UNIT 3

Biological Bases of Behavior: 3A—Neural Processing and the Endocrine System

UNIT PREVIEW

Our nervous system plays a vital role in how we think, feel, and act. Neurons, the basic building blocks of the body's circuitry, receive signals through their branching dendrites and cell bodies and transmit electrical impulses down their axons. Chemical messengers called neurotransmitters traverse the tiny synaptic gap between neurons and pass on excitatory or inhibitory messages.

The central nervous system consists of the brain and spinal cord. The peripheral nervous system consists of the somatic nervous system, which directs voluntary movements and reflexes, and the autonomic nervous system, which controls the glands and muscles of our internal organs.

Hormones released by endocrine glands affect other tissues, including the brain. The most influential endocrine gland, the pituitary gland, releases hormones that influence growth, and its secretions also influence the release of hormones by other glands. The nervous system directs endocrine secretions, which then affect the nervous system.

UNIT GUIDE

Introductory Exercise: Fact or Falsehood?
Lecture: Phrenology

1. *Explain why psychologists are concerned with human biology, and describe the ill-fated phrenology theory.*

Everything psychological is simultaneously biological. We think, feel, and act with our bodies. By studying the links between biology and behavior, ***biological psychologists*** are gaining a better understanding of our experiences of sights and sounds, meanings and memories, pain and passion. In the 1800s, Franz Gall invented *phrenology*, a popular theory that claimed that bumps on the skull reveal our mental abilities and our character traits. Although bumps on the skull reveal nothing about the brain's underlying functions, Gall was accurate in supposing that various brain regions have particular functions. Today, we know that we are each a system composed of subsystems that are in turn composed of even smaller subsystems. Tiny cells organize to form such body organs as the stomach, heart, and brain. These organs in turn form larger systems for digestion, circulation, and information processing. And those systems are part of an even larger system—the individual, who in turn is a part of a family, culture, and community. Thus, we are *biopsychosocia*l systems.

Neural **Communicatio**n

Lecture: Multiple Sclerosis and Guillain-Barré Syndrome
Exercise: Modeling a Neuron and Using Dominoes to Illustrate the Action Potential
Videos: Module 6 of *Psychology*: *Th*e *Huma*n *Experience*: *Neurologica*l *Disorder*; Module 7 of *Psychology*: *Th*e *Huma*n *Experience*: *Brai*n *Surger*y *fo*r *Neurologica*l *Disorde*r
PsychSim 5: Neural Messages At all levels, researchers examine how we take in information and then how we organize, interpret, store, and use it. The information systems of humans and other animals operate similarly. This

similarity permits researchers to study relatively simple animals to discover how our neural systems operate.

2. *Describ*e *th*e *part*s *o*f a *neuron*, *an*d *explai*n *ho*w *it*s *impulse*s *ar*e *generated*. A ***neuro***n consists of a cell body and branching fibers: The ***dendrit***e fibers receive information from sensory receptors or other neurons, and the ***axo***n fibers pass that information along to other neurons. ***Sensor***y ***neuron***s send information from the body's tissues and sensory organs inward to the brain and spinal cord, which process the information. ***Moto***r ***neuron***s carry outgoing information from the central nervous system to the body's tissues. ***Interneuron***s in the central nervous system communicate internally and intervene between the sensory inputs and the motor outputs. The axons of some neurons are encased by a ***myeli***n ***sheath***, which helps speed their impulses. A neural impulse, or ***actio***n ***potential***, fires when the neuron is stimulated by signals from the senses or when triggered by chemical signals from neighboring neurons. The action potential is a brief electrical charge that travels down the axon. Received signals trigger an impulse only if the excitatory signals minus the inhibitory signals exceeds a minimum intensity called the ***threshold***. The neuron's reaction is an all-or-none response. During the *restin*g *potential*, the fluid interior of the axon carries mostly negatively charged atoms (*ions*), while the fluid outside has mostly positively charged atoms. Then, the first bit of the axon is *depolarize*d (its *selectivel*y *permeabl*e surface allows positive ions in), and the electrical impulse travels down the axon as channels open, admitting ions with a positive charge. When these channels close, others open and positive ions are pumped back out, restoring the neuron to its polarized state.

Exercises: Neural Transmission; Crossing the Synaptic Gap
Video: Video Clip 1 of *Digita*l *Medi*a *Archive*, *Psychology*: 1st ed.: *Neura*l *Communicatio*n
ActivePsych: *Digita*l *Medi*a *Archive*, 2nd ed.: *Neura*l *Communication*: *Impuls*e *Transmissio*n *Acros*s *th*e *Synaps*e

3. *Describ*e *ho*w *nerv*e *cell*s *communicate*. When electrical impulses reach the axon terminal, they stimulate the release of chemical messengers called ***neurotransmitter***s that cross the junction between neurons called the ***synapse***. After these molecules traverse the tiny *synapti*c *ga*p (*cleft*) between neurons, they bind to receptor sites on neighboring neurons, thus passing on their excitatory or inhibitory messages. The sending neuron, in a process called ***reuptake***, normally absorbs the excess neurotransmitter molecules in the synaptic gap.

