The Brain: Source of Mind and Self
Study of the brain

Neuropsychologists
Study the brain and the rest of the nervous system in order to gain a better understanding of behavior.

Includes the study of the biological foundations of consciousness, perception, memory, emotion, stress, and mental disorders.
Learning objectives

4.1 – The major parts of the nervous system and their primary functions
The central nervous system

**Brain**

**Spinal cord**

A collection of neurons and supportive tissue running from the base of the brain down the center of the back

Protected by spinal column
The withdrawal reflex
The peripheral nervous system
Handles the central nervous system’s input and output

Somatic nervous system
Autonomic nervous system
Sympathetic nervous system
Parasympathetic nervous system

Parasympathetic Division
- Constricts pupils
- Stimulates tear glands
- Strongly stimulates salivation
- Slows heartbeat
- Constricts bronchial tubes in lungs
- Activates digestion
- Inhibits glucose release by liver

Sympathetic Division
- Dilates pupils
- Weakly stimulates salivation
- Stimulates sweat glands
- Accelerates heartbeat
- Dilates bronchial tubes in lungs
- Inhibits digestion
- Increases epinephrine, norepinephrine secretion by adrenal glands
- Relaxes bladder wall
- Decreases urine volume
- Stimulates glucose release by liver
- Stimulates ejaculation in males

Contracts bladder wall
Stimulates genital erection (both sexes) and vaginal lubrication (females)
Organization of the nervous system

- **Central Nervous System**
  - Processes, interprets, stores information; issues orders to muscles, glands, organs

- **Peripheral Nervous System**
  - Transmits information to and from the CNS

- **Brain**

- **Spinal Cord**
  - Bridge between brain and peripheral nerves

- **Somatic Nervous System**
  - Controls skeletal muscles

- **Autonomic Nervous System**
  - Regulates glands, blood vessels, internal organs

- **Sympathetic Nervous System**
  - Mobilizes body for action, energy output

- **Parasympathetic Nervous System**
  - Conserves energy; maintains quiet state
What do you know?

The peripheral nervous system is responsible for reflexes.

A. True
B. False
Learning objectives

4.2 – How neurons are structured and how they communicate with one another

4.3 – The function of glial cells, the most numerous cells in the brain

4.4 – Why researchers are excited about the discovery of stem cells in the brain

4.5 – How learning and experience alter the brain’s circuits

4.6 – What happens with levels of neurotransmitters are too low or too high

4.7 – Which hormones are of special interest to psychologists, and why
Neurons

The brain’s communication specialists, transmitting information to, from, and within the central nervous system

Glial cells

Provide the neurons with nutrients, insulate them, protect the brain from toxic agents, and remove cellular debris when neurons die. They also communicate chemically with each other and with neurons.
Structure of a neuron

**Dendrites**
Receive information from other neurons and transmit toward the cell body

**Cell body**
Keeps the neuron alive and determines whether it will fire

**Axon**
Extending fiber that conducts impulses away from the cell body and transmits to other cells
Your turn

Which part of a neuron is tree-like or “branchy”?

1. Dendrites
2. The axon
3. The cell body
4. The nucleus
Your turn

Which part of a neuron is tree-like or “branchy”?  
1. Dendrites  
2. The axon  
3. The cell body  
4. The nucleus
Myelin sheath

A fatty material that covers many axons

Prevents signals in adjacent cells from interfering with each other

Speeds up the conduction of neural impulses
What do you know?

There are gaps, or nodes, along the myelin sheath which help to speed up neural communication.

A. True
B. False
Types of neurons

- Spinal cord (motor neuron)
- Thalamus
- Cerebellum
- Cortex
Neurons in the news

**Neurogenesis**

The production of new neurons from immature stem cells

**Stem cells**

Immature cells that renew themselves and have the potential to develop into mature cells
Stem-cell research

Embryonic stem cells hold the promise of medical advances, yet federal funding faces resistance from some advocates.

In recent years, scientists have successfully reprogrammed cells from adult organs, most notably skin cells, to become stem cells.

Patient-advocacy groups hope that transplanted stem cells will eventually help people recover from diseases of the brain (such as Parkinson’s) and from damage to the spinal cord and other parts of the body.
How neurons communicate

Axon terminals release neurotransmitter.

Neurotransmitter enters synapse.

