

1. **Neurons** – nerve cells that make up the nervous system

Specialized for responding to chemical/physical stimuli, sending impulses, releasing chemical regulators

Cell Body – contains the nucleus and other organelles

Dendrites – receive stimuli and conduct impulses toward the cell body

Axon – carries impulses away from the cell body

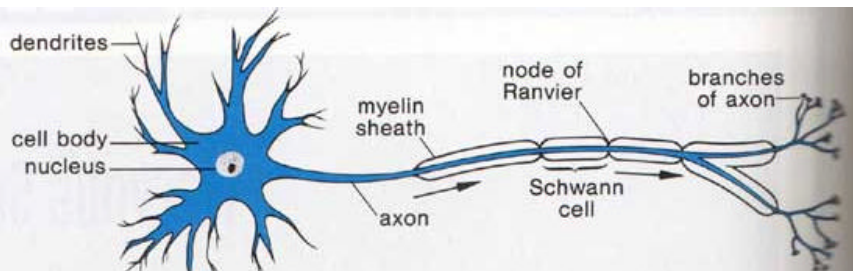
Nerve – a bundle of axons

Myelin Sheath – insulating coat of plasma membranes, formed by **Schwann cells**, present in vertebrates

Nodes of Ranvier – bare patches of axonal membrane that lie between the Schwann Cells

Axons with myelin sheaths transmit impulses 10 times faster than without myelin sheaths

FIGURE 22.1 A diagram of a motor neuron of a vertebrate. The axon carries impulses away from the cell body, as the arrows indicate. The dendrites carry impulses toward the cell body.



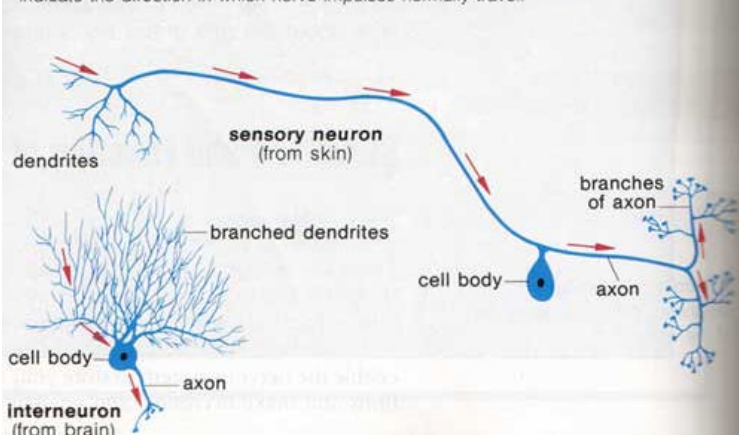
Motor Neurons – a type of neuron that transmit signals that originate in the brain and spinal cord

Sensory Neurons – gets information from the environment and transmit it toward the brain or spinal cord

Interneurons – transmit signals from one neuron to another within the central nervous system

Most abundant type of neuron in vertebrates

FIGURE 22.3 Different neurons from different parts of the vertebrate nervous system have different shapes, and they can be recognized by their structure. The arrows indicate the direction in which nerve impulses normally travel.



Central Nervous System – the brain and the spinal cord

Peripheral Nervous System – consists of motor neurons and sensory neurons

Serves as a communication network between the central nervous system and the rest of the body

2. **The Human Eye**

Cornea – a curved outer cover that covers the iris, pupil, and lens. The first bender of light

Iris – a muscle that controls the size of the pupil

Pupil – a “hole” in the iris in front of the lens

The iris adjusts the size of the pupil due to the intensity of light

When the light intensity is high, the size of the pupil becomes smaller

When the light intensity is low, the size of the pupil becomes larger

Lens – a double convex structure that bends light and focuses it onto the retina

Retina – part of the eye that contains rods and cones, receptors of light waves

Rods – responsible for peripheral vision and respond to dim light and black and white vision

