Chapter 3
Biological Bases of Behavior

I. Biological Psychology and Neurotransmission
II. The Nervous and Endocrine Systems
III. Studying the Brain, and Other Structures
IV. The Cerebral Cortex
V. Brain Hemisphere Organization and the Biology of Consciousness
VI. Behavior Genetics: Predicting Individual Differences
VII. Evolutionary Psychology: Understanding Human Nature
I. Biological Psychology and Neurotransmission

Objectives:

- Explain why psychologists are concerned with human biology.
- Describe the parts of a neuron, and explain how its impulses are generated.
- Describe how nerve cells communicate with other nerve cells.
- Describe how neurotransmitters influence behavior, and explain how drugs and other chemicals affect neurotransmission.
Everything psychological is simultaneously biological!

Why are psychologists interested in studying the biology of the brain?!

- Our every idea, mood or urge is a biological happening!
- ____________________________
- ____________________________ study the links between biological activity and psychological events.

_History: Brain and the mind has come a long way. Remember Plato and Aristotle?_
Phrenology (study of the surface of the skull)

Invented by __________________________ in the early 1800’s.

- A theory that claimed that bumps on the skull could reveal our mental abilities and character traits.

- Theory was disproved.

- However, *phrenology* focused the attention that various regions of the brain have particular, specific functions.
Appreciate the Neuron!!!

Neuron: ___________________________

- the basic building block of the nervous system
- our bodies information system is built from 100 billion of interconnected cells called neurons.
- many different types of neurons, but all are composed in the same way.

Glial Cells: __________________________________________
Parts of a Neuron

A. ___________________________ (Greek for tree)

- The bushy, branching extensions of a neuron that receive messages (pressure, light, sound) and conduct impulses toward the cell body.
- They ______________ information from other nerve cells and send it through the _______________ or cell body.

B. ___________________________ (cell body)

- Stimulus such as sound or pinprick make the soma excited.
- When the arousal reaches a critical level, it will fire.
Parts of a Neuron

C. ____________________ (Greek for axle)

- The extension of a neuron, (long fiber) ending in branching terminal fibers, through which messages are sent to other neurons or to muscles or glands (senders). At the end of the axon are thousands of terminal buttons.

D. ________________________ [MY-uh-lin] Sheath

- A layer of fatty cells segmentally encasing the fibers of many neurons (insulating the axons); enables vastly greater transmission speed of neural impulses. Formed by Glial cells.
- ____________________________, a disease in which the myelin sheath degenerates, which results in a slowing of communication to the muscles and loss of muscle control.
Structure of a Neuron

- **Cell body** (the cell’s life-support center)
- **Dendrites** (receive messages from other cells)
- **Axon** (passes messages away from the cell body to other neurons, muscles, or glands)
- **Myelin sheath** (covers the axon of some neurons and helps speed neural impulses)
- **Terminal branches of axon** (form junctions with other cells)
- **Neural impulse** (electrical signal traveling down the axon)
Action Potential
A neural impulse; a brief electrical charge that travels down an axon.

“I sing the body electric.” - Walt Whitman

Action Potential (General idea)
- A brief _____________________________ that travels down an axon, each tripping the next.
- Generated by the movement of positively charged ions (electrically charged atoms) in and out of channels in the axon’s membrane.
- Fluid outside cell membrane: ________________________.
- Fluid inside cell membrane: ________________________.
Action Potential

“What one neuron tells another neuron is simply how much it is excited!” -Francis Crick

A. Axons get its electrical energy from charged chemicals, called ________. In its resting state (_______________________), the axons interior (insides) consist of negative potassium ions while the fluid outside the membrane consists of positive sodium ions.

  Positive Sodium (PS)-outside/Negative Potassium (NP)-inside state: Resting Potential

B. ____________________________ - when the cell body becomes excited it fires OR triggers the action potential (a neural impulse). During an action potential, sodium gates in the neuron open and sodium ions enter the axon bringing a positive charge with them. If it has enough of a positive charge, the neuron will fire.
C. As sodium ions are being pumped in along the axon, a pump in the cell membrane (sodium/potassium pump) transports the sodium ions back to the cell when the action potential is over.

D. Momentary delay where the neuron pumps the positively charged sodium ions back outside. As the action potential continues speedily down the axon, the first section has now completely recharged.
E. Other terms used with Action Potential

- _______________: signal to send the message (accelerator)
- _______________: signal to stop the message (brake)
- Threshold: the level of stimulation required to trigger a neural impulse.