Neurotransmitter binds to receptors that it fits.
Action potential

A brief change in electrical voltage that occurs between the inside and outside of an axon when a neuron is stimulated.
Neurotransmitter

Chemical released by a transmitting neuron at the synapse and capable of affecting the activity of a receiving neuron.
The plastic brain

**Plasticity**

The brain’s ability to change and adapt in response to experience—for example, by reorganizing or growing new neural connections.
Adapting to blindness

[Graph showing the relationship between percent CBF change and mean absolute error score (degrees) for sighted and blind participants.]
Major neurotransmitters

Serotonin
Dopamine
Acetylcholine (Ach)
Norepinephrine
Gamma aminobutyric acid (GABA)
Glutamate
Endorphins
What do you know?

Which neurotransmitter affects neurons involved in sleep, appetite, sensory perception, temperature regulation, pain suppression, and mood?

A. Serotonin
B. Dopamine
C. GABA
D. Glutamate
What do you know?

Which neurotransmitter affects neurons involved in voluntary movement, learning, memory, emotion, pleasure or reward, and, possibly, response to novelty?

A. Serotonin  
B. Dopamine  
C. GABA  
D. Glutamate
What do you know?

Which neurotransmitter is the major excitatory neurotransmitter in the brain, and it is released by about 90 percent of the brain’s neurons?

A. Serotonin  
B. Dopamine  
C. GABA  
D. Glutamate
What do you know?

Which neurotransmitter is the major inhibitory neurotransmitter in the brain?

A. Serotonin
B. Dopamine
C. GABA
D. Glutamate
The endocrine system

Endocrine glands release hormones into the bloodstream...

...Hormones regulate growth, metabolism, sexual development and behavior, and other functions.
The endocrine system

- **Pineal gland** secretes melatonin, which helps regulate sleep-wake cycles.
- **Pituitary gland**, controlled by the hypothalamus, produces a wide variety of hormones that regulate the activities of several other glands. Pituitary hormones are also involved in growth, uterine contractions during childbirth, and milk production.
- **Parathyroids** regulate calcium and phosphate levels in the body, influencing excitability.
- **Thyroid gland** secretes the hormone thyroxin, which regulates the body's metabolic rate.
- **Pancreas** regulates blood sugar levels with two hormones: insulin and glucagon.
- **Adrenal glands** consist of two glands: the adrenal cortex (the outer layer) and adrenal medulla (the inner core) secrete a variety of hormones that are involved in the body's response to stress and arousal when physically threatened.
- **Ovaries** secrete estrogen, which organizes the development of the female reproductive system, including the secondary sexual characteristics.
- **Testes** secrete testosterone, which during prenatal growth regulates the development of the male reproductive system. Testosterone levels are also linked to sexual interest and sexual behavior in adults.
Hormones

**Melatonin**
Regulates daily biological rhythms

**Adrenal hormones**
Involved in emotions and stress
Cortisol, epinephrine, and norepinephrine

**Sex hormones**
Regulate development and functioning of reproductive organs
Androgens, estrogens, and progesterone
Which is correct?

Which type of nervous-system chemical enables neurons to excite or inhibit each other?

A. Neurotransmitters
B. Endorphins
C. Hormones
Which is correct?

Which type of nervous-system chemical affects functioning of target organs and tissues?

A. Neurotransmitters
B. Endorphins
C. Hormones
Learning objectives

4.8 – The techniques researchers use for understanding the workings of the brain

4.9 – The limitations of brain scans as a way of understanding the brain
Mapping the brain

Lesioning
Involves damaging and removing sections of brain in animals, then observing their effects
Electroencephalogram

A recording of neural activity detected by electrodes
Transcranial magnetic stimulation (TMS)

Involves delivering an electrical current through a wire coil on a person’s head

Can be used to
- Produce motor responses
- Temporarily inactivate an area of the brain
- Treat depression
Learning objectives

4.10 – The major parts of the brain and some of their major functions

4.11 – Why it is a good thing that the outer covering of the human brain is so wrinkled

4.12 – How a bizarre nineteenth-century accident illuminated the role of the frontal lobes
The brain stem

**Pons**
Involved in sleeping, waking, and dreaming

**Medulla**
Responsible for certain automatic functions such as breathing and heart rate

**Reticular activating system**
Arouses cortex and screens incoming information
What do you know?

The part of the brain that is involved in sleeping, waking, and dreaming is called the:

A. Pons
B. Medulla
C. Reticular formation
The cerebellum

Regulates movement and balance

Involved in remembering simple skills and acquired reflexes

Plays a part in
Analyzing sensory information
Solving problems
Understanding words
The thalamus

Relays sensory messages to the cerebral cortex

Includes all sensory messages except those from olfactory bulb
Hypothalamus and pituitary gland

Involved in emotions and drives vital to survival
Fear, hunger, thirst, and reproduction

Regulates autonomic nervous system

Pituitary gland
Small endocrine gland which releases hormones and regulates other endocrine glands
The amygdala

**Responsible for**
- Arousal
- Regulation of emotion
- Initial emotional response to sensory information

**Plays important role in**
- Mediating anxiety and depression
- Emotional memory
The hippocampus

**Responsible for**
- Storage of new information in memory
- Comparing sensory information with what the brain expects about the world
- Enabling us to form spatial memories for navigating the environment
What do you know?

