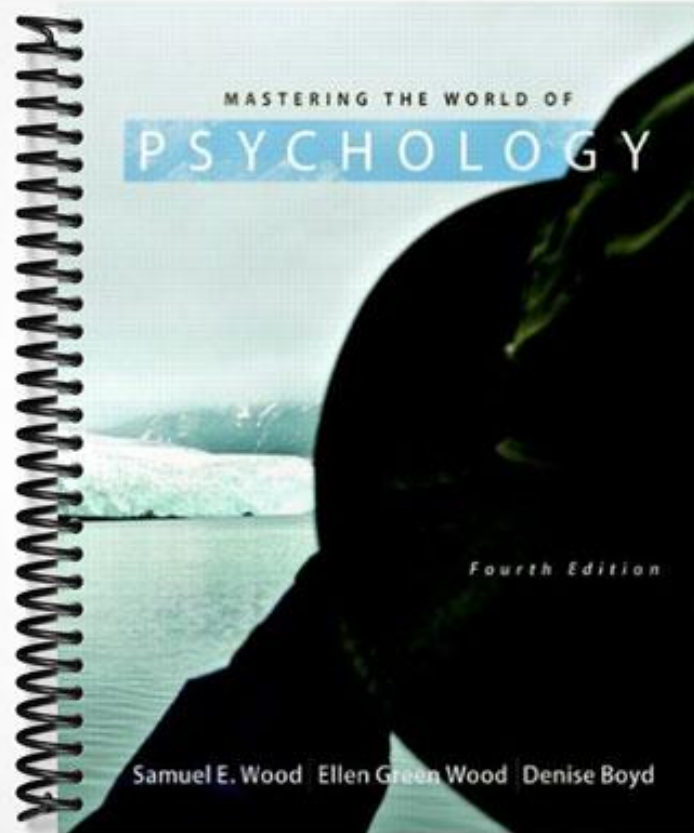


# SOLUTIONS MANUAL



MASTERING THE WORLD OF

PSYCHOLOGY

*Fourth Edition*

Samuel E. Wood Ellen Green Wood Denise Boyd

# 2 Biology and Behavior

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## LECTURE GUIDE

### DISCOVERING THE MYSTERIES OF THE NERVOUS SYSTEM (pp. 36–37)

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#### 2.1 The EEG and the Microelectrode: *What does the electroencephalogram (EEG) reveal about the brain?*

- The **electroencephalogram (EEG)** is a record of brain-wave activity.
- The **beta wave** is associated with mental and physical activity.
- The **alpha wave** appears when people are in a state of relaxation.
- **Delta waves** are the slow-wave patterns that occur during sleep.
- A **microelectrode** is a small wire used to monitor electrical activity or stimulate.

#### 2.2 Imaging Techniques: *How do researchers use imaging techniques to study the nervous system?*

- The **computerized axial tomography (CT) scan** uses X-rays to produce images of “slices” of the brain, yielding highly detailed pictures of brain structures.
- **Magnetic resonance imagery (MRI)** does not use radiation but produces detailed images of brain structures that are similar to those produced by the CT scan.
- **Pet scans** reveal where energy is being consumed in the brain.
- The **fMRI** shows brain functions as well as structures.
- Other imaging techniques include **SQUID** (superconducting quantum interference device) and **MEG** (magnetoencephalography).

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### THE NEURONS AND THE NEUROTRANSMITTERS (TEXT pp. 37–43)

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- [Explore: The Action Potential](#)
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#### 2.3 The Structure of the Neuron: *What does each part of the neuron do?*

- **Neurons** are specialized cells that conduct impulses through the nervous system.
- **Neurotransmitters** are chemicals released into the synaptic cleft from the axon terminal of the sending neuron.
- The **cell body** contains the nucleus and carries out the metabolic, or life-sustaining, functions of a neuron.

- The **dendrites**, which project out from the cell bodies, are the primary receivers of signals from other neurons.
- The **axon** is a tail-like extension of the neuron. It transmits signals to other neurons.
- At the ends of the axons are the **axon terminals**. Signals move from the axon terminals to the dendrites or cell bodies of other neurons and to muscles, glands, and other parts of the body.
- **Glial cells** are specialized cells in the brain and spinal cord that hold the neurons together.

#### 2.4 Communication between Neurons: *How do neurons transmit messages through the nervous system?*

- Communication between neurons occurs at the **synapse**, or the junction between the axon of one neuron and the dendrites of another.
- Prior to stimulation, the polarity of a neuron is slightly negative. This state is known as the cell's **resting potential**.
- An **action potential** happens when a neuron is stimulated. It involves the reversal of the cell's polarity.
- Neurons fire according to the “all-or-none” principle.
- The **myelin sheath**, the fatty white coating of the axon, prevents impulses from being misdirected.

#### 2.5 Neurotransmitters: *How do neurotransmitters work?*

- They cross the synaptic cleft and bind to **receptors** on the receiving neuron, influencing the cell to fire or not to fire. The lock-and-key analogy is often used to describe the relationship between each neurotransmitter and its specialized receptors.
- After an action potential occurs, neurotransmitters are reabsorbed into the synaptic vesicles in which they are stored. This process is known as **reuptake**.
- Acetylcholine (ACTH) is involved in learning, movement, and memory.
- Dopamine affects movement, attention, learning, and reinforcement.
- Norepinephrine and epinephrine help regulate eating, metabolism, and alertness.
- Glutamate is the brain's primary excitatory neurotransmitter.
- Serotonin and GABA help us sleep, while glutamate helps us stay awake.
- Endorphins are natural painkillers that contribute to our sense of pleasure and well-being.

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- [Explore: The Limbic System](#)
- [Explore: The Autonomic Nervous System](#)

#### 2.6 The Peripheral Nervous System: *What are the structures and functions of the peripheral nervous system?*

- The two divisions of the nervous system are the **central nervous system** (brain and spinal cord) and the **peripheral nervous system**.

- The peripheral nervous system connects the central nervous system to the rest of the body. It has two subdivisions: (1) the somatic nervous system, which consists of the nerves that make it possible for the body to sense and move, and (2) the autonomic nervous system.
- One division of the autonomic system, the **sympathetic nervous system**, mobilizes the body's resources during emergencies or during stress.
- The **parasympathetic nervous system** is the division of the autonomic system that brings the heightened bodily responses back to normal after an emergency.

### 2.7 The Central Nervous System: *What are the structures and functions of the central nervous system?*

- The **spinal cord** is an extension of the brain connecting it to the peripheral nervous system. The spinal cord must be intact so that sensory information can reach the brain, and messages from the brain can reach the muscles and glands.
- The **hindbrain** links the spinal cord to the brain.
- The **brainstem** contains structures that regulate vital functions.
- The **medulla** controls heartbeat, breathing, blood pressure, coughing, and swallowing.
- The **reticular formation** plays a crucial role in arousal and attention.
- The **pons** extends across the top front of the brainstem and connects to both halves of the cerebellum. It is involved in movement, sleeping, and dreaming.
- The **cerebellum** allows the body to execute skilled movements and regulates muscle tone and posture.
- The **midbrain** links the physiological functions of the hindbrain to the cognitive functions of the forebrain.
- The **substantia nigra** controls unconscious motor movements. It may be involved in nervous system diseases that affect motor functions.
- The **forebrain** is the largest part of the brain. It is where cognitive and motor functions are carried out.
- The **thalamus** acts as a relay station for information flowing into and out of the higher brain centers.
- The **hypothalamus** controls the pituitary gland and regulates hunger, thirst, sexual behavior, body temperature, and a variety of emotional behaviors.
- The **limbic system** is a group of structures in the forebrain, including the **amygdala** and the **hippocampus**, which are collectively involved in emotion, memory, and motivation.

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### Forty Studies that Changed Psychology: Explorations into the History of Psychological Research

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- [The Brain](#)
- [Phineas Gage](#)

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- [Brain Building](#)

- [Exercise Your Brain](#)
- [Men, Women, and Sex Differences](#)

#### Multimedia Resources

- [Explore: Split-Brain Experiments](#)
- [Simulate: Connie: Head Injury](#)
- [Simulate: Psychological Bases of Behavioral Problems](#)
- [Watch: Brain Building](#)

### 2.8 Components of the Cerebrum: *What are the components of the cerebrum?*

- The **cerebrum** is the largest structure of the brain.
- The **cerebral hemispheres** control movement and feeling on the opposing sides of the body.
- The **corpus callosum** connects the left and right hemispheres.
- The **cerebral cortex** is primarily responsible for the higher mental processes of language, memory, and thinking. Three types of areas are contained in the cerebral cortex. Sensory input areas receive sensory information. Motor areas control movements.
- **Association areas** house memories and are involved in thought, perception, and language.

### 2.9 The Cerebral Hemispheres: *What are the specialized functions of the left and right cerebral hemispheres?*

- The process of **lateralization** results in a division of functions between the cerebral hemispheres.
- In most people (right-handed more than left) the **left hemisphere** handles most of the language functions, including speaking, writing, reading, speech comprehension, and comprehension of the logic of written information. The left hemisphere coordinates complex movements by directly controlling the right side of the body and by indirectly controlling the movements of the left side of the body.
- The **right hemisphere** is generally considered to be the hemisphere more adept at visual–spatial relations. The right hemisphere also augments the left hemisphere’s language-processing activities. The right hemisphere responds to the emotional message conveyed by another’s tone of voice. Reading and interpreting nonverbal behavior is a right hemisphere task.
- The **split-brain operation** is a surgical procedure, performed to treat severe cases of epilepsy, in which the corpus callosum is cut, separating the cerebral hemispheres. Split-brain patients are important in research that examines how the right and left hemispheres work together.
- The two sides of the brain are less specialized in many left-handers. Left-handers tend to have higher rates of learning disabilities and mental disorders than right-handers.

### 2.10 The Four Cerebral Lobes: *Which functions are associated with each of the four lobes of the cerebral cortex?*

- The **frontal lobes** are the largest of the brain’s four lobes. The **motor cortex** is the area that controls voluntary body movement. **Broca’s area** is involved in directing the pattern of muscle movement required to produce speech sounds. **Broca’s aphasia** is impairment in the physical ability to produce speech sounds or, in extreme cases, an inability to speak at all. It is caused by damage to Broca’s area. Aphasia is a general term for a loss or impairment of the ability to use or understand language, resulting from damage to the brain. Much of the frontal lobes consist of association areas involved in thinking, motivation, planning for the future, impulse control, and emotional responses.
- The **parietal lobes** are on the top of the brain. A parietal lobe structure that is involved in the reception and processing of touch stimuli is the **somatosensory cortex**.
- The **occipital lobes** are at the back of the brain. The **primary visual cortex** is located in the occipital lobes. It receives and interprets visual information.
- The **temporal lobes** are on the sides of the brain. The **primary auditory cortex** is located in the temporal lobes. **Wernicke’s area** is the language area involved in comprehending the spoken word and in formulating coherent written and spoken language. **Wernicke’s aphasia** is a type of aphasia resulting from damage to Wernicke’s area. Auditory aphasia is word deafness. The remainder of the temporal lobes consists of the association areas that house memories and are involved in the interpretation of auditory stimuli.

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**AGE, GENDER, AND THE BRAIN (pp. 56–58)**

## Web Resources

- [General Resources](#)

**2.11 The Ever-Changing Brain: *How does the brain change across the lifespan?***

- Synaptogenesis is the process of synapse formation. It continues throughout life.
- **Pruning** is the process through which the developing brain eliminates unnecessary or redundant synapses. It allows the brain to preserve the most efficient pathways and eliminate those that are redundant.
- The process of myelination, or the development of myelin sheaths around axons, begins prior to birth but continues well into adulthood.
- Lateralization also changes with age. Language processing occurs primarily in the left hemisphere of the fetal and infant brain just as it does in the adult brain. Other functions may not be lateralized until late in childhood.
- **Plasticity** is greatest in young children within whom the hemispheres are not yet completely lateralized.
- Aging eventually leads to a reduction in the number of synapses.
- Aging is also associated with a loss of gray matter in the cerebellum. This may be the underlying cause of balance problems in the elderly.
- The risk of stroke and other cardiovascular events that damage the brain rises with age. A **stroke** is an event in the cardiovascular system in which a blood clot or plug of fat blocks an artery and cuts off the blood supply to a particular area of the brain.

**2.12 Gender Differences in the Brain: *How do the brains of men and women differ?***

- Men's brains have a higher proportion of white matter in the left brain, while women's brains have equal proportions of gray and white matter in both hemispheres.
- Some tasks tap different areas in men's brains than in those of women.

