Biology

The nervous system is a network of cells that carries information to and from all parts of the body; **neuroscience** is the field of study that deals with the structure of the brain and components of the nervous system

Neurons and Nerves

brain is comprised of neurons and glial cells

- **glial cells:** provide physical and metabolic support to neurons; communicate with other cells; specific types have stem cell-like properties
  - **oligodendrocytes:** produce myelin in the central nervous system
  - **Schwann cells:** produce myelin in the peripheral nervous system
    - myelin insulates axons and speeds up transmission of neural message
- **neurons:** specialized cells in nervous system; send and receive messages within that system
  - have specialized components
    - **dendrites**
    - **soma**
    - **axon**
      - axon terminals/synaptic knobs
  - have an electrical charge at rest—the resting potential
    - made possible by balance between ions in and outside of the cell
    - membrane is semipermeable; inside is negatively charged as compared to outside
    - change in the electrical charge can result in an action potential; cell fires; inside becomes positive relative to outside
      - fires in an all-or-none fashion
      - cell firing is dependent on sum of excitatory and inhibitory messages received by the cell
  - are affected by neurotransmitters (see Table 2.1); chemicals that have an effect on neurons
  - are separated by a gap called the synapse; when nerve impulse reaches synaptic knobs, neurotransmitter is released into synaptic space
    - neurotransmitters (NTs) move across synapse and activate ion channel receptor sites on adjacent cells; some NTs are agonistic/excitatory, others are antagonistic/inhibitory
    - neurotransmitter action stopped by exiting synapse; neurotransmitters end back up in the releasing cell through reuptake or broken down by enzymes

Biology

The Central Nervous System

(comprised of the brain and spinal cord)

- **brain** — true core of nervous system: takes information from senses, processes it, makes decisions, sends commands to rest of body
- **spinal cord** — long bundle of neurons that carries information to and away from the brain; helps control pain response
  - spinal cord reflexes involve several different neurons (sensory neurons, interneurons, and motor neurons)
  - spinal reflexes enable fast, often lifesaving, actions that do not require conscious thought

The Peripheral Nervous System

(comprised of the nerves and neurons not contained in the brain and spinal cord; allows the brain and spinal cord to communicate with the sensory systems and to control the muscles and glands of the body; divided into somatic and autonomic nervous systems)

- **somatic nervous system** controls the voluntary muscles of the body; involves the sensory pathway (sensory neurons carrying information to spinal cord and/or brain) and the motor pathway (nerves that carry information to voluntary skeletal muscles)
- **autonomic nervous system** controls automatic functions of the body (organs, glands, involuntary muscles)
  - **sympathetic division:** "fight-or-flight" functions—reacts to stressful events and bodily arousal
  - **parasympathetic division:** "eat-drink-and-rest" functions—restores body to normal functioning after arousal and is responsible for day-to-day functioning of glands and organs

- **glands** are organs in the body that secrete chemicals; some affect functioning of the body but not behavior; others have widespread influence on the body and behavior

Distant Connections: The Endocrine Glands

- **endocrine glands** secrete chemicals called *hormones* into bloodstream; affect behavior and emotions by influencing the activity of the brain and by controlling muscles and organs such as the heart, pancreas, and sex organs
  - **pituitary gland**
  - **pineal gland**
  - **thyroid gland**
  - **pancreas**
  - **gonads**
  - **adrenal glands**

Biology

- **older methods**
  - often relied on dissection techniques after death
  - unable to directly observe function
- **lesioning studies**
  - study animals or humans with brain damage; damage may by accident, injury, or in animals, deliberate
  - brain areas can be studied according to the location of lesions (injured or destroyed areas) or through electrical stimulation (invasive or noninvasive)

Looking Inside the Living Brain

(methods for studying the structures and/or activity of the living brain)

- **mapping function**
  - **the electroencephalogram (EEG)**
    - has good temporal but relatively poor spatial resolution; records the electrical activity of the brain through the use of scalp electrodes; both spontaneous activity and event-related potentials (ERP) can be studied
    - activity can be classified according to frequency and morphology; traditional bands include delta, theta, alpha, and beta
  - **positron emission tomography (PET)** — used for imaging function; involves injection of a radioactive tracer that binds to glucose, records activity of cells that use radioactive glucose
  - **functional MRI (fMRI)** — image brain function through tracking changes in blood oxygen levels; increase in oxygen levels associated with increased functioning
- **mapping structure**
  - **computed tomography (CT)** — based on X-ray technology; good for imaging brain structure, especially when there is metal in the body
  - **magnetic resonance imaging (MRI)** — superior spatial resolution for structure

