Biopsychology

The Nervous System

- the nervous system is divided into two parts
  - the central nervous system refers to the brain and the spinal cord
  - the peripheral nervous system refers to the neural pathways going to and coming from the central nervous system; these are all the other nerves in the body not encased in bone
- sensory (or afferent) neurons relay information from the sense receptors to the spinal cord and brain
- motor (or efferent) neurons relay information from the central nervous system to the muscles

- reflex arcs allow behavior responses without processing by the higher-order levels of the brain—these are essential for survival and allow for rapid motor responses
- for example, stimulating the correct area of the kneecap will cause the leg the jerk or removing the hand when it touches something very hot

- the peripheral nervous system (PNS) can be divided into two systems
  - the somatic nervous system is in charge of voluntary skeletal muscles that allow us to move
  - the autonomic nervous system is in charge of predominantly involuntary smooth and cardiac muscle activity
    - this includes the heart, lungs, internal organs and glands
- the autonomic nervous system can be divided into two systems
  - the parasympathetic nervous system is in charge of the body at rest (slowing down biological processes) and in digestion of food
  - the sympathetic nervous system kicks in during times of stress, fear or rage—it controls our “fight or flight” behaviors and accelerates functions like heart rate and blood pressure

The Neuron Diagram p. 55

The Neuron

- the dendrites receive incoming information
- the cell body (sometimes called the soma) which contains the nucleus, and is the living part of the neuron
- the axon is the long fiber over which outgoing messages travel
- the terminal buttons (or end buttons, terminal branches of the axon or synaptic knobs) are the transmitters, sending information on to the next neuron
• the space between neurons is the **synaptic gap**
• the **synapse** is made up of the axon terminal buttons of one neuron, the synaptic gap, and the dendrites of the next neuron

**Neurotransmitters**
• there are several **neurotransmitters** or chemicals released by the synaptic vesicles that travel across the synaptic gap and affect adjacent neurons
• these can be
  – **inhibitory** which inhibits the next cell from firing
  – **excitatory** which excites the next cell into firing
• major neurotransmitters:
  – **dopamine** which inhibitory neurotransmitter involved in motor movement and alertness
    • lack of dopamine is linked to Parkinson’s Disease
    • excessive dopamine levels are linked to schizophrenia
  – **serotonin** which is a neurotransmitter involved in mood control
    • obsessive-compulsive disorder (OCD) is linked to excessive serotonin
    • depression is linked to clinical depression
• **acetylcholine** is involved in motor movement
  – lack of acetylcholine is linked to Alzheimer’s Disease
• **norepinephrine** which is involved in arousal, wakefulness, leaning, memory, depression and mania
• **endorphins** are associated with pain control and involved in addictions

**Reuptake Mechanisms**
• antidepressants work by increasing the availability of norepinephrine or serotonin
  – these neurotransmitters elevate mood and arousal
• **Prozac** (Zoloft and Paxil) partially blocks the reabsorption and removal of serotonin from synapses
  – because they slow the vacuuming serotonin in the synapse they are called **selective serotonin reuptake inhibitors** (SSRIs)
• other dual-action antidepressants work by blocking the reabsorption or breakdown of both norepinephrine and serotonin
  – dual action drugs have more potential side effects—dry mouth, weight gain, hypertension, dizziness
  – they are administered via a patch, bypassing the intestines and liver, reducing the side effects

**Old Methods of Brain Study**
• there are several methods of brain study which have been conducted in the past, with new, computerized studies rendering more accurate information
• old methods of brain study include:
  – **direct stimulation** (or microelectrode method): part of the brain is stimulated to see its effect
  – **evoked potential**: part of the brain is monitored to see if external stimuli change its functioning
  – **lesioning** (or **ablation**): severing or cutting parts of the brain
  – **EEG**: measures brain wave activity—frequently used in dream research

**New Methods of Brain Study**
• new methods of brain study include:
  – **MRI**: magnetic fields from radio waves to look at density and brain material
  – **PET**: positron emission tomography, uses radioactive material, good for metabolic activity of the brain; measures how much the brain is using of certain chemicals (e.g. glucose)
  – **CT-SCAN**: uses X-rays to look at soft tissue
  – **fMRI**: functional MRIs combine elements of PET and MRI scans; looks for blood flow and can tie brain structures to cognitive brain activities
  – **SPECT**: single proton emission computerized axial tomography, traces blood flow in the brain
  – **SQUID**: super conducting quantum interference device, senses tiny changes in the brain’s magnetic fields and represents them in 3-D, deals with electrical impulses from neural firing
The Three Brains

