UNIT – 1 🧠 NERVOUS SYSTEM

POINTS TO BE COVERED IN THIS TOPIC

- ➤ ORGANIZATION OF NERVOUS SYSTEM
- ➤ NEURON
- ➤ NEUROGLIA
- ➤ CLASSIFICATION AND PROPERTIES OF NERVE FIBRE
- ➤ ELECTROPHYSIOLOGY
- ➤ ACTION POTENTIAL
- ➤ NERVE IMPULSE
- ➤ RECEPTORS
- ➤ SYNAPSE
- ➤ NEUROTRANSMITTERS
- ➤ CENTRAL NERVOUS SYSTEM
- ➤ MENINGES
- ➤ VENTRICLES OF BRAIN AND CEREBROSPINAL FLUID
- ➤ STRUCTURE AND FUNCTIONS OF BRAIN
- ➤ SPINAL CORD

🧠 ORGANIZATION OF NERVOUS SYSTEM

The nervous system is the master controlling and communicating system of the body. It is responsible for monitoring, integrating, and responding to information in the environment. The nervous system is anatomically and functionally divided into two main divisions:

ANATOMICAL DIVISIONS

1. CENTRAL NERVOUS SYSTEM (CNS)

- Consists of brain and spinal cord
- Protected by bone, meninges, and cerebrospinal fluid
- Functions as the integration and command center
- Interprets incoming sensory information and dictates motor responses

2. PERIPHERAL NERVOUS SYSTEM (PNS)

- Consists of all neural tissue outside the CNS
- Includes nerves and ganglia
- Serves as communication lines between CNS and rest of body
- Divided into cranial nerves and spinal nerves

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FUNCTIONAL DIVISIONS

1. SENSORY (AFFERENT) DIVISION

- Carries impulses from sensory receptors to CNS
- Keeps CNS informed of events in internal and external environment
- Includes somatic sensory fibers and visceral sensory fibers

2. MOTOR (EFFERENT) DIVISION

- Carries impulses from CNS to effector organs

- Two main subdivisions:

a) SOMATIC NERVOUS SYSTEM

- Controls skeletal muscles
- Voluntary control
- Single neuron pathway from CNS to effector

b) AUTONOMIC NERVOUS SYSTEM (ANS)

- Controls smooth muscle, cardiac muscle, and glands
- Involuntary control
- Two-neuron pathway from CNS to effector
- Further divided into:
  - Sympathetic Division (fight or flight)
  - Parasympathetic Division (rest and digest)
  - Enteric Division (gut nervous system)

🔬 NEURON

Neurons are the structural and functional units of the nervous system. They are highly specialized cells designed to transmit electrical and chemical signals throughout the body.

STRUCTURE OF NEURON

CELL BODY (SOMA)

- Contains nucleus and most organelles

- Site of metabolic activities and protein synthesis
- Contains Nissl bodies (rough endoplasmic reticulum)
- Lacks centrosome, so cannot undergo mitosis

DENDRITES

- Short, branched extensions of cell body
- Receptive regions of neuron
- Contain receptors for neurotransmitters
- Increase surface area for receiving signals

AXON

- Single long projection from cell body
- Conducts nerve impulses away from cell body
- May be myelinated or unmyelinated
- Ends in axon terminals containing synaptic vesicles

AXON HILLOCK

- Junction between cell body and axon
- Site where action potentials are initiated
- Contains high concentration of voltage-gated sodium channels

CLASSIFICATION OF NEURONS

Structural Classification	Functional Classification	Location Classification
Multipolar - Multiple	**Motor (Efferent)** - Carry	**CNS Neurons** - Brain and

Structural Classification	**Functional Classification**	**Location Classification**
dendrites, one axon	impulses from CNS	spinal cord
Bipolar - One dendrite, one axon	**Sensory (Afferent)** - Carry impulses to CNS	**PNS Neurons** - Outside brain and spinal cord
Unipolar - Single process from cell body	**Interneurons** - Connect neurons within CNS	

PROPERTIES OF NEURONS

EXCITABILITY

- Ability to respond to stimuli by producing electrical signals
- Depends on membrane potential differences

CONDUCTIVITY

- Ability to transmit electrical impulses along membrane
- Speed depends on axon diameter and myelination

SECRETION

- Ability to release neurotransmitters at synapses
- Essential for communication between neurons

🧪 NEUROGLIA

Neuroglia, or glial cells, are non-neuronal cells that support, protect, and maintain neurons. They outnumber neurons by 10:1 and make up about

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half the mass of the brain.

