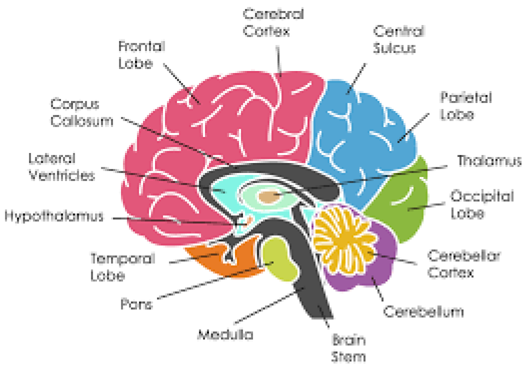
CHAPTER 1. NERVOUS SYSTEM

CHAPTER 5: MALE REPRODUCTIVE SYSTEM

DR.D.KILIMOZHI

TheBrain



The Structure of the Brain

The largest organ in the nervous system; composed of about 100 billion

The human brain is split up into three major layers: the hindbrain, the midbrain, and the forebrain.

Meninges

The brain and spinal cord are covered and protected by three layers of tissue called meninges. From the outermost layer inward they are: the dura mater, arachnoid mater, and pia mater.

Dura mater: is a strong, thick membrane that closely lines the inside of the skull; its two layers, the periosteal and meningeal dura, are fused and separate only to form venous sinuses. The dura creates little folds or compartments. There are two special dural folds, the falx and the tentorium. The falx separates the right and left hemispheres of the brain and the tentorium separates the cerebrum from the cerebellum.

Arachnoid mater: is a thin, web-like membrane that covers the entire brain. The arachnoid is made of elastic tissue. The space between the dura and arachnoid membranes is called the subdural space.

Pia mater: hugs the surface of the brain following its folds and grooves. The pia mater has many blood vessels that reach deep into the brain. The space between the arachnoid and pia is called the subarachnoid space. It is here where the cerebrospinal fluid bathes and cushions the brain.

The Hindbrain

The hindbrain, which includes the medulla oblongata, the pons, and the cerebellum, is responsible some of the oldest and most primitive body functions. Each of these structures is described below.

Medulla Oblongata

The medulla oblongata sits at the transition zone between the brain and the spinal cord. It is the first region that formally belongs to the brain (rather than the spinal cord). It is the control center for respiratory, cardiovascular, and digestive functions.

Pons

The pons connects the medulla oblongata with the midbrain region, and also relays signals from the forebrain to the cerebellum. It houses the control centers for respiration and inhibitory functions. The cerebellum is attached to the dorsal side of the pons.

Cerebellum

The cerebellum is a separate region of the brain located behind the medulla oblongata and pons. It is attached to the rest of the brain by three stalks (called *pedunculi*), and coordinates skeletal muscles to produce smooth, graceful motions. The cerebellum receives information from our eyes, ears, muscles, and joints about the body's current positioning (referred to as proprioception). It also receives output from the cerebral cortex about where these body parts should be. After processing this information, the cerebellum sends motor impulses from the brain stem to the skeletal muscles so that they can move. The main function of the cerebellum is this muscle coordination. However, it is also responsible for balance and posture, and it assists us when we are learning a new motor skill, such as playing a sport or musical instrument. Recent research shows that apart from motor functions the cerebellum also has some role in emotional sensitivity.

The Midbrain

The midbrain is located between the hindbrain and forebrain, but it is actually part of the brain stem. It displays the same basic functional composition found in the spinal cord and the hindbrain. Ventral areas control motor function and convey motor information from the cerebral cortex. Dorsal regions of the midbrain are involved in sensory information circuits. The substantia nigra, a part of the brain that plays a role in reward, addiction, and movement (due to its high levels of dopaminergic neurons) is located in the midbrain. In Parkinson's disease, which is characterized by a deficit of dopamine, death of the substantia nigra is evident.

The Diencephalon

The diencephalon is the region of the embryonic vertebrate neural tube that gives rise to posterior forebrain structures. In adults, the diencephalon appears at the upper end of the brain stem, situated between the cerebrum and the brain stem. It is home to the limbic system, which is considered the seat of emotion in the human brain. The diencephalon is made up of four distinct components: the thalamus, the subthalamus, the hypothalamus, and the epithalamus.

Thalamus

The thalamus is part of the limbic system. It consists of two lobes of grey matter along the bottom of the cerebral cortex. Because nearly all sensory information passes through the thalamus it is considered the sensory "way station" of the brain, passing information on to the cerebral cortex (which is in the forebrain). Lesions of, or stimulation to, the thalamus are associated with changes in emotional reactivity. However, the importance of this structure on the regulation of emotional behavior is not due to the activity of the thalamus itself, but to the connections between the thalamus and other limbic-system structures.

