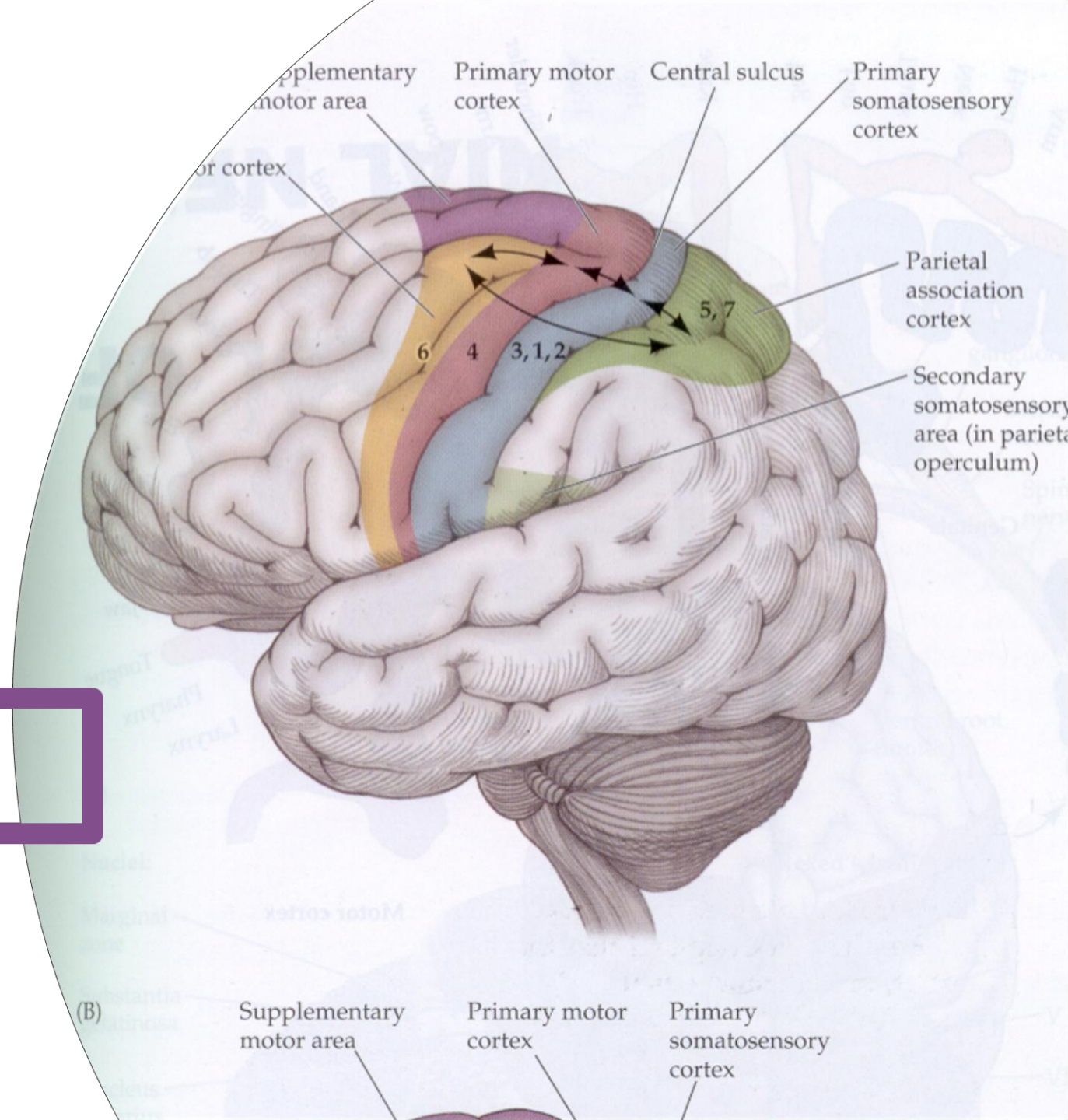
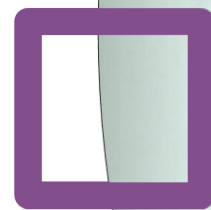


The Motor Pathways



Learning Objectives

1. Explain the general organization of the motor systems.
2. Indicate the names, function and trajectory, from origin to termination, of the descending motor pathways from the cerebral cortex to the spinal cord.
3. Describe the names, function and trajectory, from origin to termination, of the descending motor pathways from the cerebral cortex to the brainstem.
4. Name the fiber tracts from the brainstem innervating interneuronal networks in the spinal cord.
5. Describe the organization of the motor pathways in the spinal cord.
6. Explain the somatotopic organization of ventral horn motor neurons.