TYPES OF NEUROGLIA IN CNS

ASTROCYTES

- Star-shaped cells with numerous processes
- Form blood-brain barrier
- Regulate extracellular K^+ concentration
- Uptake and release neurotransmitters
- Provide structural support and nutrition to neurons

OLIGODENDROCYTES

- Produce myelin sheaths around CNS axons
- One oligodendrocyte can myelinate multiple axons
- Essential for rapid nerve conduction in CNS

MICROGLIA

- Small cells that act as immune cells of CNS
- Phagocytic function - remove debris and pathogens
- Monitor neuronal health
- Activate during injury or disease

EPENDYMAL CELLS

- Line ventricles of brain and central canal of spinal cord
- Ciliated cells that help circulate cerebrospinal fluid

- Some differentiate into tanycytes with barrier functions

TYPES OF NEUROGLIA IN PNS

SCHWANN CELLS

- Form myelin sheaths around PNS axons
- One Schwann cell myelinates one axon segment
- Aid in nerve regeneration after injury

SATELLITE CELLS

- Surround neuron cell bodies in ganglia
- Provide structural support and regulate environment
- Similar function to astrocytes in CNS

⚡ CLASSIFICATION AND PROPERTIES OF NERVE FIBRE

Nerve fibers are axons of neurons, classified based on various structural and functional properties.

CLASSIFICATION BASED ON MYELINATION

MYELINATED FIBERS

- Covered by myelin sheath
- Faster conduction velocity
- Saltatory conduction
- Found in motor neurons and sensory neurons for touch, pressure

UNMYELINATED FIBERS

- Lack myelin sheath
- Slower conduction velocity
- Continuous conduction
- Found in autonomic neurons and pain/temperature sensory neurons

CLASSIFICATION BASED ON DIAMETER AND CONDUCTION VELOCITY

Fiber Type	Diameter (μm)	Conduction Velocity (m/s)	Function
A-alpha	12-20	70-120	Motor to skeletal muscle, proprioception
A-beta	5-12	30-70	Touch, pressure
A-gamma	3-6	15-30	Motor to muscle spindles
A-delta	2-5	12-30	Pain, temperature, touch
B fibers	1-3	3-15	Preganglionic autonomic
C fibers	0.4-1.2	0.5-2	Pain, temperature, postganglionic sympathetic

PROPERTIES OF NERVE FIBERS

EXCITABILITY

- Threshold potential must be reached for action potential
- All-or-none principle applies

- Refractory periods prevent backward conduction

CONDUCTION

- Myelinated fibers show saltatory conduction
- Conduction velocity increases with fiber diameter
- Temperature affects conduction velocity

ACCOMMODATION

- Gradual adaptation to slowly rising stimuli
- Prevents activation by slow changes in environment

⚡ ELECTROPHYSIOLOGY

Electrophysiology deals with electrical properties of biological cells and tissues, particularly neurons and muscle cells.

MEMBRANE POTENTIAL

RESTING MEMBRANE POTENTIAL

- Electrical potential difference across cell membrane at rest
- Typically -70mV in neurons (inside negative relative to outside)
- Maintained by sodium-potassium pump and selective membrane permeability

FACTORS DETERMINING RESTING POTENTIAL

- Unequal distribution of ions across membrane

- Selective membrane permeability
- Na^+-K^+ ATPase pump activity
- Presence of large intracellular anions

ION CHANNELS

VOLTAGE-GATED CHANNELS

- Open or close in response to changes in membrane potential
- Essential for action potential generation
- Include Na^+, K^+, and Ca^{2+} channels

LIGAND-GATED CHANNELS

- Open or close in response to binding of specific molecules
- Important for synaptic transmission
- Include neurotransmitter receptors

MECHANICALLY-GATED CHANNELS

- Open or close in response to mechanical forces
- Important for sensory transduction
- Found in sensory receptors

🔥 ACTION POTENTIAL

Action potential is a rapid, transient change in membrane potential that travels along the neuron membrane. It is the fundamental mechanism of neural communication.