Hypothalamus

The hypothalamus is a small part of the brain located just below the thalamus. Lesions of the hypothalamus interfere with motivated behaviors like sexuality, combativeness, and hunger. The hypothalamus also plays a role in emotion: parts of the hypothalamus seem to be involved in pleasure and rage, while the central part is linked to aversion, displeasure, and a tendency towards uncontrollable and loud laughing. When external stimuli are presented (for example, a dangerous stimuli), the hypothalamus sends signals to other limbic areas to trigger feeling states in response to the stimuli (in this case, fear).

The Spinal Cord

The spinal cord is a tail-like structure embedded in the vertebral canal of the spine. The adult spinal cord is about 40 cm long and weighs approximately 30 g. The spinal cord is attached to the underside of the medulla oblongata, and is organized to serve four distinct tasks:

1. to convey (mainly sensory) information to the brain;
2. to carry information generated in the brain to peripheral targets like skeletal muscles;
3. to control nearby organs via the autonomic nervous system;
4. to enable sensorimotor functions to control posture and other fundamental movements.

Cortex

The cerebral cortex, the largest part of the mammalian brain, is the wrinkly gray outer covering of the cerebrum. While the cortex is less than 1/4″ thick, it is here that all sensation, perception, memory, association, thought, and voluntary physical actions occur. The cerebral cortex is considered the ultimate control and information-processing center in the brain.

The cortex is made of layers of neurons with many inputs; these cortical neurons function like mini microprocessors or logic gates. It contains glial cells, which guide neural connections, provide nutrients and myelin to neurons, and absorb extra ions and neurotransmitters. The cortex is divided into four different lobes (the parietal, occipital, temporal, and frontal lobes), each with a different specific function.

The cortex is wrinkly in appearance. Evolutionary constraints on skull size brought about this development; it allowed for the cortex to become larger without our brains (and therefore craniums) becoming disadvantageously large. At times it has been theorized that brain size correlated positively with intelligence; it has also been suggested that surface area of cortex (basically, “wrinkliness” of the brain) rather than brain size that correlates most directly with intelligence. Current research suggests that both of these may be at least partially true, but the degree to which they correlate is not clear.

The “valleys” of the wrinkles are called *sulci* (or sometimes, fissures); the “peaks” between wrinkles are called *gyri*. While there are variations from person to person in their sulci and gyri, the brain has been studied enough to identify patterns. One notable sulcus is the central sulcus, or the wrinkle dividing the parietal lobe from the frontal lobe.

Cerebrum

Beneath the cerebral cortex is the cerebrum, which serves as the main thought and control center of the brain. It is the seat of higher-level thought like emotions and decision making (as opposed to lower-level thought like balance, movement, and reflexes).

The cerebrum is composed of gray and white matter. Gray matter is the mass of all the cell bodies, dendrites, and synapses of neurons interlaced with one another, while white matter consists of the long, myelin-coated axons of those neurons connecting masses of gray matter to each other.

Cerebral Hemispheres and Lobes of the Brain

The brain is divided into two hemispheres and four lobes, each of which specializes in a different function.

Brain Lateralization

The brain is divided into two halves, called hemispheres. There is evidence that each brain hemisphere has its own distinct functions, a phenomenon referred to as lateralization. The left hemisphere appears to dominate the functions of speech, language processing and comprehension, and logical reasoning, while the right is more dominant in spatial tasks like vision-independent object recognition (such as identifying an object by touch or another nonvisual sense). However, it is easy to exaggerate the differences between the functions of the left and right hemispheres; both hemispheres are involved with most processes. Additionally, neuroplasticity (the ability of a brain to adapt to experience) enables the brain to compensate for damage to one hemisphere by taking on extra functions in the other half, especially in young brains.

Corpus Callosum

The two hemispheres communicate with one another through the corpus callosum. The corpus callosum is a wide, flat bundle of neural fibers beneath the cortex that connects the left and right cerebral hemispheres and facilitates interhemispheric communication. The corpus callosum is sometimes implicated in the cause of seizures; patients with epilepsy sometimes undergo a corpus callostomy, or the removal of the corpus callosum.

The Lobes of the Brain

The brain is separated into four lobes: the frontal, temporal, occipital, and parietal lobes.

The Frontal Lobe

The frontal lobe is associated with executive functions and motor performance. Executive functions are some of the highest-order cognitive processes that humans have. Examples include:

- planing and engaging in goal-directed behavior;
- recognizing future consequences of current actions;
- choosing between good and bad actions;
- overriding and suppressing socially unacceptable responses;
- determining similarities and differences between objects or situations.