- the brain can be divided into three brains--forebrain, midbrain and hindbrain
- the forebrain includes:
  - hypothalamus: controls hunger, thirst, sexual behavior, body temperature and motivation
  - thalamus: the relay center for sense receptors
  - cerebral cortex: higher-order thinking and language
  - corpus callosum: band of fibers that connects the two hemispheres
- the midbrain:
  - integrates some sensory information and muscle movements
  - includes the reticular formation (not on diagram): the alert system of the brain
- the hindbrain includes:
  - cerebellum: controls balance, fine movement and muscle tone
  - pons: the sleep-wake cycle
  - medulla: controls breathing, heart rate and blood pressure
- the brainstem--the midbrain and hindbrain combined that are typically considered the most primitive part of the brain
- phylogeny--the study of the evolutionary development of humans

The Limbic System

- also included is the limbic system which includes:
  - the amygdala is responsible for some aspects of memory as well as aggressive and defensive behaviors
  - the hippocampus is also responsible for memory and preservation
  - the septum regulates aggression, pleasure and sexual arousal
removal of the hippocampus has resulted in significant problems with memory
  – *anterograde amnesia*—this is the inability to develop new memories while older memories remain intact
  – *retrograde amnesia*—memory loss just prior to a traumatic event or brain injury

*The Limbic System Diagram p. 72*

*The Four Lobes Diagram p. 76*
The Four Lobes
• the brain can also be divided into four lobes:
  – the frontal lobe is responsible for psychomotor behavior; it is responsible for initiative, planning, abstraction, expression, expressive speech, and aggression
    • Broca's brain, involved in expressive speech, is in the left frontal lobe
  – the temporal lobe processes hearing and receptive speech;
    • Wernicke's area, involved in receptive speech, is in the left temporal lobe
  – the occipital lobe (sometimes called the striate cortex) is responsible for visual information
  – the parietal lobe processes some speech and somatosensory information from sense receptors in the skin, muscles and joints

The Two Hemispheres
• the brain can also be divided into two hemispheres with predominant functions in each hemisphere
• hemispheres are joined by the corpus callosum
• they are
  – asymmetrical (not the same size or same purposes)
  – predominantly contralateral (processes cross to opposite side of the body)
  – some aspects of behavior are ipsilateral (same side of the body)
  – set up so information crosses at the corpus callosum
• the left hemisphere is
  – verbal
  – mathematical
  – analytical
  – concrete
  – considers extremes of things
  – is non-emotional
  – deals with the present
• the right hemisphere is
  – pictoral
  – abstract
  – preverbal
  – sees the big picture
  – has spatial ability
  – creative
  – musical
  – emotional
  – deals with the past and future

The Endocrine System
• the endocrine system in the body is a communication system that releases hormones through the bloodstream to various parts of the body

• the thyroid gland is responsible for metabolic activity and is located in the front of the neck; it releases the hormone thyroxin
• the pituitary gland works in conjunction with the hypothalamus and is located on the underside of the brain; it regulates the activities of the endocrine system and releases the largest number of the body's hormones
• the adrenal glands release adrenaline or epinephrine in response to fear or other emotionally-charged situations
• the *sex glands* work in conjunction with the pituitary gland
  – the *testes* are the male sex glands
  • secondary sex traits in males are governed by *androgens*
  – the *ovaries* are the female sex glands
  • secondary sex traits in females are governed by *estrogen* and *progesterone*

