# ****CNS Physiology & Motor Pathways – Exam Summary****

## ✅ ****I. Functional Areas of the Cerebral Cortex****

| **Area Type** | **Function** |
| --- | --- |
| **Motor** | Controls voluntary movement |
| **Sensory** | Conscious perception of stimuli |
| **Association** | Integration & higher functions |

## ✅ ****II. Primary Motor Cortex (Area 4)****

**Location**: Precentral gyrus, frontal lobe (anterior to central sulcus)

**Representation**: Crossed & inverted (motor homunculus)

Large area for **face**, **hands**, **speech muscles**

**Function**:

Initiates **fine, voluntary movements** (e.g., fingers)

Facilitates **stretch reflexes** (tone, tendon jerk)

**Lesion Effects**:

Flaccid paralysis (opposite side)

Loss of reflexes

**Positive Babinski sign** (dorsiflexion of big toe)

## ✅ ****III. Premotor Area (Area 6)****

**Location**: Anterior to area 4

**Body Representation**: Crossed & inverted

**Connections**:

To motor cortex, sensory areas, cerebellum (via cortico-ponto-cerebellar tract), BG

**Function**:

Controls **coordinated gross movements**

Starts **extrapyramidal tract**

**Stimulation**: Produces coordinated complex patterns (e.g., flexion, extension)

## ✅ ****IV. Special Premotor Areas****

| **Area** | **Location** | **Function** |
| --- | --- | --- |
| **Broca’s area (44, 45)** | Anterior to motor area | Word formation; **speech production** |
| **Frontal eye field (Area 8)** | Above Broca’s area | Voluntary **eye & eyelid** movement |

**Lesion**: Fixation of eye on an object

## ✅ ****V. Prefrontal Cortex (Areas 9–12)****

**Location**: Anterior frontal lobe ("organ of mind")

**Connections**: Hypothalamus, limbic system, hippocampus, occipital & temporal lobes

**Functions**:

Intelligence, planning, judgment

Recent memory

Emotional behavior

ANS regulation

**Lesion Effects**:

Poor judgment, disinhibition

Loss of attention, disorientation

Change in social behavior

## ✅ ****VI. Descending (Motor) Pathways****

| **Type** | **Includes** | **Function** |
| --- | --- | --- |
| **Pyramidal** | Corticospinal, Corticobulbar | Direct voluntary movement |
| **Extrapyramidal** | BG, cerebellum, brainstem nuclei | Posture, coordination |

## ✅ ****VII. Pyramidal Tracts****

**Originate from**: Lamina V of cortex (pyramidal cells)

Primary motor cortex (30%)

Premotor cortex (30%)

Somatosensory areas (40%)

### A. ****Corticospinal Tract****

| **Feature** | **Details** |
| --- | --- |
| **Decussation** | 80% cross → **Lateral corticospinal tract** |
| **Uncrossed** | 20% → **Ventral corticospinal tract** |
| **Function** | Controls limbs and trunk muscles (opposite side) |

### B. ****Corticobulbar Tract****

Origin: Motor cortex

Terminates in **cranial nerve nuclei** in brainstem:

CN III, IV, VI (eye movement)

CN V (mastication), VII (facial expression)

CN XII (tongue), XI (sternocleidomastoid), etc.

**Function**: Voluntary control of **eye, face, tongue, neck**

## ✅ ****VIII. Summary: Motor Control Pathway Flow****

**Motor cortex (area 4)** → planning via premotor & prefrontal areas

**Corticospinal tract** → spinal motor neurons

**Corticobulbar tract** → cranial motor neurons

**Cerebellum & BG** → coordinate & refine movement

**Extrapyramidal system** → posture, tone, reflex modulation  
  
  
**Extrapyramidal Pathways & Somatosensory Cortex – Exam Summary**

## ✅ I. ****Extrapyramidal Pathways (Indirect Motor System)****

### 🔹 Definition:

Motor tracts **not originating from the cerebral cortex**.

Arise from **brainstem nuclei**, **basal ganglia**, **cerebellum**, and **reticular formation**.

Modulate **involuntary movements**, **posture**, **muscle tone**, and **reflexes**.