The frontal lobe is considered to be the moral center of the brain because it is responsible for advanced decision-making processes. It also plays an important role in retaining emotional memories derived from the limbic system, and modifying those emotions to fit socially accepted norms.

The Temporal Lobe

The temporal lobe is associated with the retention of short- and long-term memories. It processes sensory input including auditory information, language comprehension, and naming. It also creates emotional responses and controls biological drives such as aggression and sexuality.

The temporal lobe contains the hippocampus, which is the memory center of the brain. The hippocampus plays a key role in the formation of emotion-laden, long-term memories based on emotional input from the amygdala. The left temporal lobe holds the primary auditory cortex, which is important for processing the semantics of speech.

One specific portion of the temporal lobe, Wernicke’s area, plays a key role in speech comprehension. Another portion, Broca’s area, underlies the ability to produce (rather than understand) speech. Patients with damage to Wernicke's area can speak clearly but the words make no sense, while patients with damage to Broca's area will fail to form words properly and speech will be halting and slurred. These disorders are known as Wernicke's and Broca's aphasia respectively; an aphasia is an inability to speak.

The Occipital Lobe

The occipital lobe contains most of the visual cortex and is the visual processing center of the brain. Cells on the posterior side of the occipital lobe are arranged as a spatial map of the retinal field. The visual cortex receives raw sensory information through sensors in the retina of the eyes, which is then conveyed through the optic tracts to the visual cortex. Other areas of the occipital lobe are specialized for different visual tasks, such as visuospatial processing, color discrimination, and motion perception. Damage to the primary visual cortex (located on the surface of the posterior occipital lobe) can cause blindness, due to the holes in the visual map on the surface of the cortex caused by the lesions.

The Parietal Lobe

The parietal lobe is associated with sensory skills. It integrates different types of sensory information and is particularly useful in spatial processing and navigation. The parietal lobe plays an important role in integrating sensory information from various parts of the body, understanding numbers and their relations, and manipulating objects. Its also processes information related to the sense of touch.

The parietal lobe is comprised of the somatosensory cortex and part of the visual system. The somatosensory cortex consists of a "map" of the body that processes sensory information from specific areas of the body. Several portions of the parietal lobe are important to language and visuospatial processing; the left parietal lobe is involved in symbolic functions in language and mathematics, while the right parietal lobe is specialized to process images and interpretation of maps (i.e., spatial relationships).

The Limbic System

The limbic system combines higher mental functions and primitive emotion into one system.

The limbic system is a complex set of structures found on the central underside of the cerebrum, comprising inner sections of the temporal lobes and the bottom of the frontal lobe. It combines higher mental functions and primitive emotion into a single system often referred to as the emotional nervous system. It is not only responsible for our emotional lives but also our higher mental functions, such as learning and formation of memories. The limbic system is the reason that some physical things such as eating seem so pleasurable to us, and the reason why some medical conditions, such as high blood pressure, are caused by mental stress. There are several important structures within the limbic system: the amygdala, hippocampus, thalamus, hypothalamus, basal ganglia, and cingulate gyrus.

The Amygdala

The amygdala is a small almond-shaped structure; there is one located in each of the left and right temporal lobes. Known as the emotional center of the brain, the amygdala is involved in evaluating the emotional valence of situations (e.g., happy, sad, scary). It helps the brain recognize potential threats and helps prepare the body for fight-or-flight reactions by increasing heart and breathing rate. The amygdala is also responsible for learning on the basis of reward or punishment.

Due to its close proximity to the hippocampus, the amygdala is involved in the modulation of memory consolidation, particularly emotionally-laden memories. Emotional arousal following a learning event influences the strength of the subsequent memory of that event, so that greater emotional arousal following a learning event enhances a person's retention of that memory. In fact, experiments have shown that administering stress hormones to individuals immediately after they learn something enhances their retention when they are tested two weeks later.

The Basal Ganglia

The basal ganglia is a group of nuclei lying deep in the subcortical white matter of the frontal lobes that organizes motor behavior. The *caudate*, *putamen*, and *globus pallidus* are major components of the basal ganglia. The basal ganglia appears to serve as a gating mechanism for physical movements, inhibiting potential movements until they are fully appropriate for the circumstances in which they are to be executed. The basal ganglia is also involved with:

- rule-based habit learning (e.g., initiating, stopping, monitoring, temporal sequencing, and maintaining the appropriate movement);
- inhibiting undesired movements and permitting desired ones;
- choosing from potential actions;
- motor planning;
- sequencing;
- predictive control;
- working memory;
- attention.

