Chapter 11 Review, pages 560–565

Knowledge

1. c
2. a
3. b
4. a
5. b
6. c
7. d
8. a
9. a
10. c
11. d
12. b

13. False. Neurons are cells that are specialized for the reception and transmission of electrical signals.
14. False. Neurons have dendrites that receive information and conduct signals towards the cell body.
15. False. In an electrical synapse, neurotransmitter molecules are released by a presynaptic neuron, diffuse across the chemical synapse and bind to receptors in the plasma membrane of the postsynaptic cell.
16. True
17. False. The blood-brain barrier allows only selected substances to enter the cerebrospinal fluid.
18. True
19. False. The somatic system is mainly conscious and voluntary.
20. False. The 31 pairs of spinal nerves transmit motor, sensory, and autonomic signals between the spinal cord and the rest of the body.
21. False. In the visual system, photoreceptors detect light at particular wavelengths and convert the stimuli to nerve impulses.
22. True
24. True
25. (a) v
   (b) i
   (c) ii
   (d) iv
   (e) iii
26. (a) iii
   (b) v
   (c) i
   (d) ii
   (e) iv
27. The components of a neural signalling pathway are reception, transmission, integration, and response.
28. afferent; interneurons; efferent
29. The high lipid content of the membrane allows the myelin sheath to act as an electrical insulator.
30. The nodes of Ranvier are regularly occurring gaps between sections of myelin sheath along the axon. They increase the speed at which electrical impulses move along the axon.
31. The structure found only in electrical synapses not in chemical synapses is a gap junction.
32. The neuron plasma membrane needs a refractory period to ensure that an impulse will travel in only one direction.
33. (a) The threshold potential is \(-50\) to \(-55\) mV.
(b) When the threshold potential is reached, Na\(^+\) channels open.
34. The effects of the degeneration of acetylcholine-releasing neurons in people with Alzheimer’s disease are declines in memory, speech, and perceptual abilities.
35. White matter consists of myelinated nerve fibres, while gray matter consists of bundles of unmyelinated nerve fibres and cell bodies.
36. The four lobes of the cerebral cortex are frontal, parietal, temporal, and occipital.
37. The purpose of the blood-brain barrier is to prevent many substances from passing from the blood to the neurons. This provides protection from toxins and microorganisms.
38. The sympathetic division stimulates functions that may be needed in stressful situations while the parasympathetic division inhibits them, to conserve energy and allow normal functions to proceed.
39. Pain is an interpretation of sensory input received by specialized cells known as substantia gelatinosa.
40. Endorphins are opioid peptides that function as neurotransmitters, which produce analgesia and a feeling of well being.
41. Echolocation is an organism’s transmission of a sound and interpretation of the sound that is reflected as an echo. It is useful where visibility is limited.
42. The Eustachian tube protects the eardrum from damage caused by changes in atmospheric pressure.
43. The Renin-angiotensin-aldosterone pathway is the pathway that attempts to maintain blood pressure if an injury results in blood loss. If blood flow to kidneys is reduced through blood loss, the kidneys secrete the hormone renin that stimulates the production of angiotensin, which in turn stimulates the secretion of the hormone aldosterone from the adrenal cortex. Aldosterone causes the reabsorption of sodium and water by nephrons in the kidneys. This retention of water increases the body’s fluid volume, which increases blood pressure.
44. Epinephrine stops anaphylactic shock by dilating airways and blood vessels, thereby restoring air and blood flow.

**Understanding**
45. The three neurons involved in the reflex are are: 1) afferent neuron, 2) interneuron, and 3) efferent neuron.
46. Afferent neurons transmit stimuli collected by sensory receptors to interneurons that integrate the information to formulate and appropriate response. Efferent neurons carry the response signal away from the interneuron networks to the effectors.
47. The membrane potential is caused by the uneven distribution of \( \text{Na}^+ \) and \( \text{K}^+ \) inside and outside the cell.

48. (a) This is a chemical synapse because the gap junctions are missing. (Gap junctions are only found in electrical synapses).
(b) C represents the synaptic cleft.
(c) A represents the axon terminal of a presynaptic cell.
(d) In structure B, neurotransmitter molecules are being released.
(e) After the neurotransmitters bind to receptors in the postsynaptic cell, channels open that allow ions to flow, which may generate an impulse in the postsynaptic cell.