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## Web Resources

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- [Hormones and Glands](#)
- [Genes, Chromosomes, and DNA](#)
- [Nature and Nurture](#)

## Video Clips

- [How the Human Genome Map Affects You](#)

## Multimedia Resources

- [Explore: The Endocrine System](#)
- [Explore: Building Blocks of Genetics](#)
- [Watch: Cloned Child](#)
- [Watch: Human Cloning: The Ethics](#)
- [Watch: How the Human Genome Map Affects You](#)
- [Watch: Genetic Time Clock](#)
- [Watch: Junk DNA](#)
- [Explore: Dominant and Recessive Traits](#)

**2.13 The Endocrine System: *What are the functions of the glands of the endocrine system?***

- The **endocrine system** is a network of ductless glands in various parts of the body that manufacture hormones and secrete them into the bloodstream, thus affecting cells in other parts of the body.
- A **hormone** is a chemical substance that is manufactured and released in one part of the body and affects other parts of the body.
- The **pituitary gland** is the endocrine gland located in the brain that releases hormones that

- activate other endocrine glands as well as growth hormone. It is often called the “master gland.”
- The **pineal gland** secretes the hormone that controls the sleep/wakefulness cycle.
  - The **thyroid gland** produces thyroxine and regulates metabolism.
  - The **parathyroid glands** produce PTH, a hormone that helps the body absorb minerals from the diet.
  - The **thymus gland** produces hormones that are essential to immune system functioning.
  - The **adrenal glands** are a pair of endocrine glands that release hormones that prepare the body for emergencies and stressful situations and also release corticoids and small amounts of the sex hormones.
  - The **gonads**, the ovaries in females and the testes in males, produce sex hormones.
- 2.14 Genes and Behavioral Genetics: *How does heredity affect physical and psychological traits?***
- **Genes** are the segments of DNA that are located on the *chromosomes* (structures in the nuclei of all the body’s cells). They are the basic units for the transmission of all hereditary traits.
  - **Chromosomes** are rod-shaped structures in the nuclei of body cells, which contain all the genes and carry all the genetic information necessary to make a human being.
  - A person’s **genotype** is his/her genetic code.
  - The **phenotype** is a person’s actual characteristics.
  - **Dominant-recessive pattern** is a set of inheritance rules in which the presence of a single dominant gene causes a trait to be expressed, but two genes must be present for the expression of a recessive trait.
  - In **polygenic inheritance**, many genes influence a characteristic.
  - **Multifactorial inheritance** is a pattern of inheritance in which a trait is influenced by both genes and environmental factors.
  - Sex-linked inheritance involves the genes on the X and Y chromosomes.
  - **Behavioral genetics** is a field of research that uses twin studies and adoption studies to investigate the relative effects of heredity and environment on behavior.
  - Behavioral genetics studies show that heredity influences most psychological characteristics to some degree.

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## INSTRUCTIONAL RESOURCES

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[Review of Brain-Imaging Techniques](#)  
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### Lecture/Discussion: Berger's Wave

Learning Objective 2.1: *What does the electroencephalogram (EEG) reveal about the brain?*

Ask if anyone knows what is meant by the term, *Berger's wave*. Explain that the study of electrical activity in the brain was once limited to studies in which different kinds of measuring devices were attached to the exposed brains of animals. Studies involving humans were rare because researchers could only measure the electrical activity of the living human brain in individuals who had genetic defects of their skull bones that cause the skin of their scalps to be in direct contact with the surfaces of their brains.

All this changed when a German physicist named Hans Berger, after several years of painstaking research, discovered that it was possible to amplify and measure the electrical activity of the brain by attaching special electrodes to the scalp which, in turn, sent impulses to a machine that graphed them. In his research, Berger discovered several types of waves, one of which he called the "alpha" wave for no other reason than its having been the first one he discovered ("alpha" is the first letter of the Greek alphabet). He kept his research a secret until he published an article about it in 1929.

Obviously, Berger achieved one of the most important discoveries in the history of neuroscience. However, his life was not a happy one. Shortly after his article was published, the Nazis rose to power in Germany, which greatly distressed him. In addition, his work wasn't valued in Germany; he was far better known in the United States. As a result, Berger fell into a deep depression in 1941 and hanged himself.

The alpha wave is also sometimes called *Berger's wave* in honor of Berger's discovery.

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## Lecture/Discussion: Using fMRI and Magnetoencephalogram to Study Phantom Limb Pain

Learning Objective 2.2: *How do researchers use imaging techniques to study the nervous system?*

The idea of pain sensation means different things to different people. Many students are aware of phantom pain sensations and are actually very curious as to what it is. Medical professionals have recorded many cases of what has come to be called “phantom limbs.” Phantom limb phenomenon occurs when a person who has had an amputation of some body part, such as an arm or leg, reports “feeling” sensations from the now-missing limb. Phantom limb refers to the subjective sensory awareness of an amputated body part, and may include numbness, itchiness, temperature, posture, volume, or movement. For example, one man whose left arm was amputated just above the elbow during a horrific car accident claimed that he could still feel the arm as a kind of ghostly presence. He could feel himself wiggling non-existent fingers and “grabbing” objects that would have been in his reach had his arm still been there (Ramachandran & Blakeslee, 1998). Phantom sensations may take years to fade, and usually do so from the end of the limb up to the body—in other words, one’s phantom arm seems to get shorter and shorter until it can no longer be felt. In addition to legs and arms there have been cases of phantom breasts, bladders, rectums, vision, hearing, and internal organs.

Phantom limb pain refers to the specific case of painful sensations that appear to reside in the amputated body part. Patients have variously reported pins-and-needles sensations, burning sensations, shooting pains that seem to travel up and down the limb, or cramps, as though the severed limb was in an uncomfortable and unnatural position. Many amputees often experience several types of pain; others report that the sensations are unlike other pain they’ve experienced. Unfortunately, some estimates suggest that over 70 percent of amputees still experience intense pain, even 25 years after amputation. Most treatments for phantom limb pain (there are over 50 types of therapy) help only about 7 percent of sufferers.

What causes these phantom sensations? A recent study has shed light on the causes of phantom limb sensations. Researchers at Humboldt University in Berlin suggest that the most severe type of this pain occurs in amputees whose brains undergo extensive sensory reorganization. Magnetic responses were measured in the brains of 13 arm amputees in response to light pressure on their intact thumbs, pinkies, lower lips, and chins. These responses were then mapped onto the somatosensory cortex controlling that side of the body. Because of the brain’s contralateral control over the body, the researchers were able to estimate the location of the somatosensory sites for the missing limb. They found that those amputees who reported the most phantom limb pain also showed the greatest cortical reorganization. Somatosensory areas for the face encroached into regions previously reserved for the amputated fingers.

Renowned neuroscientist Dr. V. S. Ramachandran has investigated many cases of phantom limb sensations in his career. He believes that examination of people who experience these phenomena, using the non-invasive techniques of magnetoencephalograms and functional MRIs, can teach us much about the relationship between sensory experience and consciousness. Researchers have long known that touching certain points on the stump of the amputation (and in some cases on the person’s face) can produce phantom sensations in a missing arm or fingers (Ramachandran & Hirstein, 1998). Older explanations of phantom limb sensations have called it an illusion brought on by the irritation of the nerve endings in the stump due to scar tissue. But using anesthesia on the stump does not remove the phantom limb sensations or the pain experienced by some patients in the missing limb, so that explanation is not adequate. Ramachandran and colleagues suggest instead that phantom limb sensations may occur because areas of the face and body near the stump “take over” the nerve functions that were once in the control of the living limb, creating the false impression that the limb is still there, feeling and moving. This “remapping” of the limb functions, together with the sensations from the neurons ending at the stump and the person’s mental “body image” work together to produce phantom limb sensations.

Although these findings do not by themselves solve the riddle of phantom limb pain, they do offer avenues for future research. For example, damage to the nervous system may cause a strengthening of connections between somatosensory cells and the formation of new ones. Phantom limb pain may result due to an

imbalance of pain messages from other parts of the brain. As another possibility, pain may result from a remapping of somatosensory areas that infringes on pain centers close by.

Boas, R. A., Schug, S. A., & Acland, R. H. (1993). Perineal pain after rectal amputation: A 5-year follow-up. *Pain*, 52, 67–70.

Bower, B. (1995). Brain changes linked to phantom-limb pain. *Science News*, 147, 357.

Brena, S. F., & Sammons, E. E. (1979). Phantom urinary bladder pain – Case report. *Pain*, 7, 197–201.

Bressler, B., Cohen, S. I., & Magnussen, F. (1955). Bilateral breast phantom and breast phantom pain. *Journal of Nervous and Mental Disease*, 122, 315–320.

Dorpat, T. L. (1971). Phantom sensations of internal organs. *Comprehensive Psychiatry*, 12, 27–35.

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Ramachandran, V. S., & Blakeslee, S. (1998). *Phantoms in the Brain*. William Morrow, N.Y.

Ramachandran, V. S. and W. Hirstein (1998). The perception of phantom limbs: The D. O. Hebb lecture. *Brain*, 121, 1603–1630.

Shreeve, J. (1993, June). Touching the phantom. *Discover*, pp. 35–42.

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## Lecture Discussion: Review of Brain-Imaging Techniques

Learning Objective 2.2: *How do researchers use imaging techniques to study the nervous system?*

Ask students to tell which brain-imaging technique could answer each of the following questions:

1. How do the brains of children and adults differ with regard to energy consumption? (PET)
2. In what ways do brain waves change as a person falls asleep? (EEG)
3. In which part of the brain has a stroke patient experienced a disruption of blood flow? (CT, MRI)
4. What is the precise location of a suspected brain tumor? (CT, MRI)
5. How can brain structures be examined without exposing a patient to radiation? (MRI)
6. How can scientists view structures and their functions at the same time? (fMRI)
7. What techniques allow scientists to view changes in the magnetic characteristics of neurons as they fire? (SQUID, MEG)

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## Lecture/Discussion: Biographical Profiles

Learning Objectives 2.9, 2.11

### Walter Cannon

Walter Cannon was a physiologist who was highly critical of the James-Lange theory of emotion. Together with his colleague, Philip Bard, he developed an alternative theory that posited that physiological arousal and cognitive awareness occur simultaneously.

### Michael Gazzaniga

Michael Gazzaniga is a modern neuroscientist who has conducted clever “split-brain” studies to examine the special functions of each of the brain’s hemispheres. In particular, Gazzaniga’s research revealed some fascinating information processing properties of the right hemisphere.

**Roger Sperry**

Roger Sperry won a Nobel Prize for his ingenious experiments on the “split brain”--His experiments involved severing the corpus callosum, which functionally creates two brains: the left hemisphere and the right hemisphere.

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**Lecture/Discussion: Synaptic Transmission**

Learning Objective 2.4: *How do neurons transmit messages through the nervous system?*

Point out to students that neurons do not touch each other. Instead, two neurons are connected through a small space called a *synapse*, into which flow substances called *neurotransmitters* that either enhance or impede impulses moving from one neuron to the next. During the first half of the 1900s, there was controversy over whether synaptic transmission was primarily chemical or electric. By the 1950s, it was apparent that the communication between the neurons was chemical. During this period, some synapses showed what was termed *gap junction* or electrical transmission between neurons at the synapse. Recent research has shown that electrical synaptic transmission may be more frequent than neuroscientists once believed (Bennett, 2000). Even though the transmission of information between neurons at the synapses is primarily chemical, some electrical synapses are known to exist in the retina, the olfactory bulb, and the cerebral cortex (Bennett, 2000).

Use “The Wave,” an activity at sports arenas, as an analogy for the action potential. Like “The Wave,” the action potential travels the length of the neuron; the neuron doesn’t experience the action potential all at once. To extend the analogy, mention that right after people stand up in “The Wave,” they are somewhat tired and must recover (i.e., refractory period) to be prepared for the next go-round (i.e., action potential).

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**Lecture/Discussion: The Neural Effects of a Concussion**

Learning Objective 2.4: *How do neurons transmit messages through the nervous system?*

During the fall term, when college football is in season, it is especially appropriate to stress the discussion of the neuronal and behavioral effects of concussion. Chances are good that in any given class, you will have several students who will report having had a concussion in the past, usually as a result of participation in football or other sports activities, or as a result of an automobile accident. You can ask the students to discuss their experiences with the class, asking what kind of physiological and cognitive effects occurred. The most common effects include loss of vision (“black out”), blurred vision, ringing in the ears, nausea/vomiting, and not being able to think clearly. However, the physiological and cognitive effects vary between individuals; some may not have experienced nausea at all, whereas others only experienced blurred vision. It is important to point out the variability between individuals, because it can be inferred that concussions vary greatly in terms of the severity of brain damage and the brain areas affected.

The brain sits in the cranium surrounded by cerebral fluid. When a severe blow to the head occurs, the brain may collide with the cranium, then “bounce back” and collide with the opposite side of the cranium. For example, if a football player falls and hits the back of his or her head, the brain may hit the back of the cranium, then the front. At this point, you might ask students what brain areas would be affected in this example (“occipital and frontal lobes” are a pretty decent answer). Therefore, both vision and some cognitive functioning may be affected. At the neuronal level, a concussive blow to the head results in a twisting or stretching of the axons, which in turn creates swelling. Eventually, the swelling may subside

and the neuron may return to its normal functioning. However, if the swelling of the axon is severe enough, the axon may disintegrate. A more severe blow to the head may even sever axons, rendering those neurons permanently damaged. Either way, neuronal signaling is disrupted, either temporarily or permanently. Depending on the brain areas where the damaged axons are located, different physiological symptoms may occur.

