuclei in the gray matter relay ascending impulses to the other side of the brain stem and higher brain centers. Other nuclei control vital visceral activities and are called the cardiac center, the vasomotor center, and the respiratory center.

27. Describe the location and function of the reticular formation.

The **reticular formation** is scattered throughout the medulla oblongata, pons, and midbrain as a complex network of nerve fibers associating with small islands of gray matter. It extends from the superior portion of the spinal cord through to the diencephalon and connects the hypothalamus, basal ganglia, cerebellum, and cerebrum with fibers in all the major ascending and descending tracts. Because the cerebral cortex is totally dependent on sensory impulses for its awareness of the external environment, the reticular formation is responsible for activating it into a state of wakefulness. Decreased activity in the reticular formation causes sleep. The reticular formation also filters incoming sensory impulses to prevent the cortex from being constantly bombarded by sensory stimulation, and allows it to concentrate on the significant information. The cerebral cortex can also activate the reticular formation during intense cerebral activities, keeping a person awake.

28. Distinguish between normal and paradoxical sleep.

Normal sleep (*slow wave or non-REM*) occurs when a person is very tired and is caused by decreased activity of the reticular formation. It is restful, dreamless, and accompanied by reduced blood pressure and respiratory rate. **Paradoxical sleep** (*REM sleep*) is so named because some areas of the brain are active. It is identified by dreaming, rapid eye movement beneath the eyelids, and irregular respiratory and heart rates.

29. Describe the functions of the cerebellum.

The main function of the **cerebellum** is to serve as the reflex center for control of body part positions in response to sensory information from various nerve centers. It is the primary area for control of the complex skeletal movements involved in posture and locomotion. To accomplish this, the cerebellum communicates with the body and brain via three pairs of nerve tracts:

Inferior peduncles—This pair receives sensory information concerning limb, joint, and other body part positions.

Middle peduncles—This pair sends impulses concerning the desired position of these body parts from the cerebrum to the cerebellum.

Superior peduncles—This pair sends the newly integrated information through the pons, medulla oblongata, and spinal cord as motor impulses to the skeletal muscles concerned.

Damage to the cerebellum will cause tremors, muscle tone loss, reeling walk, loss of equilibrium, and inaccurate muscle movements.

30. Distinguish between the somatic and autonomic nervous systems.

The **somatic nervous system** is a division of the peripheral nervous system (PNS) and consists of cranial and spinal nerves that oversee conscious activities. The **autonomic nervous system** is the other division of the PNS and includes the fibers that connect the central nervous system (CNS) to the viscera. It controls unconscious activities.

31. Describe the structure of a peripheral nerve.

A **peripheral nerve** consists of nerve fiber bundles surrounded by connective tissue. Each bundle of nerve fibers (fascicle) is encased in a sleeve of connective tissue called the perineurium, which is in turn, enclosed by dense collagenous fibers called the epineurium. The individual nerve fibers are surrounded by loose connective tissue called the endoneurium within the perineurium.

32. Distinguish between sensory, motor, and mixed nerves.

Nerves that carry impulses to the CNS are called **sensory nerves**. Nerves that carry impulses from the CNS to muscles or glands are called **motor nerves**. Nerves that perform both functions are called **mixed nerves**.

33. List four general types of nerve fibers.

The four general types of nerve fibers are: **general somatic efferent fibers, general somatic afferent fibers, general visceral efferent fibers, and general visceral afferent fibers.**

34. Name, locate, and describe the major functions of each pair of cranial nerves.

Olfactory nerves (I)—This pair serves as olfactory receptor nerve fibers that being as olfactory bulbs in the nasal linings. They pass through the cribriform places as olfactory tracts to cerebral centers for interpretation as sensations of smell.

Optic nerves (II)—These lead from the eyes to the brain and are associated with the sense of sight.

Oculomotor nerves (III)—These arise from the midbrain and pass into the orbits of the eyes. These function to raise the eyelid, innervate muscles that move the eye, and allow the eye to adjust the amount of light entering the eyes and allow the lens to focus.

Trochlear nerves (IV)—These arise from the midbrain and carry motor impulses to certain voluntary muscles that move the eyes but are not supplied by the oculomotor nerves.

