The two regions of the nervous system:

- Central nervous system (CNS) = The brain and spinal cord
- Peripheral nervous system (PNS) = All nervous tissue outside the CNS

Fig 12.2

Nervous system

Organs made of nervous tissue. The nervous system carries out these three functions:

- Senses stimuli (such as sight, touch, taste, etc.)
- Formulates a response to the stimuli
  - √ This function is our perceptions, thoughts, and reflexes
  - √ This function occurs in the CNS (the central nervous system, which is the brain and spinal cord)
- Transmits signals rapidly between body parts
  - √ Ex: Signals from sense organs to the CNS
  - √ Ex: Response signals from the CNS to the muscles

Figs 12.2, 12.6, and 12.14

Neuron

The nervous tissue cell that senses stimuli and carries electrical signals between body parts

- Nervous tissue = Neurons and their supporting cells (neuroglia)

Figs 4.19, 4.20, 12.11, and 12.12; Table 12.2

Neuron structure

- Cell body = The round part of the neuron that contains the nucleus and the major organelles

- Dendrites = Tree-like extensions from the cell body that detect the stimulus and generate the electrical signal

  √ A neuron's dendrites can be stimulated by a sense stimuli or by another neuron

- Axon = A long tube-like extension from the cell body that conducts the electrical signal toward the target cell (the cell that will receive the signal)

  √ Axon terminals = Bulbs at end of axon where signal the passes to the target cell

Figs 4.19 and 12.8

Myelin sheath

A sheath of myelin (white fatty material) wrapped around most axons that speeds the signal

- Formed by neuroglia cells wrapping around the axon

  √ Nodes of Ranvier = The gaps between neighboring neuroglia cells on the axon

Figs 4.19, 4.20, 12.8, and 12.13

Functionally, there are three neuron types:

1) Sensory neurons (afferent neurons)

PNS neurons that (a) sense stimuli, and (b) conduct sense signals into the CNS

- They are stimulated by light, sound, touch, smells, tastes, etc.
- They pass their signal to neurons in the CNS

2) Interneurons (association neurons)

CNS neurons that analyze sensory neuron signals and generate an appropriate response

- They are stimulated by sensory neurons or other interneurons
- They pass their signal to motor neurons or to other interneurons

3) Motor neurons (efferent neurons)

PNS neurons that conduct response signals out from the CNS

- They are stimulated by interneurons
- They pass their signal to muscles and glands

Figs 12.6 and 12.14

Reflex

An involuntary response to stimulation

- Autonomic reflexes = regulate involuntary muscles
- Somatic reflexes = regulate voluntary (skeletal) muscle
- Reflex arc = the neural pathway of a reflex
    - √ All reflex arcs must have sensory and motor neurons
    - √ Some, but not all, reflex arcs have interneurons

Fig 15.8

Action potential

The electrical signal that travels through a neuron

- A resting (non-signaling) neuron is electrically polarized (it is positively charged outside and negatively charged inside)

  √ The polarization is due to many Na^+ ions outside

- The action potential is when the neuron becomes depolarized (it becomes positively charged inside and negatively charged outside)

  √ Depolarization is due to the Na^+ ions entering the neuron

  √ The Na^+ enter through voltage gated ion channels

- After the action potential, the neuron repolarizes (returns to positive charge outside and negative charge inside).

  √ Repolarization is due to K^+ ions exiting the neuron

  √ The K^+ exit through voltage gated ion channels

Figs 12.20, 12.21, 12.23, 12.24

Synapse

The gap between a neuron's axon terminals and the target cell

- Electrical signals cannot cross the synapse
- The electrical signal must become a molecular signal to cross the synapse

Fig 12.27

Neurotransmitter

A molecule released by axon terminals to carry the signal across the synapse to the target cell

- Examples: Acetylcholine and norepinephrine
- The target cell has receptors for neurotransmitters

√ Neurotransmitters cause target cell to generate its own electrical signal

Figs 12.18, 12.27; Table 12.3

Nerves

Bundles of neurons (with supporting blood vessels and connective tissue) in the PNS

• Mixed nerves = the commonest kind of nerve; contains sensory and motor neurons

• Cranial nerves = Nerves that connect to the CNS in the head

• Spinal nerves = Nerves that connect to the CNS in the spine

(• Inside the CNS, bundles of axons are called tracts)

Figs 12.2, 13.21 13.23, and 13.24; Table 12.1

Ganglion

A cluster of neuron cell bodies in a nerve

(• Inside the CNS, clusters of cell bodies are called nuclei)

Fig 12.2; Table 12.1

Central nervous system (CNS)

The brain and the spinal cord

• The brain and the spinal cord are wrapped in three layers of membranes called the meninges and are bathed in a liquid called the cerebrospinal fluid (CSF). There are hollow spaces within the brain called ventricles which are filled with CSF.

