Nervous Systems

- **Sensory receptors** collect information about the world outside the body as well as process inside the body.
- The **central nervous system** (CNS) consists of the brain and spinal cord
- The **peripheral nervous system** consists of the nerves that communicate motor and sensory signals throughout the rest of the body.
- **Motor output** is the conduction of signals from the CNS to **effector cells**, which are muscle or gland cells that carry out responses.
- The **neuron** is the functional unit of the nervous system.
  - It is composed of a cell body which contains the nucleus and organelles
  - **Dendrites**, which are cell extensions that receive incoming messages from other cells
  - And **axons**, which convey messages to other cells
- Many axons are covered by an insulating fatty **myelin sheath.**
  - At the end of the axons there are **synaptic terminals**, which relay signals from one neuron to another cell through chemical messengers called **neurotransmitters**.
- In nerve transmission, the transmitting cell is the **presynaptic cell**, and the receiving cell is the **postsynaptic cell**.
- A **simple nerve circuit** is the reflex arc, in which a sensory nerve receives information and passes it on to the spinal cord and then to a motor neuron, which signals an effector cell.
- **Ganglia** are clusters of nerve cells.
- **Glial cells** are supporting nerve cells, and they outnumber nerve cells in the body.
  - Three important types of glial cells are **astrocytes**, which provide suport for neurons
  - **Oligodendrocytes**, which form myelin sheathes in the CNS
  - and **Schwann cells**, which form myelin sheaths in the peripheral nervous system (PNS).

The Nature of Nerve Signals

- **Membrane potential** describes the difference in electrical charge across a cell membrane.
- The membrane potential of a nerve cell at rest is called its **resting potential**.
  - It exists because of differences in the ionic composition of the extracellular and intracellular fluids of the axonal membrane.
- Changes in the axonal membrane potential of a neuron are what give rise to **nerve impulses**.
  - A stimulus first affects the membrane's permeability to ions, and this is a graded potential with a magnitude proportional to the size of the stimulus.
- An **action potential** (nerve impulse) is an all-or-none depolarization of the membrane of the nerve cell.
  - It opens voltage-gated sodium channels, and Na+ ions enter the cell, bringing the membrane potential to a positive value.
  - The Na+ gates then close, and the cell goes back to resting potential.

- Action potentials are propagated along the axon; **saltatory conduction**, which is the jumping of the nerve impulse between nodes of Ranvier (areas on the axon not covered by myelin sheath), which speeds up the conduction of the nerve impulse.
- The signal is conducted from the axon of a presynaptic cell to the dendrite of a postsynaptic cell via an **electrical** or **chemical synapse**.
- Electrical synapses occur via gap junctions.
  - In chemical synapses, neurotransmitters are released by the presynaptic membrane into the synaptic cleft.
  - They bind to receptors on the postsynaptic membrane and are then broken down by enzymes, or taken back up into surrounding cells.
- **Excitatory postsynaptic potential** (EPSP) is the electrical charge caused by the binding of the neurotransmitter to its receptor on the postsynaptic membrane.
- **Inhibitory postsynaptic potential** (IPSP) is the voltage charge associated with chemical signaling at an inhibitory synapse.
- **Acetylcholine** is a very common neurotransmitter; it can be inhibitory or excitatory.
- Other neurotransmitters are epinephrine and norepinephrine, dopamine, and serotonin.

Vertebrate Nervous Systems

- The **autonomic nervous system** transmits signals that regulate the internal environment by controlling smooth and cardiac muscle, including those in the gastrointestinal, cardiovascular, excretory and endocrine systems.
- The autonomic nervous system is composed of the
  - **sympathetic division**, which when activated, causes the heart to beat faster and epinephrine to be secreted
  - And the **parasympathetic division**, which has the opposite effect when activated