If excitatory signals exceed inhibitory signals, it triggers an AP. Increasing the level of stimulation ABOVE threshold will not increase impulses intensity. (all-or-none response)
Action Potential (step by step)

1. Neuron stimulation causes a brief change in electrical charge. If strong enough, this produces depolarization and an action potential.

2. This depolarization produces another action potential a little farther along the axon. Gates in this neighboring area now open, and more positively charged atoms rush in, while the positively charged atoms in the previous section of axon exit.

3. As the action potential continues speedily down the axon, the first section has now completely recharged.

Direction of neural impulse: toward axon terminals
How Neurons Communicate

How do nerve cells communicate with other nerve cells?

A. Terminal Buttons

B. Vesicles

The area where the axon ends, in the terminal buttons, just before the synapse. _________________________________. Inside these vesicles are thousands of chemical messengers called neurotransmitters.
How Neurons Communicate

C. ________________________ (means junction point)

- The microscopic space between the axon tip of the sending neuron and the dendrite of the receiving neuron
- Tiny gap at this junction is called the ________________________________.
- “Like elegant ladies air-kissing so as not to mess their makeup, dendrites and axons don’t quite touch.” - Poet Diane Ackerman (air kisses)

- The terminal buttons, synaptic vesicles containing neurotransmitters are spilled into the synapse. From there if a certain transmitter is the right shape, it will fit in the receptor site of a dendrite sort of like a key into a lock. Neurotransmitters that do not fit are reabsorbed or broken down in a process called reuptake.
How Neurons Communicate

D. _______________________________

- Chemical messengers that relay neural messages across the synapse.
- When released by the sending neuron,
  ________________________________, thereby influencing whether it will generate a neural impulse.
- If the message is for arm movement, the vesicles only release neurotransmitters involved in the movement circuit.
- Influences our motions and our emotions. Excess or deficiencies are linked to psychological disorders.
Neurotransmitters

- Neurotransmitters are produced **inside** the body. They can excite and inhibit neural communication.

- Drugs and other chemicals come from **outside** the body. They can have an agonistic effect or an antagonistic effect on neurotransmission.

- Excite by mimicking particular neurotransmitters or block their reuptake. (Opiates)

- Inhibit a neurotransmitter’s release or block its effect. (Botulinum toxin blocks ACh release and causes paralysis)
# Examples of Neurotransmitters

## Table 2.1

<table>
<thead>
<tr>
<th>Neurotransmitter</th>
<th>Function</th>
<th>Examples of Malfunctions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylcholine (ACh)</td>
<td>Enables muscle action, learning, and memory</td>
<td>Undersupply, as ACh-producing neurons deteriorate, marks Alzheimer’s disease</td>
</tr>
<tr>
<td>Dopamine</td>
<td>Influences movement, learning, attention, and emotion</td>
<td>Excess dopamine receptor activity linked to schizophrenia; starved of dopamine, the brain produces the tremors and decreased mobility of Parkinson’s disease</td>
</tr>
<tr>
<td>Serotonin</td>
<td>Affects mood, hunger, sleep, and arousal</td>
<td>Undersupply linked to depression; Prozac and some other antidepressant drugs raise serotonin levels</td>
</tr>
<tr>
<td>Norepinephrine</td>
<td>Helps control alertness and arousal</td>
<td>Undersupply can depress mood</td>
</tr>
<tr>
<td>GABA (gamma-aminobutyric acid)</td>
<td>A major inhibitory neurotransmitter</td>
<td>Undersupply linked to seizures, tremors, and insomnia</td>
</tr>
<tr>
<td>Glutamate</td>
<td>A major excitatory neurotransmitter; involved in memory</td>
<td>Oversupply can overstimulate brain, producing migraines or seizures (which is why some people avoid MSG, monosodium glutamate, in food)</td>
</tr>
</tbody>
</table>
Examples of Neurotransmitters

**Acetylcholine [ah-seat-el-KO-leen] (ACh)**
- Most common, best understood
- A neurotransmitter that, among its functions, triggers muscle contraction
- Involved in memory (a shortage of causes Alzheimer’s Disease)

**Endorphins [en-DOR-fins]**
- “morphine within” bodies natural painkiller
- Natural, opiate like neurotransmitters
- Linked to pain control and to pleasure

**Dopamine**
- Influences movement, learning, attention, and emotion.
- Shortage causes Parkinson’s disease
- Excessive dopamine linked with schizophrenia

**Seratonin**
- Affects mood, hunger, sleep and arousal
- Linked to depression
Neural Communication

1. Electrical impulses (action potentials) travel down a neuron's axon until reaching a tiny junction known as a synapse.