• There are four major regions of the brain: The cerebrum, the diencephalon, the brain stem, and the cerebellum

Figs 12.2, 12.6 and 13.18; Table 13.2

Cerebrum (Cerebral hemispheres)

The largest and most superior region. It contains the following areas

• The folds on the surface of the cerebrum are called gyri, sulci, convolutions, or fissures.

• Cortexes (areas) for receiving each type of sense signals

• The motor area for control of voluntary movements.

• Association areas for "higher" functions (memory, language, logic)

• The corpus callosum is an area of white nerve fibers that allow the left and right halves of the cerebrum to communicate with each other

Figs 13.6 13.8, 14.23, and 16.5

Diencephalon

The brain region located between the cerebral hemispheres and the brain stem. Some of its structures are…

• The thalamus: It acts as a routing center to send incoming sense signals to the proper cortex

• The hypothalamus: It sets the proper levels of many functions of the body (such as sleep, temperature, thirst, hunger), as well as contributes to our emotions and sex drive.

Fig 13.11

Brain stem

A tubular region between the diencephalon and the spinal cord that controls many basic body functions

• Its three regions (from top to bottom) are the midbrain, the pons, and the medulla oblongata

• The medulla oblongata controls blood pressure and the rates of heart beats and breathing

Fig 13.12

Cerebellum

Small convoluted hemispheres at the brain's posterior

• Controls balance and smoothness of our movements

Fig 13.13

The spinal cord

A downward extension of nervous tissue from the brain stem

• The spinal cord conducts motor signals downward from the brain and sense signals (especially touch sense) upward to the brain.

Figs 12.2, 12.6, and 16.12

Peripheral nervous system (PNS)

All the nervous tissue outside the CNS

• The subdivisions of the PNS:

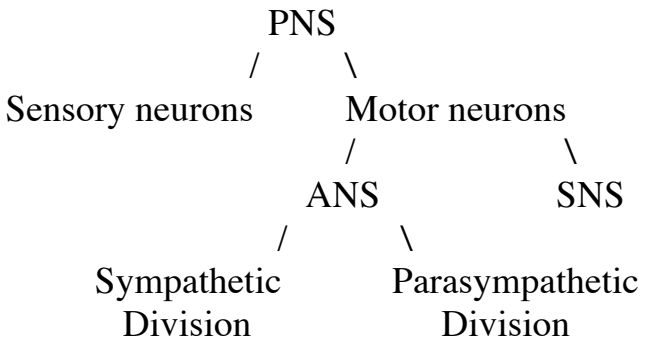

Fig 12.2

Somatic (voluntary) nervous system (SNS)

Motor neurons that control voluntary muscles

• Each SNS signal travels by a single motor neuron to its target cell

Fig 15.6

Autonomic (involuntary) nervous system (ANS)

Motor neurons that control involuntary muscles and glands

• The ANS mostly controls hollow organs and glands

• Each ANS signal travels through two consecutive motor neurons to its target cell

√ Preganglionic neuron = the first of the two neurons

√ Postganglionic neuron = the second of the two neurons

Figs 15.2, 15.4, and 15.6

Divisions of ANS:

The sympathetic and parasympathetic divisions

- They have mutually antagonistic effects on most organs

Figs 15.2 and 15.4

Sympathetic division

Puts organs in mode appropriate for threatening or harmful situations

- Ganglion usually near spine, distant from target organ
- Postganglionic neurons release norepinephrine as neurotransmitter

Figs 15.2 and 15.4; Table 15.1

Parasympathetic division

Puts organs in mode appropriate for relaxed peaceful situations

- Ganglion in or near target organ
- Postganglionic neurons release acetylcholine as neurotransmitter

Figs 15.2 and 15.4; Table 15.1

Nervous system disorders:

Newborns

- Downs syndrome = Mental retardation and physical abnormalities due to an extra chromosome

- Cerebral palsy = neuromuscular disability; poorly controlled voluntary muscles

Any age:

- Spinal cord injury = Leads to paralysis of all limbs controlled by nerves below the point of damage

- Brain injuries = symptoms vary with site of damage

  √ Concussion = no permanent damage

  √ Brain contusion = some permanent damage

- Alcohol and drugs = Kill brain cells; decrease brain mass

Older adults:

- Slow loss of neurons throughout life is normal; causes mild senility (forgetfulness or confusion) in some seniors

- Stroke (cerebrovascular accident) = lack of O_2 to a region of brain due to clogged blood vessel

  √ Effects vary with part of brain affected

- Alzheimers disease = Neurons become engulfed and damaged by protein fibers

  √ Causes severe senility and dementia

  √ Cause not known

Fig 16.3