

# Unit 1: The Electrifying Nervous System

# VOCABULARY LEVELS

Choose the word list based on your skill level. Every student should be able to master Level 1 words. Add words from Levels 2 and 3 as needed. More proficient students should be able to learn all three levels.

## Level 1 Vocabulary

- Arbor Vitae
- Central Nervous System
- Cerebral Hemispheres
- Cerebellum
- Cerebrum
- Frontal Lobe
- Gray Matter
- Neurons
- Occipital Lobe
- Parietal Lobe
- Temporal Lobe
- White Matter

## Level 2 Vocabulary

### Review and Know Level 1 Vocabulary

- Autonomic Nervous System
- Blood-Brain Barrier
- Cerebral Spinal Fluid
- Corpus Callosum
- Dermatomes
- Homunculus
- Meninges
- Pituitary Gland

## Level 3 Vocabulary

### Review and Know Level 1 and 2 Vocabulary

- Astroglia
- Axon
- Broca's and Wernicke's Areas
- Cerebral Palsy
- Dendrites
- Diencephalon
- Ependymal Cells
- Gyrus
- Hypothalamus
- Medulla Oblongata
- Mesencephalon
- Microglia
- Myelin Sheath
- Neuroglia
- Oligodendroglia
- Pons
- Pyrogens
- Shingles
- Synapse
- Thalamus
- Ventricles



**God created you with much care, love, and incredible design! The human brain has 1 quadrillion synapses (that is a 1 followed by 15 zeroes or 1,000,000,000,000). All those synapses fit into the tiny compartment of your brain. In comparison to man's design, a typical computer has approximately 16,000,000,000 bytes of memory. It would take a million computers to have the equivalent amount of connections to rival the brain!**

## See it, Say it, Know it!

Level 1 Vocabulary

Level 2 Vocabulary

Level 3 Vocabulary

Word [Pronunciation]	Definition
Arbor Vitae [Arbor 'vaɪti:/]	“Tree of life” located in the middle section of the cerebellum; helps to coordinate movement.
Astroglia [äs-trög'lē-ə]	A type of brain cell that supplies nutrients to the neuron.
Autonomic Nervous System [ô'tə-nöm'ɪk]	Self-controlling part of the nervous system that does not require conscious thought to operate.
Axon [äk'sön']	The part of the neuron through which electrical impulses travel down the body of the nerve cell to other nerve cells; many are wrapped in a white fatty substance called the myelin sheath.
Blood-Brain Barrier	A special barrier that surrounds the brain and acts like the gate keeper from the rest of the body. It is composed of small blood vessels and cells packed close together that act as a filter that blocks unwanted materials from entering the brain.
Broca's Area [Brô'kəz]	Located on the left hemisphere; the area that houses the motor speech region, which provides the ability to form spoken words.
Central Nervous System	The central nervous system consists of the brain and the spinal cord.
Cerebral Hemispheres [Sēr'ə-brəl]	The two halves of the brain, right and left.
Cerebral Palsy [Sēr'ə-brəl pòl'zē]	A group of disorders that affects the brain and nervous system functions that can affect movement, learning, hearing, vision, and speech. There are different types of cerebral palsy; in one type, an individual may experience spasticity, which means his or her movements are jerky and difficult to coordinate.
Cerebral Spinal Fluid [Sēr'ə-brəl]	A clear fluid that bathes the brain and spinal cord and transports nutrients, chemical messengers, and waste products.
Cerebellum [sēr'ə-běl'əm]	The region of the brain located behind the brain stem. The arbor vitae resides here.
Cerebrum [sēr'ə-brəm]	The main part of the brain composed of the two hemispheres.
Corpus Callosum [kôr'pəs kə-lô'səm]	The arched white matter found in the center of the cerebrum that connects the two hemispheres of the brain.
Dendrites [dën'drīt']	Tentacle-like structures that extend from the cell body of the neuron and reach out to other neurons.