2. When an action potential reaches an axon terminal, it stimulates the release of neurotransmitter molecules. These molecules cross the synaptic gap and bind to receptor sites on the receiving neuron. This allows electrically charged atoms to enter the receiving neuron and excite or inhibit a new action potential.

3. The sending neuron normally reabsorbs excess neurotransmitter molecules, a process called reuptake.
Neural Communication

Serotonin Pathways

Dopamine Pathways
Types of Neurons: Three Types

A. _______________________ neuron (afferent neuron)

- Nerve cell that carries incoming messages from sense receptors TOWARDS the brain and spinal cord (CNS).

B. _______________________

- Nerve cell that relays messages between nerve cells (sensory and motor), especially in the brain and spinal cord.

C. _________________________ neuron (efferent neuron)- nerve cell that carries messages away

- Nerve cell that carries outgoing messages AWAY from the CNS toward the muscle and glands.

Note: A prime example of all three types of neurons are reflexes.
Reflex:

- A simple, automatic, inborn response to a sensory stimulus.
Sensory Neuron

Interneuron

Motor Neuron

Receptors (thermal and pain in the skin)

Effector (biceps brachii muscle)
II. The Nervous and Endocrine Systems
II. The Nervous and Endocrine Systems

A. Nervous System

- The body’s speedy, electrochemical communication system consists of all the nerve cells of the peripheral and central nervous systems.

______________ (CNS)

- The brain and spinal cord
- Connects Peripheral Nervous System to the brain
- Controls reflexes
The sensory and motor neurons that connect the central nervous system (CNS) to the rest of the body. Consists of autonomic nervous system and somatic nervous system.

1. ____________________________- controls the glands and muscles of our internal organs. For example: regulates heartbeat, breathing, and digestion. The ANS is a dual system.
   ✦ *Sympathetic Nervous System*- main job is to **arouse** and excite. Accelerates blood pressure and raises your heartbeat.
   ✦ *Parasympathetic Nervous System*- main job is to **calm** you down. Decreases heart rate, lowers blood sugar, etc…

2. ____________________________- Communicates with sense organs and voluntary muscles.
The Nervous System

Nervous system

Peripheral

Autonomic (controls self-regulated action of internal organs and glands)
  - Sympathetic (arousing)
  - Parasympathetic (calming)

Central (brain and spinal cord)

Somatic or Skeletal (controls voluntary movements of skeletal muscles)
The Nervous System

- CENTRAL NERVOUS SYSTEM
  - Brain

- SYMPATHETIC
  - Dilates pupil
  - Stimulates salivation (weakly)
  - Relaxes bronchi
  - Accelerates heartbeat (strengthens contractions)
  - Inhibits activity
  - Stimulates glucose release by liver
  - Secretion of adrenaline, noradrenaline
  - Relaxes bladder
  - Stimulates ejaculation in male

- Salivary glands
- Lungs
- Heart
- Stomach
- Pancreas
- Liver
- Adrenal gland
- Kidney
The Nervous System

- **Central Nervous System**
  - Brain
  - Spinal cord

- **Parasympathetic**
  -Contracts pupil
  -Stimulates salivation (strongly)
  -Constricts bronchi
  -Slows heartbeat
  -Stimulates activity
  -Stimulates gallbladder
  -Contracts bladder
  -Stimulates erection of sex organs

- **Gallbladder**
II. The Nervous and Endocrine Systems

B. Endocrine System

- Produces melatonin that helps regulate circadian rhythms.
- Associated with Season Affective Disorder.

- Called the “master gland” because it secretes many different hormones, some of which affect other glands.
- Controlled by the Hypothalamus
- E.G. HGH, Thyroid, Egg and Sperm production

- Stimulates metabolic activities
Maintains calcium ion levels in the blood for normal neuron functioning.

Produces cortisol (a stress hormone)
Secretes adrenaline and noradrenaline which prepares the body for the flight or fight response.

Regulates blood sugar (glucose) that fuels all behavioral processes
III. Studying The Brain and Other Structures

1. Accidents (case study)

- In 1848, a railroad worker named _______________________ was involved in an accident that damaged the front part of his brain. Gage’s doctor took detailed notes documenting the brain damage and about Gage’s behavior & personality changes.

- Before the accident, Gage was a nice guy, after the accident he was highly emotional and impulsive.
2. Lesions

- A brain lesion is a naturally or experimentally caused destruction of brain tissue
  - Frontal lobotomies
3. Electroencephalogram (EEG)

- An amplified recording of the waves of electrical activity that sweep across the brain’s surface.
- These waves are measured by electrodes placed on the scalp.
4. Newer neuroimaging techniques

- CT (computed tomography) Scan
  
  ________________________________ taken from different angles and combined by computer into a composite representation of a slice through the body; also called CAT scan

  It creates a 3-D image of brain’s structure. Does not show function or activity.