PHASES OF ACTION POTENTIAL

1. RESTING PHASE

- Membrane potential at -70mV
- Na^+ channels closed, K^+ channels slightly open
- Na^+-K^+ pump maintains ion gradients

2. DEPOLARIZATION PHASE

- Stimulus causes membrane potential to reach threshold (-55mV)
- Voltage-gated Na^+ channels open rapidly
- Na^+ influx causes membrane potential to become positive (+30mV)

3. REPOLARIZATION PHASE

- Na^+ channels inactivate
- Voltage-gated K^+ channels open
- K^+ efflux returns membrane potential toward resting level

4. HYPERPOLARIZATION PHASE

- K^+ channels remain open briefly
- Membrane becomes more negative than resting potential
- Absolute refractory period

5. RETURN TO RESTING POTENTIAL

- K^+ channels close
- Na^+-K^+ pump restores ion gradients

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- Relative refractory period

PROPERTIES OF ACTION POTENTIAL

ALL-OR-NONE PRINCIPLE

- Action potential either occurs completely or not at all
- Amplitude remains constant regardless of stimulus strength
- Ensures reliable signal transmission

REFRACTORY PERIODS

- Absolute refractory period - no second action potential possible
- Relative refractory period - stronger stimulus required
- Prevents backward conduction and limits firing frequency

🚀 NERVE IMPULSE

Nerve impulse is the propagation of action potential along the nerve fiber. The manner of propagation depends on whether the fiber is myelinated or unmyelinated.

CONDUCTION IN UNMYELINATED FIBERS

CONTINUOUS CONDUCTION

- Action potential propagates continuously along entire membrane
- Each segment of membrane must be depolarized
- Slower conduction velocity (0.5-2 m/s)
- Energy-intensive process

CONDUCTION IN MYELINATED FIBERS

SALTATORY CONDUCTION

- Action potential jumps from node to node (nodes of Ranvier)
- Myelin acts as insulator, preventing ion flow
- Current flows internally between nodes
- Faster conduction velocity (up to 120 m/s)
- Energy-efficient process

FACTORS AFFECTING CONDUCTION VELOCITY

AXON DIAMETER

- Larger diameter = faster conduction
- Less resistance to current flow
- More space for ion channels

MYELINATION

- Myelinated fibers conduct faster
- Saltatory conduction mechanism
- Nodes of Ranvier concentrate ion channels

TEMPERATURE

- Higher temperature = faster conduction
- Affects ion channel kinetics
- Cold blocks nerve conduction

👁️ RECEPTORS

Receptors are specialized structures that detect changes in the environment and convert them into electrical signals that can be processed by the nervous system.

CLASSIFICATION OF RECEPTORS

BASED ON STIMULUS TYPE

- **Mechanoreceptors** - Detect mechanical forces (touch, pressure, stretch)
- **Thermoreceptors** - Detect temperature changes
- **Photoreceptors** - Detect light
- **Chemoreceptors** - Detect chemicals (taste, smell, blood chemistry)
- **Nociceptors** - Detect harmful stimuli (pain)

BASED ON LOCATION

- **Exteroceptors** - Detect external environment stimuli
- **Interoceptors** - Detect internal environment changes
- **Proprioceptors** - Detect body position and movement

BASED ON COMPLEXITY

- **Simple Receptors** - Free nerve endings
- **Complex Receptors** - Specialized receptor cells with accessory structures

RECEPTOR PROPERTIES

SPECIFICITY

- Each receptor type responds best to specific stimulus
- Adequate stimulus produces response at lowest threshold
- Cross-sensitivity may occur at high stimulus intensities

ADAPTATION

- Decrease in response during sustained stimulation
- **Tonic receptors** - slowly adapting, provide continuous information
- **Phasic receptors** - rapidly adapting, detect changes in stimulus

TRANSDUCTION

- Conversion of stimulus energy into electrical energy
- Involves opening or closing of ion channels
- Results in generator potential or receptor potential

🔗 SYNAPSE

Synapse is the junction between two neurons or between a neuron and an effector cell. It is the site where information is transmitted from one cell to another.

