

Overview of the Nervous System and the Action Potential (nerve impulse)



The Nervous System

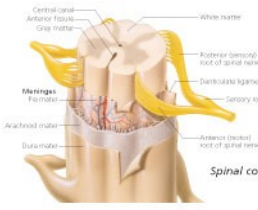
The nervous system

The nervous system is composed of two integrated subdivisions that are responsible for conducting and processing sensory and motor information: the **central nervous system (CNS)** and the **peripheral nervous system (PNS)**, which connects the CNS to the rest of the body.

The CNS includes the **brain and spinal cord**, which are covered by protective membranes called meninges (dura mater, arachnoid, and pia mater). The brain processes and coordinates all neural signals received from the spinal cord as well as its own nerves, such as the olfactory and optic nerves. It also performs complex mental functions such as thinking and learning.

The peripheral nervous system consists of input gathered from the sensory organs to the CNS. Motor output signals are relayed back to the PNS and on to the body muscles and glands. The PNS has three separate divisions: called the **somatic, sensory and motor nervous systems**.

The functional units of the nervous system are **neurons**. **Sensory neurons** contribute information from sensory receptors to the CNS. **Motor neurons** relay signals from the CNS to effector organs and glands cells. **Interneurons** contribute and integrate sensory input and motor output. **Glia cells** also make up a significant portion of the nervous system and provide important support for neurons activity.

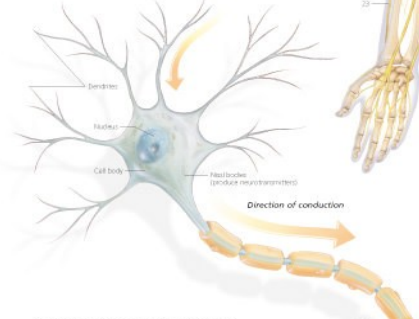


Spinal cord

The spinal cord and nerves

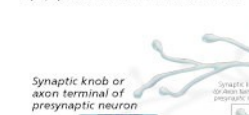
The spinal cord connects the peripheral nervous system to the brain, coordinates single reflexes to stimuli, and helps regulate the internal organs. It contains 31 pairs of **spinal nerves**, which include both sensory and motor nerves. Nerve signals generated by the sensory neurons travel through the spinal cord to the brain. Signals from the motor areas of the brain are sent back through the cord and directed to the motor neurons, triggering a response.

The inner core of the spinal cord is gray matter composed of neuron cell bodies and interneurons. The outer core or white matter is made up of tracts of myelinated axons responsible for transporting nerve signals. Surrounding the spinal cord are the meninges, protective layers of the neural column and a surrounding layer of fat and connective tissue in the epidural space.

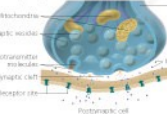


Structure of motor neurons

Motor neurons transmit impulses to other cells, specifically muscle fibers or glands. Each neuron consists of a **cell body** with a nucleus and various organelles. The **axon** is a long, thin projection that carries nerve impulses away from the cell body to the target cells. The axon is covered by a **myelin sheath**, which is composed of **myelinocytes**. The axon terminals are located at the end of the axon, where they connect to the target cells.

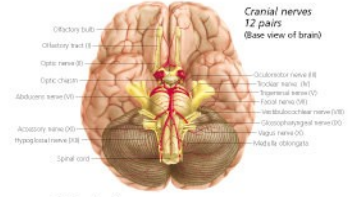


Synaptic knob or axon terminal of presynaptic neuron



What are synaptic connections?

Neurons in the CNS create thousands of input and output connections with other neurons, forming dense networks within the brain. These connections are called **synapses** and are the points where signals are passed from one neuron to another. The signals are passed through the **synaptic cleft**, a small gap between the axon terminal of one neuron and the dendrite of another neuron. The signals are passed through the **synaptic cleft** by the release of **neurotransmitters**. These highly specialized chemicals carry nerve impulses across the gap between the axon and the adjacent neuron or cell, either stimulating or inhibiting neural impulses in the target cell.



