Introduction to the Nervous System

The nervous system is the major controlling, regulatory, and communicating system in the body. It is the center of all mental activity including thought, learning, and memory. Together with the endocrine system, the nervous system is responsible for regulating and maintaining homeostasis. Through its receptors, the nervous system keeps us in touch with our environment, both external and internal.

Like other systems in the body, the nervous system is composed of organs, principally the brain, spinal cord, nerves, and ganglia. These, in turn, consist of various tissues, including nerve, blood, and connective tissue. Together these carry out the complex activities of the nervous system.

The various activities of the nervous system can be grouped together as three general, overlapping functions:

- Sensory
- Integrative
- Motor

Millions of sensory receptors detect changes, called stimuli, which occur inside and outside the body. They monitor such things as temperature, light, and sound from the external environment. Inside the body, the internal environment, receptors detect variations in pressure, pH, carbon dioxide concentration, and the levels of various electrolytes. All of this gathered information is called sensory input.
Sensory input is converted into electrical signals called nerve impulses that are transmitted to the brain. There the signals are brought together to create sensations, to produce thoughts, or to add to memory; Decisions are made each moment based on the sensory input. This is integration.

Based on the sensory input and integration, the nervous system responds by sending signals to muscles, causing them to contract, or to glands, causing them to produce secretions. Muscles and glands are called effectors because they cause an effect in response to directions from the nervous system. This is the motor output or motor function.

**Nerve Tissue**

Although the nervous system is very complex, there are only two main types of cells in nerve tissue. The actual nerve cell is the neuron. It is the "conducting" cell that transmits impulses and the structural unit of the nervous system. The other type of cell is neuroglia, or glial, cell. The word "neuroglia" means "nerve glue." These cells are nonconductive and provide a support system for the neurons. They are a special type of "connective tissue" for the nervous system.

**Neurons**

Neurons, or nerve cells, carry out the functions of the nervous system by conducting nerve impulses. They are highly specialized and amitotic. This means that if a neuron is destroyed, it cannot be replaced because neurons do not go through mitosis. The image below illustrates the structure of a typical neuron.

![Structure of a Typical Neuron](image)

Each neuron has three basic parts: cell body (soma), one or more dendrites, and a single axon.

**Cell Body**

In many ways, the cell body is similar to other types of cells. It has a nucleus with at least one nucleolus and contains many of the typical cytoplasmic organelles. It lacks centrioles, however. Because centrioles function in cell division, the fact that neurons lack these organelles is consistent with the amitotic nature of the cell.

**Dendrites**

Dendrites and axons are cytoplasmic extensions, or processes, that project from the cell body. They are sometimes referred to as fibers. Dendrites are usually, but not always, short and branching, which increases their surface area to receive signals from other neurons. The number of dendrites on a neuron varies. They are called afferent processes because they transmit impulses to the neuron cell body. There is only one axon that projects from each cell body. It is usually elongated and because it carries impulses away from the cell body, it is called an efferent process.

**Axon**

An axon may have infrequent branches called axon collaterals. Axons and axon collaterals terminate in many short branches or telodendria. The distal ends of the telodendria are slightly enlarged to form synaptic bulbs. Many axons are surrounded by a segmented, white, fatty substance called *myelin* or the myelin sheath. Myelinated fibers make up the white matter in the CNS, while cell bodies and unmyelinated fibers make the gray matter. The unmyelinated regions between the myelin segments are called the nodes of Ranvier.

In the peripheral nervous system, the myelin is produced by Schwann cells. The cytoplasm, nucleus, and outer cell membrane of the Schwann cell form a tight covering around the myelin and around the axon itself at the nodes of Ranvier. This covering is the neurilemma, which plays an important role in the regeneration of nerve fibers. In the CNS, oligodendrocytes produce myelin, but there is no neurilemma,
which is why fibers within the CNS do not regenerate.

Functionally, neurons are classified as afferent, efferent, or interneurons (association neurons) according to the direction in which they transmit impulses relative to the central nervous system. Afferent, or sensory, neurons carry impulses from peripheral sense receptors to the CNS. They usually have long dendrites and relatively short axons. Efferent, or motor, neurons transmit impulses from the CNS to effector organs such as muscles and glands. Efferent neurons usually have short dendrites and long axons. Interneurons, or association neurons, are located entirely within the CNS in which they form the connecting link between the afferent and efferent neurons. They have short dendrites and may have either a short or long axon.