49. The CNS includes the brain and spinal cord where integration of neural activity occurs. The PNS includes all of the nerves outside the brain and spinal cord. It is involved with the transmission of information to the CNS (the afferent system) and transmission of information away from the CNS (the efferent system) to target structures and organs.

50. The cerebrum is divided into two hemispheres: right and left. Each hemisphere is divided into four lobes: temporal, parietal, frontal, and occipital.

51. (a) I identifies the tympanic membrane.
(b) E identifies the structure that vibrates and creates pressure waves in the fluid in the cochlea.
(c) C identifies the structure that transmits signals to the brain.

52. (a) The CNS releases endorphins as natural pain suppressors.
(b) In response to stimuli, such as exercise, hypnosis, and stress, the brain releases endorphins, natural painkillers that bind to membrane receptors on substance P neurons, reducing the amount of neurotransmitter released.

Analysis and Application

53. (a) The doctor is testing the involuntary knee jerk reflex. The doctor is checking for a condition of the nervous system or spinal cord that could be an early indicator of a disease like multiple sclerosis.
(b) The sensory receptor relays the signal to the sensory neuron that carries the signal to the spinal column. An interneuron passes the impulse to a motor neuron. The knee jerks when the muscle above the knee receives the signal and contracts. The brain receives the message an instant later.

54. For an action potential to be propagated as quickly as possible, the axon would need to be myelinated with a large diameter.

55. A toxin would cause the postsynaptic membrane action potential to form more slowly, if at all. It would also slow the action potential propagation.

56. Alcohol increases the effect of GABA, an inhibitory transmitter, and weakens the effect of glutamine, an excitatory transmitter. Both make a person feel slow and sluggish.

57. (a) The \( \text{Na}^+ \) channels are opening and the \( \text{K}^+ \) channels are closing at D.
(b) Many Na+ channels are open and many K+ channels are closed at A.

58. Graph (c) is correct. Despite the different levels of stimuli, if the stimulus is any strength above threshold, the nerve or muscle fiber will give a complete response. Otherwise it will give no response at all.
59. Based on the symptoms, Parkinson’s disease is caused by a lack of dopamine, which results in abnormal nerve functioning, causing a loss in the ability to control body movements.

60. Compared with the human brain, the cerebellum is more developed in bats. The cerebellum is the part of the brain responsible for movement and equilibrium. Bats fly and jump requiring greater development than humans in this area.

61. Eating a turkey dinner could make you sleepy because serotonin is an inhibitory neurotransmitter that acts on the CNS. One of its functions is control of sleep.

62. Destruction of the motor areas of the right cerebral cortex would impair voluntary movement on the left side of the body. Sensation would not be affected on either side of the body.

63. The purpose of pain is to reduce damage of the body. In adaptation, a constant stimulus results in fewer action potentials being sent to the central nervous system. This allows the brain to focus on changes in the environment while ignoring stimuli that remain constant. With pain, however, adaptation could lead to a continuation, or an increase, of damage. For this reason, pain receptors do not adapt or reduce the frequency of action potentials.

64. A flushed face after exertion is a homeostatic mechanism because change in body temperature is detected by thermoreceptors, then transmitted and interpreted by the hypothalamus that sends out a signal to dilate the blood vessels in the skin. Increased blood flow near the skin increases the transfer of thermal energy to the air, which cools the body (and also makes our skin flushed temporarily).

Evaluation

65. (a) A or C; He can move his hand, so the motor nerve is intact but the sensory nerve and/or the dorsal root of the spinal cord likely is not as he has no sensation.

(b) B; The sensory nerve is intact, as he can feel pain but the motor nerve is likely not as he cannot move it.

(c) There is no block as both sets of messages are getting through.

66. Sodium is required for the nervous system to effectively communicate with and coordinate various parts of the body. Action potentials are generated within a neuron and pass along and between neurons throughout the body to coordinate numerous functions. Without proper levels of sodium, the electrical signals in nerve cells cannot be established or transmitted, and the nervous system will fail to function properly.

67. Without cholinesterase function, any signals that stimulate muscles would not be terminated, so there would be repeated stimulation and continuous actions of muscles. Nerve toxins like this can cause death by allowing the larynx to spasm.