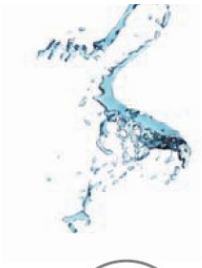
- **the hindbrain**
  - **medulla**
  - **pons**
  - **reticular formation**
  - **cerebellum**
- **structures under the cortex**
  - **thalamus**
  - **hypothalamus**
  - **hippocampus**
  - **amygdala**

From the Bottom Up: The Structures of the Brain

- **the cortex** — the outermost, wrinkled layer of the brain; comprised of left and right hemispheres, connected by corpus callosum; each hemisphere can be further divided into four lobes
  - **frontal lobes**
  - **temporal lobes**
  - **parietal lobes**
  - **occipital lobes**
- **the association areas of the cortex** — devoted to making connections between incoming sensory information and stored memories, images, and knowledge; damage to right association areas can result in spatial neglect where person fails to recognize the left side of the visual field
  - **Broca's area:** found in left frontal lobe; devoted to speech production; damage to this area can result in Broca's aphasia
  - **Wernicke's area:** found in the left temporal lobe; plays a role in understanding the meaning of words

The Structures of the Brain (continued)

- **the cerebral hemispheres** — some brain functions governed by one hemisphere more than the other; differences found due to work of various researchers (e.g., split-brain studies by both Sperry and Gazzaniga; work of Springer & Deutsch)
  - **left hemisphere** specializes in tasks that involve sequence and analysis (language, speech, handwriting, math)
  - **right hemisphere** processes information in a more global sense (perception; visualization; spatial perception; recognition of patterns, faces, and emotional expression)



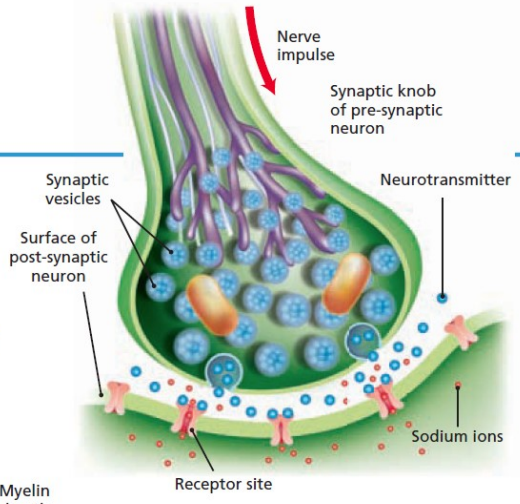
2 the biological perspective

2.1 2.2 p. 55

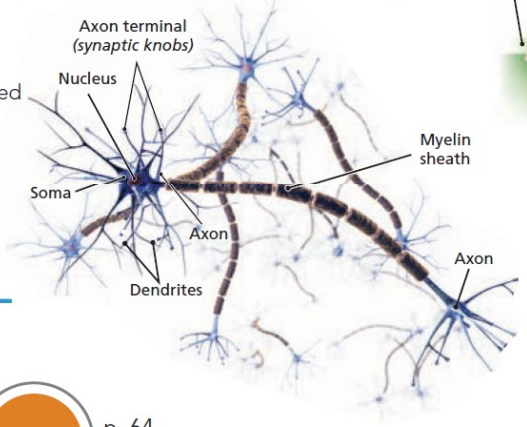
Neurons and Nerves

(the brain is comprised of glial cells and neurons)

- have an electrical charge at rest—the resting potential (see Fig. 2.3, p. 50)
- are affected by neurotransmitters (see Table 2.1, p. 53)
- are separated by a gap called the synapse