**Neuroglia**

Neuroglia cells do not conduct nerve impulses, but instead, they support, nourish, and protect the neurons. They are far more numerous than neurons and, unlike neurons, are capable of mitosis.

**Tumors**

Schwannomas are benign tumors of the peripheral nervous system which commonly occur in their sporadic, solitary form in otherwise normal individuals. Rarely, individuals develop multiple schwannomas arising from one or many elements of the peripheral nervous system.

Commonly called a Morton's Neuroma, this problem is a fairly common benign nerve growth and begins when the outer coating of a nerve in your foot thickens. This thickening is caused by irritation of branches of the medial and lateral plantar nerves that results when two bones repeatedly rub together.

**Organization of the Nervous System**

Although terminology seems to indicate otherwise, there is really only one nervous system in the body. Although each subdivision of the system is also called a "nervous system," all of these smaller systems belong to the single, highly integrated nervous system. Each subdivision has structural and functional characteristics that distinguish it from the others. The nervous system as a whole is divided into two subdivisions: the central nervous system (CNS) and the peripheral nervous system (PNS).

**The Central Nervous System**

The brain and spinal cord are the organs of the central nervous system. Because they are so vitally important, the brain and spinal cord, located in the dorsal body cavity, are encased in bone for protection. The brain is in the cranial vault, and the spinal cord is in the vertebral canal of the vertebral column. Although considered to be two separate organs, the brain and spinal cord are continuous at the foramen magnum.

**The Peripheral Nervous System**

The organs of the peripheral nervous system are the nerves and ganglia. Nerves are bundles of nerve fibers, much like muscles are bundles of muscle fibers. Cranial nerves and spinal nerves extend from the CNS to peripheral organs such as muscles and glands. Ganglia are collections, or small knots, of nerve cell bodies outside the CNS.

The peripheral nervous system is further subdivided into an afferent (sensory) division and an efferent (motor) division. The afferent or
sensory division transmits impulses from peripheral organs to the CNS. The efferent or motor division transmits impulses from the CNS out to the peripheral organs to cause an effect or action.

Finally, the efferent or motor division is again subdivided into the somatic nervous system and the autonomic nervous system. The somatic nervous system, also called the somatmotor or somatic efferent nervous system, supplies motor impulses to the skeletal muscles. Because these nerves permit conscious control of the skeletal muscles, it is sometimes called the voluntary nervous system. The autonomic nervous system, also called the visceral efferent nervous system, supplies motor impulses to cardiac muscle, to smooth muscle, and to glandular epithelium. It is further subdivided into sympathetic and parasympathetic divisions. Because the autonomic nervous system regulates involuntary or automatic functions, it is called the involuntary nervous system.

The Central Nervous System

The Central Nervous System space, is filled with cerebrospinal fluid and contains blood vessels. The pia mater is the innermost layer of meninges. This thin, delicate membrane is tightly bound to the surface of the brain and spinal cord and cannot be dissected away without damaging the surface.

Meningiomas are tumors of the nerve tissue covering the brain and spinal cord. Although meningiomas are usually not likely to spread, physicians often treat them as though they were malignant to treat symptoms that may develop when a tumor applies pressure to the brain.

Brain

The brain is divided into the cerebrum, diencephalons, brain stem, and cerebellum.

Cerebrum

The largest and most obvious portion of the brain is the cerebrum, which is divided by a deep longitudinal fissure into two cerebral hemispheres. The two hemispheres are two separate entities but are connected by an arching band of white fibers, called the corpus callosum that provides a communication pathway between the two halves.