TYPES OF SYNAPSES

CHEMICAL SYNAPSES

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- Most common type in nervous system
- Use neurotransmitters for signal transmission
- Unidirectional transmission
- Synaptic delay present
- Modifiable strength

ELECTRICAL SYNAPSES

- Connected by gap junctions
- Direct electrical coupling between cells
- Bidirectional transmission
- No synaptic delay
- Found in cardiac muscle and some brain regions

STRUCTURE OF CHEMICAL SYNAPSE

PRESYNAPTIC TERMINAL

- Contains synaptic vesicles filled with neurotransmitter
- Voltage-gated Ca^{2+} channels
- Mitochondria for energy production

SYNAPTIC CLEFT

- Narrow gap (20-50 nm) between neurons
- Contains extracellular fluid
- Site where neurotransmitter diffuses

POSTSYNAPTIC MEMBRANE

- Contains neurotransmitter receptors
- May have ion channels linked to receptors
- Integration of synaptic signals occurs here

SYNAPTIC TRANSMISSION

1. ACTION POTENTIAL ARRIVAL

- Depolarization reaches presynaptic terminal
- Voltage-gated Ca^{2+} channels open

2. CALCIUM INFLUX

- Ca^{2+} enters presynaptic terminal
- Triggers vesicle fusion with membrane

3. NEUROTRANSMITTER RELEASE

- Exocytosis of synaptic vesicles
- Neurotransmitter released into synaptic cleft

4. RECEPTOR BINDING

- Neurotransmitter binds to postsynaptic receptors
- Ion channels open or close

5. POSTSYNAPTIC RESPONSE

- Excitatory or inhibitory postsynaptic potential
- Integration determines if action potential generated

6. TERMINATION

- Neurotransmitter removed from cleft
- Reuptake, enzymatic degradation, or diffusion

🧪 NEUROTRANSMITTERS

Neurotransmitters are chemical messengers that transmit signals across synapses. They are essential for all nervous system functions.

CLASSIFICATION OF NEUROTRANSMITTERS

Category	**Examples**	**Functions**
Amino Acids	Glutamate, GABA, Glycine	Fast synaptic transmission
Biogenic Amines	Dopamine, Norepinephrine, Serotonin	Mood, arousal, motor control
Peptides	Endorphins, Substance P	Pain modulation, hormone-like effects
Acetylcholine	ACh	Muscle contraction, memory, attention
Purines	ATP, Adenosine	Energy metabolism, sleep
Gases	Nitric Oxide, Carbon Monoxide	Vascular regulation, memory

MAJOR NEUROTRANSMITTERS

ACETYLCHOLINE (ACh)

- First neurotransmitter discovered

- Found at neuromuscular junction and autonomic ganglia
- Important for memory and attention
- Degraded by acetylcholinesterase

GLUTAMATE

- Primary excitatory neurotransmitter in CNS
- Involved in learning and memory
- Excessive levels can cause excitotoxicity
- Removed by glial cell uptake

GABA (Gamma-Aminobutyric Acid)

- Primary inhibitory neurotransmitter in CNS
- Produces calming effects
- Target of anti-anxiety medications
- Synthesized from glutamate

DOPAMINE

- Important for motor control and reward pathways
- Deficiency causes Parkinson's disease
- Excess associated with schizophrenia
- Precursor to norepinephrine

SEROTONIN

- Regulates mood, sleep, and appetite
- Deficiency linked to depression

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- Most serotonin found in gut
- Target of antidepressant medications

🏛️ CENTRAL NERVOUS SYSTEM

The central nervous system consists of the brain and spinal cord, which are protected by bone, meninges, and cerebrospinal fluid.

PROTECTION OF CNS

BONY PROTECTION

- Brain protected by skull (cranium)
- Spinal cord protected by vertebral column
- Provides rigid outer barrier

MENINGEAL PROTECTION

- Three layers of connective tissue membranes
- Cushion and protect neural tissue
- Contain cerebrospinal fluid

CEREBROSPINAL FLUID PROTECTION

- Liquid cushion around brain and spinal cord
- Provides buoyancy and shock absorption
- Maintains chemical environment

🧠 MENINGES

The meninges are three protective membranes that surround the brain and spinal cord.