The brain

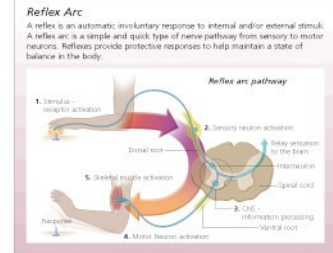
Average brain weighs between 1 and 1.5 lbs. and is composed of over 100 billion neurons. The brain is divided into 2 hemispheres, the **left** and **right** hemispheres. The **left hemisphere** controls the **right side** of the body, and the **right hemisphere** controls the **left side** of the body. The **left hemisphere** controls the higher brain functions such as sensory speech and vision, while the **right hemisphere** controls balance and coordination.

Functional areas of the brain



- Primary motor area
- Secondary motor area
- Primary somatosensory area
- Secondary somatosensory area
- Primary visual area
- Secondary visual area
- Primary acoustic area
- Secondary acoustic area
- Sensory speech area

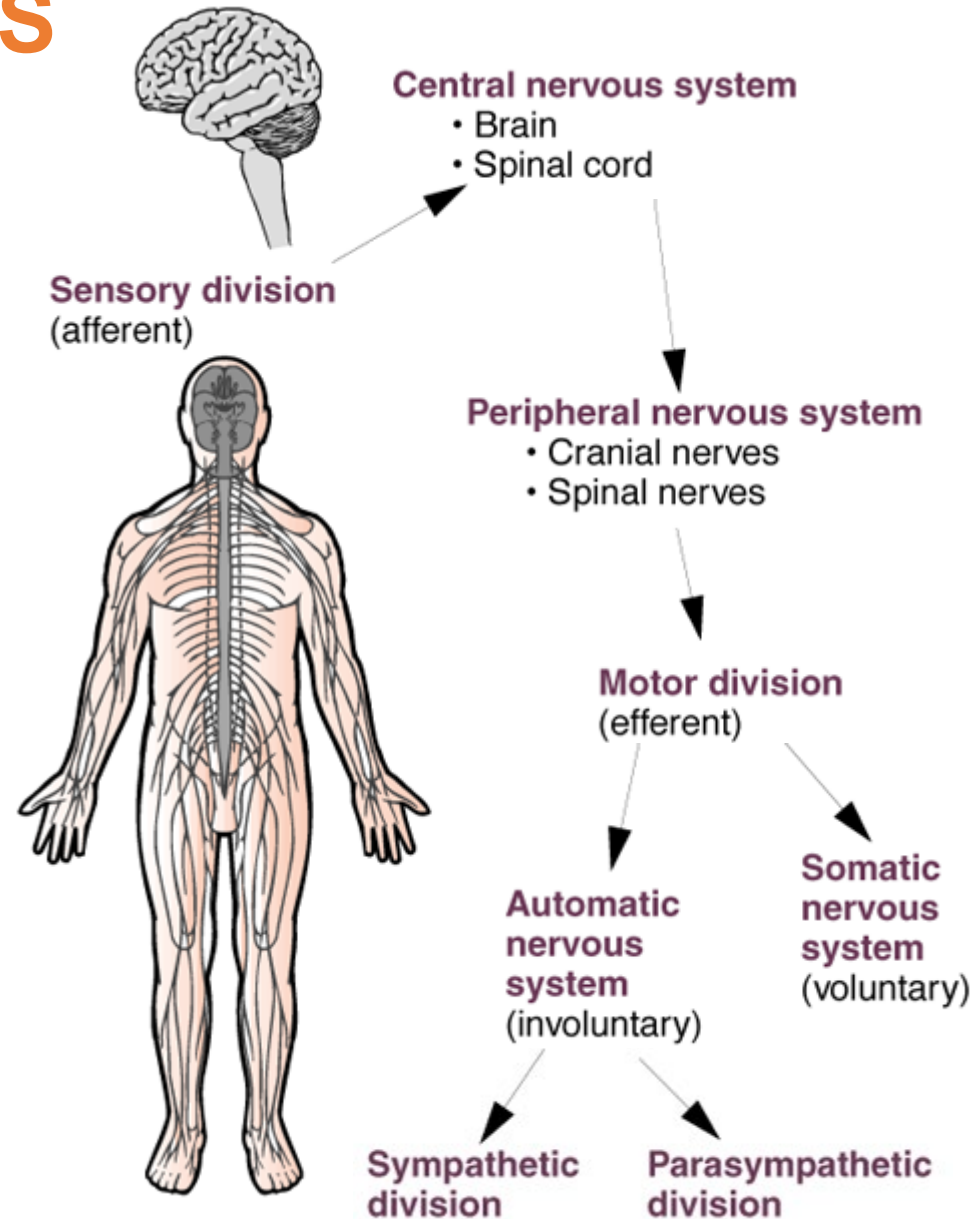
Key:	
1 Right cerebral hemisphere	16 Vestibular nerve
2 Left cerebral hemisphere	17 Substantia nigra
3 Longitudinal cerebral fissure	18 Cerebral cortex
4 Caudate nucleus	19 Deep branch of radial nerve
5 Basal ganglia	20 Pericardium
6 Spinal cord	21 Spinal cord
7 Cerebral cortex	22 Cerebral cortex
8 Cerebral cortex	23 Superficial branch of radial nerve
9 Cerebral cortex	24 Olfactory nerve
10 Cerebral cortex	25 Olfactory nerve
11 Cerebral cortex	26 Optic nerve
12 Cerebral cortex	27 Optic nerve
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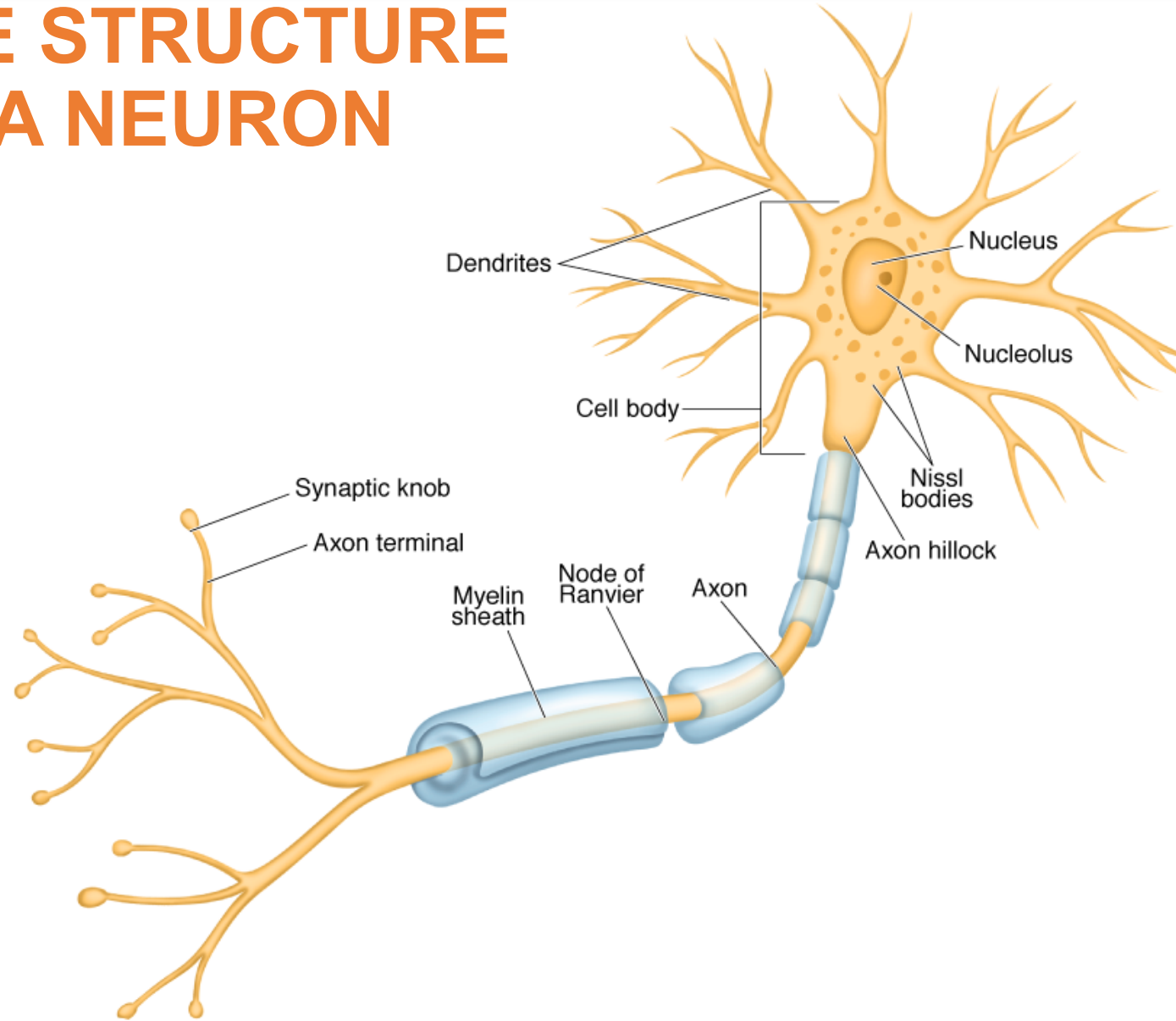
Lecture Aims