Cones – responsible for daylight color vision

Optic Nerve – nerve that leads from the retina to the brain

3. **Stimuli and the Transmission of Impulses**

Stimuli – a change in the environment that causes an organism to respond

Sensory Receptors – specialized structures at the dendrite ends of sensory neurons that detect stimuli

Polarization – the changing of the electric charge inside and outside a nerve cell, causes nerve impulses

The membrane of cells allow K^+ to diffuse easily, but not Na^+
Hence, there is a higher concentration of K^+ inside, and a higher concentration of Na^+ outside
 K^+ ions can diffuse freely out of the cell, but Na^+ ions diffuse in much slower
Since more ions are leaving the cell than entering, the outside becomes positively charged
Electric Potential – the difference between the charge on the outside and inside of the cell
When stimulated, neurons allow Na^+ to diffuse quickly into the cell, balancing the charge
The neuron is no longer polarized, resulting in the transmission of an impulse
However, the Na^+ ions quickly stop diffusing, reestablishing the + charge outside the cell
Once the cell is polarized again, it is ready to transmit another impulse

Nerve Impulse - the wave of depolarization traveling along a neuron

Once one part of the membrane begins to allow Na^+ to diffuse in quickly, it begins to spread
This phenomena continues in one direction along the axon
Nerves need time to recover before they can transfer another impulse, which varies by cell type
Neurons with a myelin sheath transmit pulses much faster

Instead of the impulse traveling down the axon, it jumps from one node to the next

Threshold – the amount of stimulation required before Na^+ ions start diffusing in rapidly
Strong stimuli and weak stimuli both cause neurons to fire impulses, but strong impulses usually fire more neurons at one time, resulting in a stronger stimulus perceived in the brain

4. **Synapses** – a junction between a neuron and a second cell (muscle, gland, or another neuron)

Neurotransmitters – chemical messengers that are released when a pulse reaches the end of the axon

The transmitter diffuses across the synapse and stimulated the dendrite to trigger a 2nd neuron
In gland cells, they cause secretions to be released

After the transmitter stimulates the 2nd neuron, an enzyme quickly breaks the transmitter down

Polypeptide chains, such as endorphins and enkephalins, are also considered neurotransmitters
They almost stimulate nerve cells like morphine and heroin

5. **Drugs and Why They Make You Feel Good**

Drugs either stimulate or block certain nerve cells, giving you a sensation

However, pain is often used to warn that the body is being hurt

Drugs can also permanently damage the brain, since nerve cells can never be replaced

6. **The Evolution of the Nervous System** – These do NOT necessary apply to humans/mammals

Ganglia – clusters of nerve cells that allow only small parts of the nervous system to be stimulated

Nerve Net – the equal distribution of nerve cells throughout the body. Hydras have a nerve net

Humans and higher organisms have an organized nervous system

Hindbrain – the brain stem, present in vertebrates and humans, connects brain w/ spinal cord

Cerebellum – a portion of the hindbrain that coordinates movement

Midbrain – serves as a relay and reflex center for mammals

Forebrain – processes audio and visual information

Divided into the cerebrum, the thalamus, and the hypothalamus

Cerebrum – the part of the brain most important in learning and memory

Thalamus – a relay station that analyzes and transmits sensory input

Hypothalamus - regulates homeostatic mechanisms, links the nervous and endocrine systems.

7. **The Central Nervous System** – consists of the brain and the spinal cord

Specialized to interpret nerve impulses, coordinate the activities of all other systems, and retain memory

Meninges – protective membranes around the brain and the spinal cord

Cerebrospinal fluid – further cushions and protects the brain and spinal cord

The entire central nervous system is encased within the cranium and vertebrae

The Spinal Cord – carries impulses to and from the brain, responds to reflexes

Cerebrum – controls seeing, hearing, tasting, smelling, and feeling

Scientists study brains of those in serious accidents or with serious brain tumors