- PET (positron emission tomography) Scan
  
  A visual display of brain activity that detects where a ________________________________ goes while the brain performs a given task.

- MRI (magnetic resonance imaging)
  
  A technique that uses magnetic fields and radio waves to produce computer-generated images that distinguish among different types of soft tissue; allows us to __________________ within the brain, __________________.
PET Scan

Detectors around the person’s head picks up release of gamma rays from sugar, which has concentrated in active brain areas.
MRI Scan

MRI scan of an healthy individual (left) and person with schizophrenia (right) Enlarged ventricle, fluid filled brain region
III. Studying The Brain and Other Structures

Three regions of the brain:

A. ___________________
- Consists of structures in top part of the spinal cord, most of the brain stem.

B. ___________________
- Contains the upper part of the brain stem.

C. ___________________
- Most recently evolved section.
The Hindbrain

Hindbrain aka Brainstem

- The oldest part and central core of the brain, beginning where the spinal cord swells as it enters the skull.
- Responsible for automatic survival functions.

A. _______________________

- Base of the brainstem, attaches to spinal cord.
- Controls ________________________________.

B. _______________________

- Controls ________________.
- Could play an important role in dreaming
The Hindbrain

C. ______________________________________

- A nerve network in the brainstem that plays an important role in controlling ________________________________.
- Involved in controlling muscle reflexes, breathing & perception.

D. _______________________

- The “little brain” attached to the rear of the brainstem.
- Nonverbal learning and memory.
- It helps ____________________________________________________________.
The Midbrain

A segment of the brainstem located between the hindbrain & forebrain, containing part of the reticular formation-regulating sleep & arousal. Located in the middle of our brain.

Smallest region of brain that acts as a relay station for auditory and visual information.
The Forebrain

Forebrain

- Considered as the highest region of the brain because it essentially differentiates us humans from the rest in the animal kingdom.
- Involved in processing complex information.

A. ____________________________

- The brain’s ________________________, located on top of the brainstem.
- It directs messages to the sensory receiving areas in the cortex and transmits replies to the cerebellum and medulla.

B. ____________________________

- A doughnut-shaped system of neural structures at the border of the brainstem and cerebral hemispheres.
- Associated with ________________________________ and drives such as those for food and sex, regulates emotion, memory & motivation.
- Includes the hippocampus, amygdala, and hypothalamus.
The Forebrain

B. Limbic System

1. ____________________: Two almond shaped neural clusters that are linked to emotion, aggression, and fear.
2. ____________________: Structure lying below (hypo) the thalamus; directs several maintenance activities (eating, drinking, body temp). Helps govern the endocrine system "master", it controls the pituitary gland. Linked to emotion and reward.
3. ____________________: Involved in the formation of new memories. Sending memories out to the appropriate part of the cerebral hemisphere for long-term storage and retrieving them when necessary.

C. Cerebral Cortex

- The outer most layer of the brain. In charge of ______________________________.
- Divided into two hemispheres; Left and Right.
IV. The Cerebral Cortex

- Outer most layer of the brain. Does higher order thinking.

fMRI scan shows the visual cortex activated as the subject looks at faces.
Cerebral Cortex AKA Neocortex AKA Cerebrum AKA Human Brain

- Outer most layer of the brain. Does higher order thinking.

Cerebrum- the large mass of the forebrain, which contains two hemispheres.
Cerebral Cortex- outer most layer of the brain. Does higher order thinking.

1. __________________________- involved in movement and in thinking.
   E.G. The case of Phineas Gage
   Prefrontal Cortex- complex cognitive behaviors (judgement, planning, and personality)
   Motor Cortex- controls voluntary movement.

2. __________________________- receives sensory input for touch and body position.
   Sensory Cortex- registers and processes body touch and movement sensations.

3. __________________________- interprets visual information.

4. __________________________- controls speaking, language, and hearing.
Output: Motor cortex
(Left-hemisphere section controls the body’s right side)

Input: Sensory cortex
(Left-hemisphere section receives input from the body’s right side)
Language and the Brain

- Outer most layer of the brain. Does higher order thinking.

_______________- an impaired use of language.
_______________- where word is pronounced.

1. _________________ area- an area in the left temporal lobe that controls language comprehension and expression.
2. _________________ area- an area of the frontal lobe, usually in the left hemisphere, that directs the muscle movements involved in speech.
The Brain’s Plasticity

- Brains ability to change, especially during childhood, by reorganizing after damage or by building new pathways based in experience.

