Nervous System

Nervous System Functions

- Maintains homeostasis (fast)
- Provides for sensation, higher mental functioning, and emotional response
- Activates muscles and glands

Divisions of the Nervous System

- Somatic NS
  - voluntary
  - Sensory function
  - Motor function

- Autonomic NS (ANS)
  - involuntary
  - Sympathetic NS
    - motor
    - fight or flight
  - Parasympathetic NS
    - motor
    - rest
Organization of the Nervous System

Two Means of Classification:

1. **Structural Classification**
   - includes all NS organs
     - Central Nervous System (CNS)
     - Brain and spinal cord
     - Peripheral Nervous System (PNS)
       - Nerves and ganglia

2. **Functional Classification**
   - **Peripheral NS**
     - Sensory (afferent)
       - conveys impulses to the CNS
     - Motor (efferent)
       - carries impulses from the CNS to effector organs
     - 2 subdivisions
       - Somatic (voluntary) NS
       - Autonomic (involuntary) NS
         - parasympathetic & sympathetic
   - **Central NS**
     - Association (integrate/analyze)
     - interneuron

**Autonomic Nervous System**

- Motor part of PNS
- Controls involuntary body activities
- Major contributor to homeostasis
- Regulates:
  - Cardiac muscle
  - Smooth muscle
Autonomic Nervous System pg2

**Autonomic sensory neurons**
- monitors internal conditions of body
  - ex: blood CO2 level
  - ex: stretching of blood vessels
- Sensory signals usually not consciously perceived

Autonomic Nervous System pg3

**Autonomic Motor Neurons**
- 2 Divisions:
  - Sympathetic NS
  - Parasympathetic NS
- both affect many of the same organs
  - opposite effects (counterbalance)
Autonomic Nervous System pg4

**Sympathetic Nervous System**
- “fight or flight” system
- mobilizes body for a physical response
  - E – excitement, emergency & embarrassment

**Parasympathetic Nervous System**
- resting and digesting system
  - D – digestion, defecation & diuresis (urination)

Anatomy of a Neuron
Anatomy of a Neuron

- **Dendrites** (one to many per cell)
  - Conducts impulses toward the cell body
- **Cell body**
  - Contains the nucleus
- **Axon** (one per cell)
  - Conducts impulses away from the cell body
  - Releases a neurotransmitter

Types of Neurons

Neuron Classification by Function

According to direction of impulse transmission relative to CNS

1. Sensory (afferent) neurons
2. Association (interneurons) neurons
3. Motor (efferent) neurons
Classification of Neurons by Structure

Based upon number of processes extending from cell body

- **Unipolar (one process)**
  - Most sensory neurons
- **Bipolar (two processes)**
  - Sensory neurons in eyes and ears
- **Multipolar (many processes)**
  - Motor and association neurons

Neuron Physiology

- A nerve impulse is an electrochemical event
- Various stimuli causes a change in the plasma membrane permeability
- No direct contact between neurons
How Neurons Communicate At Synapses

Synaptic Transmission

Nomenclature

<table>
<thead>
<tr>
<th>CNS</th>
<th>PNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clusters of nerve cell bodies</td>
<td>nuclei</td>
</tr>
<tr>
<td>Nerve fiber bundles</td>
<td>tracts</td>
</tr>
</tbody>
</table>
Reflex

A rapid, predictable, and involuntary response to a stimulus

- one-way streets
- reflex arcs

Reflexes

Two types

- Autonomic reflex
  - smooth muscle, cardiac muscle and glands
  - involuntary muscle
- Somatic reflex
  - skeletal muscle
  - voluntary muscle

Components of a Reflex Arc

1. Receptor
2. Sensory neuron
3. Interneuron (CNS)
4. Motor neuron
5. Effector
Central Nervous System

- **Brain**
  1. cerebral hemispheres
  2. diencephalon
  3. brain stem
  4. cerebellum
- **Spinal cord**
Human Brain - Sagittal View

- Cerebral hemispheres
- Choroid plexus
- Pituitary gland
- Cerebellum
- Corpus callosum
- Thalamus
- Hypothalamus
- Midbrain
- Pons
- Medulla oblongata