68. A dentist may suggest alternating acetaminophen and acetylsalicylic acid for an adult with a severe toothache because specific types of pain may respond better to one kind of medication than to another kind as the medications impact different receptors. What takes away pain for one person might not work for someone else.

69. (a) (i) Answers may vary. Sample answer: To reinforce existing neural pathways, you could play chess, do crossword puzzles, play board games, solve sudoku puzzles, play card games with counting, and play electronic brain-age type games.
(ii) Answers may vary. Sample answer: To create new neural pathways, you could learn a new language, take up a sport you have never tried before, and use your non-dominant hand to brush your teeth.
(b) Answers may vary. Sample answer: Creating new neural pathways will be more difficult as myelination has to take place before signals move quickly and easily and that takes many repetitions.
70. Answers may vary. Students should create a poem, song or rap that is general and simple enough that an elementary or middle-school student could understand. Students should include a definition of stress, how stress affects the body, and how stress affects homeostasis.
Reflect on Your Learning

71. Answers may vary. Sample answer: People respond to and handle stress differently. For example, a movie might be frightening to one person, but not at all frightening to someone else. The different responses of people to stress or stressful incidents may be due to prior experiences and how these experiences have impacted their lives, may be due to the cumulative effects of many stressors at once, may be due to strategies people use to avoid or manage stress, and may be due to physiological differences in the body or brain.

72. (a) Answers may vary. Sample answer: Yes, I do think that helmets should be worn when playing any sport that involves risk of head or neck injury. The brain and spinal cord are central regulators of our bodies and our abilities to maintain homeostasis. It is important that the brain and spinal cord be as protected as possible.
(b) Answers may vary. Sample answer: Yes, I would definitely wear a helmet when playing sports that involve risk of head or neck injury. I would not want to risk getting an epidural hematoma or other brain or spinal cord injury.

73. (a) Answers may vary but should include rooms at home, at school, and in other locations the student travels as well as modes of transportation used.
(b) Answers may vary depending on location chosen.
(c) Answers may vary. Students will probably indicate at least one or two locations they would not be able to gain access to by themselves, such as a city bus or the second floor of a home.
(d) Answers may vary. Sample answer: My best friend lives on the second floor of a building with no elevator. I would really miss not being able to visit him. To access his home, I would have to be carried up the stairs.
(e) Answers may vary. Sample answer: Elevators could be added to the back of buildings, on the outside if necessary. Ramps could be installed where possible, rules for new construction could be changed to make all areas accessible to people in wheelchairs.
(f) Answers may vary.
(g) Answers may vary. Sample answer: People close to me would know me well, so they would probably not treat me very differently, although I hope they would recognize when I needed help. Strangers would probably assume I wasn’t able to do a lot of things for myself that I would still actually be able to do. I would try to explain politely that the only part of me affected by the spinal cord injury was my legs and my ability to walk. I might lose patience after explaining this several times.
(h) Answers may vary. Sample answer: Depending on where on the spinal cord the injury occurred many other body functions could be affected. For example, I might not be able to sense heat or cold and I might not be able to use my arms. In addition, I could develop medical conditions as a result of spending every day sitting in a wheelchair, such as obesity, skin lesions, and lack of muscle tone.

74. (a) Answers may vary. Sample answer: Yes, I believe head shots should be banned from all levels of hockey. An adult’s nervous system is just as important as a child’s. Also, players in the NHL are very important role models for younger players and the league has a responsibility to do everything it can to set an example of fair, safe play.
(b) Answers may vary.
(c) Answers may vary. Sample answer: I think all sports organizations should take a much firmer stand on bad hits. The penalty for a bad hit should be whatever it takes to convince players not to make them and coaches not to ask players to make them. This
may be a suspension of several games or a reduction of the team’s points standing in the league.

(d) Answers may vary. Sample answer: If there are strict rules about not making bad hits, the participant should have the right to sue the organization and the perpetrator if the participant is injured. If the hit violates a law, legal charges should also be laid. These measures will also help stop head injuries.