LAYERS OF MENINGES

DURA MATER (Outermost Layer)

- **Meaning**: "Hard mother"
- **Structure**: Dense, fibrous connective tissue
- **Brain**: Two layers - periosteal and meningeal
- **Spinal Cord**: Single layer separated from vertebrae by epidural space
- **Functions**:
  - Provides mechanical protection
  - Contains venous sinuses for blood drainage
  - Forms partitions between brain regions

ARACHNOID MATER (Middle Layer)

- **Meaning**: "Spider-like mother"
- **Structure**: Delicate, web-like membrane
- **Avascular**: No blood vessels
- **Subarachnoid Space**: Between arachnoid and pia mater
- **Functions**:
  - Contains cerebrospinal fluid
  - Arachnoid villi allow CSF absorption

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    - Cushions brain and spinal cord

PIA MATER (Innermost Layer)

- **Meaning**: "Gentle mother"
- **Structure**: Thin, delicate membrane
- **Highly Vascular**: Rich blood supply
- **Adherent**: Closely follows brain and spinal cord contours
- **Functions**:
    - Provides nutrients to neural tissue
    - Forms part of blood-brain barrier
    - Supports blood vessels entering brain

MENINGEAL SPACES

EPIDURAL SPACE

- Between skull/vertebrae and dura mater
- Contains fat and blood vessels in spinal region
- Site for epidural anesthesia

SUBDURAL SPACE

- Potential space between dura and arachnoid
- Contains small amount of serous fluid
- Site of subdural hematomas

SUBARACHNOID SPACE

- Between arachnoid and pia mater
- Contains cerebrospinal fluid
- Site for lumbar puncture

💧 VENTRICLES OF BRAIN AND CEREBROSPINAL FLUID

The ventricular system consists of four interconnected cavities within the brain that produce, circulate, and absorb cerebrospinal fluid.

VENTRICULAR SYSTEM

LATERAL VENTRICLES (First and Second Ventricles)

- Located within cerebral hemispheres
- Largest ventricles
- Connected to third ventricle via interventricular foramina
- Contains choroid plexus for CSF production

THIRD VENTRICLE

- Located in diencephalon between thalami
- Connected to lateral ventricles above
- Connected to fourth ventricle via cerebral aqueduct
- Contains choroid plexus

FOURTH VENTRICLE

- Located between brainstem and cerebellum
- Connected to third ventricle above

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- Connected to central canal of spinal cord below
- Contains choroid plexus
- Has openings to subarachnoid space

CEREBROSPINAL FLUID (CSF)

PRODUCTION

- Produced by choroid plexuses in ventricles
- Rate: approximately 500ml per day
- Total volume: 150ml (replaced 3-4 times daily)

COMPOSITION

- Clear, colorless liquid
- Similar to blood plasma but with less protein
- Contains glucose, electrolytes, and small amounts of protein
- Few cells (mainly lymphocytes)

CIRCULATION

- **Flow Pattern**:
  1. Lateral ventricles → Third ventricle
  2. Third ventricle → Cerebral aqueduct → Fourth ventricle
  3. Fourth ventricle → Subarachnoid space
  4. Subarachnoid space → Arachnoid villi → Venous system

FUNCTIONS

- **Mechanical Protection**: Cushions brain against impact
- **Chemical Protection**: Maintains optimal chemical environment
- **Circulation**: Carries nutrients and removes waste
- **Buoyancy**: Reduces effective brain weight

🧠 STRUCTURE AND FUNCTIONS OF BRAIN

The brain is the control center of the nervous system, weighing approximately 1.4 kg in adults and containing about 86 billion neurons.

MAJOR DIVISIONS OF BRAIN

CEREBRUM

- Largest part of brain (83% of brain weight)
- Divided into left and right hemispheres
- Surface highly folded with gyri and sulci
- Controls higher mental functions

BRAIN STEM

- Connects brain to spinal cord
- Includes midbrain, pons, and medulla oblongata
- Controls vital functions

CEREBELLUM

- "Little brain" located posterior to brainstem
- Important for motor coordination and balance

🧠 CEREBRUM

The cerebrum is the largest part of the brain, responsible for higher cognitive functions, sensory processing, and voluntary motor control.