### 🔹 Components (Mnemonic: ****RUS TEST RST VST OST****)

| **Tract** | **Origin** | **Decussation** | **Function** |
| --- | --- | --- | --- |
| **Rubrospinal (RUS)** | Red nucleus (magnocellular part) | Crossed (brainstem) | Facilitates flexor muscles in limbs |
| **Tectospinal (TEST)** | Superior & inferior colliculi | Crossed (midbrain) | Coordinates head & eye movement toward visual (superior) and auditory (inferior) stimuli |
| **Reticulospinal (RST)** | Reticular formation | Lateral = partially crossed; Ventral = uncrossed | Lateral: inhibits stretch reflex; Ventral: facilitates stretch reflex |
| **Vestibulospinal (VST)** | Vestibular nuclei (medulla) | Lateral = uncrossed; Ventral = partial | Maintains balance and posture; facilitates postural reflexes |
| **Olivospinal (OST)** | Inferior olive (medulla) | Uncrossed | Facilitates stretch reflex; transmits motor signals from cerebrum & cerebellum |

### 🔹 Basal Ganglia Role in Extrapyramidal System

Afferent input from **motor cortex** → **corpus striatum** → **globus pallidus**

Output to:

**Red nucleus**

**Tectum (midbrain)**

**Reticular formation**

**Vestibular nuclei**

**Inferior olive**

Communicates with red nucleus via **corticorubral fibers**.

Red nucleus gives rise to **rubrospinal tract** (fine muscle control, less developed than motor cortex).

## ✅ II. ****Somatosensory Cortex (SI, SII, SIII)****

### 🔹 Location:

**Anterior parietal lobe**, **postcentral gyrus**

**Primary Somatosensory Area (SI)**: Brodmann areas **3, 1, 2**

**Secondary Somatosensory Area (SII)**: Supramarginal gyrus (Brodmann area 40)

**Association Somatosensory Area (SIII)**: Posterior to SI

### 🔹 Primary Somatosensory Cortex (SI)

**Receives fine somatosensory input** from thalamic nuclei.

**Body Map**: Crossed & inverted (sensory homunculus)

Face/lips/thumbs = largest representation

Trunk/lower limbs = smaller

**Representation proportional to number of sensory receptors**, not body size

#### Functions:

**Fine touch**

**Tactile localization & discrimination**

**Localization of pain and temperature** (not the sensation itself)

**Texture detection**

**Proprioception** (static & dynamic)

Sends data to **SII & SIII** for higher sensory processing (e.g., stereognosis)

### 🔹 Secondary Somatosensory Cortex (SII)

**Location**: Supramarginal gyrus, behind lower SI (Area 40)

**Body Representation**: Bilateral, poorly topographic

**Inputs**: SI, thalamic nuclei, visual & auditory areas

#### Functions:

Potentiates SI functions (amplifies)

**SI can function without SII, but not vice versa**

### 🔹 Sensory Homunculus (SI)

Crossed & inverted representation

Face and lips → bottom lateral cortex

Legs and feet → top medial cortex

Greater cortical area = more peripheral receptors

## ✅ III. ****Sensory Signal Perception****

| **Stimulus** | **Site of Primary Perception** |
| --- | --- |
| **Fine sensation** (touch, proprioception) | **SI (parietal lobe)** |
| **Crude pain, temp** | Brainstem & **thalamus** (relay center) |
| **Visual** | **Occipital lobe** |
| **Auditory** | **Temporal lobe** |

**Cerebral cortex** involved in localizing crude sensation.

Perception of crude sensations starts in **thalamus**, but **localization and higher interpretation** occur in cortex.

## ✅ IV. Degenerative Diseases of Motor Neurons

Affect **ventral horn cells** (motor) and **dorsal root ganglia** (sensory)

### Causes:

**Vitamin deficiencies**: B1, B2, B6, B12, folic acid

**Heavy metal toxicity**: Lead, mercury

**Infections**: Poliovirus, syphilis

**Chronic diseases**: Diabetes, renal failure  
s**omatosensory Cortex, Sensory Systems & Speech Centers – Exam Summary**

## ✅ I. ****Somatosensory Area I (SI) – Functions & Lesion Effects****

### 🔹 ****Location****: Postcentral gyrus (parietal lobe), Brodmann areas 3, 1, 2

### 🔹 ****Functions****:

Fine touch, pressure, pain localization

Proprioception (static/dynamic)