- Consider the organisation of the nervous system into its different branches
- Consider the anatomy of a neuron or nerve
- Understand the action potential

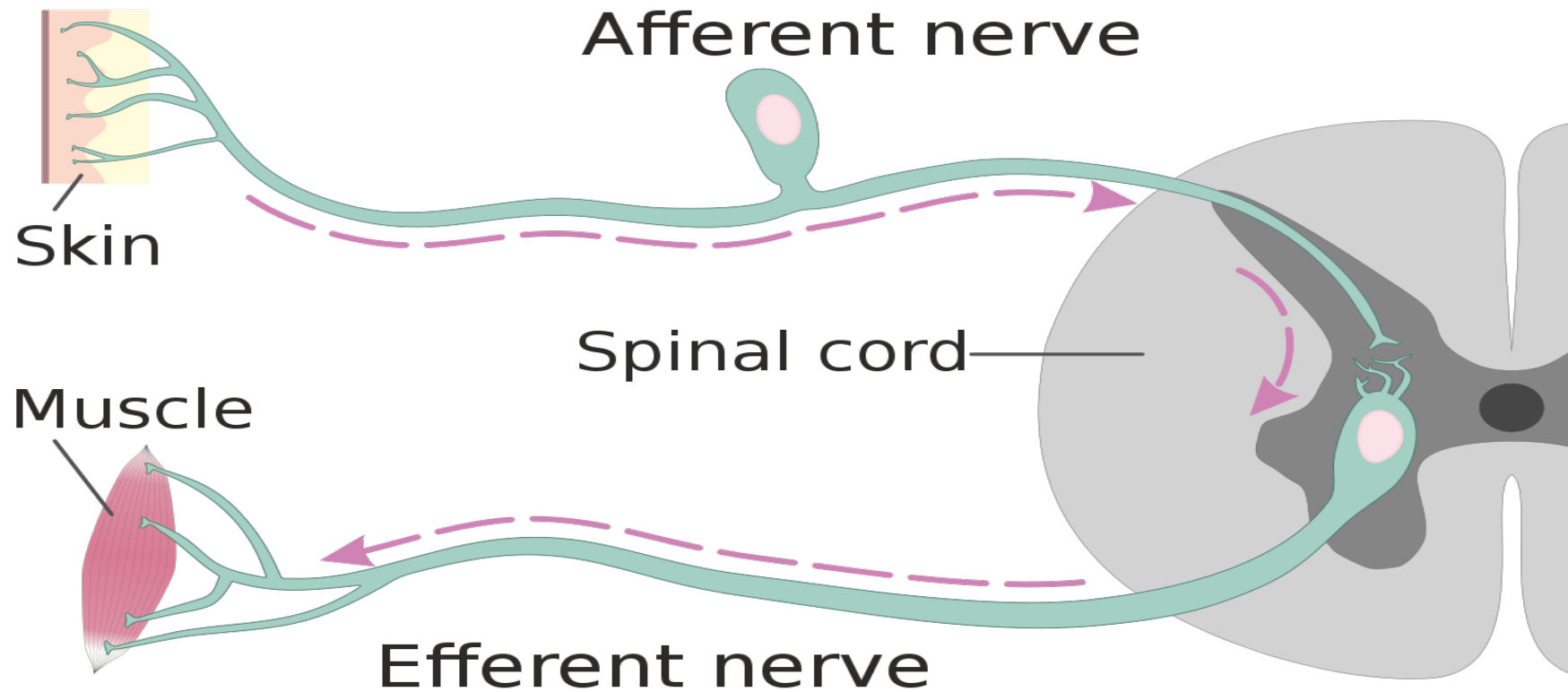
THE NERVOUS SYSTEMS