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### Lecture/Discussion: The Discovery of Neurotransmitters

Learning Objective 2.5: *How do neurotransmitters work?*

In 1921, a scientist in Austria put two living, beating hearts in a fluid bath that kept them beating. He stimulated the vagus nerve of one of the hearts. This is a bundle of neurons that serves the parasympathetic nervous system and causes a reduction in the heart's rate of beating. A substance was released by the nerve of the first heart and was transported through the fluid to the second heart. The second heart reduced its rate of beating. The substance released from the vagus nerve of the first heart was later identified as *acetylcholine*, one of the first neurotransmitters to be identified. Many neurotransmitters have been identified in the years since 1921, and there is increasing evidence of their importance in human behavior. There are probably only a few ounces of these substances in the body, but they may have a profound effect on mood, memory, perception, and behavior.

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### Lecture/Discussion: The Major Neurotransmitters

Learning Objective 2.5: *How do neurotransmitters work?*

Acetylcholine (ACh) is one of the most important neurotransmitters. It plays an important role in transmitting the electrical impulse from motor neurons to the skeletal muscles, enabling our muscles to contract. ACh is involved in a variety of functions, including "arousal, attention, and memory, as well as a host of more specific motivated behaviors, such as aggression, sexuality, and thirst" (Panksepp, 1986). Its crucial role in the formation of memories can be seen in Alzheimer's patients, who have a deficiency in acetylcholine and suffer from severe memory loss (Mishkin & Appenzeller, 1987; Silberner, 1985).

A number of substances alter nervous system functioning as a result of their effect on ACh. For example, curare is a poison that was discovered by South American Indians. They put it on tips of the darts they shoot from their blowguns. Curare blocks acetylcholine receptors; paralysis of internal organs results. The victim is unable to breathe, and dies. A substance in the venom of black widow spiders stimulates release of acetylcholine at the synapses. Botulism toxin, found in improperly canned foods, blocks release of acetylcholine at the synapses and has a deadly effect. It takes less than one millionth of a gram of this toxin to kill a person.

Similarly, drugs affect consciousness because of their effects on neurotransmitters. For example, cocaine and the amphetamines prolong the action of certain neurotransmitters. Opiates such as heroin imitate the action of the endorphins.

It appears that the neurotransmitters dopamine, serotonin, and norepinephrine, are associated with some of the most severe forms of mental illness. Research suggests that dopamine is linked to schizophrenia. Adequate levels of serotonin and norepinephrine are related to positive feelings (Carlson, 1990). Thus, a deficiency in the two has been linked to depression. A class of antidepressant drugs called *tricyclics*

relieves the symptoms of depression in many of its victims by blocking the reuptake of these neurotransmitters, thus increasing their availability in the synapses.

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## Lecture/Discussion: Would You Like Fries With That Peptide?

Learning Objective 2.7: *What are the structures and functions of the central nervous system?*

Toast and juice for breakfast. Pasta salad for lunch. An orange, rather than a bagel, for an afternoon snack. These sound like reasonable dietary choices, involving some amount of deliberation and free will. However, our craving for certain foods at certain times of the day may be more a product of the brain than of the mind.

Sarah F. Leibowitz, Rockefeller University, has been studying food preferences for over a decade. What she has learned is that a stew of neurochemicals in the paraventricular nucleus, housed in the hypothalamus, plays a crucial role in helping to determine what we eat and when. Two in particular – Neuropeptide Y and galanin – help guide the brain’s craving for carbohydrates and for fat.

Here’s how they work. Neuropeptide Y (NPY) is responsible for turning on and off our desire for carbohydrate. Animal studies have shown a striking correlation between NPY and carbohydrate intake; the more NPY produced, the more carbohydrates eaten, both in terms of meal size and duration. Earlier in the sequence, the stress hormone cortisol seems responsible, along with other factors, for upping the production of Neuropeptide Y. This stress  $\Rightarrow$  cortisol  $\Rightarrow$  Neuropeptide Y  $\Rightarrow$  carbohydrate craving sequence may help explain overweight due to high carbohydrate intake. But weight, and craving, rely on fat intake as well. Leibowitz has found that the neuropeptide galanin plays a critical role in this case. Galanin is the on/off switch for fat craving, correlating positively with fat intake; the more galanin produced, the heavier an animal will become. Galanin also triggers other hormones to process the fat consumed into stored fat. Galanin itself is triggered by metabolic cues resulting from burning fat as energy, but also from another source: estrogen.

Neuropeptide Y triggers a craving for carbohydrate, galanin triggers a craving for fat, but the two march to different drummers throughout a day’s cycle. Neuropeptide Y has its greatest effects in the morning (at the start of the feeding cycle), after food deprivation (such as dieting), and during periods of stress. Galanin, by contrast, tends to increase after lunch and peaks toward the end of our daily feeding cycle.

The implications of this research are many. For example, the findings suggest that America’s obsession with dieting is a losing proposition (but not around the waistline). Skipping meals, gulping appetite suppressers, or experiencing the stress of dieting will trigger Neuropeptide Y to encourage carbohydrate consumption, which in turn can foster overeating. Paradoxically, then, by trying to fight nature we may stimulate it even more. As another example, the onset and maintenance of anorexia may be tied to the chemical cravings in the hypothalamus. Anorexia tends to develop during puberty, a time when estrogen is helping to trigger galanin’s craving for fat consumption. Some women (due to societal demands, obsessive-compulsive tendencies, or other pressures) react to this fat trigger by trying to accomplish just the opposite; subsisting on very small, frequent, carbohydrate-rich meals. The problem is that the stress and starvation produced by this diet cause Neuropeptide Y to be released, confining dietary interest to carbohydrates, but also affecting the sex centers nearby in the hypothalamus. Specifically, neuropeptide Y may act to shut down production of gonadal hormones.

Marano, H. E. (1993, January/February). Chemistry and craving. *Psychology Today*, pp. 30–36, 74.  
<http://www.rockefeller.edu/labheads/leibowitz/research.php>

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## Lecture/Discussion: The Cranial Nerves

Learning Objective 2.8: *What are the components of the cerebrum?*

You may want to add a description of the cranial nerves to your outline of the cerebrum. Although the function of the cranial nerves is not different from that of the sensory and motor nerves in the spinal cord, they do not enter and leave the brain through the spinal cord. There are twelve cranial nerves, numbered 1 to 12 and ordered from the front to the back of the brain, that primarily transmit sensory information and control motor movements of the face and head. The twelve cranial nerves are:

- *Olfactory*. A sensory nerve that transmits odor information from the olfactory receptors to the brain.
- *Optic*. A sensory nerve that transmits information from the retina to the brain.
- *Oculomotor*. A motor nerve that controls eye movements, the iris (and therefore pupil size), lens accommodation, and tear production.
- *Trochlear*. A motor nerve that is also involved in controlling eye movements.
- *Trigeminal*. A sensory and motor nerve that conveys somatosensory information from receptors in the face and head and controls muscles involved in chewing.
- *Abducens*. Another motor nerve involved in controlling eye movements.
- *Facial*. Conveys sensory information and controls motor and parasympathetic functions associated with facial muscles, taste, and the salivary glands.
- *Auditory-vestibular*. A sensory nerve with two branches, one of which transmits information from the auditory receptors in the cochlea and the other conveys information concerning balance from the vestibular receptors in the inner ear.
- *Glossopharyngeal*. This nerve conveys sensory information and controls motor and parasympathetic functions associated with the taste receptors, throat muscles, and salivary glands.
- *Vagus*. Primarily transmits sensory information and controls autonomic functions of the internal organs in the thoracic and abdominal cavities.
- *Spinal accessory*. A motor nerve that controls head and neck muscles.
- *Hypoglossal*. A motor nerve that controls tongue and neck muscles.

Carlson, N. R. (1994). *Physiology of behavior* (5th ed.). Boston: Allyn and Bacon.

Thompson, R. F. (1993). *The brain: A neuroscience primer* (2nd ed.). New York: W. H. Freeman.

Reprinted from Hill, W. G. (1995). Instructor's resource manual for *Psychology* by S. F. Davis and J. J. Palladino. Englewood Cliffs, NJ: Prentice Hall.

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## Lecture/Discussion: Understanding Hemispheric Function

Learning Objective 2.9: *What are the specialized functions of the left and right cerebral hemispheres?*

A variation on the rather dubious statement that “we only use one-tenth of our brain” is that “we only use one-half (hemisphere) of our brain.” Research suggests that each cerebral hemisphere is specialized to perform certain tasks (e.g., left hemisphere/language; right hemisphere/visuospatial relationships), with the abilities of one hemisphere complementary to the other. From this came numerous distortions, oversimplifications, and unwarranted extensions, many of which are discussed in two interesting reviews of this trend toward “dichomania” (Corballis, 1980; Levy, 1985). For example, the left hemisphere has been described variously as logical, intellectual, deductive, convergent, and “Western,” while the right hemisphere has been described as intuitive or creative, sensuous, imaginative, divergent, and “Eastern.” Even complex tasks are described as right- or left-hemispheric because of their language component. In every individual one hemisphere supposedly dominates, affecting that person's mode of thought, skills, and

approach to life. One commonly cited, but questionable test for dominance is to note the direction of gaze when a person is asked a question (left gaze signaling right hemisphere activity; right gaze showing left hemisphere activity). Advertisements have claimed that artistic abilities can be improved if the right hemisphere is freed, and the public schools have been blamed for stifling creativity by emphasizing left-hemisphere skills and by neglecting to teach the children's right hemisphere.

Corballis and Levy explode these myths and trace their development. In reality, the two hemispheres are quite similar and can function remarkably well even if separated by split-brain surgery. Each hemisphere does have specialized abilities, but the two hemispheres work together in all complex tasks. For example, writing a story involves left-hemispheric input concerning syntax, but right-hemispheric input for developing an integrated structure and for using humor or metaphor. The left hemisphere is not the sole determinant of logic, nor is the right hemisphere essential for creativity. Disturbances of logic are more prevalent with right-hemisphere damage, and creativity is not necessarily affected. Although one hemisphere can be somewhat more active than the other, no individual is purely "right brained" or "left brained." Also, eye movement and hemispheric activity patterns poorly correlate with cognitive style or occupation. Finally, because of the coordinated, interactive manner of functioning of both hemispheres, educating or using only the right or left hemisphere is impossible (without split-brain surgery). (Note: Suggestions for a student activity on this topic are given in the following Demonstrations and Activities section of this manual).

Corballis, M.C. (1980). Laterality and myth. *American Psychologist*, 35, 284–295.

Levy, J. (1985). Right brain, left brain: Fact or fiction? *Psychology Today*, 19, 38–45.

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### **Lecture/Discussion: Workplace Problems: Left-Handedness**

Learning Objective 2.9: *What are the specialized functions of the left and right cerebral hemispheres?*

Between Canada and the United States, there are approximately 33 million people who are left handed. This presents a severe detriment to the work place. It has been shown that left handed individuals are more likely to have accidents at work than are right handed individuals, in fact 25% more likely and if they are working with tools and machinery, 51% more likely. Accommodations such as being able to rearrange the work area and having tools available that are either left or right hand adapted would make the workplace a safer place to be. Have students suggest ways that the work place could be made safer or even what could be done in the classroom that would make it easier for students who are left handed to take notes or tests. What about the mouse on computers? The mouse is actually made for people who are right handed. How adaptable must a left handed person become in order not to be frustrated by using a right handed mouse?

Gunsch, D. For Your Information: Left-handed workers struggle in a right-handed work world. *Personnel Journal*, 93, 23–24.

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### **Lecture/Discussion: The Case of Phineas Gage**

Learning Objective 2.10: *Which functions are associated with each of the four lobes of the cerebral cortex?*

The case of Phineas Gage is discussed in the text. Here are a few more details.

Phineas Gage stood five feet six inches tall, weighed 150 pounds, and was 25 years old at the time of the incident. By all accounts this muscular foreman of the Rutland and Burlington Railroad excavating crew



was well-liked and respected by his workers, due in part to “an iron will” that matched “his iron frame.” He had scarcely known illness until his accident on September 13, 1848, in Cavendish, Vermont. Here is an account of the incident, in the words of John Martyn Harlow (1848, 1868), a physician who treated Gage:

He was engaged in charging a hold (sic) drilled in the rock, for the purpose of blasting, sitting at the time upon a shelf of rock above the hole. His men were engaged in the pit, a few feet behind him... The powder and fuse had been adjusted in the hole, and he was in the act of ‘tamping it in,’ as it is called... While doing this, his attention was attracted by his men in the pit behind him. Averting his head and looking over his right shoulder, at the same instant dropping the iron upon the charge, it struck fire upon the rock, and the explosion followed, which projected the iron obliquely upwards... passing completely through his head, and high into the air, falling to the ground several rods behind him, where it was afterwards picked up by his men, smeared with blood and brain.

The tamping rod itself was three feet seven inches in length, with a diameter of 1¼ inches at its base and a weight of 13¼ pounds. The bar was round and smooth from continued use, and it tapered to a point 12 inches from the end; the point itself was approximately ¼ inch in diameter.

