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| 1. What is biological psychology and neuroscience, and why are they important areas of study?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: Biological psychology is the scientific study of the biological bases of behavior and mental processes. It is one of many scientific disciplines that makes important contributions to neuroscience—the scientific study of the nervous system. Neuroscience has become increasingly important in the field of psychology, impacting virtually every area of research. Neuroscience helps people develop an understanding of the nervous system, especially the brain, and its relationship to behavior. Learning more about the brain helps us to understand the inner workings of what makes us “human.” | |

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| 2. How are sensory neurons, motor neurons, and interneurons alike, and how do they differ?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: Communication throughout the nervous system takes place via neurons, including sensory neurons, motor neurons, and interneurons. These cells are highly specialized to receive and transmit information from one part of the body to another. They differ in terms of the information each type of neuron communicates. Sensory neurons receive information from the environment via specialized receptors cells that detect light, sound, touch, taste, and smell. These cells provide input to the central nervous system and convey information to neurons and then ultimately the brain. Motor neurons represent the output of the central nervous system conveying information to muscles and glands. Interneurons are the most numerous cells in the central nervous system; they allow the communication of information among neurons in the brain. | |

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| 3. What are the three basic components of a neuron, and what function does each component perform?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: The three basic components of a neuron include the cell body, the dendrites, and the axon. The cell body, also called the "soma," contains structures that provide energy for the neuron, sites for processing of nutrients, as well as the manufacture of proteins. The soma also contains the nucleus of the cell, which contains the genetic material or chromosomes of the neuron. The dendrites represent the input to the neuron receiving information from other neurons or specialized receptor cells. Dendrites branch extensively, producing a tree-like appearance; *dendrite* derives from a Greek word that means "tree." Some cells have thousands of dendrites, greatly increasing the amount of information that cells can receive. Finally, the axon is a single elongated tube that extends from the cell body of most neurons. The axon may branch at the tip to form multiple terminals with other cells. Thus, axons convey information from the neuron to other cells, such as neurons, glands, or muscles. Some neurons do not have axons. Axons can vary in length with most so small you cannot detect the difference with the human eye. The longest axon extends from the base of your spine to your foot. | |

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| 4. Describe the functions of glial cells, as well as oligodendrocytes, microglia, and astrocytes.   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: Glial cells are abundant in the brain. The primary role of these cells is to provide structural support for the neurons throughout the nervous system. There are several different kinds of glial cells, each with its own specialized function. Oligodendrocytes produce the myelin sheath that wraps around the axons of neurons and speeds up the conduction process of information to and from the nervous system by about 50 times. There are small gaps in the covering of the cells' nodes of Ranvier that allow ions to enter and leave the cell through the membrane of the neuron. Microglia do a lot of the brain’s "clean-up" work. They break down and remove dead or damaged cells as part of the brain’s immune response. If there are more microglia present, then there is likely an infection, trauma, or stroke. Astrocytes are the most common glial cells and provide critical structural support for neurons, provide neurons with nutrients, and help keep the neurons healthy. They also supply nutrients to the cells that keep toxic substances from entering the brain’s bloodstream. | |

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| 5. What takes place during the refractory period?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: After an action potential has occurred, the neuron enters a refractory period, a period of time in which the neuron is unresponsive to stimulation. While this period may be for a thousandth of a second or less, the neuron cannot fire because it is in the process of repolarizing. This process involves reestablishing the negative-inside/positive-outside condition so that the neuron is able to fire again. Repolarization is a progressive process that occurs at each segment down the axon, much like depolarization. The refractory period ends when the electrical charge in the cell reaches approximately −70 mV. | |

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| 6. List and describe the five stages of an action potential.   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: First, at resting potential the inside of the cell is negatively charged (−70 mV) and the outside is positively charged. Both sodium and potassium channels are closed. Second, at the stimulus threshold the cell body has received enough stimulation from neighboring cells for an action potential to be initiated, making the neuron polarized. Third, depolarization occurs with sodium channels opening and positively charged ions outside the neuron moving into the cell. This makes the inside of the cell positively charged and the outside of the cell negatively charged. Once this occurs, sodium channels close. Fourth, repolarization occurs with potassium channels opening so that positive potassium ions flow out of the cell. This makes the inside of the cell negatively charged and the outside positively charged. Fifth, a refractory period occurs because positive potassium ions continue to leave the neuron making the outside of the cell more positively charged. The neuron then returns to resting potential. | |