Functions of Brain

- Receives impulses.
- Regulates body temperature.
- Controls the mood and emotions.
- Controls the sense of taste and smell.
- Synthesises the body's essential hormones.
- Coordinates the messages from the autonomous nervous system.

SPINAL CORD

The spinal cord is a part of the central nervous system. It is a long pipe-like structure arising from the medulla oblongata part of the brain consisting of a collection of nerve fibres, running through the vertebral column of the backbone. It is segmented with a pair of roots (dorsal and ventral roots) consisting of nerve fibres joining to form the spinal nerves.

Anatomy

In adults, the spinal cord is usually 40cm long and 2cm wide. It forms a vital link between the brain and the body.

The spinal cord is divided into five different parts.

- Sacral cord
- Lumbar cord
- Thoracic cord
- Cervical cord
- Coccygeal

Several spinal nerves emerge out of each segment of the spinal cord. There are 8 pairs of cervical, 5 lumbar, 12 thoracic, 5 sacral and 1 coccygeal pair of spinal nerves

It performs the primary processing of information as it carries sensory signals from all parts of the body to the through afferent fibres.

Nerve tissue consists of the grey and white matter spread across uniformly.

The smooth muscles and the skeletal system carrying nerve fibres liaise different reflexes when ventral horn projects axons which carry motor neurons.

It also helps intercede autonomic control for visceral functions which consist of neurons with descending axons. It is a sensitive site, which is severely affected in case of a traumatic injury.

Understanding the physiology of the spinal cord helps in detecting and determining the various methods to deal with diseases and damage related to the spinal cord.

Structure Of Spinal Cord

The Spinal cord runs through a hollow case from the skull enclosed within the vertebral column. Spinal nerves arise from different regions of the vertebral column and are named accordingly, the regions are – Neck, chest, pelvic and abdominal.

Cross-section of spinal cord displays grey matter shaped like a butterfly surrounded by a white matter.

Grey matter consists of the central canal at the centre and is filled with a fluid called CSF (Cerebrospinal fluid). It consists of horns (four projections) and forms the core mainly containing neurons and cells of the CNS. There are two dorsal and two ventral horns.

The white matter consists of a collection of axons permitting communication between different layers of CNS. A tract is a collection of axons and carries specialized information. Ascending tracts and descending tracts send and transmit signals from the brain respectively to various nerve cells across the body.

Spinal nerves act as mediators, communicating information to and from the rest of the body and the spinal cord. We have 31 pairs of spinal nerves.

Three layers of meninges surround the spinal cord and spinal nerve roots.

- Dura mater
- Arachnoid mater
- Pia mater

Dura mater consists of two layers- periosteal and meningeal. Epidural space is present between the two layers.

Subarachnoid space lies between the arachnoid mater and pia mater. It is filled with cerebrospinal fluid.

Spinal Cord Injuries

Damage to any part of the spinal cord or spinal nerves results in permanent and life-long damage to the spinal cord affecting the normal functioning of the spinal cord without any replacements.

It often causes long-term changes in the strength, body posture and reflexing of the body. Voluntary control of limbs post an injury depends on the severity and location of the injury.

One has a complete injury when he loses the ability to move or sense below the injury. The incomplete injury allows the injured to perform some sensory and motor functions.

Spinal cord injury not only has an impact on the spinal nerves and the vertebral column but affects other muscles and vital organs as well.

Paralysis from an injury can be of two types:

- Tetraplegic
- Paraplegic

Tetraplegia is a paralysis that results in total or partial loss of use of all four limbs and torso.

Paraplegia, on the other hand, is similar to tetraplegia, except it doesn’t affect the arms.

These injuries result in the inability to voluntarily move limbs, lose sensation, delayed or exaggerated reflexes, changes in sexual functions, intense shooting pain due to damaged nerve fibres. It also causes shortness of breath, cough and muscle spasms.

Spinal Cord Nerves

The spinal nerves consist of a group of 31 nerves. These nerves are attached to the spinal cord by two roots- dorsal sensory root and ventral motor root.

The sensory root fibers carry sensory impulses to the spinal cord. The motor roots, on the contrary, carry impulses from the spinal cord.

The spinal nerves carry messages to and from the skin of specific regions of the body called dermatomes.

The spinal cord nerves can be grouped as:

- Cervical
- Thoracic

- Sacral
- Lumbar
- Coccygeal

Cervical Nerves

Cervical means of the neck. There are 8 cervical nerves that emerge from the cervical spine (C1-C8).

Thoracic Nerves

Thoracic means of the chest. There are 12 thoracic nerves that emerge from the thoracic spine (T1-T12).