The Big Picture

OBJ. # 1

Motor Systems

There are 2 motor systems:

- Somatic or Skeletal
- Visceral or Autonomic

Controlled by the cortex

Controlled by the hypothalamus

Skeletal Motor System

OBJ. # 1

There are 3 levels of voluntary motor control

- Highest level : Cerebral cortex and some brainstem nuclei - **Upper motor neurons**
- Intermediate level: Cerebellum and basal ganglia
- Lower level: Spinal cord and brainstem - **Lower motor neurons** transmitting information **directly** to the skeletal muscles



Descending Pathways From the Cortex

- The **corticospinal tracts**: from cortex to spinal cord
- The **corticobulbar tracts**: from cortex to motor nuclei in the brainstem. (AKA corticonuclear tract)

Descending Motor Pathway

OBJ. # 2 & 3

Tracts from the cortex (betz cells)

Corticospinal

To the Spinal
Cord

Corticobulbar

To the
Brainstem

Corticopontine

To the pons

TRACTS ORIGIN: these are the places in the cerebral cortex where all corticospinal and corticobulbar fibers originate

55 % Of the fibers

- Primary motor cortex (MI) / Brodmann's area 4, precentral and anterior paracentral gyri
- Premotor area (PMA) / Brodmann's area 6, located just anterior to primary motor cortex
- Supplementary motor area (SMA) / Brodmann's area 6

35 % of fibers

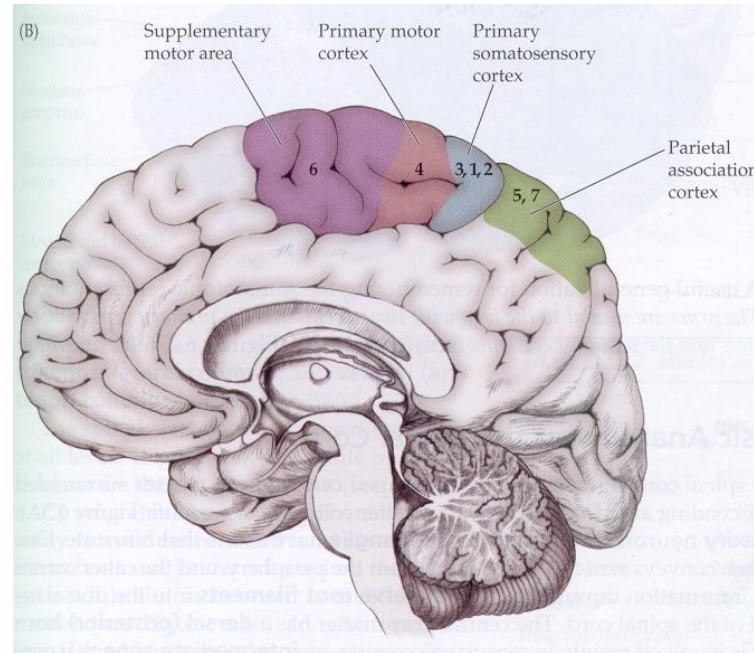
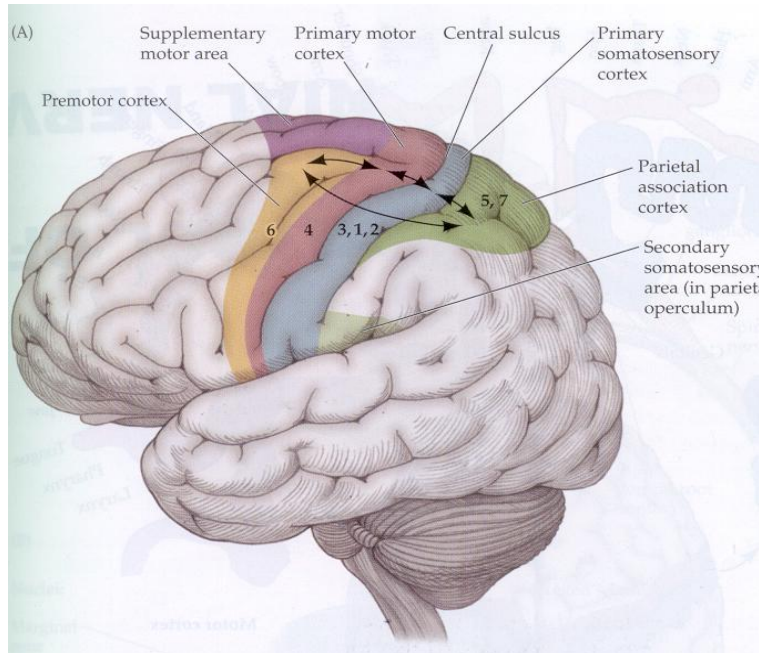
- Primary sensory cortex / Brodmann's areas 3,1,2, postcentral gyrus

