Section 2.1

How Do Our Nervous Systems Affect Thinking and Behavior?
2.1 How Do Our Nervous Systems Affect Thinking and Behavior?

- **Nervous system**
  - A network of billions of cells in the brain and the body, responsible for all aspects of what we feel, think, and do
2.1 How Do Our Nervous Systems Affect Thinking and Behavior?

- The nervous system has three basic functions:
  1. Receive sensory input from the world through vision, hearing, touch, taste, and smell
  2. Process the information in the brain by paying attention to it, perceiving it, and remembering it
  3. Respond to the information by acting on it
2.1 How Do Our Nervous Systems Affect Thinking and Behavior?

• **Central nervous system**
  – The part of the nervous system that consists of the brain and the spinal cord

• **Peripheral nervous system**
  – The part of the nervous system that enables nerves to connect the central nervous system to the muscles, organs, and glands

• See figure 2.2 next slide
Nervous system

- Central nervous system
  - Brain
  - Spinal cord

- Peripheral nervous system
  - Somatic nervous system
  - Autonomic nervous system
    - Sympathetic nervous system
    - Parasympathetic nervous system
Neurons Are the Basic Units of Our Nervous Systems

• Neurons
  – The basic units of the nervous system; cells that receive, integrate, and transmit information in the nervous system. Neurons operate through electrical impulses, communicate with other neurons through chemical signals, and form neural networks

• See figure 2.3 next slide
Neurons Are the Basic Units of Our Nervous Systems

• Structure of Neurons
  – **Dendrites**: Branchlike extensions of the neuron with receptors that detect information from other neurons
  – **Cell body**: The part of the neuron where information from thousands of other neurons is collected and integrated
  – **Axon**: The long, narrow outgrowth of a neuron that enables it to transmit information to other neurons
Neurons Are the Basic Units of Our Nervous Systems

• Structure of Neurons
  – **Synapse**: The site of communication between neurons through neurotransmitters
  – See figure 2.4 next slide
- Dendrites
- Cell body
- Axon
- Myelin sheath (covering axon)
- Direction of electrical impulse
- Terminal buttons
- Synapses

*Psychology in Your Life  Figure 2.4  
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Neurons Are the Basic Units of Our Nervous Systems

• Electrical properties of neurons
  – Parts of the neuron are covered with a membrane
  – The neuron begins in a resting state
  – **Action potential:** The neural impulse that travels along the axon and then causes the release of neurotransmitters into the synapse
Action Potentials Allow Neurons to Communicate With Each Other

• Neurons communicate with other neurons in three phases:
  1. Neurons pass signals to receiving neurons
  2. Neurons receive signals from neighboring neurons
  3. Neurons assess the incoming signals

• See figure 2.5 next slide
Transmission: Neural communication begins when there is enough stimulation in the presynaptic neuron (A) to create an action potential. The action potential travels quickly down the myelinated axon to the terminal buttons.

Reception: The action potential causes chemicals called neurotransmitters to be released from the terminal buttons at the end of the axon. The neurotransmitters cross the synapse and fit into receptors in the dendrites of the postsynaptic neuron (B).

Integration: Each neurotransmitter has either excitatory or inhibitory effects on the postsynaptic neuron (B). These effects are summed together in the cell body. If there is enough activation, it will lead to another action potential. At that point, the process begins again with Step 1 in a new neuron.
Action Potentials Allow Neurons to Communicate With Each Other

• Action potentials
  – Myelin sheath
  – To communicate, a neuron fires an action potential. A neuron cannot fire just a little bit: It either fires or it does not
Action Potentials Allow Neurons to Communicate With Each Other

• Neurotransmitters in the synapse
  – Neurons do not touch one another. Instead, they communicate chemically at the synapse
  – **Neurotransmitters**: Chemical substances that carry signals from one neuron to another
  – Receptors are specialized sites that specifically respond to certain types of neurotransmitters

• See figure 2.6 next slide
Action Potentials Allow Neurons to Communicate With Each Other

