# Textbook: Chapter 2 (page 46-83)

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**Definitions**

- Action potential: a neural impulse; a brief electrical charge that travels down an axon
- Adrenal glands: a pair of endocrine glands that sit just above the kidneys and secrete hormones (epinephrine and norepinephrine) that help arouse the body in times of stress
- Amygdala: two lima bean-sized neural clusters in the limbic system; linked to emotion
- Association areas: areas of the cerebral cortex that are not involved in primary motor or sensory functions; rather, they are involved in higher mental functions such as learning, remembering, thinking and speaking
- Autonomic nervous system (ANS): the part of the peripheral nervous system that controls the glands and the muscles of the internal organs (such as the heart). Its sympathetic division arouses; its parasympathetic division calms.
- Axon: the neuron extensions that passes messages through its branches to other neurons or to muscles or glands
- Biological perspective: concerned with the links between biology and behavior. Includes psychologists working in neuroscience, behavior genetics, and evolutionary psychology. These researchers may call themselves behavioral neuroscientists, neuropsychologists, behavior geneticists, physiological psychologists or biopsychologists
- Brainstem: the oldest part and central core of the brain, beginning where the brain cord swells as it enters the skull; the brainstem is responsible for automatic survival functions
- Central nervous system (CNS): the brain and spinal cord
- Cerebellum: the "little brain" at the rear of the brainstem; functions include processing sensory input and coordinating movement output and balance
- Cerebral cortex: the intricate fabric of interconnected neural cells covering the cerebral hemispheres; the body's ultimate control and information-processing center
- Corpus callosum: the large band of neural fibers connecting the two brain hemispheres and carrying messages between them
- Dendrites: a neuron's bushy, branching extensions that receive messages and conduct impulses toward the cell body
- Electroencephalogram (EEG): an amplified recording of the waves of electrical activity that sweep across the brain's surface. These waves are measured by electrodes placed on the scalp
- Endocrine system: the body's "slow" chemical communication system; a set of glands that secrete hormones into the bloodstream
- Endorphins: natural, opiate-like neurotransmitters linked to pain control and to pleasure
- fMRI (functional MRI): a technique for revealing blood flow and, therefore, brain activity by comparing successive MRI scans. fMRI scans show brain function
- Frontal lobes: portion of the cerebral cortex lying just behind the forehead; involved in speaking and muscle movements and in making plans and judgments
- Glial cells (glia): cells in the nervous system that support, nourish and protect neurons; they may also play a role in learning and thinking
- Hormones: chemical messengers that are manufactured by the endocrine glands, travel through the bloodstream, and affect other tissues
- Hypothalamus: a neural structure lying below the thalamus; it directs several maintenance activities (eating, drinking, body temperature), helps govern the endocrine system via the pituitary gland, and is linked to emotion and reward
- Interneurons: neurons within the brain and spinal cord that communicate internally and intervene between the sensory inputs and motor outputs
- Lesion: tissue destruction. A brain lesion is a naturally or experimentally caused destruction of brain tissue
- Limbic system: neural system (including the hippocampus, amygdala, and hypothalamus) located below the cerebral hemispheres; associated with emotions and drives
- Medulla: the base of the brainstem; controls heartbeat and breathing