CEREBRAL HEMISPHERES

LEFT HEMISPHERE

- Dominant for language in most people
- Controls right side of body
- Analytical and logical thinking
- Mathematical and verbal skills

RIGHT HEMISPHERE

- Spatial and artistic abilities
- Controls left side of body
- Emotional expression
- Pattern recognition and creativity

CEREBRAL CORTEX

GRAY MATTER

- Outer layer of cerebrum
- Contains neuron cell bodies
- 2-4 mm thick

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- Highly folded to increase surface area

WHITE MATTER

- Inner layer beneath cortex
- Contains myelinated axons
- Connects different brain regions
- Includes association, commissural, and projection fibers

FUNCTIONAL AREAS OF CEREBRAL CORTEX

FRONTAL LOBE

- **Primary Motor Cortex**: Controls voluntary movements
- **Premotor Cortex**: Plans complex movements
- **Prefrontal Cortex**: Executive functions, personality
- **Broca's Area**: Speech production

PARIETAL LOBE

- **Primary Somatosensory Cortex**: Processes touch, temperature, pain
- **Association Areas**: Spatial awareness, body image

TEMPORAL LOBE

- **Primary Auditory Cortex**: Processes sound
- **Wernicke's Area**: Language comprehension
- **Hippocampus**: Memory formation

OCCIPITAL LOBE

- **Primary Visual Cortex**: Processes visual information
- **Visual Association Areas**: Interpret visual stimuli

🌉 BRAIN STEM

The brain stem connects the brain to the spinal cord and controls many vital functions necessary for survival.

COMPONENTS OF BRAIN STEM

MIDBRAIN

- **Location**: Between diencephalon and pons
- **Structures**:
  - Cerebral peduncles (motor tracts)
  - Superior and inferior colliculi (reflexes)
  - Substantia nigra (dopamine production)
- **Functions**:
  - Visual and auditory reflexes
  - Eye movement control
  - Motor pathway relay

PONS

- **Location**: Between midbrain and medulla
- **Structures**:
  - Pontine nuclei (relay station)

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    - Respiratory centers
    - Cranial nerve nuclei
- **Functions**:
    - Relay information between cerebrum and cerebellum
    - Respiratory control
    - Sleep and arousal

MEDULLA OBLONGATA

- **Location**: Between pons and spinal cord
- **Structures**:
    - Cardiovascular center
    - Respiratory center
    - Pyramids (motor decussation)
- **Functions**:
    - Heart rate and blood pressure regulation
    - Breathing control
    - Swallowing and vomiting reflexes

🎯 CEREBELLUM

The cerebellum is crucial for motor coordination, balance, and motor learning.

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STRUCTURE OF CEREBELLUM

ANATOMICAL DIVISIONS

- **Cerebellar Hemispheres**: Left and right sides
- **Vermis**: Central connecting structure
- **Lobes**: Anterior, posterior, and flocculonodular

CELLULAR ORGANIZATION

- **Molecular Layer**: Outer layer with parallel fibers
- **Purkinje Cell Layer**: Single layer of large neurons
- **Granule Cell Layer**: Inner layer with small neurons

FUNCTIONS OF CEREBELLUM

MOTOR COORDINATION

- Smooths and coordinates voluntary movements
- Compares intended movement with actual movement
- Makes corrective adjustments

BALANCE AND EQUILIBRIUM

- Processes vestibular information
- Maintains posture and balance
- Coordinates eye movements with head movements

MOTOR LEARNING

- Stores motor memories

- Improves motor performance through practice
- Adapts movements to changing conditions

COGNITIVE FUNCTIONS

- Language processing
- Attention and executive functions
- Emotional regulation

🦴 SPINAL CORD

The spinal cord is a cylindrical structure that extends from the medulla oblongata to the level of the first or second lumbar vertebra.