Trigeminal nerves (V)—These are the largest and arise from the pons. These are mixed nerves that have three major branches:

Ophthalmic division—Bring sensory impulses to the brain from the surface of the eyes, the tear glands, and the skin of the anterior scalp, forehead, and upper eyelids.

Maxillary division—Carry sensory impulses from the upper teeth, upper gum, and upper lip, as well as from the mucous lining of the palate and the skin of the face.

Mandibular division—Transmits impulses from the scalp behind the ears, the skin of the jaw, the lower teeth, the lower gum, and the lower lip. It has motor branches that supply the muscles of mastication, and certain muscles in the floor of the mouth.

Abducens nerve (VI)—These originate from the pons and enter the orbits of the eyes and supply motor impulses to a pair of muscles that move the eyes.

Facial nerves (VII)—These arise from the lower part of the pons and emerge on the sides of the face. The sensory branches are associated with taste receptors on the tongue. The motor fibers transmit impulses to the muscles of facial expression while others function in the autonomic nervous system and stimulate secretions from the tear glands and salivary glands.

Vestibulocochlear nerves (VIII)—These sensory nerves that arise from the medulla oblongata. There are two distinct parts:

Vestibular branch—Located in the ganglia associated with the parts of the inner ear and serve to help to maintain equilibrium.

Cochlear branch—Located in parts of the inner ear that house the hearing receptors. Impulses from this branch pass through the pons and medulla oblongata on their way to the temporal lobes for interpretation.

Glossopharyngeal nerves (IX)—These arise from the medulla oblongata and are associated with the tongue and pharynx. These are mixed nerves but are predominantly sensory. They carry impulses from the linings of the pharynx, tonsils and posterior third of the tongue to the brain. The motor portion innervates muscles of the pharynx that function in swallowing.

Vagus nerves (X)—These originate in the medulla oblongata and extend downward into the chest and abdomen. These are mixed nerves containing both autonomic and somatic branches. The autonomic are the predominate ones, associated with speech, swallowing, and motor activity of the smooth muscles and glands in the thorax and abdomen.

Accessory nerves (XI)—These originate in the medulla oblongata and the spinal cord. The cranial branch joins a vagus nerve and carries impulses to muscles of the soft palate, pharynx and larynx.

Hypoglossal nerves (XII)—These arise from the medulla oblongata and pass into the tongue. These work on tongue muscles that function in speaking, chewing, and swallowing.

35. Explain how the spinal nerves are grouped and numbered.

They are grouped according to the level from which they arise, and each nerve is numbered in sequence. There are eight pairs of *cervical spinal nerves*, twelve pairs of *thoracic spinal nerves*, five pairs of *sacral spinal nerves*, and one pair of *coccygeal nerves*.

36. Define cauda equina.

The **cauda equina** is so named because in the adult, the spinal cord ends between the first and second lumbar vertebrae. Because of this the lumbar, sacral, and coccygeal nerves must descend down the spinal column to the exit points resembling a horse's tail.

37. Describe the structure of a spinal nerve.

Each **spinal nerve** emerges from the spinal cord by two short branches that lie within the vertebral column. The dorsal root is also called the posterior or sensory root. It can be identified by the dorsal root ganglion. This root conducts sensory impulses inward from the peripheral body parts. The ventral root is also called the anterior or motor root. It consists of axons from the motor neurons. The roots unite to form a spinal nerve, which extends outward from the vertebral canal through and intervertebral foramen. Each spinal nerve splits into three parts called the meningeal, posterior, and anterior branches. Spinal nerves in the thoracic and lumbar regions have a fourth or visceral branch, which supplies the autonomic nerve fibers.

38. Define plexus, and locate the major plexuses of the spinal nerves.

A **plexus** is the main portion of the spinal nerves that have combined to form complex networks. Except in the thoracic region, anterior branches of the spinal nerves provide the network for the plexus. In a plexus, the fibers of various spinal nerves are sorted and recombined so that the fibers associated with a particular peripheral body part reach it in the same nerve, even though the fibers originate from different spinal nerves. There are three main plexuses:

Cervical plexuses—Supply the muscles of the skin and neck and the phrenic nerves innervate the diaphragm.

Brachial plexuses—Supply the muscles and skin of the arm, forearm, and hand.

Lumbosacral plexuses—Give rise to motor and sensory fibers associated with the muscles and skin of the lower abdominal wall, external genitalia, buttocks, thighs, legs, and feet.