The cerebrum is divided into 2 separate hemispheres

Left Hemisphere – logic, rdading, speech, writing, math, right side of body

Right hemisphere – creativity, art, insight, 3D perception, left side of body

Lobes of the cerebrum

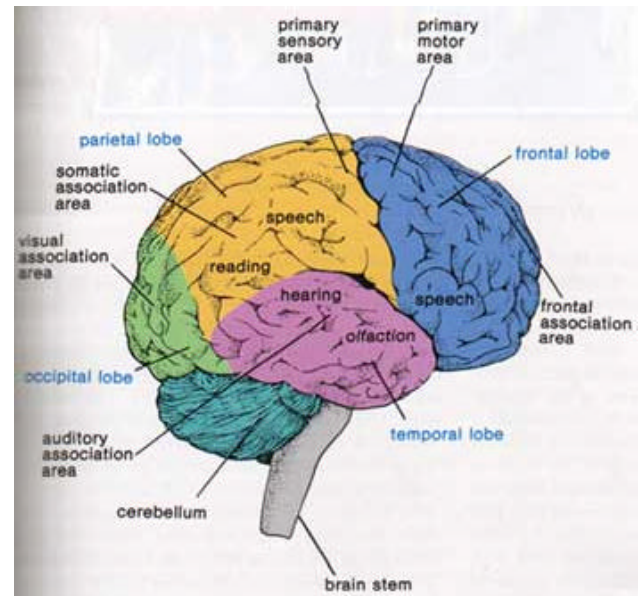
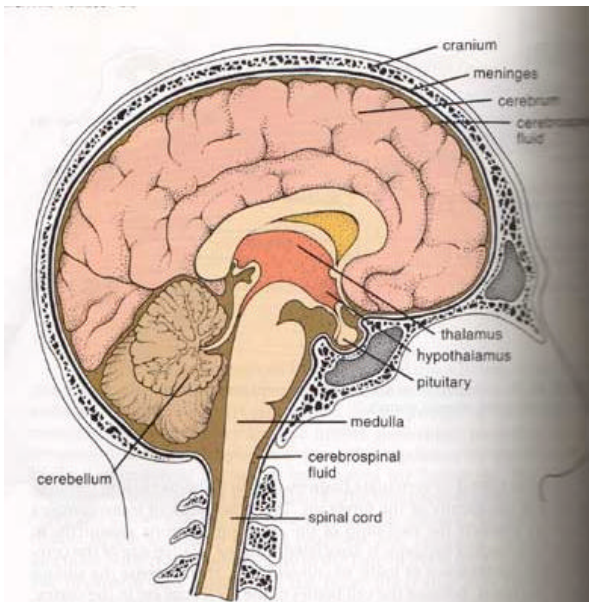
Parietal Lobe – reading, speech, senses

Frontal Lobe – also controls speech

Temporal Lobe – hearing

Occipital Lobe – visual images

Medulla – regulates automatic reflex, ie heart rate, rate of breathing, etc.



8. The Peripheral Nervous System

Consists of 12 pairs of cranial nerves that stimulate the upper body

Also consists of 31 pairs of spinal nerves that stimulate the entire body

Almost all nerves consist of both sensory and motor neurons

Somatic Nervous System – motor neurons that carry signals to skeletal muscles in response to stimuli

Considered the voluntary nervous system

Autonomic Nervous System – coordinates the function of organs and helps maintain homeostasis

Mostly reflexes that are not under our control, controls internal organs

Sympathetic and Parasympathetic systems – both control organs, have opposite effects

If the sympathetic system speeds heart rate, the parasympathetic slows it down

The sympathetic system serves as a stimulator

The parasympathetic system returns the stimulated organs back to normal

Reflex Arcs – automatic, involuntary response to a stimulus

Much faster because the brain doesn't have to process it

When someone hits you in the knee with a hammer, you react to it by reflex

Pain receptors occur in the same way

Painkillers work by disabling interneurons so they cannot continue to transmit the pulse