Each cerebral hemisphere is divided into five lobes, four of which have the same name as the bone over them: the frontal lobe, the parietal lobe, the occipital lobe, and the temporal lobe. A fifth lobe, the insula or Island of Reil, lies deep within the lateral sulcus.
**Diencephalon**

The diencephalon is centrally located and is nearly surrounded by the cerebral hemispheres. It includes the thalamus, hypothalamus, and epithalamus. The thalamus, about 80 percent of the diencephalon, consists of two oval masses of gray matter that serve as relay stations for sensory impulses, except for the sense of smell, going to the cerebral cortex. The hypothalamus is a small region below the thalamus, which plays a key role in maintaining homeostasis because it regulates many visceral activities. The epithalamus is the most dorsal portion of the diencephalon. This small gland is involved with the onset of puberty and rhythmic cycles in the body. It is like a biological clock.

**Brain Stem**

The brain stem is the region between the diencephalon and the spinal cord. It consists of three parts: midbrain, pons, and medulla oblongata. The midbrain is the most superior portion of the brain stem. The pons is the bulging middle portion of the brain stem. This region primarily consists of nerve fibers that form conduction tracts between the higher brain centers and spinal cord. The medulla oblongata, or simply medulla, extends inferiorly from the pons. It is continuous with the spinal cord at the foramen magnum. All the ascending (sensory) and descending (motor) nerve fibers connecting the brain and spinal cord pass through the medulla.

**Cerebellum**

The cerebellum, the second largest portion of the brain, is located below the occipital lobes of the cerebrum. Three paired bundles of myelinated nerve fibers, called cerebellar peduncles, form communication pathways between the cerebellum and other parts of the central nervous system.

**Ventricles and Cerebrospinal Fluid**

A series of interconnected, fluid-filled cavities are found within the brain. These cavities are the ventricles of the brain, and the fluid is cerebrospinal fluid (CSF).

**Spinal Cord**

The spinal cord extends from the foramen magnum at the base of the skull to the level of the first lumbar vertebra. The cord is continuous with the medulla oblongata at the foramen magnum. Like the brain, the spinal cord is surrounded by bone, meninges, and cerebrospinal fluid.

The spinal cord is divided into 31 segments with each segment giving rise to a pair of spinal nerves. At the distal end of the cord, many spinal nerves extend beyond the conus medullaris to form a collection that resembles a horse's tail. This is the cauda equina. In cross section, the spinal cord appears oval in shape.

The spinal cord has two main functions:
Serving as a conduction pathway for impulses going to and from the brain. Sensory impulses travel to the brain on ascending tracts in the cord. Motor impulses travel on descending tracts.

Serving as a reflex center. The reflex arc is the functional unit of the nervous system. Reflexes are responses to stimuli that do not require conscious thought and consequently, they occur more quickly than reactions that require thought processes. For example, with the withdrawal reflex, the reflex action withdraws the affected part before you are aware of the pain. Many reflexes are mediated in the spinal cord without going to the higher brain centers.

The Peripheral Nervous System

The peripheral nervous system consists of the nerves that branch out from the brain and spinal cord. These nerves form the communication network between the CNS and the body parts. The peripheral nervous system is further subdivided into the somatic nervous system and the autonomic nervous system. The somatic nervous system consists of nerves that go to the skin and muscles and is involved in conscious activities. The autonomic nervous system consists of nerves that connect the CNS to the visceral organs such as the heart, stomach, and intestines. It mediates unconscious activities.

Structure of a Nerve

A nerve contains bundles of nerve fibers, either axons or dendrites, surrounded by connective tissue. Sensory nerves contain only afferent fibers, long dendrites of sensory neurons. Motor nerves have only efferent fibers, long axons of motor neurons. Mixed nerves contain both types of fibers.

A connective tissue sheath called the epineurium surrounds each nerve. Each bundle of nerve fibers is called a fasciculus and is surrounded by a layer of connective tissue called the perineurium. Within the fasciculus, each individual nerve fiber, with its myelin and neurilemma, is surrounded by connective tissue called the endoneurium. A nerve may also have blood vessels enclosed in its connective tissue wrappings.

Cranial Nerves

Twelve pairs of cranial nerves emerge from the inferior surface of the brain. All of these nerves, except the vagus nerve, pass through foramina of the skull to innervate structures in the head, neck, and facial region.

The cranial nerves are designated both by name and by Roman numerals, according to the order in which they appear on the inferior surface of the brain. Most of the nerves have both sensory and motor components. Three of the nerves are associated with the special senses of smell, vision, hearing, and equilibrium and have only sensory fibers. Five other nerves are primarily motor in function but do have some sensory fibers for proprioception. The remaining four nerves consist of significant amounts of both sensory and motor fibers.