* If one hemisphere is damaged early in life, the other will pick up many of its functions.

* This plasticity does diminish later in life.

* EX: video of little girl
V. Brain Hemisphere Organization and the Biology of Consciousness

Split Brain: Condition resulting from surgery that isolates the brain’s two hemispheres by cutting the fibers connecting them.
Split Brain Research (Sperry and Gazzaniga):

a. Procedure used to treat epilepsy in which the *corpus callosum* is cut.

Corpus Callosum: Large band of neural fibers connecting the two brain hemispheres and carrying messages between them. Allows information to quickly transmit from one hemisphere to the other.

b. Important to understand that the left side of the body controls the right and vice-versa.

c. Conclusions:
   - Left Hemisphere: Speech, Language, Logic, Writing
   - Right Hemisphere: Spatial Reasoning, Visual Perception, and Emotions
Apparatus for Studying Split Brain Patients
Biology of Consciousness

Consciousness: Our awareness of ourselves and our environment.

*Evolutionary psychologists suggest that consciousness promotes our survival.

*Dual Processing: Two-track mind. The principle that info is often simultaneously processed on sep conscious and unconscious tracks.

- Conscious of our surroundings
- Unconscious information processing also occurring
  - EX: It’s a hummingbird!
VI. Behavior Genetics

- The study of the relative power and limits of genetic and environmental influences on behavior.

A. Cell: The basic structural unit of living things.

B. Nucleus: The inner area of a cell that houses chromosomes and genes.

C. Chromosomes: Threadlike structures made up of DNA molecules that make up the genes. 46 (23 pairs) from the mother, (23 pairs) from the father.

D. Genes: The units of heredity that make up the chromosomes.
E. DNA: a complex molecule containing the genetic information that makes up chromosomes.

F. Genome: The complete instructions for making an organism, consisting of all the genetic material in that organism’s chromosomes.

G. Genotype: Refers to the set of genes we’re born with.

H. Phenotype: Set of traits that are “expressed”- our observable characteristics (influenced by genes-genotype.) Results from interactions between your genes and the environment.
Ex: An outward appearance of an organism; such as hair or eye color.
I. Determining Gender

- Males- X and Y Chromosome
- Females- X and X Chromosome
- The male contributes an X chromosome, the baby is female, the male contributes a Y chromosome, the baby is male.
J. Chromosomal Abnormalities

- Turner’s Syndrome- females with only one X sex chromosome, typically short with a webbed neck, lack ovaries, and fail to develop secondary sex characteristics.

- Klinefelter’s Syndrome- males with XXY Sex chromosomes, develop breast tissue and tend to be passive.

- Down Syndrome- usually three copies of chromosome 21 in their cells, leads to mental retardation, a defect in physical features, and poor muscle tone and coordination.
K. Twin and Adoption Studies

- Identical twins (monozygotic): 1 zygote that split during early pregnancy.

- Fraternal twins (dizygotic): come from 2 different eggs produced during the same menstrual cycle that were fertilized at the same time.
VII. Evolutionary Psychology

Understanding human nature

Evolutionary Psychology: The study of the evolution of behavior and the mind, using principles of natural selection.

- Evolutionary psychologists study how natural selection has shaped our universal behavior tendencies.
- Explore the genetic and environmental roots of human differences.
- Looks at Darwin’s principle of natural selection to understand the roots of behavior and mental processes.
VII. Evolutionary Psychology

Understanding human nature

Areas of Interest connected to Evolutionary Psychology:

- Gender differences in sexuality:
  - “Males are more likely than females to initiate sexual activity.” (Segall and colleagues, 1990) cross cultural study
  - Men have lower thresholds for perceiving warm responses causing them to think a cordial girl is displaying sexual interest. (Abbey, 1987; Johnson et al., 1991)

- Natural selection and Mating preferences
  - Male preferences in mate selection vs. Female preferences in mate selection
  - Men found women equally attractive whether in Ford or Bentley car. (Dunn & Searle, 2010)
  - Females found men more attractive behind the wheel of a luxury car. (Dunn & Searle, 2010)
Interference Effect (Stroop Effect or Strooping)- in the stroop effect, you have to say the color of the word, not the word.
When you look at a set of words, you see its meaning and the color it is written in. If those two pieces of evidence are in conflict then you have to make a choice. Because experience has taught you that word meaning is more important than the color a word is written in, interference occurs when you try to pay attention only to the color.