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| 7. Colin is 19 years old and has smoked cigarettes for the past year. Colin has recently switched to vaping because he has heard it is less dangerous and less addictive. However, Colin feels equally addicted to vaping as he did to cigarettes. Which neurotransmitter is responsible for making nicotine products psychologically addicting? What else is this neurotransmitter responsible for?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: Dopamine is the neurotransmitter that is responsible for drugs becoming psychologically addictive, like nicotine for Colin. Dopamine is involved in movement, attention, learning, and pleasurable or rewarding sensations. Specifically, dopamine has been linked to the anticipation of rewards or the feeling that something good is about to happen. It is this anticipation of excitement and/or reward that is a powerful motivational force for addiction. Nicotine increases the release of dopamine in the motivational circuits in the human brain. | |

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| 8. Describe the sequence of events that occurs when one neuron communicates with another neuron.   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: Activation of a presynaptic neuron will generate an action potential that travels to the end of the axon. The action potential will travel to the axon terminals and stimulate the release of neurotransmitters from synaptic vesicles. The action potential causes the synaptic vesicles to "dock" on the axon terminal membrane and release the neurotransmitters into the synaptic gap (space between the neurons). Thus, communication between/among neurons involves electrochemical conduction such that the electrical signal (action potential) is converted into a chemical signal. The neurotransmitters cross the synaptic gap and attach to receptor sites on the dendrites of the receiving, or postsynaptic, neuron. This synaptic transmission process takes only milliseconds and stimulates an electrical potential in the postsynaptic cell. After making contact with the postsynaptic receptors, the neurotransmitter molecules detach from the receptor and are reabsorbed by the presynaptic neuron so that they can be recycled and used again. This process is called "reuptake," and it occurs for neurotransmitters that bond to a receptor as well as for those that failed to do so. Neurotransmitter molecules that are not reabsorbed or that remain attached to the receptor site are broken down or destroyed by enzymes. | |

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| 9. Doris has Alzheimer's disease. She reports not feeling mentally sharp and often forgets her keys and the names of her friends. What role does the neurotransmitter acetylcholine play in her disease?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: Acetylcholine, a neurotransmitter, is involved in muscle contractions, learning, memory, and general intellectual functioning. Deficits in this neurotransmitter have been linked to Alzheimer's disease. Doris is likely experiencing memory loss and deterioration of intellectual functioning because of a severe depletion of acetylcholine. | |

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| 10. What are endorphins, and what are their functions?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: Endorphins are an important class of neurotransmitter that are released in stressful circumstances, following trauma, and during painful stimulation. They have been implicated in the pain-reducing effects of acupuncture and are also associated with positive mood. For example, endorphins are thought to give some people a "runner’s high" from intense and prolonged physical exertion. Opioid drugs like morphine and heroin are chemically similar to endorphins. Endorphins produced by your brain are thought to be more potent than their synthetic counterparts, but because they cannot be released at will, their synthetic parts can be highly addictive. | |

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| 11. Contrast the effects of agonist and antagonist drugs. Provide an example of an agonist and an antagonist drug.   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: Drugs may increase or decrease the amounts of neurotransmitters released by neurons. An agonist is a drug or other chemical that binds to a receptor and facilitates synaptic transmission. Often, agonist drugs are chemically similar to a specific neurotransmitter and produce the same effect. For example, nicotine is a stimulant because it is chemically similar to acetylcholine. It occupies acetylcholine receptor sites, stimulating skeletal muscles and causing the heart to beat more rapidly. Alternatively, a drug can act as an antagonist by blocking the effect of neurotransmitters. A drug may fit into receptor sites and prevent neurotransmitters from acting. The drug naloxone is an opioid antagonist. By blocking endorphin receptors, it can quickly reverse the effects of heroin, oxycodone, or other opioid drugs. | |