**Behavioral Genetics**

• *traits* are defined as behavioral and physical characteristics
• *genes* are the biological material that cause traits to be passed on from one generation to the next
  – *recessive genes* are less likely to be passed on
  – *dominant genes* are more likely to be passed on
• at conception, both the male and female contribute sets of 23 chromosomes each (46 total)
  – while the mother always passes on an X chromosome to determine the gender of the fetus; if the father passes on an X chromosome the fetus is genetically female and if he passes on a Y chromosome the fetus is genetically male
• genetic disorders can also occur during development:
  – *Down's syndrome*, which is linked to mental retardation, is caused by an extra 21st chromosome
  – *Huntington's Chorea*, which typically occurs after the age of 40, is a debilitating genetic disorder that involves involuntary movements and progressive dementia
  – *Turner's syndrome*--only a single X chromosome on the 23rd pair, results in shortness, webbed necks and differences in physical sexual development
  – *Klinefelter's syndrome*--an extra X chromosome resulting in an XXY pattern, linked to minimal sexual development and personality traits like introversion

• genetics encompasses one side of the ongoing *nature versus nurture* debate, with environmental arguments being offered by the opposing side

**Evolutionary Psychology**

• *evolutionary psychology* is the study of the evolution of behavior and the mind, using principles of natural selection
• *natural selection* is the principle that, among the range of inherited trait variations, those that lead to increased reproduction and survival will most likely be passed on to succeed generations
• Charles Darwin’s *On the Origin of the Species* became the basic text for evolutionary psychologists
• gender refers to the biologically and socially influenced characteristics by which we define male and female
• human sexual behavior is interpreted in terms of its survival value—the tendency for behaviors to be selected if they increase the likelihood of sending one’s genes into the future

• criticisms of evolutionary psychology include:
  – psychologists start with an effect and work backward to an explanation
  – cultural expectations and socialization are often underestimated
  – the perspective absolves people from taking ethical or moral responsibility for behaviors
• our shared capacity for culture is a common thread running throughout the human species

• men more than women behave aggressively; this gender gap appears in many cultures at various ages
• men are more socially-dominant in most societies; men tend to occupy more leadership positions and their leadership style is more directive
• our biology provides certain abilities and limitations; environment directs us toward specific roles and rewards those behavior
• individual biological and psychological characteristics evoke reactions in those around us, which influences our behavior
**AP Check**

**AP students in psychology should be able to do the following:**

- Identify basic processes and systems in the biological bases of behavior, including *parts of the neuron* and *the process of transmission of a signal between neurons* (pp. 55-56).
- Discuss the *influence of drugs on neurotransmitters* (pp. 59-60) (e.g. reuptake mechanisms).
- Discuss the *effect of the endocrine system on behavior*.
- Describe the nervous system and its subdivisions and functions:
  - central and peripheral nervous systems;
  - major brain regions, lobes, and cortical areas (pp. 77-80);
  - brain lateralization and hemispheric specialization.
- Recount *historic and contemporary research strategies* and technologies that support research (e.g. case studies, split-brain research, imaging techniques). (pp. 53-54, 68-70)
- Discuss psychology’s abiding interest in how *heredity, environment and evolution* (pp. 107-113) work together to shape behavior.
- Predict how *traits and behavior* can be selected for their adaptive value.
- Identify key contributors (e.g. *Paul Broca*, *Charles Darwin* (p. 113), *Michael Gazzaniga*, *Roger Sperry*, *Carl Wernicke*).
BRAIN FUNCTIONS AND BEHAVIORS

DIRECTIONS: On a separate paper, list what part of the brain influences the following behaviors.

1. An injury to this section of the brain may lead to lack of motor coordination, stumbling, and loss of muscle tone.

2. To control epilepsy doctors sometimes remove this system, which consist of the thalamus, the hypothalamus, and various other structures. What is this system?

3. This structure regulates vital functions such as heart rate, blood pressure, and respiration. What is this structure?

4. This structure is involved in maintaining balance and in controlling motor (muscle) behavior.

5. After damage to this structure an individual may go through a prolonged period of inactivity.

6. A person who has difficulty walking a straight line, speaks haltingly, and slurs words. May have had damage to what structure?

7. Almost any damage to these two structures are fatal because they control so many life-preserving functions.

8. A person who has trouble completing a finger-to-nose test has possible damage to this structure.

9. Many surgeons have disconnected the two hemispheres of the brain by removing this structure to lessen the severity of epileptic seizures, thus only affecting have of the body.

10. A pre-frontal lobotomy became a common treatment for what two main disorders in the 1940's. The operation was popularized by Dr. Walter Freeman. What disorders was this a treatment for?