Word [Pronunciation]	Definition
Dermatomes [dûr'mə-tôm']	Areas or zones of the skin where sensation arises from a particular spinal nerve root.
Diencephalon [dī'ĕn-sĕf'ə-lŏn', -lən]	A structure in the middle of the brain that connects to the brain-stem; also the location of the thalamus and the hypothalamus.
Ependymal Cells [ĕ-pĕndi-măl]	The cells that make up the lining of the ventricles of the brain and of the spinal cord that help in producing spinal fluid.
Fissures [fis-sure]	A groove or deep fold in the cerebral cortex.
Frontal Lobe	The front (anterior) part of the brain involved in reasoning and personality.
Gray Matter	The thin outer rim on the surface of the brain where memory storage, processing, and conscious and subconscious regulation of skeletal movement occur.
Gyrus [Ji'rus]	A rounded convolution (folded or ridged part) on the surface of the brain.
Homunculus [Hō-mŭng'kyə-ləs]	“Very small man,” a visual representation of the connection between different body parts and the areas in the brain hemisphere that control them.
Hypothalamus [Hi'pō-thăl'ə-məs]	The part of the brain that regulates body temperature, sleep, and puberty.
Medulla Oblongata [Me-dul-la ōb'lŏng-gā'tə]	Located in the lower half of the brainstem, connecting to the pons, it regulates the vital functions of breathing, swallowing, and heart rate.
Meninges [Mĕn-in'jĕz]	The tough fibrous membranes that cover the brain and spinal cord.
Mesencephalon [Mez''-en-sef'ah-lŏn]	The midbrain located below the cerebral cortex near the center of the brain. The key in sorting through the visual and auditory data received by the brain.
Microglia [Mi-krog'le-ah]	The “garbage collector” cells of the brain that kill unwanted organisms and remove waste products produced by the neurons.
Myelin Sheath [Mīĕ-lin shĕth]	A substance that coils around and insulates (coats) the nerve cell; made from a lipid (fat).
Neuroglia [Noo-rog-lee-a]	General term for the glia cells of the brain that support nerves. Glia comes from the Greek word meaning “glue.”

Level 1 Vocabulary

Level 2 Vocabulary

Level 3 Vocabulary

Word [Pronunciation]	Definition
Neurons [Noŏr'ŏn']	An electrical conducting cell of the nervous system.
Occipital Lobe [ŏk-sĭp'ĭ-tl]	The back or posterior part of the brain that houses the visual processing center.
Oligodendroglia [ŏl'ĭ-gŏ-dĕn-drŏg'lĕ-ə]	The “protector” cells of the nervous system that support, protect, and insulate the axons by helping to form the myelin sheaths.
Parietal Lobe [pa-ri-e-tal]	Located between the frontal and occipital lobes of the brain; serves as the primary sensory cortex. Enables conscious perception of touch, pressure, vibration, pain, taste, and temperature. Memory storage, processing, and conscious and subconscious regulation of skeletal movement also originate in this area.
Pituitary Gland [pi-tu-i-tary]	A pea-sized structure at the base of the skull that secretes hormones. It is the “master gland” of the body by overseeing key functions, such as growth during childhood and the onset of puberty, by controlling male and female hormones.
Pons	Latin for “bridge.” Located anterior to (in front of) the cerebellum, it serves as a bridge between the cerebellum and the thalamus, acts as a relay station for sensory information between the structures.
Pyrogens [pĭ'rə-jən]	A substance released from the brain that tells the hypothalamus to increase the body's temperature, causing a fever.
Shingles	A painful, blistering skin rash caused by the chicken pox virus. Pain, tingling, or burning occurs along a dermatome.
Synapse [sĭn'ăps']	A small gap between neurons across which electrical information travels from one neuron to the next.
Temporal Lobe [tĕm'pər-əl]	The side (lateral) region of the brain in which the auditory perception, and language comprehension are located.
Thalamus [thāl'ə-məs]	Buried under the cerebral cortex, it serves like a communications center; relays and processes sensory information to various destinations in the brain.
Ventricles [vĕn'trĭ-kəl]	Spaces in the middle part of the brain that produce and are filled with cerebrospinal fluid.
Wernicke's Area [vĕr'nĭ-kĕz]	The region of the brain that interprets what one hears and makes sense of spoken communication.
White Matter	Regions of the brain that lie at a deeper depth in brain; the area where neurological nerve tracts are housed.