Lecture: Endorphins

Lecture/Feature Film: Parkinson's Disease and *Awakenings*
Videos: Module 30 of *The Brain* series, 2nd ed.: *Understanding the Brain Through Epilepsy*; Module 5 of *The Mind* series, 2nd ed.: *Endorphins*: *The Brain's Natural Morphine*
Psychology Video Tool Kit: *Chemically Induced Hallucinations*: *Studies of Anesthetic Drugs*; *The Runner's High*; *Parkinson's Disease*: A *Case Study*; *Treating Parkinson's Disease*: *Deep Brain Electrode Implantation*

4. *Describe how neurotransmitters influence behavior, and explain how drugs and other chemicals affect neurotransmission*.

   Different neurotransmitters have different effects on behavior and emotion. For example, the neurotransmitter *acetylcholine (ACh)* plays a crucial role in learning and memory. Found at every

junction between a motor neuron and skeletal muscle, ACh causes the muscle to contract. The brain's ***endorphins***, natural opiates released in response to pain and vigorous exercise, explain the "runner's high" and the indifference to pain in some injured people.

When the brain is flooded with opiate drugs such as heroin and morphine, it may stop producing its own natural opiates, and withdrawal of these drugs may result in intense discomfort until the brain resumes production of its natural opiates. Some drugs (*agonists*), such as some of the opiates, mimic a natural neurotransmitter's effects. Others (*antagonists*), block the functioning or the effects of a particular neurotransmitter. Botulin, a poison that can form in improperly canned food, causes paralysis by blocking ACh release.

The Nervous System

Lecture: Lou Gehrig's Disease
Exercise: Reaction-Time Measure of Neural Transmission and Mental Processes

5. *Identify the two major divisions of the nervous system, and describe their basic functions*.
   Neurons communicating with other neurons form our body's primary system, the ***nervous system***. The brain and spinal cord form the ***central nervous system (CNS)***. The ***peripheral nervous system***
   (PNS) links the central nervous system with the body's sense receptors, muscles, and glands. The axons carrying this PNS information are bundled into the electrical cables we know as ***nerves***. The ***somatic nervous system*** of the peripheral nervous system enables voluntary control of our
   skeletal muscles. The ***autonomic nervous system*** of the peripheral nervous system is a dual self-regulating system that influences the glands and muscles of our internal organs. The ***sympathetic nervous system*** arouses; the ***parasympathetic nervous system*** calms.

   The brain's neurons cluster into work groups called *neural networks*. The cells in each layer of a neural network interrelate with various cells in the next layer. Learning occurs as feedback strengthens the work groups.

   Reflexes, which are simple, automatic responses to stimuli, illustrate the spinal cord's work. A simple reflex pathway is composed of a single sensory neuron and a single motor neuron, which often communicate through an interneuron. For example, when our fingers touch a candle's flame, information from the skin receptors travels inward via a sensory neuron to a spinal cord interneuron, which sends a signal outward to the arm muscles via a motor neuron. Because this reflex involves only the spinal cord, we jerk our hand away before the brain creates an experience of pain.

The Endocrine System

Lectures: The Endocrine System; Oxytocin: The Hormone of Love, Bonding, and Generosity?
Video: Module 2 of *The Brain* series, 2nd ed.: *The Effects of Hormones and Environment on Brain Development*

6. *Describe the nature and functions of the endocrine system and its interaction with the nervous system.*

   The ***endocrine system's*** glands secrete ***hormones***, chemical messengers produced in one tissue that travel through the bloodstream and affect other tissues, including the brain. Compared with the speed at which messages move through the nervous system, endocrine messages move more slowly, but their effects usually last longer. The endocrine system's hormones influence many aspects of our lives, including growth, reproduction, metabolism, and mood, keeping everything in balance while responding to stress, exertion, and internal thoughts. In a moment of danger, the ***adrenal glands*** release the hormones *epinephrine* and *norepinephrine*, which increase heart rate, blood pressure, and blood sugar, providing us with increased energy (for our *fight-or-flight*

   response). The ***pituitary gland*** is the endocrine system's most influential gland. Under the influence of the brain's hypothalamus, the pituitary's secretions influence growth and the release of hormones by other endocrine glands. These may in turn influence both the brain and behavior and thus reveal the intimate connection of the nervous and endocrine systems.