Overview and functions of the brain

Cerebrum
- Sensory areas for skin senses, vision, hearing, olfaction
- Motor areas for voluntary control of movement
- Association areas for interpreting sensations, language, thinking, decision making, self-awareness, creativity, and storage of memories

Brain - 1. Cerebral Hemispheres

- paired
- superior part of brain
- separated by deep sulci/fissures
Cerebral Hemispheres pg2

**Interior & Exterior Appearance**
- **Surface (cortex)**
  - gray matter
  - efferent cell bodies
  - NOT smooth (convoluted)
  - sulci, gyri & fissures
- **Interior**
  - white matter
  - nerve fiber tracts

Cerebral Hemispheres pg3

**Lobes**
- **Four lobes**
  - frontal
  - parietal
  - occipital
  - temporal
- named for overlying cranial bone
- separated by deep sulci/fissures

Four lobes of the brain

- Frontal lobe
  - Frontal association area
  - Speech (Broca's area)
- Parietal lobe
  - Somatic association area
  - Visual association area
- Temporal lobe
  - Auditory association area
- Occipital lobe
  - Language understanding (Wernicke's area)
  - Sensory association area
Memory

Def: Storage and retrieval of information from an individual’s previous experiences
- underlies the capacity for learning

Short-term (ST) memory
- Bits of sensory info
  - seconds to hours

Long-term (LT) memory
- Unlimited amounts of info
  - up to permanent

ST → LT or LEARNING
- repetition, association & emotional state

Brain – 2. Diencephalon

- Superior to brain stem
- Enclosed by cerebral hemispheres

Regions of Diencephalon:
1. Thalamus
   - Encloses third ventricle
   - Relay station for sensory impulses
2. Hypothalamus
   - Floor of third ventricle
   - Most important regulatory center for ANS
3. Epithalamus
   - Includes pineal gland

Overview and functions of the brain

Thalamus
- Processes all sensory information (except smell)
- Relays it to appropriate higher brain centers
Brain – 3. Brain Stem

Regions of Brain Stem:
1. Midbrain
   - Most superior
   - Primarily fiber tracts
2. Pons
   - Inferior to midbrain
   - Involved in respiration
3. Medulla oblongata
   - Most inferior
   - Merges into spinal cord
   - Regulates breathing, heart rate, blood pressure, etc
**Brain – 4. Cerebellum**

- large, cauliflower like part
- appearance similar to cerebral hemispheres
- coordinates muscle activity and balance
Spinal Cord

- foramen magnum (occipital) → L2
- reflex center and conduction pathway
- found within vertebral canal

Spinal Cord pg2

Appearance:
- has central bat-shaped area of gray matter surrounded by white matter
  - white matter
    - mylenated and unmylenated axons
  - gray matter
    - contains interneurons and motor cell bodies
- spinal nerves emerge from spinal cord

Spinal Cord pg3

Function:
- carries sensory and motor tracts to and from the brain
- houses interneurons and motor cell bodies
  - receives info from sensory neuron
  - tells motor neuron what to do
Spinal Nerves

- connects CNS to sensory receptors, muscles and glands
- part of the Peripheral NS (PNS)
- nerves connect to the cord at two pts (roots)
  - Dorsal root
    - axons of sensory neurons
  - Ventral root
    - axons of motor neurons

Bionic arm responds to amputees’ thoughts

Claudia Mitchell lost her left arm at the shoulder in a motorcycle accident.
Stumps of nerves that once went to left arm rewired to pectoralis and serratus. Grafts receive thought-generated impulses. Muscle activity detected by electrodes from prosthesis.
Brain Dysfunctions

- **Head trauma**
  - Concussion - reversible damage
  - Contusion - nonreversible damage

- **Cerebrovascular accidents** (CVA/stroke)
  - Blood circulation to brain neurons blocked > brain tissue dies

- **Alzheimer’s disease**
  - Degenerative brain disease - abnormal protein deposits appear
Slide 52

Drug Actions

- Enhances release of neurotransmitter
- Blocks release of neurotransmitter
- Blocks receptor for neurotransmitter
- Blocks breakdown of neurotransmitter
- Enhances by mimicking neurotransmitter

Slide 53

Alcohol

Slide 54

Cannabinoid Receptor Sites

- Basal Ganglia
- Hippocampus
- Cerebellum