Lumbar Nerves

Lumbar means from the lower back region. There are 5 lumbar nerves that emerge from the lumbar spine (L1-L5).

Sacral Nerves

Sacral means of the sacrum. The sacrum is a bony plate at the base of the vertebral column.

There are 5 sacral nerves that emerge from the sacral bone (S1-S5).

Coccygeal Nerves

Coccygeal means of the tailbone. There is 1 nerve that emerges from the coccygeal bone.

Function Of Spinal Cord

Important functions of Spinal Cord are mentioned below:

- Forms a connecting link between the brain and the PNS
- Provides structural support and builds a body posture
- Facilitates flexible movements
- Myelin present in the white matter acts as an electrical insulation
- Communicates messages from the brain to different parts of the body
- Coordinates reflexes
- Receives sensory information from receptors and approaches towards the brain for processing.

Nervous Tissue

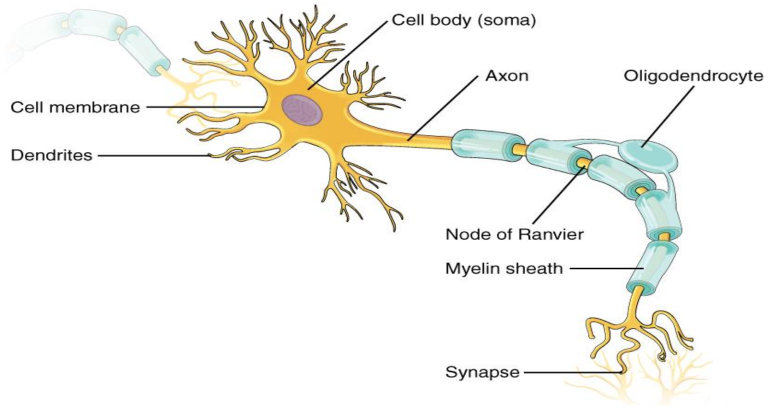
Functions of Nerve Tissue

- Nervous tissue allows an organism to sense stimuli in both the internal and external environment.
- The stimuli are analysed and integrated to provide appropriate, co-ordinated responses in various organs.
- The afferent or sensory neurons conduct nerve impulses from the sense organs and receptors to the central nervous system.
- Internuncial or connector neurons supply the connection between the afferent and efferent neurons as well as different parts of the central nervous system.
- Efferent or somatic motor neurons transmit the impulse from the central nervous system to a muscle (the effector organ) which then react to the initial stimulus.
- Autonomic motor or efferent neurons transmit impulses to the involuntary muscles and glands.

Neurons are the cells considered to be the basis of nervous tissue. They are responsible for the electrical signals that communicate information about sensations, and that produce movements in response to those stimuli, along with inducing thought processes within the brain. An important part of the function of neurons is in their structure, or shape. The three-dimensional shape of these cells makes the immense numbers of connections within the nervous system possible.

PARTS OF A NEURON

As you learned in the first section, the main part of a neuron is the cell body, which is also known as the soma (soma = "body"). The cell body contains the nucleus and most of the major organelles. But what makes neurons special is that they have many extensions of their cell membranes, which are generally referred to as processes. Neurons are usually described as having one, and only one, axon—a fiber that emerges from the cell body and projects to target cells. That single axon can branch repeatedly to communicate with many target cells. It is the axon that propagates the nerve impulse, which is communicated to one or more cells. The other processes of the neuron are dendrites, which receive information from other neurons at specialized areas of contact called **synapses**. The dendrites are usually highly branched processes, providing locations for other neurons to communicate with the cell body. Information flows through a neuron from the dendrites, across the cell body, and down the axon. This gives the neuron a polarity—meaning that information flows in this one direction. **Figure** shows the relationship of these parts to one another.



Where the axon emerges from the cell body, there is a special region referred to as the **axon hillock**. This is a tapering of the cell body toward the axon fiber. Within the axon hillock, the cytoplasm changes to a solution of limited components called **axoplasm**. Because the axon hillock represents the beginning of the axon, it is also referred to as the **initial segment**.

Many axons are wrapped by an insulating substance called myelin, which is actually made from glial cells. Myelin acts as insulation much like the plastic or rubber that is used to insulate electrical wires. A key difference between myelin and the insulation on a wire is that there are gaps in the myelin covering of an axon. Each gap is called a **node of Ranvier** and is important to the way that electrical signals travel down the axon. The length of the axon between each gap, which is wrapped in myelin, is referred to as an **axon segment**. At the end of the axon is the **axon terminal**, where there are usually several branches extending toward the target cell, each of which ends in an enlargement called a **synaptic end bulb**.

