

Chapter 34

Integration and Control: Nervous Systems

I. Neurons – The Communication Specialists

■ A. Functional Zones of a Neuron

- 1. The _____ contains the nucleus and metabolic machinery for protein synthesis.
- 2. _____ are numerous, usually short extensions that receive stimuli (input zones)
- 3. An _____ is usually a single, rather long, extension (conducting zone) that transmits impulses to other cells at its branched endings (output zones); signals actually arise in the trigger zones.

B. Membrane Gradients and Potentials

- 1. A neuron at rest maintains a steady _____ across its plasma membrane.
 - a. The inside is more negatively charged than the outside.
 - b. This is called the _____.
- 2. When a neuron receives signals, an abrupt, temporary _____ – the inside becomes more positive – in the polarity is generated (an action potential).
- 3. Any membrane that can produce action potentials is said to show *membrane excitability*.

C. Gradients Required for Action Potentials

- 1. The resting membrane potential is the result of three factors:
 - a. The concentrations of _____ and other charged molecules are not the same on the two sides of the plasma membrane.
 - b. _____ proteins spanning the membrane influence the diffusion of specific types of ions.
 - c. _____ spanning the membrane actively pump sodium and potassium ions.

Figure 34.3

Page 581

Page 577 – 11th ed.

- 2. There are more _____ ions inside and more sodium ions outside the resting neuron membrane.

- a. _____ have a tendency to leak out by facilitated diffusion through channel proteins.
- b. Most of the sodium channels are “_____” and remain closed most of the time, keeping the concentration outside high.
- c. However, small amounts of _____ do leak in and must be pumped out (and potassium pumped in) by the sodium potassium pump.

Figure 34.4
Page 581
Page 577 – 11th edition

II. How are Action Potentials Triggered and Propagated?

■ A. Approaching Threshold

- 1. “_____” means that signals at the input zone vary in magnitude depending on the intensity and duration of the stimulus.
- 2. “_____” means the signal does not usually spread beyond the input zone; however, if the stimulation is strong enough, an adjacent trigger zone may respond.
- 3. When a stimulus reaches a certain minimum – a _____ - gated channels open and sodium rushes in.
 - a. In an _____ way, more and more sodium gates open.
 - b. At threshold, the opening of more gates _____ longer depends on the stimulus but is self-propagating.
 - c. The sodium potassium pump shuts _____.

B. An All-or-Nothing Spike

- 1. Action potentials are _____ events.
- 2. A brief (_____) period follows at each depolarization site- sodium gates shut, potassium gates open – during which the membrane is insensitive to stimulation.

Review Figure 34.8 on pages 578-579 11th ed.

III. How Neurons Send Messages to Other Cells

- A. A _____ is a junction between a neuron and an adjacent cell, separated by a synaptic cleft into which a neurotransmitter substance is released.
- 1. The neuron that releases the neurotransmitter molecules into the cleft is called the _____ cell.
 - a. First, gated protein channels open to allow _____ ions to enter the neuron.
 - b. Calcium causes the vesicles to fuse with the membrane and release the transmitter substance into the cleft.
- 2. The _____ binds to receptors on the membrane of the postsynaptic cell.
 - a. Neurotransmitters may have _____ effects if they drive a cell's membrane to the threshold of an action potential.
 - b. Neurotransmitters may have _____ if they help drive the membrane away from threshold.
- 3. _____ is the transmitter at neuromuscular junctions.

Figure 34.7c
Page 584
Page 580 – 11th ed.

B. A Smorgasbord of Signals – Neurotransmitter Diversity

- 1. _____ acts on brain cells to govern sleeping, temperature regulation, and emotional states.
 - Regulates endocrine activity. Usually inhibitory.
 - Inadequate serotonin – widespread effects on attention and emotional states
 - May be linked to severe, chronic depression
 - Prozac (anti-depressant) blocks removal of serotonin from cleft.
- 2. _____ (noradrenaline) apparently effects brain regions concerned with emotions, dreaming, and awaking.
 - Increases heart rate during times of stress.
 - Anti-anxiety drugs designed to inhibit
 - Reduced levels linked to depression (and others)

- 3. _____ is the specialty of neurons in brain regions dealing with emotions.
 - Inadequate dopamine production and release can lead to overstimulation of neurons controlling skeletal muscle tone.
 - Parkinsons?
 - Excess – schizophrenia?
- 4. _____ are substances that enhance or reduce the effects of a neurotransmitter on target neurons.

C. How is a Neurotransmitter Removed from the Synaptic Cleft? Cleaning Up the Cleft.

-
- 1. _____ molecules must be removed promptly from the synaptic cleft.
-
- 2. Some molecules diffuse out; _____ degrades many; others are actively pumped back into the presynaptic cells by membrane transport proteins.