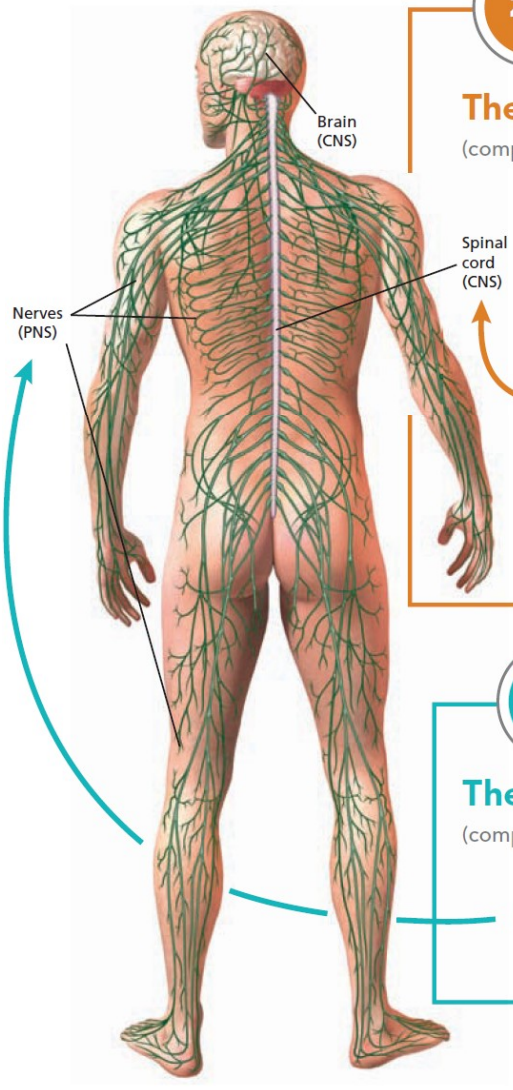
- **neurons** — specialized cells in nervous system — have specialized components
- **glial cells** — provide physical and metabolic support to neurons



2.3 p. 64

The Central Nervous System

(comprised of the brain and spinal cord)



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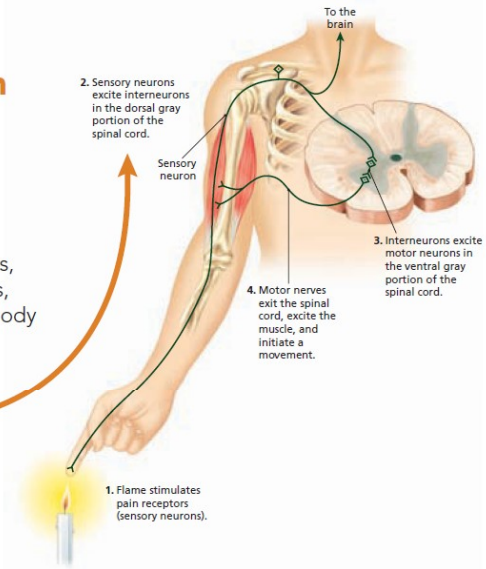

2.4 p. 64

The Peripheral Nervous System

(comprised of the nerves and neurons not contained in the brain and spinal cord)

- **somatic nervous system** — controls the voluntary muscles of the body
- **autonomic nervous system** — controls automatic functions of the body

2.5 p. 65

Distant Connections: The Endocrine Glands

- **glands** — organs in the body that secrete chemicals
- **endocrine glands** — secrete chemicals called *hormones* into bloodstream
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  - pineal gland
  - thyroid gland
  - pancreas
  - gonads
  - adrenal glands

2.6 p. 73

Looking Inside the Living Brain

(methods for studying the structures and/or activity of the living brain)

- **mapping structure**
  - computed tomography (CT)
  - magnetic resonance imaging (MRI)
- **mapping function**
  - electroencephalogram (EEG)
  - positron emission tomography (PET)
  - fMRI

2.7 2.8 p. 73 — 2.9 2.10 2.11 p. 80

- **the hindbrain**
  - medulla
  - pons
  - reticular formation
  - cerebellum
- **the cortex** — the outermost, wrinkled layer of the brain
  - frontal lobes
  - temporal lobes
  - parietal lobes
  - occipital lobes

The Structures of the Brain

- **structures under the cortex**
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  - hypothalamus
  - hippocampus
  - amygdala
- **the cerebral hemispheres** — some brain functions governed by one hemisphere more than the other