TYPES OF NEURONS

There are many neurons in the nervous system—a number in the trillions. And there are many different types of neurons. They can be classified by many different criteria. The first way to classify them is by the number of processes attached to the cell body. Using the standard model of neurons, one of these processes is the axon, and the rest are dendrites. Because information flows through the neuron from dendrites or cell bodies toward the axon, these names are based on the neuron's polarity

Unipolar cells have only one process emerging from the cell. True unipolar cells are only found in invertebrate animals, so the unipolar cells in humans are more appropriately called "pseudo-unipolar" cells. Invertebrate unipolar cells do not have dendrites. Human unipolar cells have an axon that emerges from the cell body, but it splits so that the axon can extend along a very long distance. At one end of the axon are dendrites, and at the other end, the axon forms synaptic connections with a target. Unipolar cells are exclusively sensory neurons and have two unique characteristics. First, their dendrites are receiving sensory information, sometimes directly from the stimulus itself. Secondly, the cell bodies of unipolar neurons are always found in ganglia. Sensory reception is a peripheral function (those dendrites are in the periphery, perhaps in the skin) so the cell body is in the periphery, though closer to the CNS in a ganglion. The axon projects from the dendrite endings, past the cell body in a ganglion, and into the central nervous system.

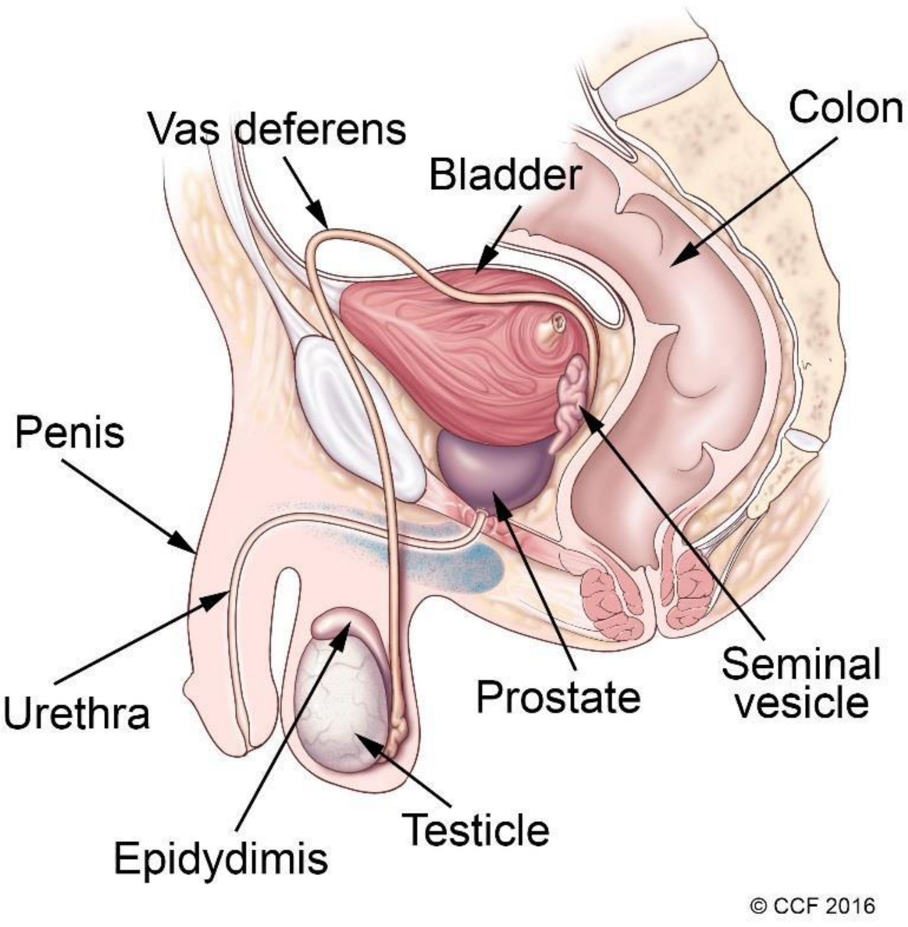
Bipolar cells have two processes, which extend from each end of the cell body, opposite to each other. One is the axon and one the dendrite. Bipolar cells are not very common. They are found mainly in the olfactory epithelium (where smell stimuli are sensed), and as part of the retina.