\*Pronunciation Keys from: <http://medical-dictionary.thefreedictionary.com>

# 1 Let's Start at the Beginning: Historical Points of Interest

Thinking, crying, breathing, running, skipping, singing, smiling, itching, sneezing, and your beating heart — all of these activities have one thing in common: your brain. Tipping the scales at a mere 3 pounds, it is the integral organ of your body. Your brain operates 24 hours a day, 7 days a week, 365 days a year. It works tirelessly, day in and day out. Serving as the central control center of your body, this marvelous machine is composed of billions of cells that make hundreds of billions of connections without any traffic jams. Through this super highway of connections, we perceive and process impulses that originate inside and outside our bodies.

In this unit, we will explore the mysteries of the brain through investigation of its anatomy (name and location of parts of the body), physiology (how the body functions), histology (microscopic cell structure), and pathology (abnormal health consequences of disease). Let's pick our brains and peer into the ultimate multi-tasker.



A curator for the Smithsonian Institution in 1935 looking at a skull that possibly shows signs of brain surgery from thousands of years ago. Other skulls have been found that also detail new bone growth, indicating that patients survived the initial procedure.

**The brain and nervous system are an important control center for your body. It can send signals throughout the body at over 320 feet per second. That is nearly the distance of a football field!**



History tells the story of the past. Over time, we have learned a great many things about how the brain works. Our knowledge of the inner workings of the brain continues to grow.