Spinal Nerves

Thirty-one pairs of spinal nerves emerge laterally from the spinal cord. Each pair of nerves corresponds to a segment of the cord and they are named accordingly. This means there are 8 cervical nerves, 12 thoracic nerves, 5 lumbar nerves, 5 sacral nerves, and 1 coccygeal nerve.

Each spinal nerve is connected to the spinal cord by a dorsal root and a ventral root. The cell bodies of the sensory neurons are in the dorsal root ganglion, but the motor neuron cell bodies are in the gray matter. The two roots join to form the spinal nerve just before the nerve leaves the vertebral column. Because all spinal nerves have
both sensory and motor components, they are all mixed nerves.

**Autonomic Nervous System**

The autonomic nervous system is a visceral efferent system, which means it sends motor impulses to the visceral organs. It functions automatically and continuously, without conscious effort, to innervate smooth muscle, cardiac muscle, and glands. It is concerned with heart rate, breathing rate, blood pressure, body temperature, and other visceral activities that work together to maintain homeostasis.

The autonomic nervous system has two parts, the sympathetic division and the parasympathetic division. Many visceral organs are supplied with fibers from both divisions. In this case, one stimulates and the other inhibits. This antagonistic functional relationship serves as a balance to help maintain homeostasis.

**Review: Introduction to the Nervous System**

Here is what we have learned from this *Introduction to the Nervous System*:

- The nervous system is the major controlling, regulatory, and communicating system in the body. It is the center of all mental activity including thought, learning, and memory.
- The various activities of the nervous system can be grouped together as three general, overlapping functions: sensory, integrative, and motor.
- Neurons are the nerve cells that transmit impulses. Supporting cells are neuroglia.
- The three components of a neuron are a cell body or soma, one or more afferent processes called dendrites, and a single efferent process called an axon.
- The central nervous system consists of the brain and spinal cord. Cranial nerves, spinal nerves, and ganglia make up the peripheral nervous system.
- The afferent division of the peripheral nervous system carries impulses to the CNS; the efferent division carries impulses away from the CNS.

- There are three layers of meninges around the brain and spinal cord. The outer layer is dura mater, the middle layer is arachnoid, and the innermost layer is pia mater.
- The spinal cord functions as a conduction pathway and as a reflex center. Sensory impulses travel to the brain on ascending tracts in the cord. Motor impulses travel on descending tracts.

**Disorders and Diseases of the Nervous System**

**Meningitis**

Meningitis is an inflammation of the membranes (meninges) surrounding the brain and spinal cord, usually due to the spread of an infection. The swelling associated with meningitis often triggers the "hallmark" signs and symptoms of this condition, including headache, fever and a stiff neck in anyone over the age of 2.

Most cases of meningitis are caused by a viral infection, but bacterial and fungal infections also can lead to meningitis. Depending on the cause of the infection, meningitis can resolve on its own in a couple of weeks — or it can be a life-threatening emergency.

It's easy to mistake the early signs and symptoms of meningitis for the flu (influenza). Meningitis signs and symptoms may develop over several hours or over one or two days and, in anyone over the age of 2, typically include:

- High fever
- Severe headache that isn't easily confused with other types of headache
- Stiff neck
- Vomiting or nausea with headache
- Confusion or difficulty concentrating — in the very young, this may appear as inability to maintain eye contact
- Seizures
- Sleepiness or difficulty waking up
- Sensitivity to light
- Lack of interest in drinking and eating
- Skin rash in some cases, such as in viral or meningococcal meningitis
**Signs in newborns**
Newborns and infants may not have the classic signs and symptoms of headache and stiff neck. Instead, signs of meningitis in this age group may include:

- High fever
- Constant crying
- Excessive sleepiness or irritability
- Inactivity or sluggishness
- Poor feeding
- A bulge in the soft spot on top of a baby's head (fontanel)
- Stiffness in a baby's body and neck
- Seizures

Infants with meningitis may be difficult to comfort, and may even cry harder when picked up.