The accounts of Phineas’ frontal lobe damage and personality change are well-known, and are corroborated by Harlow’s presentation. Details of Phineas’ subsequent life (he lived 12 years after the accident) are less known. Phineas apparently tried to regain his job as a railroad foreman, but his erratic behavior and altered personality made it impossible to do so. He took to traveling, visiting Boston and most major New England cities, and New York, where he did a brief stint at Barnum’s sideshow. He eventually returned to work in a livery stable in New Hampshire, but in August, 1852, he turned his back on New England forever. Gage lived in Chile until June of 1860, then left to join his mother and sister in San Francisco. In February, 1861, he suffered a series of epileptic seizures, leading to a rather severe convulsion at 5 a.m. on February 20. The family physician unfortunately chose bloodletting as the course of treatment. At 10 p.m., May 21, 1861, Phineas eventually died, having suffered several more seizures. Although an autopsy was not performed, Phineas’ relatives agreed to donate his skull and the iron rod (which Phineas carried with him almost daily after the accident) to the Museum of the Medical Department of Harvard University.

Miller (1993) also briefly notes that John Martyn Harlow himself had a rather pedestrian career, save for his association with the Gage case. Born in 1819, qualifying for medical practice in 1844, and dying in 1907, he practiced medicine in Vermont and later in Woburn, Massachusetts, where he engaged in civic affairs and apparently amassed a respectable fortune as an investor. Like Gage himself, Harlow was an unremarkable person brought into the annals of psychology by one remarkable event.

Harlow, J. M. (1848). Passage of an iron rod through the head. *Boston Medical and Surgical Journal*, 39, 389–393.

Harlow, J. M. (1868). Recovery from the passage of an iron bar through the head. Paper read before the Massachusetts Medical Society.

Miller, E. (1993). Recovery from the passage of an iron bar through the head. *History of Psychiatry*, 4, 271–281.

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### Lecture/Discussion: The Brain’s Bilingual Broca

Learning Objective 2.10: *Which functions are associated with each of the four lobes of the cerebral cortex?*

Se potete parlare Italiano, allora potete capire questa sentenza. Of course, if you only speak English, you probably only understand *this* sentence. If you speak both languages, then by this point in the paragraph you should be really bored.

Bilingual speakers who come to their bilingualism in different ways show different patterns of brain activity. Joy Hirsch of Memorial Sloan-Kettering Cancer Center in New York and her colleagues monitored the activity in Broca's area in the brains of bilingual speakers who acquired their second language starting in infancy, and compared it to the activity of bilingual speakers who adopted a second language in their teens. Participants were asked to silently recite brief descriptions of an event from the previous day, first in one language and then in the other. A functional magnetic resonance image (fMRI) was taken during this task. All of the 12 adult speakers were equally fluent in both languages, used both languages equally often, and represented speakers of English, French, and Turkish, among other tongues.

Hirsch and her colleagues found that among the infancy-trained speakers, the same region of Broca's area was active, regardless of the language they used. Among the teenage-trained speakers, however, a different region of Broca's area was activated when using the acquired language. Similar results were found in Wernicke's area in both groups. Although the full meaning of these results is a matter of some debate (do they reflect sensitivity in Broca's area to language exposure, or pronounced differences in adult versus childhood language learning?), they nonetheless reveal an intriguing link between *la testa e le parole*.

Bower, B. (1997, July 12). Brains show signs of two bilingual roads. *Science News*, 152, 23.

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## Lecture/Discussion: Endocrine Disorders

Learning Objective 2.13: *What are the functions of the glands of the endocrine system?*

Students may find it interesting to hear more about the various problems caused by problems within the endocrine system. The following disorders/medical problems are associated with abnormal levels within the pituitary, thyroid and adrenal glands.

### Pituitary malfunctions

#### *Hypopituitary Dwarfism*

If the pituitary secretes too little of its growth hormone during childhood, the person will be very small, although normally proportioned.

#### *Giantism*

If the pituitary gland over-secretes the growth hormone while a child is still in the growth period, the long bones of the body in the legs and other areas grow very, very long—a height of 9 feet is not unheard of. The organs of the body also increase in size, and the person may have health problems associated with both the extreme height and the organ size.

#### *Acromegaly*

If the over-secretion of the growth hormone happens after the major growth period is ended, the person's long bones will not get longer, but the bones in the face, hands, and feet will increase in size, producing abnormally large hands, feet, and facial bone structure. The famous wrestler/actor, Andre the Giant (Andre Rousimoff), had this condition.

### Thyroid malfunctions

#### *Hypothyroidism*

In hypothyroidism, the thyroid does not secrete enough thyroxin, resulting in a slower than normal metabolism. The person with this condition will feel sluggish and lethargic, have little energy, and tends to be obese.

#### *Hyperthyroidism*

In hyperthyroidism, the thyroid secretes too much thyroxin, resulting in an overly active metabolism. This person will be thin, nervous, tense, and excitable. He or she will also be able to eat large quantities of food

without gaining weight (and I hate them for that—oh, if only we came equipped with thyroid control knobs!).

*Adrenal Gland Malfunctions*

Among the disorders that can result from malfunctioning of the adrenal glands is **Addison's disease**. Its symptoms include fatigue, low blood pressure, weight loss, nausea, diarrhea, and muscle weakness.

If there is a problem with over-secretion of the sex hormones in the adrenals, **virilism** and **premature puberty** are possible problems. Virilism results in women with beards on their faces and men with exceptionally low, deep voices. Premature puberty, or full sexual development while still a child, is a result of excessive sex hormones during childhood.

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## ▼ CLASSROOM ACTIVITIES, DEMONSTRATIONS, AND EXERCISES

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### Exercise: Neuron Worksheets

Learning Objectives 2.3, 2.4, 2.5

Provide students with a copy of [Handouts 2.2, 2.3,](#) and [2.4](#) to fill in individually or in groups.

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### Demonstration Neural Conduction: The Class as a Neural Network

Learning Objective 2.4: *How do neurons transmit messages through the nervous system?*

In this engaging exercise (suggested by Paul Rozin and John Jonides), students in the class simulate a neural network and get a valuable lesson in the speed of neural transmission. Depending on your class size, arrange 15 to 40 students so that each person can place his or her right hand on the right shoulder of the person in front of them. Note that students in every other row will have to face backwards in order to form a snaking chain so that all students (playing the role of individual neurons) are connected to each other. Explain to students that their task as a neural network is to send a neural impulse from one end of the room to the other. The first student in the chain will squeeze the shoulder of the next person, who, upon receiving this “message”, will deliver (i.e., “fire”) a squeeze to the next person’s shoulder and so on, until the last person receives the message. Before starting the neural impulse, ask students (as “neurons”) to label their parts; they typically have no trouble stating that their arms are axons, their fingers are axon terminals, and their shoulders are dendrites.

To start the conduction, the instructor should start the timer on a stopwatch while simultaneously squeezing the shoulder of the first student. The instructor should then keep time as the neural impulse travels around the room, stopping the timer when the last student/neuron yells out “stop.” This process should be repeated once or twice until the time required to send the message stabilizes (i.e., students will be much slower the first time around as they adjust to the task). Next, explain to students that you want them to again send a neural impulse, but this time you want them to use their ankles as dendrites. That is, each student will “fire” by squeezing the ankle of the person in front of them. While students are busy shifting themselves into position for this exercise, ask them if they expect transmission by ankle-squeezing to be faster or slower than transmission by shoulder-squeezing. Most students will immediately recognize that the ankle-squeezing will take longer because of the greater distance the message (from the ankle as opposed to the shoulder) has to travel to reach the brain. Repeat this transmission once or twice and verify that it indeed takes longer than the shoulder squeeze.

This exercise - a student favorite - is highly recommended because it is a great ice-breaker during the first few weeks of the semester and it also makes the somewhat dry subject of neural processing come alive.

Rozin, P., & Jonides, J. (1977). Mass reaction time measurement of the speed of the nerve impulse and the duration of mental processes in class. *Teaching of Psychology*, 4, 91-94.

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### Exercise: Autonomic Nervous System Review

Learning Objective 2.6: *What are the structures and functions of the peripheral nervous system?*

Provide students with a copy of [Handout 2.5](#) to fill in individually or in groups.

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### Activity: Field Sobriety Tests

Learning Objective 2.7: *What are the structures and functions of the central nervous system?*

Assign students to groups of four to five students and instruct them to complete the activities on [Handout 2.6](#). After they have finished, tell them that these activities are drawn from behavioral tests that neurologists use as quick and easy measurements of central nervous system function. Some of these tests are used by law enforcement officers to determine whether drivers are intoxicated. The use of such tests to determine sobriety is based on the knowledge that alcohol affects the parts of the brain that control movement and balance (cerebellum). Thus, if a person exhibits difficulty with balance tasks, s/he may be intoxicated. However, there is normal variation in performance on these tests, so a person who isn't intoxicated may appear to be so when tested. Moreover, a person who is intoxicated may still be able to perform the tests.

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### Demonstration: Looking Left, Looking Right

Learning Objective 2.9: *What are the specialized functions of the left and right cerebral hemispheres?*

It has been theorized that when language-related tasks are being performed in the left hemisphere, the eyes look to the right; when nonlanguage, spatial abilities are being used in the right hemisphere, the eyes look to the left. This is a relatively easy class activity. After pairing up, one student asks the questions on [Handout 2.7](#) and records lateral eye movements, while the other attempts to answer the questions.

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### Demonstration: The Importance of a Wrinkled Cortex

Learning Objective 2.8: *What are the components of the cerebrum?*

At the beginning of your lecture on the structure and function of the brain, ask students to explain why the cerebral cortex is wrinkled. There are always a few students who correctly answer that the wrinkled appearance of the cerebral cortex allows it to have a greater surface area while fitting in a relatively small space (i.e., the head). To demonstrate this point to your class, hold a plain, white sheet of paper in your hand and then crumple it into a small, wrinkled ball. Note that the paper retains the same surface area, yet is now much smaller and is able to fit into a much smaller space, such as your hand. You can then mention that the brain's actual surface area, if flattened out, would be roughly the size of a newspaper page (Myers, 1995). Laughs usually erupt when the class imagines what our heads would look like if we had to accommodate an unwrinkled, newspaper-sized cerebral cortex!

Myers, D. G. (1995). *Psychology* (4th ed.). New York: Worth.

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[\*\*◄ Return to complete list of Classroom Activities, Demonstrations, and Exercises for Chapter 2\*\*](#)

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### **Exercise: Summarizing Age-Related Changes in the Brain**

Learning Objective 2.11: *How does the brain change across the lifespan?*

Copy [\*\*Handout 2.8\*\*](#) for students and instruct them to use the information in textbook to complete it. They may complete the handout individually or in groups.

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[\*\*◄ Return to complete list of Classroom Activities, Demonstrations, and Exercises for Chapter 2\*\*](#)

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### **Activity: Genetic Differences**

Learning Objective 2.14: *How does heredity affect physical and psychological traits?*

There are many genetic differences between people that you can illustrate or demonstrate in your classroom. One is the length of the ratio of lengths of the index finger and ring fingers. Divide your students into small groups. Have them trace outlines of their fingers, and then compare the lengths of the index and ring fingers across the individuals in their groups. Take an informal survey of your students' findings. Singer (1987) writes that "in women, having an index finger that is shorter than the ring finger is a recessive trait, whereas in men, having a shorter index finger is dominant."

Singer, S. (1987). Individual differences in biological bases of behavior. In V. P. Makosky, L. G. Whittemore, and A. M. Rogers (Eds.). *Activities handbook for the teaching of psychology* (Vol. 2) (pp. 289-293). Washington, D.C.: American Psychological Association.

[\*\*► Return to Lecture Guide: Beyond the Nervous System\*\*](#)

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▼ **APS: READINGS FROM THE ASSOCIATION FOR PSYCHOLOGICAL SCIENCE**  
***Current Directions in Introductory Psychology, Second Edition (0137143508)***  
 Edited by Abigail A. Baird, with Michele M. Tugade and Heather B. Veague

Kevin S. LaBar

***Beyond Fear: Emotional Memory Mechanisms in the Human Brain. (Vol. 16, No. 4, 2007, pp. 173—177) 64 of the APS reader***

**Learning Objective 2.7: *What are the structures and functions of the central nervous system?***

Neurobiological accounts of emotional memory have been derived largely from animal models investigating the encoding and retention of memories for events that signal threat. This literature has implicated the amygdala, a structure in the brain's temporal lobe, in the learning and consolidation of fear memories. Its role in fear conditioning has been confirmed, but the human amygdala also interacts with cortical regions to mediate other aspects of emotional memory. These include the encoding and consolidation of pleasant and unpleasant arousing events into long-term memory, the narrowing of focus on central emotional information, the retrieval of prior emotional events and contexts, and the subjective experience of recollection and emotional intensity during retrieval. Along with other mechanisms that do not involve the amygdala, these functions ensure that significant life events leave a lasting impression in memory.