Texture discrimination

Spatial orientation (mapped as sensory homunculus)

### 🔹 ****Lesion Effects (Bilateral)****

Loss of precise localization of sensation (only crude localization possible)

Inability to judge pressure

Loss of weight discrimination

Loss of shape/form recognition → **Astereognosis**

**Note**: Somatosensory area I is more critical than II; often referred to simply as the “somatosensory cortex.”

## ✅ II. ****Somatosensory Area II (SII)****

**Location**: Supramarginal gyrus (area 40)

**Representation**: Bilateral but poor topographic map

**Function**: Supports and amplifies SI function

## ✅ III. ****Somatosensory Association Area****

**Location**: Posterior parietal cortex (areas 5 & 7)

**Connections**: SI, SII, thalamus, visual & auditory areas

**Function**: Integrates sensory input → gives meaning (e.g. object recognition by touch)

**Lesion**: Astereognosis

## ✅ IV. ****Other Sensory Cortical Areas****

### 🔸 ****Temporal Lobe****

**Primary auditory cortex (areas 41 & 42)**: Receives from cochlea

**Auditory association areas (20, 21, 22)**: Interpretation & memory of sound

### 🔸 ****Occipital Lobe****

**Area 17**: Primary visual cortex (visual reception)

**Area 18**: Visual association area (interpretation)

**Area 19**: Occipital eye field (eye movements)

### 🔸 ****Insula****

Memory encoding, sensory-visceral integration

Modulates cardiovascular response to stress

### 🔸 ****Other Sensory Cortices****

| **Cortex** | **Location** | **Function** |
| --- | --- | --- |
| **Olfactory** | Frontal lobe (above orbits) | Smell |
| **Gustatory** | Parietal (deep to temporal) | Taste |
| **Vestibular** | Posterior insula | Balance & equilibrium |

## ✅ V. ****Motor Neurons & Lesions****

### 🔹 ****Types****

| **Neuron** | **Pathway** | **Function** |
| --- | --- | --- |
| **UMN** | Cortex → Spinal cord/brainstem | Initiate voluntary movement |
| **LMN** | Spinal cord/brainstem → Muscle | Execute movement |

### 🔹 ****Lesions****

| **Feature** | **UMN Lesion** | **LMN Lesion** |
| --- | --- | --- |
| **Paralysis** | Widespread, spastic | Localized, flaccid |
| **Recovery** | Poor | Partial possible |
| **Muscle tone** | Exaggerated | Absent |
| **Reflexes** | Hyperreflexia | Hyporeflexia/Absent |
| **Babinski sign** | Present | Absent |
| **Muscle wasting** | Minimal | Severe |

### 🔹 ****Causes****

**UMN**: Stroke, trauma, cortical damage

**LMN**: Poliomyelitis, trauma, neuropathy

## ✅ VI. ****Speech & Language Centers****

### 🔸 ****Speech Components****

| **Center** | **Function** |
| --- | --- |
| **Auditory (superior temporal gyrus)** | Stores spoken word memory |
| **Visual (angular gyrus - area 39)** | Stores visual symbols (written words) |
| **Broca’s area (44 & 45)** | Motor speech → word formation |
| **Wernicke’s area (upper temporal lobe)** | Comprehension, forming coherent speech |
| **Arcuate fasciculus** | Connects Wernicke’s to Broca’s |

### 🔸 ****Hemispheric Dominance****

**Left cerebral hemisphere** in 95% of right-handed individuals controls:

**Language**, **math**, **logic**

**Right hemisphere** controls:

**Music**, **art**, **face recognition**, **emotion**

## ✅ VII. ****Aphasia Types****

| **Type** | **Cause** | **Feature** |
| --- | --- | --- |
| **Wernicke’s (Fluent)** | Lesion in auditory/temporal cortex | Fluent speech, lacks meaning |
| **Motor (Broca’s, Non-fluent)** | Lesion in Broca’s area | Knows what to say but can’t express it |
| **Sensory auditory aphasia** | Word deafness | Cannot understand spoken words |
| **Sensory visual aphasia** | Word blindness | Cannot read/understand written words |