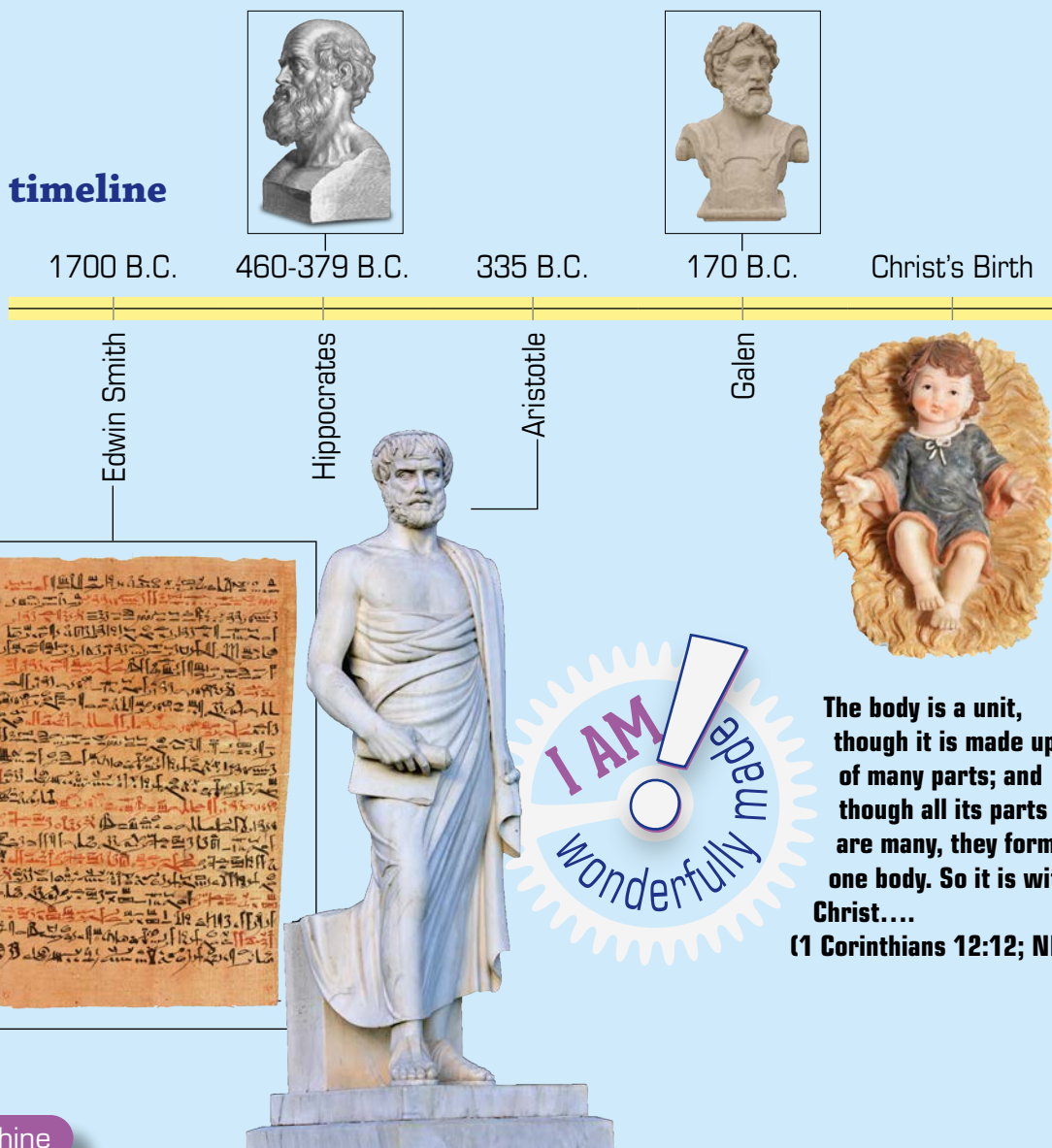


*But we have this treasure in jars of clay to show that this all-surpassing power is from God and not from us. We are hard pressed on every side, but not crushed; perplexed, but not in despair; persecuted, but not abandoned; struck down, but not destroyed. We always carry around in our body the death of Jesus, so that the life of Jesus may also be revealed in our body* (2 Corinthians 4:7-10; NIV).

Mankind has been on a quest since the beginning of time to understand our external and internal environments. Understanding the brain has been one of those perplexing pursuits. The Bible reminds us that God's power is "all surpassing" and that the life of Jesus is revealed in our bodies. Throughout time, man has continued to gain insight and understanding about the brain and its functions. Yet, even with the achievements of modern neuroscience, the inner workings of the mind are still great mysteries.

Without a doubt, the quality of life for men has improved dramatically through the centuries because of the advances and discoveries that men have made in medicine. The time-line below depicts some of the discoveries made in neuroscience. It provides an idea of how we have acquired knowledge through time.

### timeline



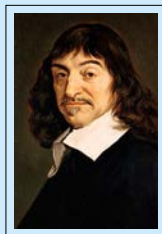


Traveling through the course of time, in 1700 B.C. the **Edwin Smith** Surgical Papyrus was written. It is the first written record of the nervous system to appear in Egyptian documents that describe cases of brain injury.

**Hippocrates** (460–379 B.C.) was born 460 years prior to Jesus’ birth and was an early doctor known as the “Father of Medicine.” Hippocrates felt that it was important that all doctors take an oath, or special promise before they began practicing medicine. He developed the Hippocratic Oath, in which all doctors promise never to use their knowledge to cause harm to anyone under their medical care.

In addition, Hippocrates discussed epilepsy as a problem in the brain. He also believed that the ability to feel sensations and intelligence originated in the brain. This was a very revolutionary idea, because prior to this the consciousness of the mind was believed to reside in the heart.

In 335 B.C., **Aristotle** wrote about sleep, but believed that mental processes originated in the heart, and that the brain was merely a place to cool hot blood pumped from the heart.



1543

Vesalius

1586

Piccolomini

1649

Descartes

1717

Van Leeuwenhoek

1808

Gall

1827

Morphine

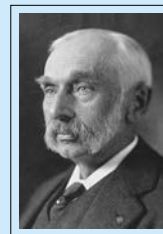


1861

Broca

1874

Wernicke



1884

Godlee

1896

Babinski

1910

Moniz

1936

Penfield

### Lead Poisoning

Alice Hamilton (1869-1970), a physician who was the world’s leading authority on industrial medicine. In 1910, she discovered the cause of a common illness that produced deadly outcomes in factory workers. The workers would suffer from shakiness, headaches, and loss of muscle control that sometimes lead to paralysis and death. She discovered “plumbism” or lead poisoning. *Plumbum* is the Latin word for lead.