THE STRUCTURE OF A NEURON



Afferent Input: Nerve Impulses Heading Towards the Brain And Spinal Cord

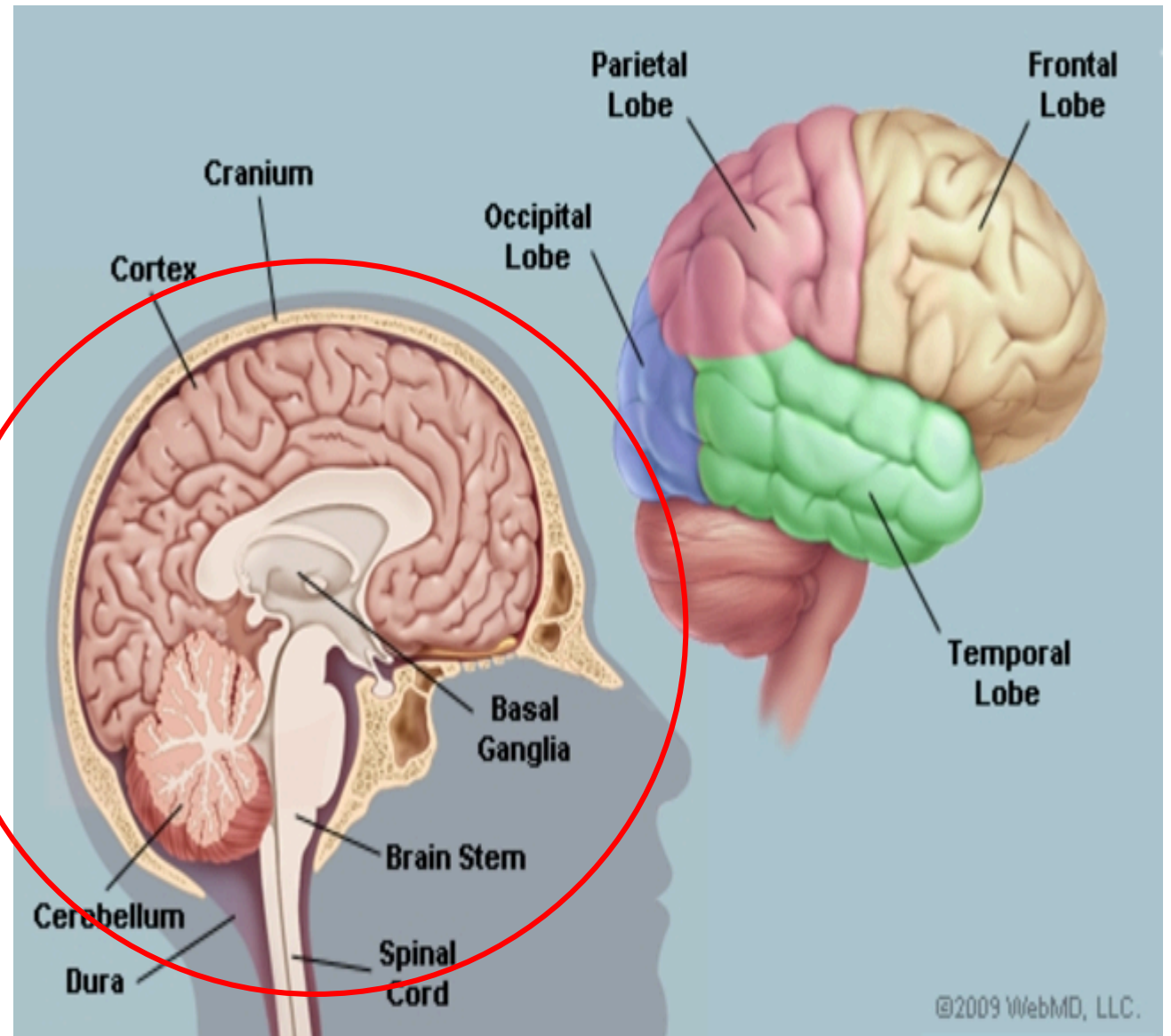


Efferent Output: Nerve Impulses Heading Away From the Brain and Spinal Cord