- Motor cortex: an area at the rear of the frontal lobes that controls voluntary movements
- Motor neurons: neurons that carry outgoing information from the brain and spinal cord to the muscles and glands
- MRI (magnetic resonance imaging): a technique that uses magnetic fields and radio waves to produce computer-generated images of soft tissue. MRI scans show brain anatomy
- Myelin sheath: a fatty tissue layer segmentally encasing the axons of some neurons; enables vastly greater transmission speed as neural impulses hop from one node to the next
- Nerves: bundled axons that form neural "cables" connecting the central nervous system with muscles, glands and sense organs
- Nervous system: the body's speedy, electrochemical communication network, consisting of all the nerve cells of the peripheral and central nervous systems
- Neurogenesis: the formation of new neurons
- Neuron: a nerve cell; the basic building block of the nervous system
- Neurotransmitters: chemical messengers that cross the synaptic gaps between neurons. When released by the sending neuron, neurotransmitter travel across the synapse and bind to receptor sites on the receiving neuron, thereby influencing whether that neuron will generate a neural impulse
- Occipital lobes: portion of the cerebral cortex lying at the back of the head; includes areas that receive information from the visual fields
- Parasympathetic nervous system: the division of the autonomic nervous system that calms the body, conserving its energy
- Parietal lobes: portion of the cerebral cortex lying at the top of the head and towards the rear; receives sensory input for touch and body position
- Peripheral nervous system (PNS): the sensory and motor neurons that connect the central nervous system to the rest of the body
- PET (positron emission tomography) scan: a visual display of brain activity that detects where a radioactive form of glucose goes while the brain performs a given task
- Pituitary gland: the endocrine system's most influential gland. Under the influence of the hypothalamus, the pituitary regulates growth and controls other endocrine glands
- Plasticity: the brain's ability to change, especially during childhood, by reorganizing after damage of by building new pathways based on experience
- Reflex: a simple, automatic response to a sensory stimulus, such as the knee-jerk response
- Reticular formation: a nerve network that travels through the brainstem and plays an important role in controlling arousal
- Reuptake: a neurotransmitter's reabsorption by the sending neuron
- Sensory cortex: area at the front of the parietal lobes that registers and processes body tough and movement sensations
- Sensory neurons: neurons that carry incoming information from the sensory receptors to the brain and spinal cord
- Somatic nervous system: the division of the peripheral nervous system that controls the body's skeletal muscles (aka skeletal nervous system)
- Split brain: a condition resulting from surgery that isolates the brain's two hemispheres by cutting the fibers (mainly the corpus callosum) connecting them
- Sympathetic nervous system: the division of the autonomic nervous system that arouses the body, mobilizing its energy in stressful situations
- Synapse: the junction between the axon tip of the sending neuron and the dendrite or cell body of the receiving neuron. The tiny gap at this junction is called the synaptic gap or synaptic cleft
- Temporal lobes: portion of the cerebral cortex lying roughly above the ears; includes the auditory areas, each receiving information primarily from the opposite ear
- Thalamus: the brain's sensory switchboard, located on top of the brainstem; it directs messages to the sensory receiving areas in the cortex and transmits replies to the cerebellum and medulla
- Threshold: the level of stimulation required to trigger a neural impulse

**Biology, Behavior and Mind**

- Phrenology- the study of bumps on the skull that could reveal a person's mental abilities and

character traits (one of the first times someone tried to link biology and behavior)
- Biological perspective: concerned with the links between biology and behavior
- To understand behavior, need to study how social, psychological and biological systems interact and work

**Neural Communication**

- Similarities between humans and other animals allows scientists to better understand the nervous system by studying other organisms (same principles apply to all)
- Neurons
    - Neuron: a nerve cell; the basic building block of the nervous system
        - Each consists of a cell body and branching fibers
            - Dendrites: a neuron's bushy, branching extensions that receive messages and conduct impulses toward the cell body; are short
            - Axon: the neuron extensions that passes messages through its branches to other neurons or to muscles or glands; can be very long (several feet)
            - Myelin sheath: a fatty tissue layer segmentally encasing the axons of some (often long) neurons; enables vastly greater transmission speed as neural impulses hop from one node to the next (insulator)
                - Multiple sclerosis: when the myelin sheath degenerates, communication to muscles slows with eventual loss of muscle control
            - Terminal branches of axon: form junction with other cells
        - Neurons transmit messages when stimulated by signals from our senses or when triggered by chemical signals from neighboring neurons
        - In response, a neuron fires an impulse called the action potential (a neural impulse; a brief electrical charge that travels down an axon)
        - Generate electricity from chemical events
            - Ions are exchanged
            - The fluid outside an axon's membrane has mostly positively charged ions
            - A resting axon's fluid interior has mostly negatively charged ions
            - Resting potential: positive outside, negative inside
            - When a neuron fires, positively charged sodium ions flood into the axon (depolarization)
            - The action potential travels down the axon towards the axon terminal ends (the channel in the next axon opening and so on and so forth like dominos)
            - Refractory period: the cell pumps the positive sodium ions out of the cell and it is ready to fire
            - Threshold: the level of stimulation required to trigger a neural impulse
                - Increasing the level of stimulation above the threshold will not increase the neural impulse's intensity (all or none)
                - A strong stimulus triggers more neurons, but doesn't affect the action potential or speed
- How Neurons Communicate
    1. Electrical impulses (action potentials) travel down a neuron's axon until reaching a tiny junction known as a synapse
    2. When an action potential reaches an axon terminal, it stimulates the release of neurotransmitter molecules. There molecules cross the synaptic cap and bind to receptor sites on the receiving neuron. This allows electrically charged atoms to enter the receiving neuron and excite or inhibit a new action potential
    3. The sending neuron normally reabsorbs excess neurotransmitter molecules, a process called reuptake
    - Synapse: the junction between the axon tip of the sending neuron and the dendrite or cell body of the receiving neuron. The tiny gap at this junction is called the synaptic gap or synaptic cleft
    - Neurotransmitters: chemical messengers that cross the synaptic gaps between neurons. When released by the sending neuron, neurotransmitter travel across the synapse and bind to receptor sites on the receiving neuron, thereby influencing whether that neuron will generate a neural impulse