Multipolar neurons are all of the neurons that are not unipolar or bipolar. They have one axon and two or more dendrites (usually many more). With the exception of the unipolar sensory ganglion cells, and the two specific bipolar cells mentioned above, all other neurons are multipolar. Some cutting edge research suggests that certain neurons in the CNS do not conform to the standard model of "one, and only one" axon. Some sources describe a fourth type of neuron, called an anaxonic neuron. The name suggests that it has no axon (an- = "without"), but this is not accurate. Anaxonic neurons are very small, and if you look through a microscope at the standard resolution used in histology (approximately 400X to 1000X total magnification), you will not be able to distinguish any process specifically as an axon or a dendrite. Any of those processes can function as an axon depending on the conditions at any given time. Nevertheless, even if they cannot be easily seen, and one specific process is definitively the axon, these neurons have multiple processes and are therefore multipolar.

Neurons can also be classified on the basis of where they are found, who found them, what they do, or even what chemicals they use to communicate with each other. Some neurons referred to in this section on the nervous system are named on the basis of those sorts of classifications a multipolar neuron that has a very important role to play in a part of the brain called the cerebellum is known as a Purkinje

- Divisions of the Nervous System
- The human nervous system consists of the Central Nervous System (CNS) and the Peripheral Nervous System (PNS).
- CNS is composed of the brain (located in the cranial cavity) and the spinal cord (located in the vertebral cavity), which serve as the main control centers for all body activities.
- PNS is composed of nerves derived from the brain and spinal cord (12 pairs of cranial nerves and 31 pairs of spinal nerves), which serve as linkage between the CNS and the body.
- PNS can be subdivided into Sensory (afferent) nerves and Motor (efferent) nerves. Sensory nerves send nerve impulse from the body to CNS, while motor nerves send impulse from CNS to effector organs.Motor nerves are divided into the Somatic Nervous system (SNS) which regulates the voluntary contraction of skeletal muscles and autonomic nervous system (ANS) which regulates the involuntary control of smooth, cardiac muscles and glands.
- Finally, the ANS can be divided into Sympathetic and Parasympathetic branches where in general sympathetic nerves stimulate activities of the effector organs (except digestive organs), and parasympathetic nerves inhibit activities of the effector organs (except digestive organs).

MALE REPRODUCTIVE SYSTEM



The organs of the male reproductive system are specialized for the following functions:

- To produce, maintain and transport sperm (the male reproductive cells) and protective fluid (semen)
- To discharge sperm within the female reproductive tract
- To produce and secrete male sex hormones

The male reproductive anatomy includes internal and external structures.

External male reproductive structures

Most of the male reproductive system is located outside of the man's abdominal cavity or pelvis. The external structures of the male reproductive system are the penis, the scrotum and the testicles.

Penis - The penis is the male organ for sexual intercourse. It has three parts: the root, which attaches to the wall of the abdomen; the body, or shaft; and the glans, which is the cone-shaped end of the penis. The glans, which also is called the head of the penis, is covered with a loose layer of skin called foreskin. (This skin is sometimes removed in a procedure called circumcision.) The opening of the urethra, the tube that transports semen and urine, is at the tip of the glans penis. The penis also contains a number of sensitive nerve endings.

The body of the penis is cylindrical in shape and consists of three internal chambers. These chambers are made up of special, sponge-like erectile tissue. This tissue contains thousands of large spaces that fill with blood when the man is sexually aroused. As the penis fills with blood, it becomes rigid and erect, which allows for penetration during sexual intercourse. The skin of the penis is loose and elastic to allow for changes in penis size during an erection.

Semen, which contains sperm, is expelled (ejaculated) through the end of the penis when the man reaches sexual climax (orgasm). When the penis is erect, the flow of urine is blocked from the urethra, allowing only semen to be ejaculated at orgasm.

Scrotum - The scrotum is the loose pouch-like sac of skin that hangs behind the penis. It contains the testicles (also called testes), as well as many nerves and blood vessels. The scrotum has a protective function and acts as a climate control system for the testes. For normal sperm development, the testes must be at a temperature slightly cooler than the body temperature. Special muscles in the wall of the scrotum allow it to contract (tighten) and relax, moving the testicles closer to the body for warmth and protection or farther away from the body to cool the temperature.

Testicles (testes) -The testes are oval organs about the size of very large olives that lie in the scrotum, secured at either end by a structure called the spermatic cord. Most men have two testes. The testes are responsible for making testosterone, the primary male sex hormone, and for producing sperm. Within the testes are coiled masses of tubes called seminiferous tubules. These tubules are responsible for producing the sperm cells through a process called spermatogenesis.

Epididymis - The epididymis is a long, coiled tube that rests on the backside of each testicle. It functions in the carrying and storage of the sperm cells that are produced in the testes. It also is the job of the epididymis to bring the sperm to maturity, since the sperm that emerge from the testes are immature and incapable of fertilization. During sexual arousal, contractions force the sperm into the vas deferens.