IV. Paths of Information Flow (Nerves and Reflex Arcs)

- A. Blocks and Cables of Neurons
 - 1. Signals between the brain or spinal cord and body regions travel by _____.
 - a. Axons of _____ neurons, motor neurons, or both are bundled together in a nerve.
 - b. Within the brain and spinal cord, such bundles are called nerve pathways, or “tracts”.

Figure 34.12
Page 587
Page 584-5 11th ed.

- 2. Many axons are covered by a _____ sheath derived in part from Schwann cells.
 - a. Each section of the sheath is separated from adjacent ones by a node where the axon membrane is exposed.

- b. The action potentials jump from _____, which is fast and efficient.
- c. _____ – the myelin sheaths around axons in the spinal cord degenerate slowly.
 - Muscular paralysis and sensory losses
- B. Reflex Arcs
 - 1. _____ are simple, stereotyped movements made in response to sensory stimuli.
 -
 - 2. In the simplest reflex, the _____, sensory neurons synapse directly on motor neurons.

V. Vertebrate Nervous Systems

■ A. Functional Divisions

- 1. The _____ includes the brain and spinal cord
- 2. The _____ includes all of the nerves carrying signals to and from the brain and spinal cord.

VI. The Major Expressways

■ A. Peripheral Nervous System

- 1. The human peripheral system has _____ types of nerves based on location:
 - a) _____ connect with the spinal cord and innervate most areas of the body
 - b) _____ connect vital organs directly to the brain.
- 2. Spinal and cranial nerves can also be classified on the basis of _____.
 - a) The _____ nerves relay sensory information from receptors in the skin and muscles and motor commands to skeletal muscles (voluntary control).
 - b) The _____ send signals to and from smooth muscles, cardiac muscle, and glands. (involuntary control)

- 3. Sympathetic and Parasympathetic Nerves

- a) _____ nerves tend to slow down body activity when the body is not under stress
- b) _____ nerves increase overall body activity during times of stress, excitement, or danger; they also call on the hormone epinephrine to increase the "fight-flight" response.
 - Interactions between the two maintains stability.

- B. The Spinal Cord

- 1. The spinal cord is a pathway for signal travel between the peripheral nervous system and the brain.
 - a) The _____ is also the center for controlling some reflex actions.
 -
 - b) The spinal cord is covered with tough membranes – the _____ – and resides within the protection of the stacked vertebrae.
 - c) _____ – results from viral or bacterial infection

VII. Functional Divisions of the Vertebrate Brain

- A. The _____ is a continuation of the anterior end of the spinal cord, and is also protected by meninges and bones.

- B. Hindbrain

- 1. The _____ has influence over respiration, blood circulation, motor response coordination, and sleep/wake responses.
 - Reflex center for vomiting, coughing, sneezing, defecating and swallowing
- 2. The _____ acts as a reflex center for maintaining posture and coordinating limbs.
 - Receives a copy of motor input from the cerebrum and sensory input from the PNS.
 - Compares the action with the intended movement and makes corrections so that the two agree.
 - Index finger experiment.

■ C. Forebrain

- 1. The _____ integrates sensory input and selected motor responses.
- 2. The _____ relays and coordinates sensory signals from the cerebrum.
- 3. The _____ monitors internal organs and influences responses to thirst, hunger and sex. (homeostatic control).

■ D. Brain Cavities and Canals (Protection at the Blood-Brain Barrier)

- 1. The brain and spinal cord are bathed with _____ that exists within a system of cavities and canals.
- 2. The fluid _____ u vital nervous tissue from sudden jarring movements.
- 3. The _____ operates at the plasma membranes of cells forming the capillaries that service the brain.
 - Membrane transport proteins allow essential nutrients (glucose) to move through but bar wastes (urea) and certain toxins.

VIII. A Closer Look at the Human Cerebrum (The Human Cerebrum)

■ A. Organization of the Cerebral Hemispheres (Functional Areas of the Cortex)

- 1. The human cerebrum is divided into left and right cerebral hemispheres.
 - a. The _____ hemisphere deals with speech, math, and analytical skills; the _____ half controls nonverbal skills, such as music.
 - b. The two halves communicate with each other by means of nerve tracts called the _____.
- 2. The _____, the thin layer of gray matter is divided into four lobes:
 - a. The _____ lobe, which is located in the rear, has centers for vision.

- b. The _____ lobe, near each temple, is a processing center for hearing and houses centers for influencing emotional behavior.
- c. The _____ lobe is the main receiving area for signals from the skin and joints.
- d. The _____ coordinates instructions for motor responses.

Figure 34.25a
Page 597
Page 590 – 11th ed.

B. Connections with the Limbic System

- 1. The _____, located at the middle of the cerebral hemispheres, governs emotion and has roles in memory.
- 2. It is distantly related to _____ and still deals with the sense of smell, especially as it relates to memory.
- 3. Connections from the cerebral cortex pass through the limbic system allowing us to correlate organ activities with self gratifying behavior such as
 - _____ and _____.
- Read about Sperry's Split-Brain Experiments. (Page 592 11th ed.)
 - End of Chapter 34!