The part of the brain responsible for the regulation of emotion is called the:

A. Hypothalamus
B. Amygdala
C. Hippocampus
The cerebrum

Largest brain structure

Two cerebral hemispheres connected by the *corpus callosum*

In charge of most sensory, motor, and cognitive processes

Surrounded by cerebral cortex, a collection of several thin layers of cells (gray matter)
Lobes of the cerebral cortex

Occipital lobes (visual cortex)

Parietal lobes (somatosensory cortex)

Temporal lobes
Memory, perception, emotion, and auditory cortex
Left lobe: Wernicke’s area

Frontal lobes
Emotion, planning, creative thinking, and motor cortex
Left lobe: Broca’s area
Lobes of the cerebral cortex
Your turn

Jenny bumps her head and is suddenly unable to see, although the doctor says there is nothing wrong with her eyes. Which part of her brain did Jenny damage?

1. The amygdala
2. The hippocampus
3. The occipital lobe of the cerebral cortex
4. The parietal lobe of the cerebral cortex
Your turn

Jenny bumps her head and is suddenly unable to see, although the doctor says there is nothing wrong with her eyes? Which part of her brain did Jenny damage?

1. The amygdala
2. The hippocampus
3. **The occipital lobe of the cerebral cortex**
4. The parietal lobe of the cerebral cortex
Phineas Gage

Gage was a railroad construction foreman.

An 1848 explosion forced a steel tamping rod through his head.

Others said he was "no longer Gage".
What do you know?

Phineas Gage’s brain injury was located in his:

A. Amygdala
B. Visual cortex
C. Prefrontal cortex
Learning objectives

4.13 – What would happen if the two cerebral hemispheres could not communicate with each other

4.14 – Why researchers often refer to the left hemisphere as “dominant”

4.15 – Why “left-brainedness” and “right-brainedness” are often exaggerations
The corpus callosum

Millions of myelinated axons connecting the brain’s hemispheres

Provides a pathway for communication

If surgically severed to treat epilepsy, hemispheres cannot communicate directly.
Split-brain experiment

(a) "Look at the center of the slide."

(b) "Point to the person you saw."

(c) Left hemisphere and Right hemisphere
Split-brain experiment

Patients were presented information to one or the other side of their brains.

Patients identified verbally the pictures to the right (e.g., boy).

When patients were asked to point to the face seen, the patients pointed to the left picture.
What do you think?

The left hemisphere of the brain is dominant and exerts control over the right hemisphere.

A. True
B. False
Allies or opposites?

Research on split-brain patients shows us. . .

Nearly all right-handed and the majority of left-handed individuals process language mainly in the left hemisphere.

Many researchers believe in left-hemisphere dominance.

Others insist right-hemisphere is important for spatial visual problem solving, comprehending non-verbal sounds, and some language abilities.
Learning objectives

4.16 – Why some brain researchers think a unified “self” is only an illusion

4.17 – Findings and fallacies about sex differences in the brain
Where is the Self?

Modern brain scientists explain the mind or soul in physical terms as a product of the cerebral cortex. Mind is a series of independent brain parts dealing with different aspects of thoughts (Dennett 1991). Mind is a loose confederation of mental systems all working without conscious awareness (Gazzaniga, 1998; Roser & Gazzaniga, 2004).

Frontal lobes may play a critical role.

Many still question the relationship between subjective experience and physical processes of the brain.
What do you think?

Sex differences in the brain explain why women are more intuitive and why men prefer to talk about sports.

A. True
B. False
“His” and “her” brains?

After analyzing 49 studies of sex differences in brain anatomy, researchers found small differences between the two groups and larger differences within groups.

There do appear to be sex differences in lateralization of language.
Males show left hemisphere activation only.
Females show left and right hemisphere activation.

Females have more gray matter.
What do differences mean for behavior?

Supposed differences are stereotypes.

Brain difference does not necessarily explain behavior or performance.

Sex differences in the brain could be the result rather than the cause of behavioral differences.