► **Return to Lecture Guide: The Human Nervous System**

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Amir Amedi, Lotfi B. Merabet, Felix Bempohl, Alvaro Pascual-Leone

***The Occipital Cortex in the Blind: Lessons About Plasticity and Vision. (Vol. 14, No. 16, 2005, pp. 306—311) p. 47 of the APS reader***

**Learning Objective 2.10: *Which functions are associated with each of the four lobes of the cerebral cortex?***

Studying the brains of blind individuals provides a unique opportunity to investigate how the brain changes and adapts in response to afferent (input) and efferent (output) demands. We discuss evidence suggesting that regions of the brain normally associated with the processing of visual information undergo remarkable dynamic change in response to blindness. These neuroplastic changes implicate not only processing carried out by the remaining senses but also higher cognitive functions such as language and memory. A strong emphasis is placed on evidence obtained from advanced neuroimaging techniques that allow researchers to identify areas of human brain activity, as well as from lesion approaches (both reversible and irreversible) to address the functional relevance and role of these activated areas. A possible mechanism and conceptual framework for these physiological and behavioral changes is proposed.

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▼ **Forty Studies that Changed Psychology: Explorations into the History of Psychological Research, Sixth Edition (013603599X)**

By Roger Hock

**One Brain or Two?**

**Learning Objective 2.9:** *What are the specialized functions of the left and right cerebral hemispheres?*

Gazzaniga, M. S. (1967). The split brain in man. *Scientific American*, 217(2), 4—29.

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**More Experience = Bigger Brain**

**Learning Objective 2.11:** *How does the brain change across the lifespan?*

Rosenzweig, M. R., Bennett, E. L., & Diamond, M. C. (1972). Brain changes in response to experience. *Scientific American*, 226(2), 22—29.

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## ▼ WEB RESOURCES

### *General Resources*

**Biological and Physiological Resources:** <http://psych.athabasca.ca/html/aupr/biological.shtml>  
Links to several sites and interesting topical articles relevant to biological and physiological psychology. A good starting point for a number of assignments, such as writing short papers or assembling study guide terms. Maintained by the Centre for Psychology Resources at Athabasca University, Alberta, Canada.

**Neuroguide.com – Neurosciences on the Internet:** <http://www.neuroguide.com/>  
A resource for all things related to neuroscience: databases, diseases, research centers, software, biology, psychology, journals, tutorials, and so much more.

**Neuropsychology Central:** <http://www.neuropsychologycentral.com/>  
Links to resources related to neuropsychology, including brain images, and extensive, well-organized, links to other sites.

**Neuroscience for Kids:** <http://faculty.washington.edu/chudler/neurok.html>  
Don't be put off by the name! This site can be enjoyed by people of all ages who want to learn about the brain. Fun, superbly organized site providing information and links to other neuroscience sites. Includes informative pages regarding Brain Basics, Higher Functions, Spinal Cord, Peripheral Nervous System, The Neuron, Sensory Systems, Methods and Techniques, Drug Effects, and Neurological and Mental Disorders. Even includes a nice answer to the perennial question "Is it true that we only use 10% of our brain?"  
<http://faculty.washington.edu/chudler/tenper.html>

**Whole Brain Atlas:** <http://www.med.harvard.edu:80/AANLIB/home.html>  
Prepared by Keith Johnson, M.D. and J. Alex Becker at Harvard University. Site includes brain images, information about imaging techniques, and information about specific brain disorders.

- ▶ [Return to Lecture Guide: Discovering the Mysteries of the Nervous System](#)
- ▶ [Return to Lecture Guide: The Neurons and the Neurotransmitters](#)
- ▶ [Return to Lecture Guide: The Human Nervous System](#)
- ▶ [Return to Lecture Guide: A Closer Look at the Thinking Part of the Brain](#)
- ▶ [Return to Lecture Guide: Age, Gender, and the Brain](#)
- ▶ [Return to Lecture Guide: Beyond the Nervous System](#)
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### *Brain Mapping*

**Dr. Paul Thompson's Brain Mapping Videos:** [http://www.loni.ucla.edu/~thompson/thompson\\_pubs.html](http://www.loni.ucla.edu/~thompson/thompson_pubs.html)  
Dr. Thompson of UCLA has used his extensive collection of brain images to create time-lapse videos of normal developmental processes as well as the effects of progressive diseases such as Alzheimer's and schizophrenia on the brain.

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### *Neurons/Neural Processes*

**Basic Neural Processes Tutorials:** <http://psych.hanover.edu/Krantz/neurotut.html>  
A good site for your students to help them learn about basic brain functioning.

**How do Nerve Cells Communicate?**  
<http://www.sfn.org/content/Publications/BrainBackgrounders/communication.htm>  
Information prepared by the Society for Neuroscience.

**Making Connections – The Synapse:** <http://faculty.washington.edu/chudler/synapse.html>

Clear, comprehensible, explanation of how synapses work, with nice illustrations, prepared by Eric Chudler.

**Neural Processes Tutorial:** <http://psych.hanover.edu/Krantz/neurotut.html>

An excellent interactive animated tutorial.

► **Return to Lecture Guide: The Neurons and the Neurotransmitters**

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### *Nervous System*

**Autonomic Nervous System:** <http://faculty.washington.edu/chudler/auto.html>

Succinct summary of information about the structure and function of the autonomic nervous system, prepared by Eric Chudler.

**Self-Quiz for Chapter on the Human Nervous System:**

<http://www.psychwww.com/selfquiz/ch02mcq.htm>

Self-quiz prepared by Russ Dewey at Georgia Southern University. Covers material typically found in an introductory psychology textbook chapter with a title like “Brain and Behavior” or “Neuropsychology.”

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### *The Brain*

**Brain and Behavior:** <http://serendip.brynmawr.edu/bb/>

This mega-site contains lots of links to information about the brain, behavior, and the bond between the two. Students can complete several interactive exercises to learn more about brain functions.

**Brain Connection: The Brain and Learning:** <http://www.brainconnection.com/>

A newspaper-style web page that contains interesting articles, news reports, activities, and commentary on brain-related issues.

**Brain Function and Pathology:** <http://www.waiting.com/brainfunction.html>

Concise table of diagrams of brain structures, descriptions of brain functions, and descriptions of signs and symptoms associated with brain structures and functions.

**Brain Model Tutorial:** <http://pegasus.cc.ucf.edu/~Brainmdl/brain.html>

This tutorial teaches students about the various parts of the human brain and allows them to test their knowledge of brain structures.

**Brain Reorganization:** [http://www.sfn.org/content/Publications/BrainBriefings/brain\\_reorg.html](http://www.sfn.org/content/Publications/BrainBriefings/brain_reorg.html)

Brief information on how the brain changes with experience, prepared by the Society for Neuroscience.

**Brain: Right Down the Middle:** <http://faculty.washington.edu/chudler/sagittal.html>

Useful drawing and succinct information about the location and functions of brain structures that can be seen on the midsagittal plane, presented by Eric Chudler.

**Conversations with Neil’s Brain (1994):** <http://www.williamcalvin.com/index.html>

An Online Book by William H. Calvin & George A. Ojemann of University of Washington. Teachers are allowed to print and photocopy chapters for educational use.

**Cross Sections of the Human Brain:** <http://www.neuropat.dote.hu/caud.gif>

A cross-sectional image of the human brain. Good to have on hand if you need one. Show your students and help them identify the various structures.

**Drugs, Brains, and Behavior:** <http://www.rci.rutgers.edu/~lwh/drugs/>

An online textbook detailing the effects of various substances on the brain, authored by C. Robin Timmons & Leonard W. Hamilton.

**History of Phrenology:** <http://pages.britishlibrary.net/phrenology/>

Follow the bumpy road to discovering phrenology's past from a professor of history at the University of Cambridge.

**Human Corpus Callosum:** <http://www.indiana.edu/~pietsch/callosum.html>

Information and links about the corpus callosum and "split-brain surgery" by Paul Pietsch.

**Lobes of the Brain:** <http://faculty.washington.edu/chudler/lobe.html>

Succinct information about the location and functions of the four lobes of the cerebrum, presented by Eric Chudler. Includes link to "Lobes of the Brain Review," a very brief quiz on functions associated with major lobes of the brain. Answers provided online: <http://faculty.washington.edu/chudler/revlobe.html>

**NPAC/OLDA Visible Human Viewer:**

<http://www.dhpc.adelaide.edu.au/projects/vishuman2/VisibleHuman.html>

A little tricky to use, but by following the instructions on this page you can view images of the brain in one of several planes. Currently, only photos are available, but these are quite nice. MRI and CT scans in the same planes are planned for the future.

**One Brain...or Two?:** <http://faculty.washington.edu/chudler/split.html>

Information on lateralization of function and how the functions of the hemispheres may be studied, presented by Eric Chudler.

**She Brains / He Brains**

<http://faculty.washington.edu/chudler/heshe.html>: Nice summary of evidence for sex-related differences in brain structure, prepared by Eric Chudler.

**What Does Handedness Have to Do with Brain Lateralization (and Who Cares?):**

<http://www.indiana.edu/~primate/brain.html>

Very nice page on lateralization of function in the brain.

**What is the Cerebellum?** <http://www.sfn.org/content/Publications/BrainBackgrounders/cerebellum.htm>

Information about the structure and function of the cerebellum, prepared by the Society for Neuroscience.

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### *Phineas Gage*

**Phineas Gage Information Page:** <http://www.deakin.edu.au/hbs/GAGEPAGE>

Everything you ever wanted to know about Phineas Gage is on this page prepared by Malcolm Macmillan at Deakin University, Victoria, Australia.

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### *Hormones and Glands*

**Inner Body/The Endocrine System:** <http://www.innerbody.com/image/endoov.html>

An interactive, multimedia presentation on the endocrine system

**Pathophysiology of the Endocrine System:** <http://www.vivo.colostate.edu/hbooks/pathphys/endocrine/>  
Hypertext ebook about disorders of the endocrine system; includes explanations of normal functioning.

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### *Genes, Chromosomes, and DNA*

**DNA Testing:** <http://www.vivo.colostate.edu/hbooks/genetics/medgen/dnatesting/index.html>  
An explanation of the techniques used in DNA testing; includes discussions of strengths and weaknesses of DNA analysis

**Human Genome Project:** [http://www.ornl.gov/sci/techresources/Human\\_Genome/home.shtml](http://www.ornl.gov/sci/techresources/Human_Genome/home.shtml)  
History, findings, and applications of the Human Genome Project.

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### *Nature and Nurture*

**Feral Children:** <http://www.feralchildren.com/en/nature.php>  
A discussion of the role that research on feral children plays in the nature/nurture debate

**Minnesota Twin and Family Study:** <http://www.psych.umn.edu/research/mtfs.htm>  
Website of the famous Minnesota Twin Study; discusses history, principal investigators, findings, current projects.

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**▼ VIDEO CLIPS**

- 📺 [Neurons and Synapses](#) (1:10)
- 📺 [Synaptic Development](#) (0:36)
- 📺 [Brain Building](#) (1:38)
- 📺 [MKM and Brain Scans](#) (3:08)
- 📺 [How the Human Genome Map Affects You](#) (1:21)
- 📺 [Exercise Your Brain](#) (1:40)
- 📺 [Brain and Nervous System](#) (1:00)
- 📺 [The Brain: An Inside Look](#) (1:05)
- 📺 [Men, Women and Sex Differences](#) (2:10)

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**▼ DESCRIPTIONS OF VIDEO CLIPS:****▼ From Introductory Psychology Teaching Films Boxed Set ISBN (0131754327) Disc #1 Behavioral Neuroscience:****Neurons and Synapses**

*Source:* *Films for Humanities & Sciences*

*Video:* *Brain and Nervous System*

*Run Time:* *1:10*

Description: This video relies on “reporters” who describe various aspects of the nervous system. In this segment, a reporter provides a brief description of neurons and synapses using an example of a pain warning message traveling from the brain to a hand on a hot stove.

Uses: The format of this segment favors simplicity over detail. Use this as a basis for more fully describing the electrochemical nature of synaptic transmission. The straightforward presentation should pique students’ interests, although a more thorough explanation of synapses is warranted.

[▶ Return to Lecture Guide: The Neurons and the Neurotransmitters](#)

[◀ Return to complete list of Video Clips for Chapter 2](#)

**Synaptic Development**

*Source:* *Pearson Education*

*Run Time:* *0:36*

Description: This video presents an animation demonstrating the process of synaptic development and pruning. In the months after birth, the brain grows rapidly. Axons and dendrites grow longer, and like a maturing tree, grow quickly and sprout new limbs. As the number of dendrites increase, so does the number of synapses, reaching a peak at about the first birthday. Soon after, synapses begin to disappear gradually, a phenomenon known as synaptic pruning. Remaining connections increase in power. Thus, beginning in infancy and continuing into early adolescence, the brain goes through its own version of “downsizing,” weeding out unnecessary connections between neurons and increasing the efficiency of those that remain. As you watch the simulation, pay particular attention to the interplay of atrophy (depicted by the thinning lines) and the increase in power of those that are selected to remain (depicted by a thickening line).