A Roman physician to the gladiators named **Galen** dissected the brains of animals in 170 B.C. From his studies, he believed the cerebellum controlled the muscles and the cerebrum, which allows us to sense our environment.

In 1543, **Andreas Vesalius** published his book, *On the Workings of the Human Body*, which discussed human anatomy, including the brain's structures in detail. Vesalius is credited with being the "father of anatomy." He broke from the traditions of the time by carrying out anatomical dissections. This was a sharp deviation from medical practices because dissection, much less touching of a deceased specimen, was considered unclean and taboo.

**Piccolomini** was the first to point out the differences between the cerebral cortex and white matter in 1586.

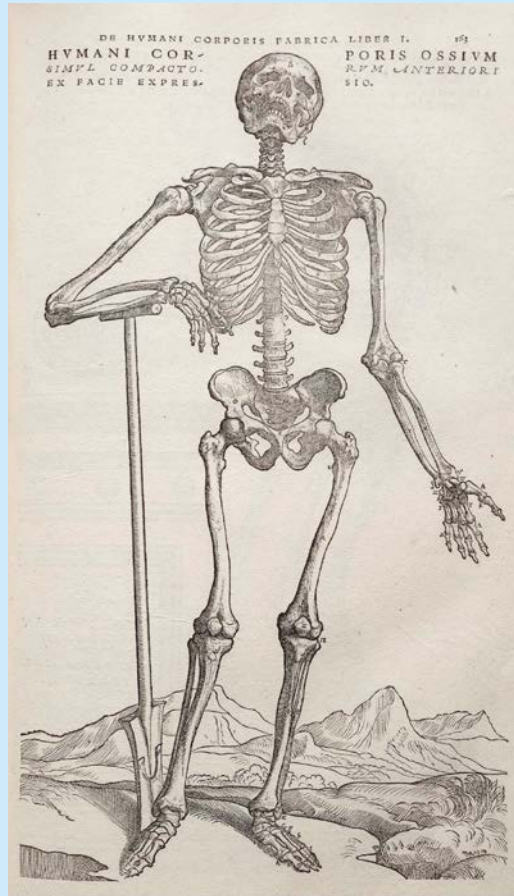


Image from Andreas Vesalius' *De humani corporis fabrica* (1543), page 163

**Rene Descartes**, in 1649, described the Pineal gland as the control center of the body and mind. The Pineal gland, located in the brain, produces Melatonin, which regulates the sleep cycle (circadian rhythm). A cross-section of a nerve cell was seen in one of the first microscopes by **Antonie Van Leeuwenhoek** in 1717. Although we know it is now incorrect, **Franz Joseph Gall** published his work on phrenology. He believed he could distinguish the traits of a person by feeling the bumps on their head.

**Paul Broca** discovered that different regions of the brain performed specific processes. He discovered "Broca's" Area (named after him) in 1861. This region is located in the frontal lobe of the left hemisphere of the brain and is intimately involved in speech articulation (talking). Near that same time, in 1874, **Carl Wernicke** published *Der Aphasische Symptomencomplex*, a book on aphasias. Aphasia is the term used to identify a difficulty in forming and understanding language. Wernicke's Area is located close to Broca's Area.



Observe the picture above. Do you see anything missing (a lack of masks, gloves, substances....)? Unlike very advanced and sterile (germ-free) environments for modern surgery, proper sanitary procedures were not practiced.



Medical staff sterilizing hands and arms before surgery

Your brain is a very complex and delicate organ. Unlike other parts of the body, disorders of the brain could not be treated or even diagnosed correctly. It wasn't until 1884 when the first successful surgical removal of a brain tumor was performed by **Sir Rickman John Godlee**. **Joseph Babinski** was the first to describe the Babinski Reflex. It is a normal reflex in infants but an abnormal reflex in older children and adults. We will learn more on this reflex later.