- Excitatory and inhibitory signals
  - Postsynaptic neurons can produce signals of two types: excitatory and inhibitory
Neurotransmitters Influence Our Mental Activity and Behavior

- Drugs that enhance the actions of neurotransmitters are known as agonists
- Drugs that inhibit the actions of neurotransmitters are known as antagonists
- See table 2.1 next slide
<table>
<thead>
<tr>
<th>NEUROTRANSMITTER</th>
<th>FUNCTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylcholine</td>
<td>Motor control over muscles</td>
</tr>
<tr>
<td></td>
<td>Attention, memory, learning, and sleeping</td>
</tr>
<tr>
<td>Epinephrine</td>
<td>Energy</td>
</tr>
<tr>
<td>Norepinephrine</td>
<td>Arousal and alertness</td>
</tr>
<tr>
<td>Serotonin</td>
<td>Emotional states and impulse control</td>
</tr>
<tr>
<td></td>
<td>Dreaming</td>
</tr>
<tr>
<td>Dopamine</td>
<td>Reward and motivation</td>
</tr>
<tr>
<td></td>
<td>Motor control over voluntary movement</td>
</tr>
<tr>
<td>GABA (gamma-aminobutyric acid)</td>
<td>Inhibition of action potentials</td>
</tr>
<tr>
<td></td>
<td>Anxiety reduction</td>
</tr>
<tr>
<td></td>
<td>Intoxication (through alcohol)</td>
</tr>
<tr>
<td>Glutamate</td>
<td>Enhancement of action potentials</td>
</tr>
<tr>
<td></td>
<td>Learning and memory</td>
</tr>
<tr>
<td>Endorphins</td>
<td>Pain reduction</td>
</tr>
<tr>
<td></td>
<td>Reward</td>
</tr>
</tbody>
</table>
Neurotransmitters Influence Our Mental Activity and Behavior

• Acetylcholine
  – Motor control over muscles
  – Attention, memory, learning, and sleeping

• Epinephrine
  – Energy
  – Formerly called adrenaline

• Norepinephrine
  – Arousal and alertness
Neurotransmitters Influence Our Mental Activity and Behavior

• Serotonin
  – Emotional states, impulse control, and dreaming
• Dopamine
  – Reward and motivation
  – Motor control over voluntary movement
• GABA and glutamate
  – Inhibition of action potentials
  – Anxiety reduction
  – Intoxication (through alcohol)
Neurotransmitters Influence Our Mental Activity and Behavior

• Glutamate
  – Enhancement of action potentials
  – Learning and memory

• Endorphins
  – Pain reduction
  – Reward
Section 2.2

How Do the Parts of Our Brains Function?
2.2 How Do the Parts of Our Brains Function?

- To truly understand how we see, hear, remember, interact with others, and sometimes experience psychological disorders, we need to understand the main structures of the brain.
Understanding of Our Brains Has Developed Over Time

• Early studies of the brain
• Franz Gall
  – **Phrenology**: Analysis of personality based on the location and size of skull bumps
• Paul Broca
  – **Broca’s area**: A small portion of the left frontal region of the brain; this area is crucial for producing speech
• See figures 2.9a, 2.9b, 2.10a, 2.10b next slide
Understanding of Our Brains Has Developed Over Time

• Contemporary brain research
  – Electroencephalograph: This measurement is useful because different behavioral states produce different and predictable EEG patterns
  – Functional magnetic resonance imaging: This technique measures changes in the blood’s oxygen level
Understanding of Our Brains Has Developed Over Time

• Contemporary brain research
  – Transcranial magnetic stimulation: This technique uses a very fast and powerful magnetic field to momentarily disrupt activity in a specific brain region

• See figures 2.11a, 2.11b, and 2.11c next slide
An electroencephalograph (EEG) measures the brain’s electrical activity.

Functional magnetic resonance imaging (fMRI) maps mental activity during a mental task by assessing the blood’s oxygen level in the brain.