Research

75. Answers may vary. Posters should include the following information:

- An epidural or extradural hematoma is a type of traumatic brain injury in which a buildup of blood occurs between the dura mater (the tough outer membrane of the central nervous system) and the skull. The dura mater also covers the spine, so epidural bleeds may also occur in the spinal column.
- An epidural hematoma is caused by a fracture of the temporal bone, just in front of the ear. The temporal bone is thin compared to the rest of the skull, and if you bump it, it tends to fracture more easily. The problem is there is an artery that lies just under the bone. This vulnerable artery, called the middle meningeal artery, carries blood to the scalp. If it is damaged, the bleeding can be swift and severe. The middle meningeal artery is not located in the brain itself, but rather outside the dura. If damaged, it bleeds into the epidural space, outside the dura, so there are no immediate symptoms. As the hemorrhage grows, however, the dura pushes in against the brain, and the brain becomes compressed. Until that compression occurs, the injured person may seem to be okay, hence the “talk” in “talk and die”.
- The most common cause is trauma, such as a blow to the head, causing a shearing injury.
- Signs and symptoms can include confusion, dizziness, drowsiness, an enlarged pupil in one eye, severe headache, nausea and vomiting, weakness of part of the body—usually on the opposite side from the enlarged pupil, and loss of consciousness after the injury, followed by a period of alertness and then rapid deterioration.
- This is an emergency condition. Any head injury should be medically assessed. Life support measures may be required. With this condition, emergency surgery is almost always necessary to reduce pressure within the brain. This may include drilling a small hole in the skull to relieve pressure and allow drainage of the blood from the brain. Large hematomas or solid blood clots may need to be removed through a larger opening in the skull. Medications used in addition to surgery will vary according to the type and severity of symptoms and brain damage that occurs. Anticonvulsant medications may be used to control or prevent seizures. Some medications called "hyperosmotic agents" (like mannitol, glycerol, and hypertonic saline) may be used to reduce brain swelling.
- An epidural hemorrhage may not be preventable once a head injury has occurred. To minimize the risk of head injury, use appropriate safety equipment (such as hard hats, bicycle or motorcycle helmets, and seat belts). Follow general safety rules. For example, do not dive into water if you don’t know how deep the water is or if rocks may be present. Use appropriate safety precautions in sports, recreation, and work. Drive safely.
76. Reports will vary. Reports should include the following information:
• THC blocks the neurotransmitter anandamide.
• Molecules called endocannabinoids bind with receptors in the brain and activate hunger.
• Endocannabinoids in the hypothalamus of the brain activate cannabinoid receptors that are responsible for maintaining food intake. THC binds with cannabinoid receptors.
• While THC is known to lower intraocular pressure (IOP) it is not currently known how it achieves this. There have been no conclusive tests to determine the mechanism of action, or even if the effect is achieved by brain-receptor interaction. If the effect is achieved through receptors, then more specific medications could be developed that do not have any unwanted effect on the CNS. It is also possible that the medical effects work through an entirely different route and are not receptor-based. The uncertainty of THC’s course of action in lowering IOP implies that it is also unknown whether or not it works in the same way as current medications do. If the mechanism of action differs from existing therapies then it is likely to be able to be used with other medications to provide additional benefits that would not be seen if either medication was taken separately.
• Side effects of THC include problems with memory and learning, distorted perception, difficulty with thinking and problem solving, loss of coordination, increased heart rate, anxiety, paranoia and panic attacks.

77. Answers may vary. Reports should include the following information:
• A spinal cord injury can occur anywhere along the spinal cord. It is the result of damage to cells in the spinal cord and causes a loss of communication between the brain and the parts of the body below the injury. Thus, the higher the injury along the spine, the greater the extent of the problems associated with the injury, such as loss of movement and sensation.
• Paraplegia is a possible result of an injury at the thoracic level of the spine. It results in loss of sensation and paralysis in the lower body and legs. Quadriplegia, however, can be the result of an injury to the cervical area of the spinal cord. It may result in loss of sensation and paralysis in both the arms and the legs or in all areas below the neck.
• Complete spinal cord injury is usually the loss of sensation and motor ability associated with a complete spinal cord injury caused by bruising, loss of blood to the spinal cord, or pressure on the spinal cord; cut and severed spinal cords are rare. Generally, complete spinal cord injuries result in total loss of sensation and movement below the site of the injury. Incomplete spinal cord injury occurs when a spinal cord injury does not result in complete loss of movement and sensation below the injury site.
• The five type of incomplete spinal cord injuries are:
  1) anterior cord syndrome, which results from damage to the motor and sensory pathways in the anterior areas of the spinal cord. Effects of this injury include loss of movement and overall sensation, although some sensations that travel by way of the still intact pathways can be felt.
  2) Central cord syndrome, which results from injury to the centre of the cervical area of the spinal cord, and results in weakness or paralysis in the arms and some loss of sensory reception.
  3) Brown-Sequard syndrome, which results from injury to the right or left side of the spinal cord. On the side of the body where the injury occurred, movement and sensation are lost below the level of the injury. On the side opposite the injury, temperature and pain sensation are lost because these pathways cross in the spinal cord.
4) Injuries to individual nerve cells, which result in loss of sensory and motor function in the area of the body to which the injured nerve root corresponds.