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| 12. Kendra abuses oxycodone, an opioid drug, because it gives her feelings of euphoria. One night, Kendra appeared to have overdosed on oxycodone, so a bystander brought her to the emergency room of a local hospital. Explain what drug was likely given to Kendra and how the drug works.   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: At the hospital, Kendra will likely be given the drug naloxone. It is an opioid antagonist that blocks endorphin receptors, thereby quickly reversing the effects of heroin, oxycodone, and other opioid drugs. Another option that most first responders carry with them is Narcan, which is nasal spray used to treat known or suspected opioid overdose. Because Narcan is easy to use, the surgeon general has suggested anyone who spends time near opioids should keep it on hand. | |

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| 13. What is a spinal reflex, and why is it important?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: A spinal reflex is a simple, automatic behavior that occurs without significant brain involvement. An example of this reflex is the withdrawal reflex, which occurs when a person touches a hot or sharp object. The reflex involves rapid communication among sensory neurons*,* interneurons in the spinal cord, and motor neurons that signal the muscles to react. These reflexes are crucial for survival, as additional time to respond to a stimulus that involved the brain might cause serious injury. Spinal reflexes are also important indicators of the health of neural pathways in the spinal cord; the knee-jerk spinal reflex is an important indicator of how well the nervous system is functioning. | |

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| 14. Briefly describe the functions of the different subdivisions of the peripheral nervous system.   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: There are two primary subdivisions of the peripheral nervous system: the somatic nervous system and the autonomic nervous system. The somatic nervous system plays an important role in communication throughout the entire body by relaying sensory information received by sensory receptors in the periphery along sensory nerves to the central nervous system. This system also carries messages from the central nervous system along motor nerves to perform voluntary muscle movements. On the other hand, the autonomic nervous system regulates involuntary functions that require little conscious thought, such as heartbeat, blood pressure, breathing, and digestion. | |

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| 15. What are the functions of the sympathetic nervous system and the parasympathetic nervous system?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: The involuntary functions regulated by the autonomic nervous system are controlled by two different branches of the system: the sympathetic and parasympathetic nervous systems*.* These systems offer opposing control of many of the same organs in your body. In general, the sympathetic nervous system arouses the body to expend energy (for "fight or flight") while the parasympathetic nervous system is involved in energy conservation. The sympathetic nervous system represents the body's emergency system that allows rapid activation of bodily systems in response to emergencies or threats in the environment. This system stimulates rapid heart rate, breathing, and bronchial dilation in the lungs; digestion and salivation are slowed or stopped, the pupils dilate and oxygen to the muscles and brain increases. On the other hand, the parasympathetic nervous system conserves bodily resources allowing one to "rest and digest." It calms the nervous system down following some type of emergency. The system causes a decline in heart rate, breathing, and blood pressure, pupils constrict back to a more normal size, and salivation and digestion begin to increase. | |

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| 16. Explain the link between the hypothalamus, endocrine system, and nervous system. How does the hypothalamus contribute to the functioning of the endocrine glands?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: The hypothalamus serves as the main link between the endocrine system and the nervous system. The hypothalamus directly regulates the release of hormones by the pituitary gland, a pea-sized gland just under the brain. The pituitary hormones, in turn, regulate the production of other hormones by many of the glands in the endocrine system. Oxytocin is another important hormone that is produced by the hypothalamus and released into the bloodstream by the pituitary gland. Oxytocin is related to breast-feeding and promotes bonding between reproductive partners and between parent and infant. In some instances, oxytocin may promote aggression or antisocial behavior. | |

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| 17. What are the limitations of brain imaging studies?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: The results of brain imaging studies are usually met with a healthy level of skepticism. For one, it is important to keep in mind that functional brain imaging may not increase our understanding of real-time human behavior. Second, there is not always one particular brain area that responds the same in everyone. Behavior is complex and so are humans as everyone has their own experiences. Third, brain imaging of a particular behavior must be interpreted within the context of existing psychological knowledge about the behavior so that too much emphasis is not put on different areas of the brain "lighting up." | |