GROSS STRUCTURE OF SPINAL CORD

EXTERNAL FEATURES

- **Length**: Approximately 45 cm in adults
- **Diameter**: About 2 cm
- **Cervical Enlargement**: C4-T1 (upper limb innervation)
- **Lumbar Enlargement**: T9-T12 (lower limb innervation)
- **Conus Medullaris**: Tapered end of spinal cord
- **Filum Terminale**: Extension of pia mater beyond conus

PROTECTIVE STRUCTURES

- **Vertebral Column**: Bony protection
- **Meninges**: Three-layer membrane protection

- **Cerebrospinal Fluid**: Liquid cushion

INTERNAL STRUCTURE

GRAY MATTER

- **Location**: Central H-shaped region
- **Components**:
  - Anterior (ventral) horns - motor neurons
  - Posterior (dorsal) horns - sensory processing
  - Lateral horns - autonomic neurons (T1-L2)
- **Function**: Integration and processing of information

WHITE MATTER

- **Location**: Surrounding gray matter
- **Components**:
  - Anterior funiculi
  - Lateral funiculi
  - Posterior funiculi
- **Function**: Contains ascending and descending tracts

AFFERENT (ASCENDING) NERVE TRACTS

SENSORY PATHWAYS TO BRAIN

DORSAL COLUMN PATHWAY

- **Function**: Fine touch, vibration, proprioception

- **Route**: Dorsal column → medulla → thalamus → somatosensory cortex
- **Decussation**: In medulla (internal arcuate fibers)

SPINOTHALAMIC TRACT

- **Function**: Pain, temperature, crude touch
- **Route**: Spinal cord → thalamus → somatosensory cortex
- **Decussation**: In spinal cord (anterior white commissure)

SPINOCEREBELLAR TRACTS

- **Function**: Unconscious proprioception
- **Route**: Spinal cord → cerebellum
- **Types**: Anterior and posterior spinocerebellar tracts

EFFERENT (DESCENDING) NERVE TRACTS

MOTOR PATHWAYS FROM BRAIN

CORTICOSPINAL TRACT

- **Function**: Voluntary motor control
- **Route**: Motor cortex → spinal cord
- **Decussation**: 85% cross in pyramids (lateral tract), 15% uncrossed (anterior tract)
- **Target**: Lower motor neurons in anterior horn

CORTICOBULBAR TRACT

- **Function**: Controls muscles of head and neck

- **Route**: Motor cortex → brainstem motor nuclei
- **Target**: Cranial nerve motor nuclei

EXTRAPYRAMIDAL TRACTS

- **Function**: Automatic movement, posture, balance
- **Types**:
  - Rubrospinal tract (red nucleus)
  - Reticulospinal tract (reticular formation)
  - Vestibulospinal tract (vestibular nuclei)
  - Tectospinal tract (superior colliculus)

REFLEX ACTIVITY

DEFINITION

- Rapid, automatic, stereotyped response to stimulus
- Does not require conscious thought
- Mediated by reflex arc

COMPONENTS OF REFLEX ARC

- **Receptor**: Detects stimulus
- **Sensory Neuron**: Carries impulse to CNS
- **Integration Center**: Processes information (spinal cord or brain)
- **Motor Neuron**: Carries response signal to effector
- **Effector**: Responds to stimulus (muscle or gland)

TYPES OF REFLEXES

STRETCH REFLEX

- **Example**: Knee-jerk reflex
- **Function**: Maintains muscle tone and posture
- **Pathway**: Monosynaptic (one synapse)
- **Components**: Muscle spindle → spinal cord → motor neuron → muscle

WITHDRAWAL REFLEX

- **Example**: Pulling hand away from hot object
- **Function**: Protective response
- **Pathway**: Polysynaptic (multiple synapses)
- **Features**: Involves reciprocal innervation

CROSSED EXTENSOR REFLEX

- **Function**: Maintains balance during withdrawal
- **Mechanism**: Extends opposite limb when one limb withdraws
- **Pathway**: Involves contralateral motor neurons

CLINICAL SIGNIFICANCE

- **Assessment Tool**: Tests nervous system integrity
- **Abnormal Reflexes**: Indicate neurological disorders
- **Hyperreflexia**: Upper motor neuron lesions
- **Hyporeflexia/Areflexia**: Lower motor neuron lesions

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📚 SUMMARY

The nervous system is a complex network responsible for controlling and coordinating body functions. It consists of the central nervous system (brain and spinal cord) and peripheral nervous system (nerves and ganglia). Neurons are the functional units that transmit electrical and chemical signals throughout the body. The brain processes higher cognitive functions, while the spinal cord serves as a major pathway for information transmission and reflex processing. Understanding the structure and function of the nervous system is essential for comprehending how the body responds to internal and external stimuli and maintains homeostasis.

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