Internal male reproductive organs

The internal organs of the male reproductive system, also called accessory organs, include the following:

- **Vas deferens** - The vas deferens is a long, muscular tube that travels from the epididymis into the pelvic cavity, to just behind the bladder. The vas deferens transports mature sperm to the urethra in preparation for ejaculation.
- **Ejaculatory ducts** - These are formed by the fusion of the vas deferens and the seminal vesicles. The ejaculatory ducts empty into the urethra.
- **Urethra** - The urethra is the tube that carries urine from the bladder to outside of the body. In males, it has the additional function of expelling (ejaculating) semen when the man reaches orgasm. When the penis is erect during sex, the flow of urine is blocked from the urethra, allowing only semen to be ejaculated at orgasm.
- **Seminal vesicles** - The seminal vesicles are sac-like pouches that attach to the vas deferens near the base of the bladder. The seminal vesicles produce a sugar-rich fluid (fructose) that provides sperm with a source of energy and helps with the sperms' motility (ability to move). The fluid of the seminal vesicles makes up most of the volume of a man's ejaculatory fluid, or ejaculate.
- **Prostate gland** - The prostate gland is a walnut-sized structure that is located below the urinary bladder in front of the rectum. The prostate gland contributes additional fluid to the ejaculate. Prostate fluids also help to nourish the sperm. The urethra, which carries the ejaculate to be expelled during orgasm, runs through the center of the prostate gland.
- **Bulbourethral glands** - The bulbourethral glands, or Cowper's glands, are pea-sized structures located on the sides of the urethra just below the prostate gland. These glands produce a clear, slippery fluid that empties directly into the urethra. This fluid serves to lubricate the urethra and to neutralize any acidity that may be present due to residual drops of urine in the urethra.

Physiology

- Makes semen
- Releases semen into the reproductive system of the female during sexual intercourse
- Produces sex hormones, which help a boy develop into a sexually mature man during puberty

When a baby boy is born, he has all the parts of his reproductive system in place, but it isn't until puberty that he is able to reproduce. When puberty begins, usually between the ages of 9 and 15, the pituitary gland - located near the brain - secretes hormones that stimulate the testicles to produce testosterone. The production of testosterone brings about many physical changes.

Although the timing of these changes is different for every guy, the stages of puberty generally follow a set sequence:

- During the first stage of male puberty, the scrotum and testes grow larger.
- Next, the penis becomes longer and the seminal vesicles and prostate gland grow.
- Hair begins to grow in the pubic area and later on the face and underarms. During this time, the voice also deepens.
- Guys also have a growth spurt during puberty as they reach their adult height and weight.

What Do Sperm Do?

A male who has reached puberty will produce millions of sperm cells every day. Each sperm is extremely small: only 1/600 of an inch (0.05 millimeters long). Sperm develop in the testicles within a system of tiny tubes called the **seminiferous tubules**. At birth, these tubules contain simple round cells. During puberty, testosterone and other hormones cause these cells to transform into sperm cells. The cells divide and change until they have a head and short tail, like tadpoles. The head contains genetic material (genes). The sperm move into the epididymis, where they complete their development.

The sperm then move to the **vas deferens** (pronounced: VAS DEF-uh-runz), or sperm duct. The seminal vesicles and prostate gland make a whitish fluid called seminal fluid, which mixes with sperm to form semen when a male is sexually stimulated. The penis, which usually hangs limp, becomes hard when a male is sexually excited. Tissues in the penis fill with blood and it becomes stiff and erect. The rigidity of the erect penis makes it easier to insert into the female's vagina during sex. When the erect penis is stimulated, muscles around the reproductive organs contract and force the semen through the duct system and urethra. Semen is pushed out of the male's body through his urethra — this process is called **ejaculation**. Each time a guy ejaculates, it can contain up to 500 million sperm.

What Is Conception?

If semen is ejaculated into a female's vagina, millions of sperm "swim" up from the vagina through the cervix and uterus to meet the egg in the fallopian tube. It takes only one sperm to fertilize the egg.

This fertilized egg is now called a zygote and contains 46 chromosomes — half from the egg and half from the sperm. Genetic material from the male and female combine so that a new individual can be created. The zygote divides again and again as it grows in the female's uterus, maturing over the course of the pregnancy into an embryo, a fetus, and finally a newborn baby.

Male reproductive system are specialized for three primary **functions**:

- To produce, maintain, transport, and nourish sperm (the **male reproductive** cells), protective fluid (semen).
- To discharge sperm within the female **reproductive tract**.
- To produce and secrete **male** sex hormones.