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| 18. Describe four commonly used brain imaging techniques in psychological research.   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: (1) Positron-emission tomography (PET) is based on the fact that increased activity in a particular brain region is associated with increased blood flow and energy consumption. A small amount of radioactively tagged glucose, oxygen, or a drug is injected into the person's bloodstream. While performing a mental task, the PET scanner tracks the amounts of radioactive substances used in thousands of different brain regions. Increased activity in a particular brain region is associated with increased blood flow and energy consumption in that region. The change in energy consumption brings in more of the radioactive compound to the area. (2) Magnetic resonance imaging (MRI) does not expose people to radiation and is virtually harmless. The individual lies inside a magnetic tube and a computer analyzes the signals generated by brain-tissue molecules in response to the magnetic fields. The result is a series of incredibly detailed digital images. (3) Functional MRI (fMRI) combines the ability to produce a detailed image of the brain's structures with the capacity to track the brain's activity or functioning. While the individual lies in the MRI scanner, a powerful computer tracks the electromagnetic signals that are generated by changes in the brain's metabolic activity, such as increased blood flow to a particular brain region. (4) Diffusion MRI (dMRI) tracks the movement of water through brain tissue. In doing this, dMRI provides detailed, three-dimensional images of the brain's neural pathways. It is a relatively new scanning method that is noninvasive. | |

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| 19. What are neural pathways, and why are they important?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: Groups of neuronal cell bodies from one area of the brain will send axons to another area of the brain to form neural pathways between nuclei in the brain. These pathways produce communication networks and circuits that link brain areas. | |

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| 20. Explain the difference between structural plasticity and functional plasticity, and give an example of each.   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: The word *neuroplasticity* represents the notion that the brain is able to change function and structure in response to experience. There are two forms of plasticity. The first is called "functional plasticity." This type of plasticity refers to the brain's ability to recover from brain damage by shifting these functions to undamaged areas of the brain. This process may require "relearning" common behaviors such as walking, speaking, or reading. If the recovery process is successful, undamaged areas of the brain will allow recovery of these functions. The second type of plasticity is referred to as structural plasticity. This process involves physical changes in the structure of the brain following learning, environmental stimulation, and active engagement in activities. Even minor changes in the environment or one's behavior can induce structural changes in the brain. | |

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| 21. What is the main function of the midbrain?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: The midbrain is an important relay station that contains centers involved in the processing of auditory and visual sensory information. Auditory sensations from the left and right ears are processed through the midbrain, helping you orient toward the direction of a sound. The midbrain is also involved in processing visual information. After passing through the midbrain level, auditory information and visual information are relayed to sensory processing centers farther up in the forebrain region. | |

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| 22. Identify the four lobes of each cerebral hemisphere and the function associated with each.   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: Each cerebral hemisphere can be roughly divided into four regions, or lobes; these lobes are referred to as the temporal, occipital, parietal, and frontal lobes. The lobes are associated with specific functions. At the back of the brain, the occipital lobe contains the primary visual cortex and processes visual information. Near the temples, the temporal lobe contains the primary auditory cortex. This area is responsible for receiving and processing auditory information. At the top of the brain, the parietal lobe processes information from the body, or somatosensory information. These sensations include touch, pressure, information from receptors in the muscles and joints, as well as temperature information. At the foremost portion of the lobe is the somatosensory cortex. This band of tissue receives information from touch receptors in the skin. The hands and the face receive proportionally more representation in the cortex while other areas receive less. Finally, the frontal lobe is the largest lobe of the brain and carries out important functions such as the production of motor behavior including speech as well as "executive" functions, such as planning, initiating, and executing voluntary movements. Like the somatosensory cortex, the primary motor cortex is a strip of tissue at the back of the frontal lobe, just in front of the somatosensory cortex. This area also has unequal representation. There are more neurons dedicated to movement of the face and hands than other areas of the body. | |

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| 23. What are the key structures of the limbic system?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: The key structures of the limbic system include the following: hippocampus, amygdala, thalamus, and hypothalamus. The hippocampus is found in the temporal lobe. It plays an important role in the formation of new memories. The amygdala is a cluster of neurons at the base of the temporal lobe. It is important for processing emotional information such as fear, anger, and disgust. The amygdala is also important in learning and forming new memories, especially those with a strong emotional component. The thalamus is an important relay station for all motor information and sensory information, with the exception of smell, that goes to and leaves the cerebral cortex. Finally, the hypothalamus is involved in many different functions regulating the autonomic nervous system, heart rate, as well as blood pressure. It is also involved in the regulation of behaviors related to survival, such as eating, drinking, frequency of sexual activity, fear, and aggression. | |