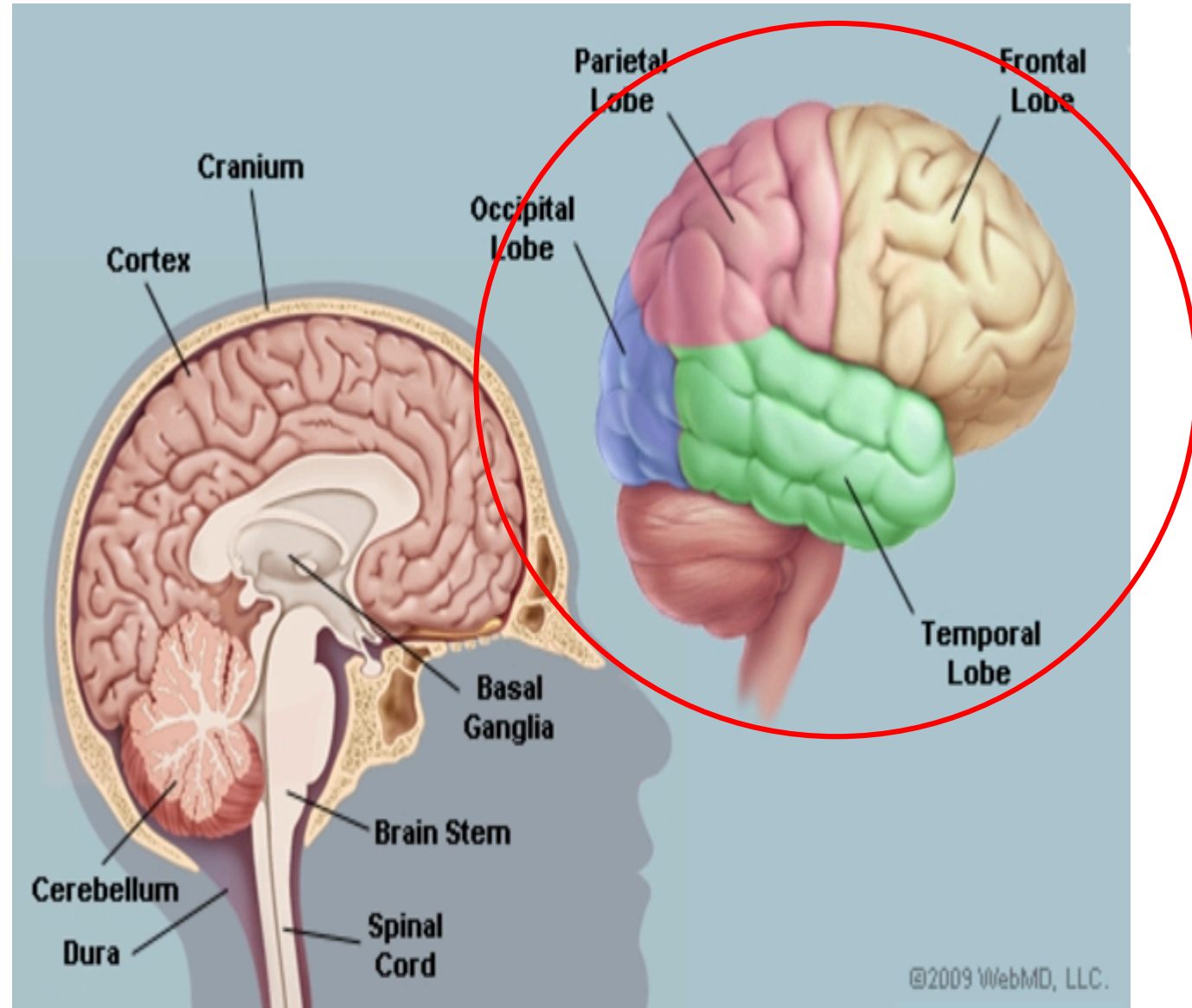
- One of the largest and most complex organs in the human body.
> 100 billion nerves that communicate in trillions of connections called synapses.

Many specialized areas that work together:

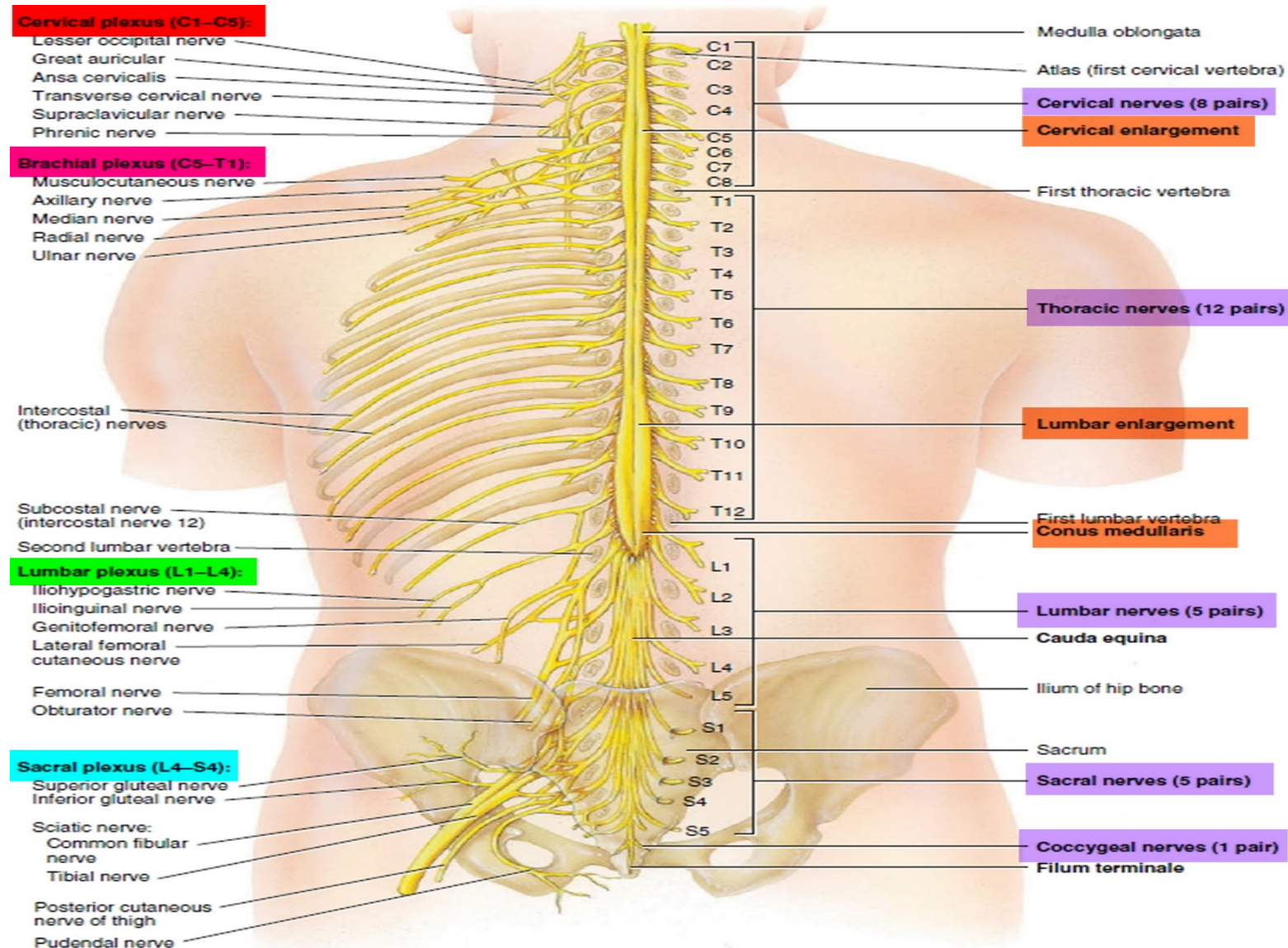
- The cortex is the outermost layer of brain cells; thinking and voluntary movements begin in the cortex.
- The brain stem is between the spinal cord and the rest of the brain; controls basic functions like breathing and sleep.
- The basal ganglia are a cluster of structures in the centre of the brain; coordinates messages between multiple other brain areas.
- The cerebellum is at the base and the back of the brain; responsible for coordination and balance.



- The brain is also divided into several lobes:
 - The frontal lobes are responsible for problem solving and judgment and motor function.
 - The parietal lobes manage sensation, handwriting, and body position.
 - The temporal lobes are involved with memory and hearing.
 - The occipital lobes contain the brain's visual processing system.