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[◀ Return to complete list of Video Clips for Chapter 2](#)

**Brain Building**

Source: *ScienCentral*

Run Time: 1:38

Discussion: According to this video the brain matures in different stages. The ages 5–20 appear to be the most productive time of brain development. This age span is the best time to learn to play a musical instrument, a new sport or new studies.

Use: This video can be used in a discussion of child development. It can also be used in a discussion of brain development.

[\*\*► Return to Lecture Guide: A Closer Look at the Thinking Part of the Brain\*\*](#)

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**▼ From: Pearson Education Teaching Films Introductory Psychology: Instructor's Library 2-Disk DVD Annual Edition (ISBN 0205652808)**

**MKM and Brain Scans**

Source: *Pearson*

Run Time: 3:08

Discussion: Report on surgical microscope procedure along with brain scans allow for great precision in neurosurgery. Second report on how new technologies are helping us learn about treatment for migraine sufferers.

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**How the Human Genome Map Affects You**

Source: *Pearson*

Run Time: 1:21

Discussion: Report on potential changes in the medical world with the discoveries from the Human Genome project.

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**Exercise Your Brain**

Source: *Pearson*

Run Time: 1:40

Discussion: The importance of aerobic exercise in countering the aging of the brain and the use of MRI in uncovering these findings.

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▼ **From: Lecture Launcher Video for Introductory Psychology (ISBN 013048640X):**

VIDEO TITLE:	SEGMENT TITLE:	RUN TIME
Brain and Nervous System	Neurons and Synapses	1:00

Description: This video relies on “reporters” who describe various aspects of the nervous system. In this segment, a reporter provides a brief description of neurons and synapses using an example of a pain warning message traveling from the brain to a hand on a hot stove.

Uses: The format of this segment favors simplicity over detail. Use this as a basis for more fully describing the electrochemical nature of synaptic transmission. The straightforward presentation should pique students’ interests, although a more thorough explanation of synapses is warranted.

VIDEO TITLE:	SEGMENT TITLE:	RUN TIME:
The Brain: An Inside Look	The Brain and Nervous System	1:05

Description: This brief animated sequence provides a clear description of the brain, central nervous system, peripheral nervous system, cerebral cortex, and cerebral hemispheres.

Uses: This clip is suitable for starting a lecture on the brain and nervous system. This quick overview will introduce students to the major divisions of the nervous system and allow you to elaborate on each element during your classroom presentation.

► **Return to Lecture Guide: The Human Nervous System**  
 ◀ **Return to complete list of Video Clips for Chapter 2**

VIDEO TITLE:	SEGMENT TITLE:	RUN TIME
Men, Women, and Sex Differences	Sex Differences in Behavior	2:10

Description: John Stossel of ABCNews explores the origins of sex differences. Are they biological, environmental, or a combination of the two? In this segment, researchers examine men’s and women’s different capacities for memory and direction. Hormones (such as testosterone) are implicated as a possible agent for producing “biologically male” and “biologically female” behaviors.

Uses: Women and men do a lot that’s different. They also do a lot that’s the same. Easy answers to the complex question of what causes sex differences in behavior are sought after but not always found. Broach this subject with your students by showing this clip to stimulate a discussion of the origins of sex differences.

► **Return to Lecture Guide: A Closer Look at the Thinking Part of the Brain**  
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## ▼ MULTIMEDIA RESOURCES


### Chapter 2 Multimedia Content available at [www.mypsychlab.com](http://www.mypsychlab.com)


Discovering the Mysteries of the Nervous System


 Watch: MKM and Brain Scans


► **Return to Lecture Guide: Discovering the Mysteries of the Nervous System**

The Neurons and the Neurotransmitters

 Explore: The Nerve Impulse and Afferent and Efferent Neurons

 Explore: The Synapse

 Explore: The Action Potential

 Explore: Neuronal Transmission

 Simulate: General Model of Drug Addiction

► **Return to Lecture Guide: The Neurons and the Neurotransmitters**

The Human Nervous System

 Watch: ALS Lost Nerve Power

 Explore: The Limbic System

 Explore: The Autonomic Nervous System

► **Return to Lecture Guide: The Human Nervous System**

A Closer Look at the Thinking Part of the Brain

 Explore: Split-Brain Experiments

 Simulate: Connie: Head Injury


 Simulate: Psychological Bases of Behavioral Problems


 Watch: Brain Building

► **Return to Lecture Guide: A Closer Look at the Thinking Part of the Brain**


Beyond the Nervous System


 Explore: The Endocrine System


 Explore: Building Blocks of Genetics


 Watch: Cloned Child

 Watch: Human Cloning: The Ethics

 Watch: How the Human Genome Map Affects You


 Watch: Genetic Time Clock

 Watch: Junk DNA

 Explore: Dominant and Recessive Traits

► **Return to Lecture Guide: Beyond the Nervous System**

Chapter Summary

 Test Yourself: Practice Quizzes

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## ▼ TRANSPARENCIES

### Two sets of transparencies are available:

#### I. Prentice Hall Transparencies for Introductory Psychology (ISBN 0131926993):

- T8: Divisions of the Nervous System
- T9: Major Endocrine Glands
- T10: Structure of the Neuron
- T11: How Neurons Communicate
- T12: Effects, Locations, and Functions of Neurotransmitters
- T13: Divisions of the Brain
- T14: The Cerebral Cortex
- T15: A Typical Split-Brain Operation

#### II. Allyn & Bacon Transparencies for Introductory Psychology (ISBN 0205398626):

- Biology of Behavior
- 16 The Secret of DNA
- 17 The Major Structures of the Neuron
- 18 Sensory Neurons, Motor Neurons, and Interneurons
- 19 The Action Potential
- 20 Neurotransmitters
- 21 Five Key Neurotransmitters and Their Functions
- 22 Reflexes: The Action of Afferent and Efferent Neurons
- 23 Divisions of the Human Nervous System
- 24 The Autonomic Nervous System
- 25 The Human Brain - A Cross-Section
- 26 Structures of the Brain
- 27 Major Regions of the Cerebral Cortex
- 28 The Principal Structures in the Limbic System
- 29 Two Views of the Cerebral Hemispheres
- 30 The Motor Cortex and the Somatosensory Cortex
- 31 The Eyes, Optic Chiasm, and Cerebral Hemispheres
- 32 Lateralized Functions of the Brain
- 33 The Effects of Severing the Corpus Callosum
- 34 Parallel Versus Serial Processing
- 35 The Neural Basis of Human Speech
- 36 Gazzaniga and LeDoux Experiment
- 37 The Endocrine Glands
- 38 Homozygous and Heterozygous Genotypes

Transparencies available at [www.pearsonhighered.com/irc](http://www.pearsonhighered.com/irc) or through your local Pearson sales representative.

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## STUDENT REVIEW RESOURCES

### ▼ CHAPTER REVIEW: CROSSWORD PUZZLE

The crossword puzzle in [Handout Master 2.9](#) will help students preview and/or review many of the important concepts in this course.

Answer Key:

#### Across

1. neurotransmitter that causes the receiving cell to stop firing. **inhibitory**
3. the cell body of the neuron, responsible for maintaining the life of the cell. **soma**
4. endocrine gland located near the base of the cerebrum which secretes melatonin. **pineal**
7. glands that secrete chemicals called hormones directly into the bloodstream. **endocrine**
8. long tube-like structure that carries the neural message to other cells. **axon**
10. chemical found in the synaptic vesicles which, when released, has an effect on the next cell. **neurotransmitter**
13. bundles of axons coated in myelin that travels together through the body. **nerves**
14. branch-like structures that receive messages from other neurons. **dendrites**
15. endocrine gland found in the neck that regulates metabolism. **thyroid**
17. thick band of neurons that connects the right and left cerebral hemispheres. **corpuscallosum**
19. part of the nervous system consisting of the brain and spinal cord. **central**

#### Down

2. part of the limbic system located in the center of the brain, it acts as a relay from the lower part of the brain to the proper areas of the cortex. **thalamus**
4. endocrine gland that controls the levels of sugar in the blood. **pancreas**
5. fatty substances produced by certain glial cells that coat the axons of neurons to insulate, protect, and speed up the neural impulse. **myelin**
6. the basic cell that makes up the nervous system and which receives and sends messages within that system. **Neuron**
8. chemical substances that mimic or enhance the effects of a neurotransmitter on the receptor sites of the next cell. **agonists**
9. part of the lower brain that controls and coordinates involuntary, rapid, fine motor movement. **cerebellum**
11. process by which neurotransmitters are taken back into the synaptic vesicles. **reuptake**
12. a group of several brain structures located under the cortex and involved in learning, emotion, memory, and motivation. **limbic**
16. chemicals released into the bloodstream by endocrine glands. **hormones**
18. brain structure located near the hippocampus, responsible for fear responses and memory of fear. **amygdala**

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## ▼ CHAPTER REVIEW: FILL-IN-THE-BLANK KEY TERMS EXERCISE

The key terms exercise in **Handout Master 2.10** will help students preview and/or review many of the important concepts in this course. It can be administered with or without the key term bank (**Handout Master 2.10a**).

Answer Key:

- |   |                                    |   |
|---|------------------------------------|---|
| 1. endorphins                               | 27. functional MRI (fMRI)          | 56. neurotransmitter                        |
| 2. stroke                                   | 28. genes                          | 57. reticular formation                     |
| 3. cerebral cortex                          | 29. cerebellum                     | 58. CT scan (computerized axial tomography) |
| 4. action potential                         | 30. substantia nigra               | 59. central nervous system (CNS)            |
| 5. reuptake                                 | 31. primary visual cortex          | 60. beta wave                               |
| 6. synapse                                  | 32. hypothalamus                   | 61. pancreas                                |
| 7. phenotype                                | 33. electroencephalogram (EEG)     | 62. Wernicke's aphasia                      |
| 8. lateralization                           | 34. cerebrum                       | 63. pituitary gland                         |
| 9. pineal gland                             | 35. Wernicke's area                | 64. microelectrode                          |
| 10. frontal lobes                           | 36. receptors                      | 65. alpha wave                              |
| 11. behavioral genetics                     | 37. cell body                      | 66. neuron                                  |
| 12. multifactorial inheritance              | 38. spinal cord                    | 67. hippocampus                             |
| 13. thalamus                                | 39. sympathetic nervous system     | 68. hormone                                 |
| 14. somatosensory cortex                    | 40. Broca's aphasia                | 69. MRI (magnetic resonance imagery)        |
| 15. forebrain                               | 41. Broca's area                   | 70. primary auditory cortex                 |
| 16. peripheral nervous system               | 42. split-brain operation          | 71. resting potential                       |
| 17. occipital lobes                         | 43. chromosomes                    | 72. right hemisphere                        |
| 18. plasticity                              | 44. endocrine system               | 73. delta wave                              |
| 19. dendrites                               | 45. hindbrain                      | 74. adrenal glands                          |
| 20. dominant-recessive pattern              | 46. parasympathetic nervous system | 75. medulla                                 |
| 21. PET scan (positron-emission tomography) | 47. parathyroid                    | 76. axon terminal                           |
| 22. limbic system                           | 48. brainstem                      | 77. polygenic                               |
| 23. cerebral hemispheres                    | 49. pruning                        | 78. motor cortex                            |
| 24. gonads                                  | 50. glial cells                    | 79. association areas                       |
| 25. myelin sheath                           | 51. midbrain                       | 80. corpus callosum                         |
| 26. thyroid                                 | 52. left hemisphere                | 81. axon                                    |
|   | 53. pons                           | 82. parietal lobes                          |
|   | 54. thymus                         | 83. amygdala                                |
|   | 55. genotype                       | 84. temporal lobes                          |

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## HANDOUT MASTERS

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- [2.3 Transmission at the Synapse](#)
- [2.4 Neurotransmitters](#)
- [2.5 The Autonomic Nervous System](#)
- [2.6 Field Sobriety Tests](#)
- [2.7 Left and Right Hemisphere Questions](#)
- [2.8 Age-Related Changes in the Brain](#)
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- [2.10 Fill-in-the-Blank Key Terms Exercise](#)
- [2.10a Key Term Bank \(Optional\)](#)

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Handout Master 2.1

## CHAPTER 2 LEARNING OBJECTIVES

- 2.1 What does the electroencephalogram (EEG) reveal about the brain?
- 2.2 How do researchers use imaging techniques to study the nervous system?
- 2.3 What does each part of the neuron do?
- 2.4 How do neurons transmit messages through the nervous system?
- 2.5 How do neurotransmitters work?
- 2.6 What are the structures and functions of the peripheral nervous system?
- 2.7 What are the structures and functions of the central nervous system?
- 2.8 What are the components of the cerebrum?
- 2.9. What are the specialized functions of the left and right cerebral hemispheres?
- 2.10 Which functions are associated with each of the four lobes of the cerebral cortex?
- 2.11 How does the brain change across the lifespan?
- 2.12 How do the brains of men and women differ?
- 2.13 What are the functions of the glands of the endocrine system?
- 2.14 How does heredity affect physical and psychological traits?