One of the most grotesque practices in neuroscience was developed in 1936 by **Dr. Antonio Egas Moniz**, who invented the procedure of frontal lobotomies for the treatment of mental illnesses. This caused changes in the person's personality and sometimes death. Fortunately, this is not practiced today.

**Dr. Wilder Penfield** developed a visual representation of the brain — called the homunculus — that identifies the sensory regions. We will visit with Dr. Penfield in an upcoming section.



The British Army's first mobile brain surgery unit shown being stocked in 1940. It was staffed with five specialist doctors and two nurses.





And last on our timeline is **Dr. Raymond Damadian**, who became a pioneer in the field of magnetic resonance imaging (MRI) through his development of several patents and a working machine named Indomitable that could be used for non-invasive detection of cancer in the human body. The first commercial MRI scanner was produced in 1980. This important technology can show disease or any damage in the brain in several ways without using surgery.



Continuing improvements to MRI technology are helping to discover new details of how our bodies function and ways to discover when there are problems. At left, Dr. Damadian with his pioneering machine, Indomitable.

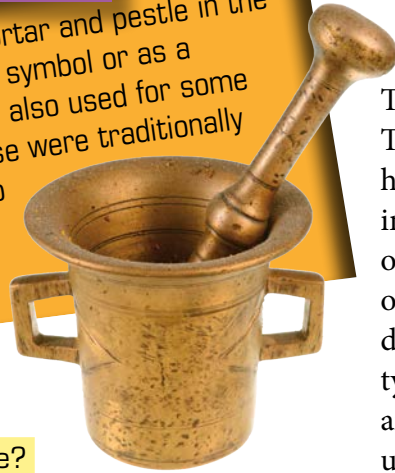
### *Word Wise!*

**ANATOMY** refers to the study of the body structure, systems, and organs of living things. The word developed from the Greek words “ana” meaning “up,” and “tomia” for cutting.



## MODERN MARVELS

You may have seen a mortar and pestle in the drug store – either as a symbol or as a decorative object. While also used for some cooking techniques, these were traditionally used in many cultures to mix up the ingredients in medicine.



### Good or Bad Medicine?

When a doctor gives you a prescription for medicine, you go to a pharmacy. Pharmacists are a type of doctor who have special training in drugs and their effects on the body. Before there were pharmacists, there were apothecaries. If you lived in the 15th century, in the times of Christopher Columbus, and became ill, you may have gone to an apothecary. They mixed their own medicines and gave advice on healthcare. Many doctors were able to formulate their own medicines as well. Evidence of prescriptions and instructions for how they were made have even been found on clay tablets as early as ancient Babylon.

There were no rules in how this had to be done. This meant that while a doctor in one place might have created a specific type of medicine, a doctor in a nearby town might make the same medicine only it would be slightly different in its formula of ingredients. Both might have prescribed a different amount of the medicine for the same type of injury. Now there are strict regulations and professional standards that help to insure uniformity in the formulas and prescriptions for medicine. Drugs for mental health, or psychotropic drugs, are a relatively new invention. Drugs developed for the specific treatment of mental health problems only came into existence after World War II.

Today many medicines are developed by huge corporations who spend billions of dollars in formulating these new drugs. They then have to go through a strict testing and approval process. The Food and Drug Administration is the government agency tasked with approving new medicines in the United States.



**BIBLICAL REFERENCES:** The Bible has a multitude of references to the body's organs and systems. However, it does not directly mention the brain.

Mind	Think	Meditate
Psalm 26:2	Romans 12:3	Psalm 48:9
Matthew 22:37	Philippians 4:8	Psalm 143:5
Luke 10:27	Proverbs 23:7	Psalm 119:15, 23, 27, 48, 78, 97, 99, 148
1 Peter 4:7	2 Peter 3:1	
Psalm 7:9	1 Corinthians 14:20	Colossians 3:2