Spinal Cord and Nerves projecting from the Spine



Sympathetic Nervous System

Fight-or-flight—prepares you for acute stress or physical activity

Facilitates your motor response with increases in

- ♦ Heart rate and strength of heart contraction
- ♦ Blood supply to the heart and active muscles
- ♦ Metabolic rate and release of glucose by the liver and fatty acids from adipose tissue
- ♦ Blood pressure
- ♦ Rate of gas exchange between lungs and blood
- ♦ Mental activity and quickness of response

Parasympathetic Nervous System

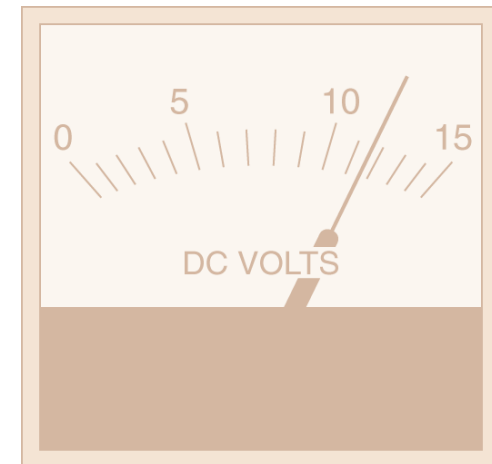
Housekeeping—digestion, urination, glandular secretion, and energy conservation

Actions oppose those of the sympathetic system

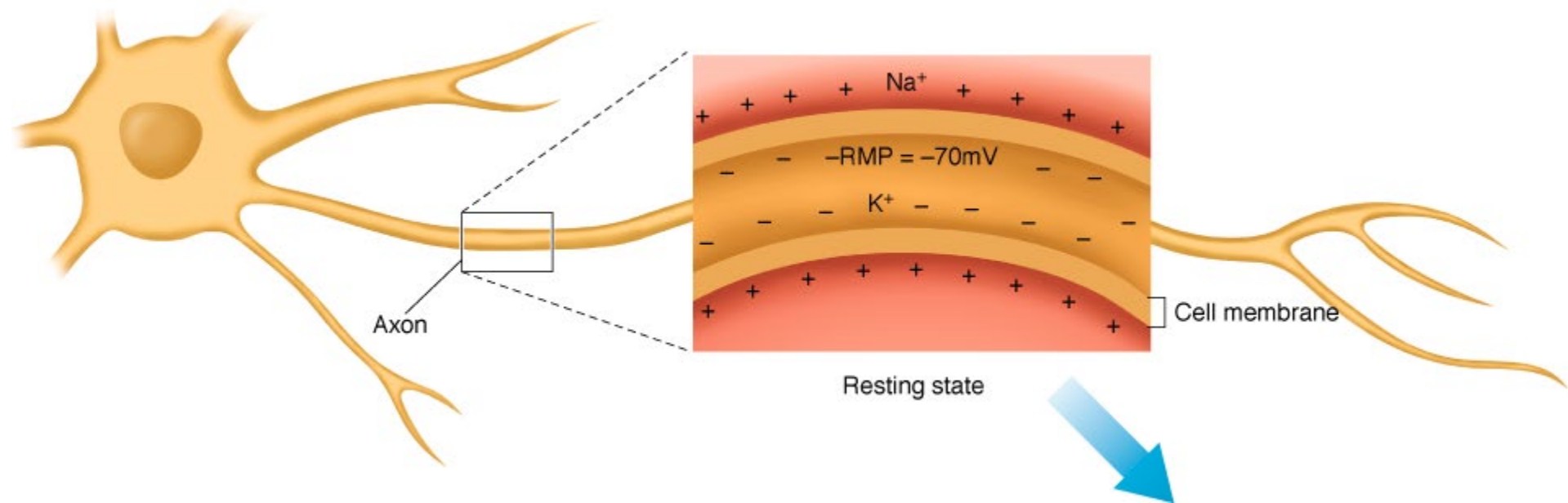
- ◆ Decreases heart rate
- ◆ Constricts coronary vessels
- ◆ Constricts tissues in the lungs

Nerve Impulse

An electrical charge that passes from one neuron to the next and finally to an end organ, such as a group of muscle fibers.



RESTING STATE



The Action Potential

<https://www.bing.com/videos/search?q=the+action+potential&&view=detail&mid=DC394D753C38430D1A7EDC394D753C38430D1A7E&&FORM=VRDGAR>

Next week...

- Closer look at sympathetic and parasympathetic nervous systems, nervous system receptors (e.g. the beta-adrenergic receptor) and what happens when receptors are activated or blocked
- The nervous system and muscle contraction
- Examples of nervous system and endocrine system integration