    - Reuptake: a neurotransmitter's reabsorption by the sending neuron
- How Neurotransmitters Influence People
    - There are many different types of neurotransmitters, each has its own designated pathway where it operates
    - Acetylcholine (ACh)
        - Plays a role in learning and memory
        - It is a messenger at every junction between motor neurons (which carry information from the brain and spinal cord to the body's tissues) and skeletal muscles
        - When ACh is released to muscle cell receptors, the muscle contracts
        - Is ACh transmission is blocked, will result in paralysis (muscles cannot contract)
    - Endorphins
        - natural, opiate-like neurotransmitters linked to pain control and to pleasure

| Neurotransmitter | Function |
|---|---|
| Acetylcholine (ACh) | Enables muscle action, learning and memory |
| Dopamine | Influences movement, learning, attention and emotion |
| Serotonin | Affect mood, hunger, sleep and arousal |
| Norepinephrine | Helps control alertness and arousal |
| GABA (gamma-aminobutyric acid) | A major inhibitory neurotransmitter |
| Glutamate | A major excitatory neurotransmitter, involved in memory |

- How Drugs and Other Chemicals Alter Neurotransmission
    - Opiates
        - Is opiates are over-consumed, the body will stop to produce natural opiates
        - When user stops using opiates, there will be no opiates in the body at all resulting in discomfort
    - Drugs and chemical affect brain chemistry at synapses
        - Agonist molecules bind to receptor sites and mimic effects of a neurotransmitter
            - Example: some opiates
        - Antagonist molecules bind to receptor, blocking a neurotransmitter
            - Example: botulism (blocks release of ACh)

**The Nervous System**

- Nervous system: the body's speedy, electrochemical communication network, consisting of all the nerve cells of the peripheral and central nervous systems
    - Central nervous system (CNS): the brain and spinal cord
    - Peripheral nervous system (PNS): the sensory and motor neurons that connect the central nervous system to the rest of the body
    - Nerves: bundled axons that form neural "cables" connecting the central nervous system with muscles, glands, and sense organs
    - There are three types of neurons:
        - Sensory neurons: neurons that carry incoming information from the sensory receptors to the brain and spinal cord for processing
        - Motor neurons: neurons that carry outgoing information from the brain and spinal cord to the muscles and glands
        - Interneurons: neurons within the brain and spinal cord that communicate internally and intervene between the sensory inputs and motor outputs
- Peripheral Nervous System: there are two components- somatic and autonomic
    - Somatic nervous system: the division of the peripheral nervous system that enables voluntary control over the body's skeletal muscles (aka skeletal nervous system)
    - Autonomic nervous system (ANS): the part of the peripheral nervous system that controls the glands and the muscles of the internal organs (such as the heart). It operates on its own (automatically). Its sympathetic division arouses; its

parasympathetic division calms.
    - Sympathetic nervous system: the division of the autonomic nervous system that arouses the body, mobilizing (expending) its energy in stressful situations
        - Examples: accelerated heartbeat, raise blood pressure, cool with perspiration
    - Parasympathetic nervous system: the division of the autonomic nervous system that calms the body, conserving its energy
        - Examples: slower heartbeat, lower blood pressure
- Central Nervous System: brain and spinal cord
    - Spinal cord connects the PNS to the brain
    - Reflex: a simple, automatic response to a sensory stimulus, such as the knee-jerk response
        - A simple reflex: the information from a stimulus is carried from the receptor along a sensory neuron to the spinal cord. The information is then passed along interneurons to motor neurons that result in an appropriate reaction to the stimulus.