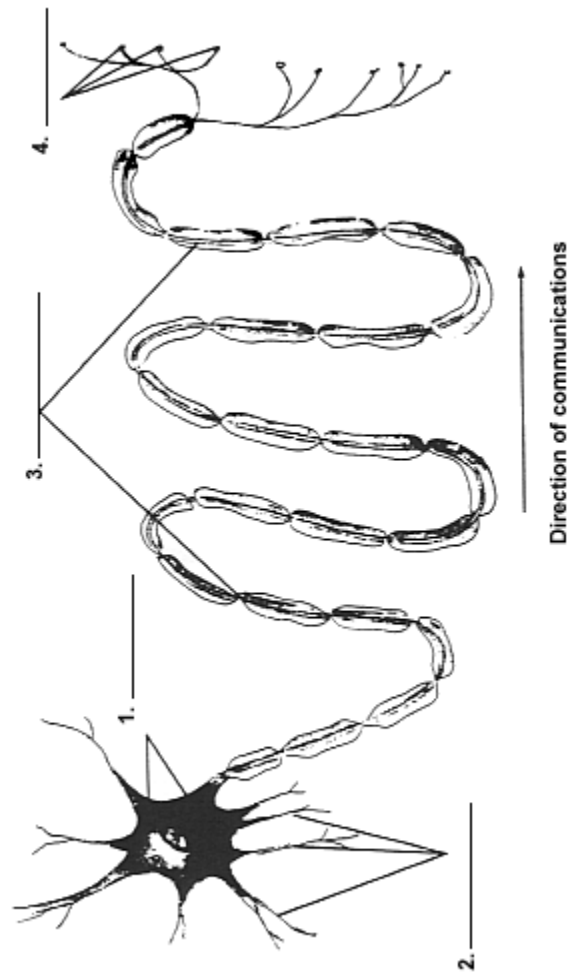
**◀ Return to complete list of Handout Masters for Chapter 2**

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Handout Master 2.2

### The Basic Structure of the Neuron

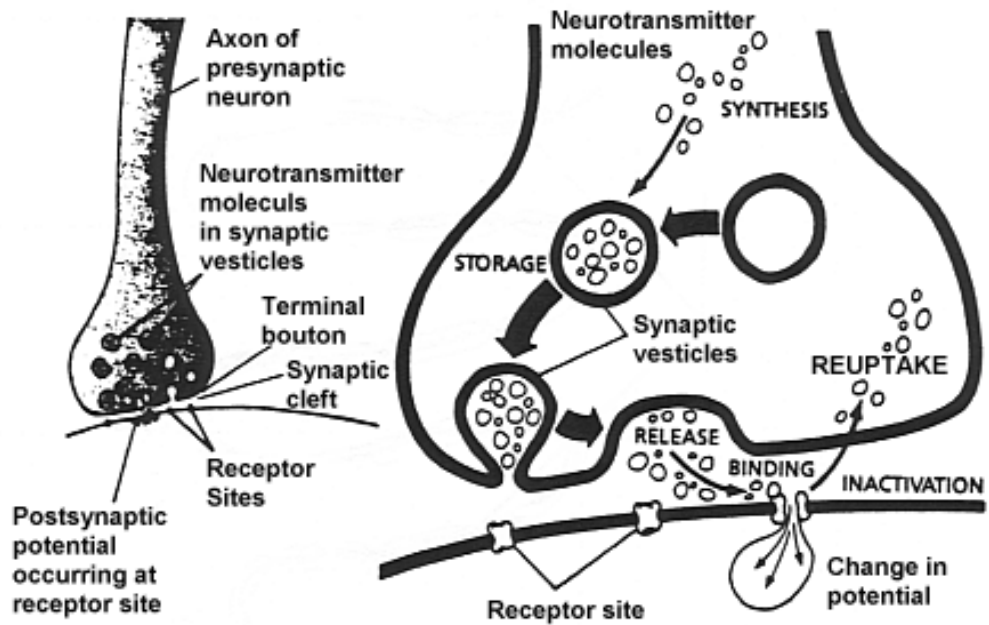
Identify the parts of the neuron discussed in the text.



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### Transmission at the Synapse

Identify the part and describe its function in the space provided.



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## Handout Master 2.4

**Neurotransmitters**

Identify where each neurotransmitter is found and the effects it has in that area on the chart below.

<i>Neurotransmitter</i>	<i>Functions</i>
Acetylcholine	
Norepinephrine	
Epinephrine	
Dopamine	
Serotonin	
Glutamate	
GABA	
Endorphins	

- ▶ [Return to Exercise: Neuron Worksheets](#)
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Handout Master 2.5

### The Autonomic Nervous System

Describe how each organ is affected by the sympathetic and parasympathetic nervous system.

<i>Organ</i>	<i>Sympathetic</i>	<i>Parasympathetic</i>
Adrenal Medulla		
Bladder		
Blood Vessels		
Abdomen		
Muscles		
Skin		
Heart		
Intestines		
Liver		
Lungs		
Pupil of Eye		
Salivary Glands		
Sweat Glands		

► [Return to Exercise: Autonomic Nervous System Review](#)

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Handout Master 2.6

### Field Sobriety Tests

The National Highway Traffic Safety Administration (NHTSA) has endorsed three tests for use as “Field Sobriety Tests” by law enforcement officers. Studies show that the majority of people who fail any of three have blood alcohol levels beyond the legal limit for driving. When examinees fail all three tests, there is a 90% chance that their blood alcohol levels are above the limit. However, there is normal variation in the tests. Try them with your classmates and record the results.

#### HORIZONTAL GAZE NYSTAGMUS

Hold a pencil in front of the examinee’s eyes and ask him or her to look at the point. Watch the examinee’s eye movement as you slowly move the pen across the visual field. The examinee fails the test if s/he exhibits jerking of the eyes while tracking the moving pencil point or the eyes suddenly jerk back toward the nose when they have moved as far as possible to the side.

#### WALK AND TURN

Instruct each examinee to take nine steps, heel-to-toe, along a straight line with arms at their sides. At the end of the line, the examinee must turn on one foot and walk the same way back to the other end of the line. Examinees fail when they exhibit at least two of the following: (a) fail to maintain balance while walking; (b) use the arms to balance; (c) deviate from the straight line; (d) lose balance during the turn; (e) require several steps to accomplish the turn; (f) take an incorrect number of steps when walking the line.

#### ONE-LEG STAND

Instruct examinees to stand with one foot elevated at least six inches off the ground and to count by thousands (one thousand one, one thousand two, etc.) until instructed to lower the foot. The examiner allows 30 seconds for this task. Failure is defined as displaying at least two of the following: (a) swaying; (b) using the arms to balance; (c) inability to keep the foot elevated; (d) hopping to maintain balance.

RESULTS	<i>Horizontal Gaze</i>		<i>Walk and Turn</i>		<i>One-Leg Stand</i>	
	Pass	Fail	Pass	Fail	Pass	Fail
<i>Name</i>						

National Highway Traffic Safety Administration (NHTSA). *Standardized field sobriety testing* Retrieved January 1, 2003 from [http://www.nhtsa.dot.gov/people/injury/alcohol/SFST/appendix\\_a.htm](http://www.nhtsa.dot.gov/people/injury/alcohol/SFST/appendix_a.htm)

- ▶ **Return to Activity: Field Sobriety Tests**
- ◀ **Return to complete list of Handout Masters for Chapter 2**
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Handout Master 2.7

### Left and Right Hemisphere Questions

1. What does the word *appetite* mean? (language).
2. How many letters are there in the word *growing*? (language)
3. What direction does the Statue of Liberty face? (spatial)
4. Name three states that border Iowa. (spatial)
5. You are walking due north and turn left and then left again and then right. What direction are you walking? (spatial)
6. How many straight lines are there in a hexagon? (spatial)
7. Which word has more letters, *publication* or *contemplation*? (language)
8. What is a synonym?

**► Return to Demonstration: Looking Left, Looking Right**  
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Handout Master 2.8

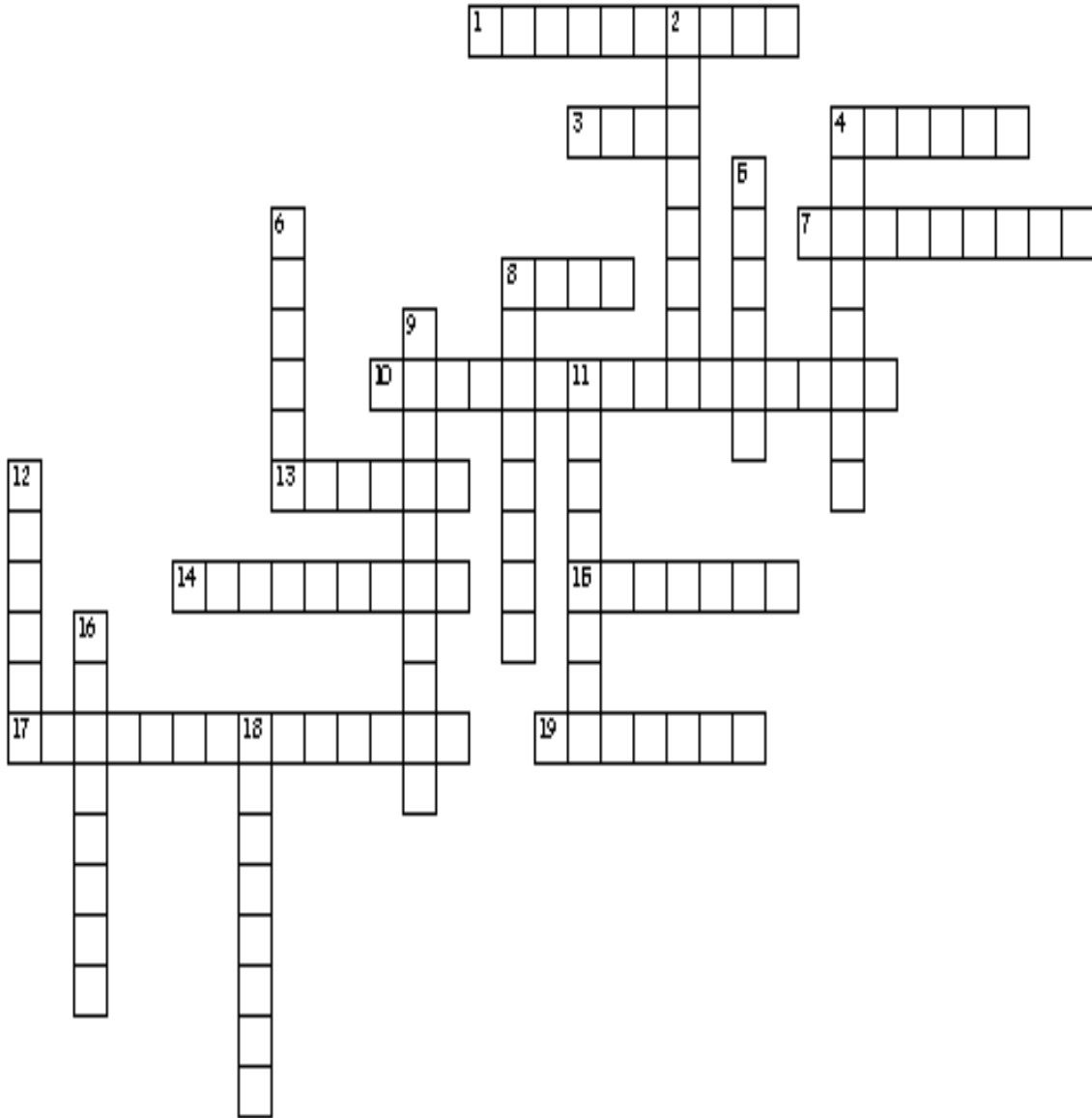
**Age-Related Changes in the Brain**

<i>Variable</i>	<i>Effect on the Brain and Behavior</i>
Synaptogenesis	
Myelination	
Hemispheric specialization	
Plasticity	
Aging	
Experience	
Stroke	

- ▶ [Return to Exercise: Summarizing Age-Related Changes in the Brain](#)
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Handout Master 2.9

### Chapter Review: Crossword Puzzle



**Across**

1. neurotransmitter that causes the receiving cell to stop firing.
3. the cell body of the neuron, responsible for maintaining the life of the cell.
4. endocrine gland located near the base of the cerebrum which secretes melatonin.
7. glands that secrete chemicals called hormones directly into the bloodstream.
8. long tube-like structure that carries the neural message to other cells.
10. chemical found in the synaptic vesicles which, when released, has an effect on the next cell.
13. bundles of axons coated in myelin that travel together through the body.
14. branch-like structures that receive messages from other neurons.
15. endocrine gland found in the neck that regulates metabolism.
17. thick band of neurons that connects the right and left cerebral hemispheres.
19. part of the nervous system consisting of the brain and spinal cord.