The complications of meningitis can be severe. The longer you or your child has the disease without treatment, the greater the risk of seizures and permanent neurological damage, including:

- Hearing loss
- Blinding
- Memory difficulty
- Loss of speech
- Learning disabilities
- Behavior problems
- Brain damage
- Paralysis

Other complications may include:

- Kidney failure
- Adrenal gland failure
- Shock
- Death

**Encephalitis**

Although the term "encephalitis" literally means "inflammation of the brain," it usually refers to brain inflammation resulting from a viral infection. The severe and potentially life-threatening form of this disease is rare. Experts suspect that the actual incidence of encephalitis is probably much higher — but because most people have such mild signs or symptoms, many cases go unrecognized.

Encephalitis occurs in two forms — a primary form and a secondary form. Primary encephalitis involves direct viral infection of the brain and spinal cord. In secondary encephalitis, a viral infection first occurs elsewhere in the body and then travels to the brain.

Most people infected with viral encephalitis have only mild, often flu-like symptoms, and the illness usually doesn't last long. In some cases, people might not have any symptoms. Possible symptoms include:

- Headache
- Irritability
- Lethargy
- Fever
- Joint pain

More serious infections can cause:

- Confusion and hallucinations
- Personality changes
- Double vision
- Seizures
- Muscle weakness
- Loss of sensation or paralysis in certain areas
- Tremors
- Rash
- Loss of consciousness
- Bulging in the soft spots (fontanels) of the skull in infants

Severe viral encephalitis can cause:

- Seizures
- Respiratory arrest
- Coma
- Death

In those who've had severe encephalitis, some problems may last for a year or more, including:

- Fatigue
- Weakness
- Depression
- Personality changes
- Gait problems
- Memory difficulties

Some complications may be permanent, such as memory loss, the inability to speak coherently, lack of muscle coordination, paralysis, or hearing or vision defects.
**Brain tumor**

A brain tumor is a mass or growth of abnormal cells in the brain.

Many different types of brain tumors exist. Some brain tumors are noncancerous (benign), and some brain tumors are cancerous (malignant). Brain tumors can begin in the brain (primary brain tumors), or cancer can begin in other parts of the body and spread to the brain (secondary, or metastatic brain tumors).

The signs and symptoms of a brain tumor vary greatly and depend on the brain tumor's size, location and rate of growth.

General signs and symptoms caused by brain tumors may include:

- New onset or change in pattern of headaches
- Headaches that gradually become more frequent and more severe
- Unexplained nausea or vomiting
- Vision problems, such as blurred vision, double vision or loss of peripheral vision
- Gradual loss of sensation or movement in an arm or a leg
- Difficulty with balance
- Speech difficulties
- Confusion in everyday matters
- Personality or behavior changes
- Seizures, especially in someone who doesn't have a history of seizures
- Hearing problems

Brain tumors occur more frequently in whites than they do in people of other races. One exception is meningioma, which occurs most frequently in blacks. Risk of a brain tumor increases with age. Brain tumors are most common in older adults. However, a brain tumor can occur at any age. And certain types of brain tumors, such as medulloblastomas, occur almost exclusively in children.

**Amyotrophic lateral sclerosis**

myotrophic lateral sclerosis (a-mi-oh-TROH-fik LAT-ur-ul skluh-ROH-sis), or ALS, is a serious neurological disease that causes muscle weakness, disability and eventually death. ALS is often called Lou Gehrig's disease, after the famous baseball player who was diagnosed with it in 1939. In the U.S., ALS and motor neuron disease (MND) are sometimes used interchangeably.

Early signs and symptoms of ALS include:

- Difficulty lifting the front part of your foot and toes (footdrop)
- Weakness in your leg, feet or ankles
- Hand weakness or clumsiness
- Slurring of speech or trouble swallowing
- Muscle cramps and twitching in arms, shoulders and tongue

The disease frequently begins in hands, feet or limbs, and then spreads to other parts of the body. As the disease advances, muscles become progressively weaker until they're paralyzed. It eventually affects chewing, swallowing, speaking and breathing.

As the disease progresses, people with ALS experience one or more of the following complications: breathing problems, eating problems, dementia (decline in mental capacity).