Transcranial magnetic stimulation (TMS) momentarily disrupts brain activity in a specific brain region.
The Hindbrain and Midbrain House
Basic Programs for Our Survival

• The lower part of the brain contains structures that are essential for survival
• The spinal cord’s most important job is communication between the brain and the rest of the body
• See figure 2.12 next slide
- Forebrain (motivation, emotion, complex thought)
- Midbrain (movement)
- Hindbrain (survival functions)
- Spinal cord (brain-body communication)
The Hindbrain and Midbrain House
Basic Programs for Our Survival

• Hindbrain
  – Brainstem: Breathing, heart rate, and other survival mechanisms
  – **Cerebellum**: A hindbrain structure at the back of the brain stem; this structure is essential for coordinated movement and balance
  – Midbrain: Involved in movement of the eyes and body
  – Substantia nigra: Initiation of voluntary motor activity

• See figure 2.13 next slide
Substantia nigra (initiating voluntary movements)

Brain stem (heart rate, breathing)

Cerebellum (balance, motor coordination, motor learning)
Forebrain Subcortical Structures Control Our Motivations and Emotions

• The forebrain includes two main areas: the cerebral cortex and the five subcortical structures

  1. **Thalamus:** A subcortical forebrain structure; the gateway to the brain for almost all incoming sensory information before that information reaches the cortex

  2. **Hypothalamus:** A subcortical forebrain structure involved in regulating bodily functions. The hypothalamus also influences our basic motivated behaviors
Forebrain Subcortical Structures Control Our Motivations and Emotions

• The forebrain includes two main areas: the cerebral cortex and the five subcortical structures

3. **Hippocampus**: A subcortical forebrain structure that is associated with the formation of memories

4. **Amygdala**: A subcortical forebrain structure that serves a vital role in our learning to associate things with emotional responses and in processing emotional information
Forebrain Subcortical Structures Control Our Motivations and Emotions

• The forebrain includes two main areas: the cerebral cortex and the five subcortical structures
  5. **Basal ganglia**: Motor planning and movement, reward

• See figure 2.14 next slide
Cerebral cortex (thought, planning)

Basal ganglia (motor planning and movement, reward)

Thalamus (sensory gateway for seeing, hearing, etc.)

Hypothalamus (regulates body functions and motivates behaviors)

Amygdala (associates emotions with experiences)

Hippocampus (formation of memories)
The Cerebral Cortex of the Forebrain Processes Our Complex Mental Activity

• The outer layer of the forebrain is called the cerebral cortex
  – The cortex is divided into two halves. These halves are called the left hemisphere and the right hemisphere
  – Each cerebral hemisphere has four areas, which are called lobes: the occipital, parietal, temporal, and frontal lobes

• See figures 2.15a, 2.15b next slide
Psychology in Your Life  Figure 2.15
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The Cerebral Cortex of the Forebrain Processes Our Complex Mental Activity

- The outer layer of the forebrain is called the cerebral cortex
  - The hemispheres are connected by a structure called the corpus callosum: a massive bridge consisting of millions of axons

- See figure 2.16 next slide
Corpus callosum

Spinal cord
The Cerebral Cortex of the Forebrain Processes Our Complex Mental Activity

• Lobes of the cerebral cortex
  – **Occipital lobes**: Regions of the cerebral cortex at the back of the brain; these regions are important for vision
  – **Parietal lobes**: Regions of the cerebral cortex in front of the occipital lobes and behind the frontal lobes; these regions are important for the sense of touch and for picturing the layout of spaces in an environment
  – “**Homunculus**”
The Cerebral Cortex of the Forebrain Processes Our Complex Mental Activity

• Lobes of the cerebral cortex
  – **Temporal lobes:** Regions of the cerebral cortex below the parietal lobes and in front of the occipital lobes; these regions are important for processing auditory information and for perceiving objects and faces
The Cerebral Cortex of the Forebrain Processes Our Complex Mental Activity

• Lobes of the cerebral cortex
  – **Frontal lobes**: Regions of the cerebral cortex at the front of the brain; these regions are important for movement and complex processes (rational thought, attention, social processes, etc.).

