

# Chapter 3: Biological Bases of Mental Life and Behavior

## Neurons: Basic Units of the Nervous System

- Nervous system- the interacting network of nerve cells that underlies all psychological activity
- Neuron- cell in the nervous system (nerve cell)
- **3 types of neurons:**
  - Sensory (afferent) neurons- transmit information from sensory cells in the body, called receptors, to the brain
  - Motor neurons (efferent)- transmit commands from the brain to the glands or musculature of the body, typically through the spinal cord
  - Interneurons- connect other neurons to each other; found only in the brain and spinal cord
- **Anatomy of a Neuron**
  - Dendrites- branchlike extensions of the neuron that receive information from other cells
  - Cell body- part of the neuron that includes a nucleus containing the genetic material of the cell (chromosomes) as well as other microstructures vital to cell functioning
  - Axon- long extension from the cell body through which electrical impulses pass
  - Myelin sheath- tight coat of cells composed primarily of lipids, which serves to isolate the axon from chemical or physical stimuli that might interfere with the transmission of nerve impulses and speeds neural transmission
  - Glial cells- origin of myelin sheath
  - Nodes of Ranvier- small spaces between myelin sheaths; when a neuron fires, the electrical impulse is rapidly conducted from node to node
  - Terminal buttons- structures at the end of the neuron that receive impulses from the axon and transmit signals to adjacent cells
  - Synapses- the place at which the transmission of information between neurons occurs
    - Synaptic cleft- space between synapses
- **Firing of a Neuron**
  - The Resting Potential
    - The condition in which the neuron is not firing
    - When neurons are at rest, the inside of the cell membrane is negatively charged and the fluid outside is positively charged
    - Proteins keep sodium ( $\text{Na}^+$ ) and chloride ( $\text{Cl}^-$ ) ions outside the cell and potassium ions ( $\text{K}^+$ ) inside the cell
  - Graded Potentials
    - When a neuron is stimulated, it can either reduce the membrane's polarization and excite the neuron, or increase the polarization and inhibit the neuron

- Depolarization (decrease in polarization) stems from an influx of positive sodium ions; charge inside cell membrane becomes less negative and is more likely to fire
  - Hyperpolarization (increase in polarization) is caused by outflow of positive potassium ions or influx of negative chloride ions; neuron less likely to fire
  - Graded potentials- a spreading voltage change that occurs when the neutral membrane receives a signal from another cell
- Action Potentials
  - After graded potential, membrane becomes permeable and positive sodium ions flow in; charge inside cell momentarily becomes positive
  - Outpouring of potassium ions then restores neuron to resting potential, making charge inside cell negative
  - Action potential- temporary shift in the polarity of the cell membrane, which leads to firing of a neuron
- **Transmission of Information Between Cells**
  - Synaptic vesicles- small sacs within terminal buttons
  - Neurotransmitters- chemicals that transmit information from one neuron to another; in synaptic vesicles
  - Receptors- protein molecules in the postsynaptic membrane that pick up neurotransmitters
  - When a receptor binds with the neurotransmitter that fits it, the chemical and electrical balance of the cell membrane changes, producing a graded potential
  - Excitatory neurotransmitters- depolarize the postsynaptic cell membrane, making an action potential more likely
  - Inhibitory neurotransmitters- increase the polarization and reduces likelihood of postsynaptic neuron firing
  - Modulatory neurotransmitters (neuromodulators)- increase or decrease the impact of other neurotransmitters released into the synapse
  - Over 75 types of neurotransmitters; 6 are best understood
    - Glutamate and GABA Glutamate (glutamic acid)- can excite every neuron in the nervous system
    - GABA (gamma-aminobutyric acid)- plays inhibitory role in brain
    - Dopamine- affects thought, feeling, motivation, and behavior
      - Parkinson's disease- too little dopamine; causes uncontrollable tremors, repetitive movements, and difficulty in initiating and stopping movements
      - Blood-brain barrier- protects brain from foreign substances in blood
    - Serotonin- involved in the regulation of mood, sleep, eating, arousal, and pain
      - SSRIs (selective serotonin reuptake inhibitors)- a class of antidepressant medications that block the presynaptic membrane from taking back serotonin which leaves it acting longer in the synapse

- Acetylcholine- involved in muscle contractions, learning, and memory
- Endorphins- chemicals in the brain similar to morphine that elevate mood and reduce pain

### **The Peripheral Nervous System**

- Nervous system has 2 major divisions: central and peripheral nervous system
- Central nervous system- consists of brain and spinal cord
- Peripheral nervous system- consists of neurons that convey messages to and from the central nervous system
- 2 subdivisions of peripheral nervous system:
  - Somatic- transmits sensory information to the central nervous system and carries out motor commands
    - Responsible mostly for voluntary actions
    - Directs some involuntary actions such as moving your hand when you touch a hot stove
  - Autonomic- conveys information to and from internal bodily structures that carry out basic life processes such as digestion and respiration
    - Sympathetic nervous system- activated in response to threats; increases heart rate, dilates pupils, and causes hair to stand
    - Parasympathetic nervous system- involved in conserving and maintaining body's energy sources; regulates blood sugar levels, secretes saliva, eliminates wastes, and regulates heart rate and pupil size
    - Sympathetic and parasympathetic nervous systems balance each other; when emergency has passed, parasympathetic resumes control and returns body to normal state
- **Studying the Brain**
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