**The Endocrine System**

- Endocrine system: the body's "slow" chemical communication system; a set of glands that secrete hormones into the bloodstream; is directed by the nervous system and affects the nervous system
- Hormones: chemical messengers that are manufactured by the endocrine glands, travel through the bloodstream, and affect other tissues
- Endocrine messages are slower than neural ones
- Endocrine messages tend to outlast the effects of neural messages
    - Adrenal glands: a pair of endocrine glands that sit just above the kidneys and secrete hormones (epinephrine and norepinephrine) that help arouse the body in times of stress
    - Pituitary gland: the endocrine systems most influential gland. Under the influence of the hypothalamus, the pituitary regulates growth and controls other endocrine glands
    - Thyroid gland: affects metabolism
    - Parathyroid: regulated the level of calcium in the blood
    - Pancreas: regulates the level of sugar in the blood

**The Brain**

- How to scientists study the brain?
    - Lesions: a naturally or experimentally caused destruction of brain tissue
    - Scientists can create lesions of stimulate (chemically, electrically, magnetically) different parts of the brain to determine which areas of the brain control/affect what function/behavior
    - Electroencephalogram (EEG): an amplified recording of the waves of electrical activity that sweep across the brain's surface. These waves are measured by electrodes placed on the scalp
    - PET (positron emission tomography) scan: a visual display of brain activity that detects where a radioactive form of glucose goes while the brain performs a given task, can show at "hot spot" (which part of the brain is most active) during a task
    - MRI (magnetic resonance imaging): a technique that uses magnetic fields and radio waves to produce computer-generated images of soft tissue. MRI scans show brain anatomy
        - fMRI (functional MRI): a technique for revealing blood flow and, therefore, brain activity by comparing successive MRI scans. fMRI scans show brain function
- Brain Structures
    - Brainstem
        - Brainstem: the oldest part and central core of the brain, beginning where the brain cord swells as it enters the skull; the brainstem is responsible for automatic survival functions
        - Crossover point, where most nerves to and from each side of the brain connect with the body's opposite side

        - Medulla: the base of the brainstem (where it swells); controls heartbeat and breathing
        - Pons: help coordinate movements, found just above the medulla
    - Thalamus
        - Thalamus: the brain's sensory switchboard, located on top of the brainstem; it directs messages to the sensory receiving areas in the cortex and transmits replies to the cerebellum and medulla
        - Receives information from all the senses except smell
    - Reticular Formation
        - Reticular formation: a nerve network that travels through the brainstem (from the spinal cord to the thalamus) and plays an important role in controlling arousal (consciousness)
        - Filters incoming stimuli
    - Cerebellum
        - Cerebellum: the "little brain" at the rear of the brainstem; functions include processing sensory input and coordinating movement output and balance
        - Enables non-verbal learning and memory
    - The Limbic System
        - Limbic system: neural system (including the hippocampus, amygdala, and hypothalamus) located below the cerebral hemispheres; associated with emotions and drives
            - Hippocampus: processes conscious memories (forms new memories)
            - Amygdala: two lima bean-sized neural clusters in the limbic system; linked to emotion (aggression and fear)
            - Hypothalamus: a neural structure lying below the thalamus; it directs several maintenance activities (eating, drinking, body temperature), helps govern the endocrine system via the pituitary gland, and is linked to emotion and reward (dopamine)
                - Monitors levels of nutrients/hormones in the blood
- Cerebral Cortex
    - Cerebral cortex: the intricate fabric of interconnected neural cells covering the cerebral hemispheres; the body's ultimate control and information-processing center
    - More complex animals have a larger cortex, allowing increased capacity for learning and thinking
    - Structure of the Cortex
        - There are so many wrinkles to increase the surface area of the brain
        - Contains 20 to 23 billion nerve cells and nine times as many glia
        - Glial cells (glia): cells in the nervous system that support, nourish and protect neurons; they may also play a role in learning and thinking
        - In more complex neurons, the ratio of glia to neurons increases
        - Each hemisphere is separated in to four lobs, separated by prominent fissures:
            - Frontal lobes: portion of the cerebral cortex lying just behind the forehead; involved in speaking and muscle movements and in making plans and judgments
            - Parietal lobes: portion of the cerebral cortex lying at the top of the head and towards the rear; receives sensory input for touch and body position
            - Occipital lobes: portion of the cerebral cortex lying at the back of the head; includes areas that receive information from the visual fields
            - Temporal lobes: portion of the cerebral cortex lying roughly above the ears; includes the auditory areas, each receiving information primarily from the opposite ear
    - Functions of the Cortex
        - Motor cortex: an area at the rear of the frontal lobes that controls voluntary movements
            - Left half of brain control right half of body and vice versa
            - Left half of brain receives input from the right half of the body and vice versa