**Dementia**

Dementia isn't a specific disease. Instead, it describes a group of symptoms affecting intellectual and social abilities severely enough to interfere with daily functioning. It's caused by conditions or changes in the brain. Different types of dementia exist, depending on the cause. Alzheimer's disease is the most common type.

Dementia symptoms vary depending on the cause, but common signs and symptoms include:

- Memory loss
- Difficulty communicating
- Inability to learn or remember new information
- Difficulty with planning and organizing
- Difficulty with coordination and motor functions
- Personality changes
- Inability to reason
- Inappropriate behavior
- Paranoia
- Agitation
Alzheimer’s disease

Alzheimer’s disease causes brain changes that gradually get worse. It’s the most common cause of dementia — a group of brain disorders that cause progressive loss of intellectual and social skills, severe enough to interfere with day-to-day life. In Alzheimer's disease, brain cells degenerate and die, causing a steady decline in memory and mental function.

The first symptoms of Alzheimer's disease one may notice are increasing forgetfulness and mild confusion. Over time, the disease has a growing impact on the memory, the ability to speak and write coherently, and your judgment and problem solving. People affected with Alzheimer's first notice that they're having unusual difficulty remembering things and organizing thoughts. Or one may not recognize that anything is wrong, even when changes are noticeable to family members, close friends or co-workers.

Brain changes associated with Alzheimer's disease lead to growing trouble with:

Memory
Everyone has occasional memory lapses. It's normal to lose track of where you put your keys or forget the name of an acquaintance. But the memory loss associated with Alzheimer's disease persists and gets worse. People with Alzheimer's may:

- Repeat statements and questions over and over
- Forget conversations, appointments or events, and not remember them later
- Routinely misplace possessions, often putting them in illogical locations
- Eventually forget the names of family members and everyday objects

Disorientation and misinterpreting spatial relationships
People with Alzheimer's disease may lose their sense of what day it is, the time of year, where they are or even their current life circumstances. Alzheimer's may also disrupt your brain's ability to interpret what you see, making it difficult to understand your surroundings. Eventually, these problems may lead to getting lost in familiar places.

Speaking and writing
Those with Alzheimer's may have trouble finding the right words to identify objects, express thoughts or take part in conversations. Over time, the ability to read and write also declines.

Thinking and reasoning
Alzheimer's disease causes difficulty concentrating and thinking, especially about abstract concepts like numbers. Many people find it challenging to manage their finances, balance their checkbooks, and keep track of bills and pay them on time. These difficulties may progress to inability to recognize and deal with numbers.

Making judgments and decisions
Responding effectively to everyday problems, such as food burning on the stove or unexpected driving situations, becomes increasingly challenging.

Planning and performing familiar tasks
Once-routine activities that require sequential steps, such as planning and cooking a meal or playing a favorite game, become a struggle as the disease progresses. Eventually, people with advanced Alzheimer's may forget how to perform basic tasks such as dressing and bathing.

Changes in personality and behavior
Brain changes that occur in Alzheimer’s disease can affect the way you act and how you feel. People with Alzheimer’s may experience:

- Depression
- Anxiety
- Social withdrawal
- Mood swings
- Distrust in others
- Increased stubbornness
- Irritability and aggressiveness
- Changes in sleeping habits
- Wandering

Parkinson’s disease

Parkinson's disease is a progressive disorder of the nervous system that affects movement. It develops gradually, often starting with a barely
noticeable tremor in just one hand. But while tremor may be the most well-known sign of Parkinson's disease, the disorder also commonly causes a slowing or freezing of movement.

Friends and family may notice that face shows little or no expression and your arms don't swing when walking. Speech often becomes soft and mumbling. Parkinson's symptoms tend to worsen as the disease progresses.