39. Distinguish between the sympathetic and parasympathetic division of the autonomic nervous system.

The **sympathetic division** of the autonomic nervous system is concerned primarily with preparing the body for energy-expending, stressful, or emergency situations. The **parasympathetic division** is active under ordinary, restful conditions. It counterbalances the effects of the sympathetic division and restores the body to a resting state following a stressful experience.

40. Explain how autonomic ganglia provide a degree of independence from the central nervous system.

Sensory impulses from the viscera and skin are sent along afferent nerve fibers to centers in the brain or spinal cord. The CNS reacts by sending motor impulses out of these centers on efferent nerve fibers along spinal and cranial nerves. These efferent fibers join the ganglia outside the CNS and integrate within the ganglia to affect various organs. This integration within the ganglia provides some independence from the CNS by deciding to what degree these organs will respond.

41. Distinguish between a preganglionic fiber and a postganglionic fiber.

The **preganglionic fiber** is the axon of the first neuron in the two neuron autonomic system. Its cell body is located in the CNS and forms a synapse with one or more nerve fibers whose cell bodies are housed within an autonomic ganglion. The axon of the second neuron is called the **postganglionic fiber**, because it extends from the ganglia to a visceral effector.

42. Define paravertebral ganglion.

Paravertebral ganglia are two groups of ganglia whose preganglionic fibers split from the spinal nerves of the thoracolumbar division at branches called white rami. They are located as chains along the sides of the vertebral column and comprise part of the sympathetic trunks.

43. Trace a sympathetic nerve pathway through a ganglion to an effector.

The pathway begins with the neuron in the lateral horn of the spinal cord. Its preganglionic fiber exits through the ventral roots of spinal nerves. It branches off in segments called white rami and enters the paravertebral ganglia (forming sympathetic trunks). Some fibers synapse with these ganglia while others pass through to other paravertebral ganglia or on to, or beyond, the collateral ganglia. The postganglionic fibers extend out to the visceral effectors. The fibers leaving the paravertebral ganglia usually pass through gray rami and return to a spinal nerve before synapsing with an effector.

44. Explain why the effects of the sympathetic and parasympathetic autonomic divisions differ.

This is due to the differing postganglionic neurotransmitters from the sympathetic and parasympathetic ganglionic nerve fibers.

45. Distinguish between cholinergic and adrenergic nerve fibers.

With a few exceptions, the preganglionic fibers of both the sympathetic and parasympathetic divisions, and the postganglionic fibers of the parasympathetic division, secrete acetylcholine, and are thus called **cholinergic fibers**. The postganglionic sympathetic fibers secrete norepinephrine (noradrenalin), and are thus called **adrenergic fibers**.

46. Define sympathetic tone.

Sympathetic tone is a maintained state of partial contraction of muscles stimulated by only the sympathetic division.

47. Explain how autonomic neurotransmitters influence the actions of effector cells.

Autonomic transmitters act by binding to protein receptors of effect cell membranes. This receptor binding alters the membrane in certain ways to produce the desired effect. Muscarinic receptors are found in the membranes of all effector cells at the end of postganglionic parasympathetic and cholinergic sympathetic nerve fibers. Nicotinic receptors are found in the synapses between the pre- and postganglionic neurons of the postganglionic neurons of the sympathetic and parasympathetic pathways.

48. Distinguish between alpha adrenergic and beta adrenergic receptors.

Alpha adrenergic receptors are responsible for smooth muscle contraction causing vasoconstriction. Stimulation of the **beta receptors**, however, will cause smooth muscle relaxation leading to bronchodilation in the lungs. In essence, stimulation of alpha receptors is constrictive in nature, which stimulation of beta receptors will cause dilation.

49. Describe three examples in which the central nervous system employs autonomic nerve pathways.

The central nervous system (CNS) uses the autonomic nervous system to control the cardiac, vasomotor, and respiratory activities in the medulla oblongata by reacting to impulses from the vagus nerve and sending impulses along autonomic nerve pathways to stimulate motor responses in muscles and glands. The hypothalamus helps to regulate body temperature, hunger, thirst, and water and electrolyte balance by influencing autonomic pathways. The limbic system and cerebral cortex use the autonomic nervous system to regulate various behaviors during emotional stress.