**Down**

2. part of the limbic system located in the center of the brain, it acts as a relay from the lower part of the brain to the proper areas of the cortex.
4. endocrine gland that controls the levels of sugar in the blood.
5. fatty substances produced by certain glial cells that coat the axons of neurons to insulate, protect, and speed up the neural impulse.
6. the basic cell that makes up the nervous system and which receives and sends messages within that system.
8. chemical substances that mimic or enhance the effects of a neurotransmitter on the receptor sites of the next cell.
9. part of the lower brain that controls and coordinates involuntary, rapid, fine motor movement.
11. process by which neurotransmitters are taken back into the synaptic vesicles.
12. a group of several brain structures located under the cortex and involved in learning, emotion, memory, and motivation.
16. chemicals released into the bloodstream by endocrine glands.
18. brain structure located near the hippocampus, responsible for fear responses and memory of fear.

**[▶ Return to Student Review Resources: Chapter Review: Crossword Puzzle](#)**

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Handout Master 2.10

**Chapter Review: Fill-in-the-Blank Key Terms Exercise**

1. \_\_\_\_\_, produced naturally by the brain and the pituitary gland, reduce pain and positively affect mood.
2. The most common cause of damage to adult brains, arising when blockage of an artery cuts off the blood supply to a particular area of the brain or when a blood vessel bursts, is \_\_\_\_\_.
3. The gray, convoluted covering of the cerebral hemispheres that is responsible for higher mental processes such as language, memory, and thinking is called the \_\_\_\_\_.
4. The sudden reversal of the resting potential, which initiates the firing of a neuron, is called the \_\_\_\_\_.
5. During the \_\_\_\_\_ process, neurotransmitter molecules are taken from the synaptic cleft back into the axon terminal for later use, thus terminating their excitatory or inhibitory effect on the receiving neuron.
6. The \_\_\_\_\_ is the junction where the axon of a sending neuron communicates with a receiving neuron across the synaptic cleft.
7. A person's \_\_\_\_\_ includes his/her actual characteristics.
8. \_\_\_\_\_ is the specialization of one of the cerebral hemispheres to handle a particular function.
9. The \_\_\_\_\_ produces a hormone that controls the sleep-wakefulness cycle.
10. The \_\_\_\_\_ control voluntary body movements, speech production, and such functions as thinking, motivation, planning for the future, impulse control, and emotional responses.
11. The field of research that investigates the relative effects of heredity and environment on behavior and ability is \_\_\_\_\_.
12. \_\_\_\_\_ is a pattern of inheritance in which a trait is influenced by both genes and environmental factors.
13. The \_\_\_\_\_ is the structure that is located above the brainstem and acts as a relay station for information flowing into or out of the higher brain centers.
14. The strip of tissue at the front of the parietal lobes where touch, pressure, temperature, and pain register in the cerebral cortex is called the \_\_\_\_\_.
15. The \_\_\_\_\_ is the largest part of the brain, where cognitive functions as well as many of the motor functions of the brain are carried out.
16. The nerves in the \_\_\_\_\_ connect the central nervous system to the rest of the body.
17. The primary visual cortex, where vision registers, and association areas involved in the interpretation of visual information are located in the \_\_\_\_\_.
18. \_\_\_\_\_ is the ability of the brain to reorganize and compensate for brain damage.
19. The branchlike extensions of a neuron that receive signals from other neurons are called the \_\_\_\_\_.
20. The \_\_\_\_\_ is a set of inheritance rules in which the presence of a single dominant gene causes a trait to be expressed but two genes must be present for the expression of a recessive trait.
21. The \_\_\_\_\_ is a brain-imaging technique that reveals activity in various parts of the brain, based on the amount of oxygen and glucose consumed.
22. The \_\_\_\_\_ is a group of structures in the brain, including the amygdala and hippocampus, that are collectively involved in emotion, memory, and motivation.
23. The right and left halves of the cerebrum, covered by the cerebral cortex and connected by the corpus callosum, are called the \_\_\_\_\_.
24. The \_\_\_\_\_ are the sex glands; the ovaries in females and the testes in males.
25. The white, fatty coating wrapped around some axons that acts as insulation and enables impulses to travel much faster is the \_\_\_\_\_.
26. Thyroxine, a hormone that regulates metabolism, is produced by the \_\_\_\_\_.
27. A brain-imaging technique that reveals both brain structure and brain activity is the \_\_\_\_\_.

28. \_\_\_\_\_ are segments of DNA that are located on the chromosomes and are the basic units for the transmission of all hereditary traits.
29. The \_\_\_\_\_ is the brain structure that executes smooth, skilled body movements and regulates muscle tone and posture.
30. The structure in the midbrain that controls unconscious motor movements is the \_\_\_\_\_.
31. The part of the brain at the rear of the occipital lobes where vision registers in the cerebral cortex is called the \_\_\_\_\_.
32. The \_\_\_\_\_ is the small but influential brain structure that controls the pituitary gland and regulates hunger, thirst, sexual behavior, body temperature, and a wide variety of emotional behaviors.
33. A(n) \_\_\_\_\_ is a record of brain-wave activity made by the electroencephalograph.
34. The \_\_\_\_\_ is the largest structure of the human brain, consisting of the two cerebral hemispheres connected by the corpus callosum and covered by the cerebral cortex.
35. Comprehension of the spoken word and formulation of coherent speech and written language is controlled by the \_\_\_\_\_, the language area in the temporal lobe of the brain.
36. \_\_\_\_\_ are protein molecules on the dendrite or cell body of a neuron that will interact only with specific neurotransmitters.
37. The \_\_\_\_\_ is the part of the neuron that contains the nucleus and carries out the neuron's metabolic functions.
38. The \_\_\_\_\_ is an extension of the brain, reaching from the base of the brain through the neck and spinal column, that transmits messages between the brain and the peripheral nervous system.
39. The division of the autonomic nervous system that mobilizes the body's resources during stress, emergencies, or heavy exertion, preparing the body for action is the \_\_\_\_\_.
40. A person with \_\_\_\_\_ has an impairment of the physical ability to produce speech sounds, or in extreme cases an inability to speak at all that is caused by damage to Broca's area.
41. \_\_\_\_\_ is the area in the frontal lobe, usually in the left hemisphere, that controls the production of speech sounds.
42. In a \_\_\_\_\_, the corpus callosum is cut, separating the cerebral hemispheres and usually lessening the severity and frequency of grand mal seizures; the procedure is performed in severe cases of epilepsy.
43. The rod-shaped structures in the nuclei of body cells, which contain all the genes and carry all the hereditary information in the cell, are called \_\_\_\_\_.
44. The \_\_\_\_\_ is the body's system of ductless glands in various parts of the body that manufacture and secrete hormones into the bloodstream or lymph fluids, thus affecting cells in other parts of the body.
45. The link between the spinal cord and the brain that contains structures that regulate physiological functions, including heart rate, respiration, and blood pressure is the \_\_\_\_\_.
46. The \_\_\_\_\_ is the division of the autonomic nervous system that is associated with relaxation and the conservation of energy and that brings bodily responses back to normal following an emergency.
47. The \_\_\_\_\_ produce a hormone that helps the body absorb minerals from food.
48. The structure that begins at the point where the spinal cord enlarges as it enters the brain and that includes the medulla, the pons, and the reticular formation is the \_\_\_\_\_.
49. \_\_\_\_\_ is the process through which the developing brain eliminates unnecessary or redundant synapses.
50. \_\_\_\_\_ are the cells that help to make the brain more efficient by holding the neurons together, removing waste products such as dead neurons, making the myelin coating for the axons, and performing other manufacturing, nourishing, and cleanup tasks.
51. The \_\_\_\_\_ contains structures linking the physiological functions of the hindbrain to the cognitive functions of the forebrain.
52. The hemisphere that controls the right side of the body, coordinates complex movements, and, in 95% of people, controls the production of speech and written language is the \_\_\_\_\_.
53. The \_\_\_\_\_ is the structure that connects the halves of the cerebellum.
54. The gland that produces hormones that are essential to the immune system is the \_\_\_\_\_.
55. An individual's genetic makeup is his or her \_\_\_\_\_.



56. A \_\_\_\_\_ is a chemical that is released into the synaptic cleft from the axon terminal of a sending neuron, crosses a synapse, and binds to appropriate receptor sites on the dendrites or cell body of a receiving neuron, influencing the cell either to fire or not to fire.
57. The \_\_\_\_\_ is a structure in the brainstem that plays a crucial role in arousal and attention and that screens sensory messages entering the brain.
58. A(n) \_\_\_\_\_ is a brain-scanning technique involving a rotating X-ray scanner and a high-speed computer analysis that produces slice-by-slice, cross-sectional images of the structure of the brain.
59. The \_\_\_\_\_ includes the brain and spinal cord.
60. The brain wave associated with mental or physical activity is the \_\_\_\_\_.
61. Insulin is produced by the \_\_\_\_\_.
62. Damage to Wernicke's area causes \_\_\_\_\_, a condition in which the person's spoken language is fluent, but the content is either vague or incomprehensible to the listener.
63. The endocrine gland located in the brain and often called the "master gland," which releases hormones that control other endocrine glands and also releases a growth hormone is the \_\_\_\_\_.
64. A(n) is an electrical wire so small that it can be used either to monitor the electrical activity of a single neuron or to stimulate activity within it.
65. The \_\_\_\_\_ is the brain wave that is associated with deep relaxation.
66. A(n) \_\_\_\_\_ is a specialized cell that conducts impulses through the nervous system and contains three major parts—a cell body, dendrites, and an axon.
67. The \_\_\_\_\_ is a structure in the limbic system that plays a central role in the formation of long-term memories.
68. A substance manufactured and released in one part of the body that affects other parts of the body is called a \_\_\_\_\_.
69. A(n) \_\_\_\_\_ is a diagnostic scanning technique that produces high-resolution images of the structures of the brain.
70. The \_\_\_\_\_ is the part of the temporal lobes where hearing registers in the cerebral cortex.
71. The \_\_\_\_\_ is the membrane potential of a neuron at rest, about 270 millivolts.
72. The hemisphere that controls the left side of the body and that, in most people, is specialized for visual-spatial perception and for interpreting nonverbal behavior is the \_\_\_\_\_.
73. The slowest brain-wave pattern, associated with Stage 3 sleep and Stage 4 sleep (deep sleep), is the \_\_\_\_\_.
74. The \_\_\_\_\_ are a pair of endocrine glands that release hormones that prepare the body for emergencies and stressful situations and also release small amounts of the sex hormones.
75. The \_\_\_\_\_ is the part of the brainstem that controls heartbeat, blood pressure, breathing, coughing, and swallowing.
76. The \_\_\_\_\_ is the bulbous end of the axon where signals move from the axon of one neuron to the dendrites of another.
77. \_\_\_\_\_ is a type of inheritance in which several genes influence a trait.
78. The \_\_\_\_\_ is the strip of tissue at the rear of the frontal lobes that controls voluntary body movement.
79. The areas of the cerebral cortex that house memories and are involved in thought, perception, learning, and language are called the \_\_\_\_\_.
80. The \_\_\_\_\_ is the thick band of nerve fibers that connects the two cerebral hemispheres and makes possible the transfer of information and the synchronization of activity between them.
81. The \_\_\_\_\_ is the slender, tail-like extension of the neuron that transmits signals to the dendrites or cell body of other neurons or to muscles or glands
82. The lobes that contain the somatosensory cortex (where touch, pressure, temperature, and pain register) and other areas that are responsible for body awareness and spatial orientation are the \_\_\_\_\_.

83. The \_\_\_\_\_ is a structure in the limbic system that plays an important role in emotion, particularly in response to aversive stimuli.

84. The \_\_\_\_\_ are the lobes that contain the primary auditory cortex, Wernicke's area, and association areas for interpreting auditory information.

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Handout Master 2.10a

**Key Terms Bank (Optional)**

action potential	functional MRI (fMRI)	tomography)
adrenal glands	genes	phenotype
alpha wave	genotype	pineal gland
amygdala	glial cells	pituitary gland
association areas	gonads	plasticity
autonomic nervous system	hindbrain	polygenic inheritance
axon	hippocampus	pons
axon terminal	hormone	primary auditory cortex
behavioral genetics	hypothalamus	primary visual cortex
beta wave	lateralization	pruning
brainstem	left hemisphere	receptors
Broca's aphasia	limbic system	resting potential
Broca's area	medulla	reticular formation
cell body	microelectrode	reuptake
central nervous system (CNS)	midbrain	right hemisphere
cerebellum	motor cortex	somatic nervous system
cerebral cortex	MRI (magnetic resonance imagery)	somatosensory cortex
cerebral hemispheres	multifactorial inheritance	spinal cord
cerebrum	myelin sheath	split-brain operation
chromosomes	neuron	stroke
corpus callosum	neurotransmitter	substantia nigra
CT scan (computerized axial tomography)	occipital lobes	sympathetic nervous system
delta wave	pancreas	synapse
dendrites	parasympathetic nervous system	temporal lobes
dominant-recessive pattern	parathyroids	thalamus
electroencephalogram (EEG)	parietal lobes	thymus
endocrine system	peripheral nervous system (PNS)	thyroid
forebrain	PET scan (positron-emission tomography)	Wernicke's aphasia
frontal lobes		Wernicke's area

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