



## Nervous System Overview

### Divisions of the Nervous System

|                                        |                                                                                                                       |
|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Central Nervous System (CNS)</b>    | Brain and spinal cord; responsible for processing and coordinating information.                                       |
| <b>Peripheral Nervous System (PNS)</b> | Nerves outside the CNS; connects the CNS to the limbs and organs, serving as a communication relay.                   |
| <b>Autonomic Nervous System (ANS)</b>  | Regulates involuntary functions (heart rate, digestion, etc.). Divided into sympathetic and parasympathetic branches. |
| <b>Sympathetic Nervous System</b>      | 'Fight or flight' response; prepares the body for action.                                                             |
| <b>Parasympathetic Nervous System</b>  | 'Rest and digest'; conserves energy and promotes relaxation.                                                          |

### Cell Communication

|                                |                                                                                                                                                               |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Indirect</b>                | Gap Junctions<br><br>Transient linkup                                                                                                                         |
| <b>Indirect</b>                | paracrine secretion<br><br>neurotransmitter secretion                                                                                                         |
| Endocrine vs nervous signaling | Endocrine act through hormones controlling process that rely on duration rather than speed<br><br>Nervous acts through electrical signals for rapid responses |
| Sympathetic vs Parasympathetic | Sympathetic releases norepinephrine to Adrenergic receptors<br><br>Parasympathetic releases ACh to cholinergic receptors                                      |

## The Auditory System

### Components of the Ear

|                     |                                                          |
|---------------------|----------------------------------------------------------|
| <b>External Ear</b> | Pinna, external auditory meatus, tympanic membrane       |
| <b>Middle Ear</b>   | Tympanic membrane, ossicles, oval window                 |
| <b>Inner Ear</b>    | oval window, cochlea, vestibular apparatus, round window |

### Components of the Ear



### Simplified Auditory Pathway

1. Sound waves
2. Vibration of Tympanic membrane
3. Vibration of Middle Ear bones
4. Vibration of Oval Window
5. Fluid movement within the Cochlea
6. Vibration of Basilar Membrane
7. Bending of Hair cells
8. Grade receptor potential
9. Action Potentials generated in Auditory Nerve
10. Propagation to Auditory Complex

### Key Concepts

|                           |                                                                                                                                                                                                    |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Auditory Receptors</b> | Hair cells located in the cochlea. These hairs are bent when the basilar membrane is deflected which opens mechanically gated channels, leading to ion movements resulting in a receptor potential |
| <b>Pitch</b>              | depends on the region of the basilar membrane that vibrates. Think "where"                                                                                                                         |
| <b>Loudness</b>           | depends on the amplitude of vibration of the basilar membrane. Think "How Much"                                                                                                                    |

## The Visual System

### Components of the Eye

|                    |                                                                                             |
|--------------------|---------------------------------------------------------------------------------------------|
| <b>Cornea</b>      | Transparent outer layer that refracts light.                                                |
| <b>Lens</b>        | Focuses light onto the retina.                                                              |
| <b>Retina</b>      | Layer of photoreceptor cells (rods and cones) that transduce light into electrical signals. |
| <b>Fovea</b>       | Central focal point in the retina, responsible for sharp central vision.                    |
| <b>Optic Disk</b>  | The 'blind spot' in the retina where the optic nerve exits; lacks photoreceptors.           |
| <b>Optic Nerve</b> | Transmits electrical signals from the retina to the brain.                                  |

### Components of the Eye



### Visual Pathway

1. Light enters the eye and is refracted by the cornea and lens.
2. Photoreceptors (rods and cones) in the retina transduce light into electrical signals.
3. Signals are processed by retinal neurons and transmitted to ganglion cells.
4. Optic nerve carries signals to the optic chiasm, where some fibers cross over.
5. Optic tracts carry signals to the thalamus (lateral geniculate nucleus), then to the visual cortex in the occipital lobe.

### Key Concepts

|              |                                                                                                                                              |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Rods</b>  | Photoreceptors sensitive to dim light do not distinguish between different wavelengths of light serve low acuity and peripheral field vision |
| <b>Cones</b> | Photoreceptors sensitive to bright light distinguish between 3 different wavelengths of light serve high acuity central field vision         |
| <b>Fovea</b> | Central region of the retina with a high concentration of cones; responsible for high-acuity vision.                                         |

# The Motor System

## Components of the Motor System

|                 |                                                                                                                                  |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------|
| Cerebral Cortex | Planning, initiating, and executing voluntary movements; primary motor cortex, premotor cortex, supplementary motor area.        |
| Basal Ganglia   | Involved in motor control, motor learning, executive functions and behaviors, and emotions.                                      |
| Cerebellum      | Coordinates movement and maintains balance.                                                                                      |
| Brainstem       | Relays motor signals from the cerebral cortex and cerebellum to the spinal cord; controls basic motor functions (e.g., posture). |

## Motor Pathways

|                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------|
| 1. action potential in motor neuron is propagated                                                                   |
| 2. voltage-gated Ca2+ channels open and Ca2+ enters terminal button                                                 |
| 3. Ca2+ triggers ACh release                                                                                        |
| 4. ACh diffuses and binds to specific receptor channels on motor end plates                                         |
| 5. binding cause opening of cation channels causing large movement of Na+ into muscle                               |
| 6. end plate potential is the result; local current flow occurs between depolarized end plate and adjacent membrane |
| 7. local current flow opens VG Na+ channels                                                                         |
| 8. Na+ enters and reduces potential to threshold                                                                    |
| 9. ACh is destroyed by acetylcholinesterase                                                                         |

## Key Concepts

|                        |                                                                                                                                                                                                                                                           |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Motor Neuron           | Nerve cell that directly innervates and controls muscle fibers<br>bring about movement<br><br>axons of motor neurons originate in the CNS and end on skeletal muscle<br>motor-neuron axon terminals release acetylcholine to stimulate muscle contraction |
| Neuromuscular Junction | Chemically links neurons and skeletal muscle fibers<br><br>each muscle cell has only 1<br><br>Muscle fiber: single, long, and cylindrical muscle cell<br><br>Terminal Button: enlarged knoblike structure at the end of axon terminal branches            |
| Spinal Cord            | each segment contains motor neurons that project to same side skeletal muscles<br><br>each segment also contains motor neurons that project to skeletal muscles via ventral roots                                                                         |

## Neuromuscular Signaling Disruptions

|            |                                                                                                                                                                                                                                    |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Curare     | poison that binds strongly to nicotinic ACh receptors<br><br>ACh therefore can not bind to receptors thus resulting in no muscle contractions                                                                                      |
| Myasthenia | autoimmune disease where antibodies attack nicotinic ACh receptors<br><br>causes muscle weakness commonly around facial expression muscles<br><br>can be treated with ACh-esterase inhibitors which reduce rate of ACh degradation |
| Tetanus    | wound becomes contaminated with Clostridium Tetani<br><br>toxins block release of inhibitory neurotransmitter<br><br>causes stiffness and rigidity                                                                                 |
| Botulism   | ingesting spores from Clostridium botulinum bacteria<br><br>inhibits release of excitatory neurotransmitter<br><br>causes muscle weakness                                                                                          |