• See figures 2.17, 2.18a, 2.18b next slide
The Cerebral Cortex of the Forebrain Processes Our Complex Mental Activity

• Prefrontal cortex
  – 30% of the brain
  – Extraordinarily large prefrontal cortex makes humans unique in the animal kingdom

• Phineas Gage
  – Studying damaged brains

• A lobotomy is a deliberate damaging of the prefrontal cortex

• See figures 2.20a, 2.20b, 2.20c, 2.21 next slide
Section 2.3

How Do Our Brains Communicate With Our Bodies?
2.3 How Do Our Brains Communicate With Our Bodies?

- The peripheral nervous system has two primary components:
  - The somatic nervous system
  - The autonomic nervous system
- Endocrine system
Our Somatic System Detects Sensory Input and Responds

• **Somatic nervous system**
  – A part of the peripheral nervous system; this part transmits sensory signals and motor signals between the central nervous system and the skin, muscles, and joints
Our Autonomic Nervous System Regulates the Body Automatically

• **Autonomic nervous system**
  – A part of the peripheral nervous system; this part transmits sensory signals and motor signals between the central nervous system and the body’s glands and internal organs
  – The autonomic nervous system has two divisions: the sympathetic nervous system and the parasympathetic nervous system

• See figure 2.22 next slide
The **sympathetic** division of the nervous system prepares the body for action.

- Eyes: Pupils dilate.
- Lungs: Respiration increases.
- Heart: Heart rate increases.
- Stomach, intestines: Digestion decreases.

The **parasympathetic** division returns the body to a resting state.

- Eyes: Pupils contract.
- Lungs: Respiration decreases.
- Heart: Heart rate decreases.
- Stomach, intestines: Digestion increases.
The Endocrine System Affects Our Behavior Through Hormones

• **Endocrine system**
  – A communication system that uses hormones to influence thoughts and actions

• **Hormones**
  – Chemical substances, released from endocrine glands, that travel through the bloodstream to targeted tissues; the tissues are later influenced by the hormones

• See figure 2.23 next slide
The Endocrine System Affects Our Behavior Through Hormones

• Hormones, sexual development, and behavior
  – Gonads: the testes in males, and the ovaries in females
  – Androgens, such as testosterone, are more prevalent in males. Estrogens, such as estradiol, are more prevalent in females
The Endocrine System Affects Our Behavior Through Hormones

• Hormones and physical growth
  – Growth hormone (GH) prompts bone, cartilage, and muscle tissue to grow and helps them regenerate after injury
Section 2.4

How Do Nature and Nurture Affect Our Brains?
2.4 How Do Nature and Nurture Affect Our Brains?

• **Genes**
  – The units of heredity, which partially determine an organism’s characteristics
Genes Affect Our Thoughts and Behavior

• Your genetic makeup is called your genotype
• Your observable physical and psychological characteristics are called your phenotype
Genes Interact With Environment to Influence Us

• The study of how genes and environment interact to influence psychological factors is known as behavioral genetics
  – **Monozygotic twins**: Identical twins; these siblings result from one zygote splitting in two, so they share the same genes
  – **Dizygotic twins**: Fraternal twins; these siblings result from two separately fertilized eggs, so they are no more similar genetically than non-twin siblings

• See figures 2.26a, 2.26b next slide
(a) Monozygotic (identical) twins
One sperm fertilizes one egg ... and the zygote splits in two.

(b) Dizygotic (fraternal) twins
Two sperm fertilize two eggs ... which become two zygotes.
Environment Changes Our Brains

• **Plasticity**
  – A property of the brain that causes it to change through experience, drugs, or injury

• **Strengthening existing connections**
  – Neurons that fire together, wire together

• **Brain reorganization**
  – Entirely new connections develop between neurons. This new growth is a major factor in recovery from brain injury
Environment Changes Our Brains

- Female and male brains
  - U.S. National Institutes of Health reported that boys’ brains are approximately 9 percent larger than girls’ brains
  - Damage from a stroke results in less language impairment in women than in men
  - The corpus callosum connects the brain’s two halves. Some researchers have found that a portion of this connective tissue is larger in women

- See figures 2.28a, 2.28b next slide