The symptoms of Parkinson's disease can vary from person to person. Early signs may be subtle and can go unnoticed. Symptoms typically begin on one side of the body and usually remain worse on that side even after symptoms begin to affect both sides. Parkinson's signs and symptoms may include:

- **Tremor.** The characteristic shaking associated with Parkinson's disease often begins in a hand. A back-and-forth rubbing of thumb and forefinger, known as pill-rolling, is common, and may occur when hand is at rest. However, not everyone experiences tremors.
- **Slowed motion (bradykinesia).** Over time, Parkinson's disease may reduce ability to initiate voluntary movement. This may make even the simplest tasks difficult and time-consuming. When one walks, the steps may become short and shuffling. Or feet may freeze to the floor, making it hard to take the first step.
- **Rigid muscles.** Muscle stiffness can occur in any part of the body. Sometimes the stiffness can be so severe that it limits the range of movements and causes pain. People may first notice this sign when person suffering from Parkinson's no longer swing arms when walking.
- **Impaired posture and balance.** Posture may become stooped as a result of Parkinson's disease. Balance problems also may occur, although this is usually in the later stages of the disease.
- **Loss of automatic movements.** Blinking, smiling and swinging the arms when walking are all unconscious acts that are a normal part of being human. In Parkinson's disease, these acts tend to be diminished and even lost. Some people may develop a fixed staring expression and unblinking eyes. Others may no longer gesture or seem animated when they speak.

- **Speech changes.** Many people with Parkinson's disease have problems with speech. One may speak more softly, rapidly or in a monotone, sometimes slurring or repeating words, or hesitating before speaking.
- **Dementia.** In the later stages of Parkinson's disease, some people develop problems with memory and mental clarity. Alzheimer's drugs appear to alleviate some of these symptoms to a mild degree.

### Cerebral palsy

Cerebral palsy is a disorder of movement, muscle tone or posture that is caused by injury or abnormal development in the immature brain, most often before birth.

Signs and symptoms appear during infancy or preschool years. In general, cerebral palsy causes impaired movement associated with exaggerated reflexes or rigidity of the limbs and trunk, abnormal posture, involuntary movements, unsteadiness of walking, or some combination of these. The effect of cerebral palsy on functional abilities varies greatly.

Signs and symptoms can vary greatly. Movement and coordination problems associated with cerebral palsy may include:

- Variations in muscle tone — either too stiff or too floppy
- Stiff muscles and exaggerated reflexes (spasticity)
- Stiff muscles with normal reflexes (rigidity)
- Lack of muscle coordination (ataxia)
- Tremors or involuntary movements
- Slow, writhing movements (athetosis)
- Delays in reaching motor skills milestones, such as pushing up on arms, sitting up alone or crawling
- Favoring one side of the body, such as reaching with only one hand or dragging a leg while crawling
- Difficulty walking, such as walking on toes, a crouched gait, a scissors-like gait with knees crossing or a wide gait
- Excessive drooling or difficulty with swallowing
- Difficulty with sucking or eating
- Delays in speech development or difficulty speaking
- Difficulty with precise motions, such as picking up a crayon or spoon

The disability associated with cerebral palsy may be limited primarily to one limb or one side of the body, or it may affect the whole body. The brain injury causing cerebral palsy doesn't change with time, so the symptoms usually don't worsen with age, although the shortening of muscles and muscle rigidity may worsen if not treated aggressively.

**Stroke**

A stroke occurs when the blood supply to part of the brain is interrupted or severely reduced, depriving brain tissue of oxygen and food. Within minutes, brain cells begin to die.

A stroke is a medical emergency. Prompt treatment is crucial. Early action can minimize brain damage and potential complications.

The good news is that strokes can be treated and prevented, and many fewer Americans now die of stroke than was the case even 15 years ago. Better control of major stroke risk factors — high blood pressure, smoking and high cholesterol — is likely responsible for the decline.

Watch for these signs and symptoms if you think someone may be having a stroke. Note when signs and symptoms begin, because the length of time they have been present may guide treatment decisions.

- **Trouble with walking.** Sudden dizziness, loss of balance or loss of coordination.
- **Trouble with speaking and understanding.** Confusion. Slurring of words or inability to find the right words to explain what is happening (aphasia). Try to repeat a simple sentence.
- **Paralysis or numbness on one side of the body or face.** Sudden numbness, weakness or paralysis on one side of the body.
- **Trouble with seeing in one or both eyes.**
- **Headache.** A sudden, severe "bolt out of the blue" headache, which may be accompanied by vomiting, dizziness or altered consciousness.

A stroke can cause temporary or permanent disabilities, depending on how long the brain suffers a lack of blood flow and which part was affected.