        - The brain has no sensory receptors, allowing scientists to stimulate different areas of the brain with wide-awake patients
        - Areas of the body requiring precise control (fingers, mouth) occupy the greatest amount of cortical space
        - Brain-Computer Interface
            - Connecting different parts of the brain to electrodes, and a computer program analyzes the signals, resulting in a particular action (a robotic arm moving, etc)
    - Sensory cortex: area at the front of the parietal lobes that registers and processes body touch and movement sensations
        - The more sensitive the region, the larger the sensory cortex area devoted to it
        - The occipital lobes (in back of the brain) receive and processes visuals
        - Sound is processed in the auditory cortex in the temporal lobes
    - Association areas: areas of the cerebral cortex that are not involved in primary motor or sensory functions; rather, they are involved in higher mental functions such as learning, remembering, thinking and speaking
        - If stimulated, there would be no visual response, which makes it very difficult to map the association areas
        - These areas interpret, integrate and act on sensory information and link it with stored memories
        - Association areas are found in all four lobes
            - Frontal: enable judgment, planning and processing new memories
                - Frontal lobe damage can alter personality, remove inhibitions (more impulsive), moral judgments aren't restrained by emotions
            - Parietal: mathematical and spatial reasoning
            - Temporal: (underside of the right lobe) allows for facial recognition
        - Complex mental functions do not reside in one place; memory, language and attention are the result of multiple areas of the brain working in synchronization
        - Mental experiences arise from coordinated brain activity
- Brain's Plasticity
    - Plasticity: the brain's ability to change, especially during childhood, by reorganizing after damage of by building new pathways based on experience
    - Effects of brain damage can be traced to two facts:
        - Severed neurons usually do not regenerate
        - Some brain functions seem pre-assigned to specific areas of the brain
    - However, some neural tissues can reorganize (build new pathways) in response to damage
    - Constraint-induced therapy: aims to rewire brains and improve the dexterity of a brain-damaged child or adult stroke victims
    - Those with disabilities will reassign the unused brain tissue to fit their needs
    - Disease/damage (example: tumor) frees up other brain areas normally dedicated to specific functions to compensate
    - Neurogenesis: the formation of new neurons
        - Baby neurons originate deep in the brain and may then migrate elsewhere and form new connections with neighboring neurons
        - In the future, stem cells may be able to be developed into new neurons and used to help repair damaged areas of the brain

- The Divided Brain
    - The left and right hemisphere serves different functions
        - Damage to the left hemisphere has shown impaired reading, writing, speaking, arithmetic reasoning and understanding
        - Damage to the right hemisphere rarely has such dramatic effects
    - Splitting the Brain
        - In a normal (not split) brain:

        - Information from the left field of vision is sent to the right half of the brain and vice versa
        - Data received by either hemispheres is quickly transmitted to the other via the corpus callosum
        - Left hemisphere controls speech
    - Split brain: a condition resulting from surgery that isolates the brain's two hemispheres by cutting the fibers (mainly the corpus callosum) connecting them
        - Corpus callosum: the large band of neural fibers connecting the two brain hemispheres and carrying messages between them
        - The isolation of the two hemispheres has shown very little effect on personality and intellect
        - This results in two separate minds
        - The left hemisphere always has to guess the reasons behind the behavior of the right non-verbal hemisphere
- Right-Left Differences in the Intact Brain
    - Different hemispheres of the brain perform different tasks
        - Right hemisphere:
            - Perceptual tasks
            - Excels at making inferences (conclusions based on reasoning and logic)
            - Helps modulate speech to make meaning clear
            - Helps orchestrate a sense of self
        - Left hemisphere:
            - Speaking or calculations
            - Language center (verbal or sign)
- Handedness
    - 90% of people are right handed
        - 96% of right handed people process speech primarily in the left hemisphere
    - 10% of people are left handed
        - 70% of left handed people process speech primarily in the left hemisphere
        - 30% of left handed people either process speech in the right hemisphere or both