5) Spinal contusions (the most common type of spinal cord injury), in which the spinal cord is bruised, not severed, but the consequence is inflammation and bleeding from blood vessels near the injury.

- The first phase of the injury includes the damage to nerve cells, axons, and blood vessels around the spinal cord. Pressure on the spinal cord can compound the damage. During this period, normal blood flow is disrupted resulting in oxygen deprivation to areas of the spinal cord. In response to the injury, in the secondary phase, immune cells flow to the injured area.
- The first step taken to aid patients of spinal cord injuries is to relieve the spinal cord compression. Not all damage to the spinal cord occurs at the time of the injury, and that the extent of the damage is related to the length of time that the spinal cord is compressed. Pharmacological intervention is the second step in treating spinal cord injuries. There is continued research on substances that can reduce secondary damage, but currently doctors administer methylprednisolone to reduce cellular damage.
- Scientists have discovered two approaches that could allow the neuron to regenerate and reconnect with its target cells. First, a study by Neuman and Woolf showed that neurons having axons in both the peripheral and central nervous system have the ability to re-grow following a lesion in the central nervous system if a lesion was produced one or two weeks before in the peripheral nervous system. It seems that the peripheral nervous system conditioned the central nervous system so that it would no longer be affected by the inhibitors in the environment following injury.
- The second discovery related to regeneration and reconnection was made by the Schwab laboratory. Scientists there demonstrated that IN-1, a monoclonal antibody against CNS myelin, enhanced axonal re-growth both on a culture of myelin and also in vivo. When IN-1 secreting cells were transplanted at the same time that the lesion was created, many axons grew rather long distances and in some cases regained their function.

78. Answers may vary. Reports should include the following information:
- Mirror neurons were first discovered in the early 1990s, when a team of Italian researchers found individual neurons in the brains of macaque monkeys that fired both when the monkeys grabbed an object and also when the monkeys watched another primate grab the same object.
- The first human mirror neuron study examined hand-muscle twitching. In a 1995 paper in the Journal of Neurophysiology (Vol. 73, No. 6, pages 2,608-2,611), Rizzolatti and neuroscientist Luciano Fadiga, MD, PhD, now at the University of Ferrara, recorded motor-evoked potentials—a signal that a muscle is ready to move—from participants’ hand muscles as the participants watched the experimenter grasp objects. They found that these potentials matched the potentials recorded when the participants actually grasped objects themselves.
- Mirror neurons also allow us to read and understand the social meaning of other people’s behaviours and emotional states. This ability to identify with and understand another’s situation, feelings, and motives promotes empathy. Understanding others’ emotional states allows us to respond appropriately in social situations.
• Mirror neurons are located in more areas of the human brain than previously thought. Given that different brain areas implement different functions, this finding also suggests that mirror neurons provide a complex and rich mirroring of the actions of other people.
79. (a) Answers may vary. Sample answer: CT scans now make it possible to see if the injury is beyond the scope of a concussion.
(b) If a person suffers a head or neck injury, you should support his or her head in the position you found it. If the person begins vomiting and is unconscious, place the victim in the recovery position to let the vomit drain from his or her mouth.
(c) You should not move the person’s neck. Moving the neck can cause compression and further damage to the spinal cord or brain.
(d) If the environment is unsafe, or the victim would die or be more severely injured if not moved, then you may have to move the person’s head or neck. If the person must be moved, support the head and neck in a brace. If no brace is available, even holding the head from behind is better than nothing.