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| 24. Distinguish between the ideas of cortical localization and lateralization.   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: Cortical localization is the idea that there are regions of the brain that are specialized to perform specific functions. Evidence suggests that areas of the brain are specialized for the reception and production of language. This evidence also suggests another phenomenon—that of lateralization of function. In other words, not only is information processing localized in the brain, there is also lateralization of these functions such that language is processed in the left hemisphere. | |

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| 25. What contributions did Pierre Paul Broca and Karl Wernicke make to the understanding of the brain?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: In the 1860s, Pierre Paul Broca, a French surgeon and neuroanatomist, treated patients with difficulty speaking but had no trouble with comprehension of spoken or written language. Autopsies of the patients showed consistent brain damage to the lower left frontal lobe suggesting that this area is critical for speech production. This area became known as Broca's area. Similarly, Karl Wernicke, a German neurologist, reported that damage in another area in the left hemisphere produced a difficulty in understanding spoken or written communications. These patients could speak quickly and easily; however, their speech was nonsensical, consisting of meaningless words and/or nonsense syllables. Autopsies of these patients' brains showed consistent damage to the left temporal lobe showing that this area is critical for language comprehension. This area became known as Wernicke's area. These clinical cases provided compelling evidence that language and speech functions are localized to the left cerebral hemisphere. Similar lesions in the right hemisphere have no impact on language and speech. | |

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| 26. Who was Roger Sperry, and what contributions did he make to the understanding of the brain?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: Roger Sperry, a psychologist and neuroscientist, along with his colleagues examined the abilities of split-brain patients. Split-brain patients were people who had their corpus callosum cut to reduce the spread of epileptic seizures. This cutting meant that the left and right hemispheres of the brain could no longer communicate with each other. Sperry and his colleagues would project an image to the person's left hemisphere while a different image was projected to the right hemisphere. When a split-brain patient was asked to identify or describe what they saw, they could only do so if the information was sent to their left hemisphere. If the information was sent to their right hemisphere, they would deny having seen anything. Sperry and colleagues reconfirmed the specialized nature of the left hemisphere in processing language that had originally been reported by Broca and Wernicke in the 1800s. | |

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| 27. LeBron is left-handed and asks you if this means he is right-hemisphere-dominant. How do you respond?   |  |  | | --- | --- | | *ANSWER:* | Answers will vary. A complete answer may include the following information: Only about 10 to 13 percent of the population identify themselves as left-handed. It's a myth that left-handers have a fundamentally different brain organization from right-handers. About 75 percent of left-handers are left-hemisphere-dominant for language, just like right-handers. The remaining 25 percent are either right-hemisphere-dominant for language or bilateral, using both hemispheres for speech and language functions. | |

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| 28. What is chronic traumatic encephalopathy (CTE), and what are the symptoms? Who is MOST likely to be affected by CTE?   |  |  | | --- | --- | | *ANSWER:* | Chronic traumatic encephalopathy, or CTE, is a progressive, degenerative brain disease that can be diagnosed only after death. Symptoms include depression and anxiety, poor judgment and lack of impulse control, and problems with memory, concentration, and attention. It ultimately leads to dementia and death. To date, CTE has been diagnosed primarily in professional athletes, especially football and hockey players, who were known to have suffered multiple brain concussions. | |

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| 29. Scott plays football at their high school. During a game against their rival team, Scott is tackled and hits their head against another player’s helmet. List and explain three observed signs of concussion and three self-reported concussion symptoms.   |  |  | | --- | --- | | *ANSWER:* | The answer should include the following information (Answers will vary.): Three possible observed signs of concussion that Scott’s coach or fellow teammates might observe are Scott appearing dazed or stunned after they hit their head, they might move clumsily like tripping over their own feet or falling down after getting up, and when asked questions afterwards they likely will answer them slowly. Scott will likely report that they have a headache, that they feel dizzy, and that the lights on the field are too bright. | |