10 % of fibers

- Posterior parietal areas and other frontal areas

Cortical Areas Contributing to Corticospinal and Corticobulbar tracts

OBJ. # 2 & 3



Brodmann's area 4 –
Primary Motor
Cortex

Brodmann's area 6 –
Pre-motor and
supplementary
motor cortex

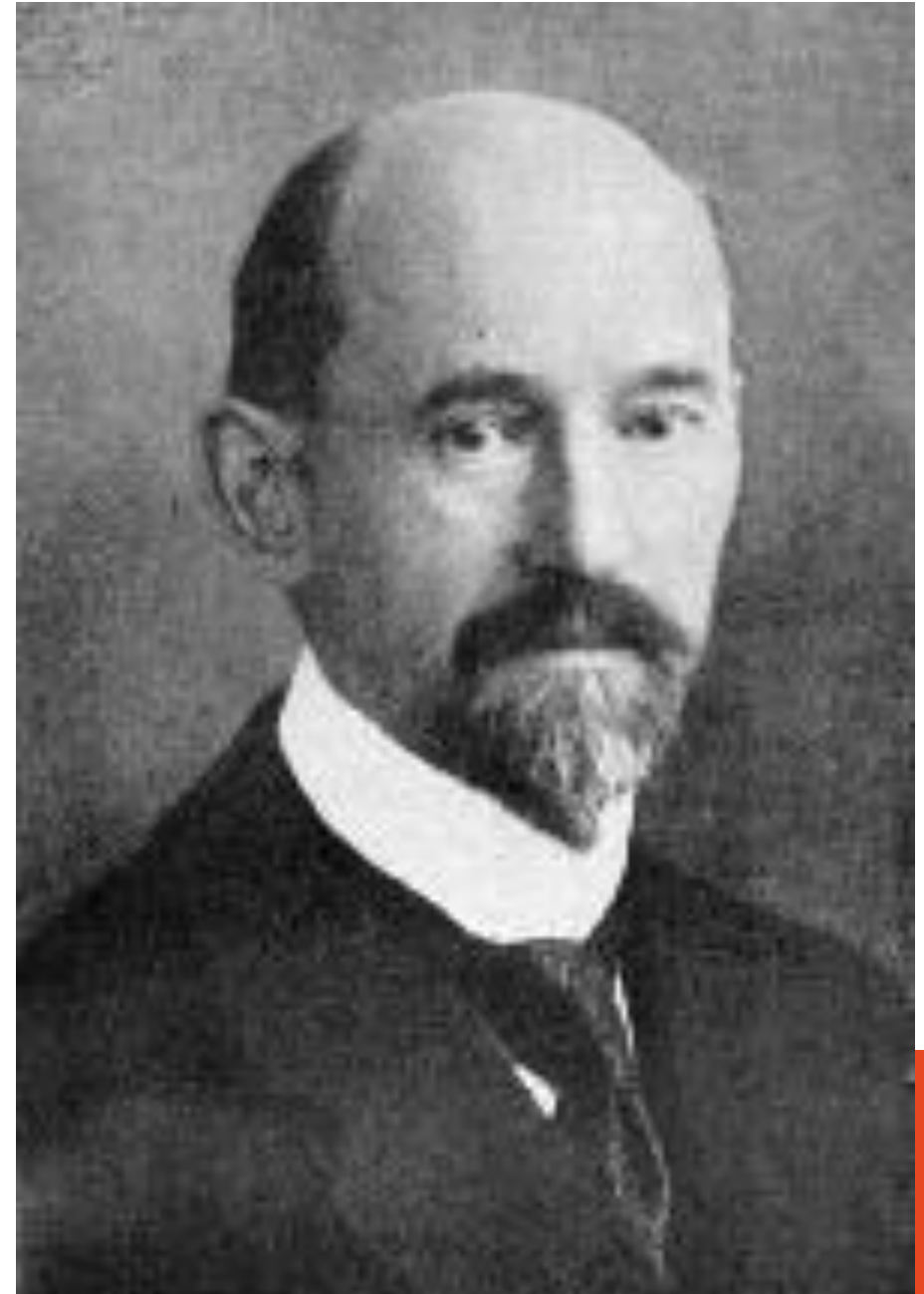
Brodmann Cortical Areas

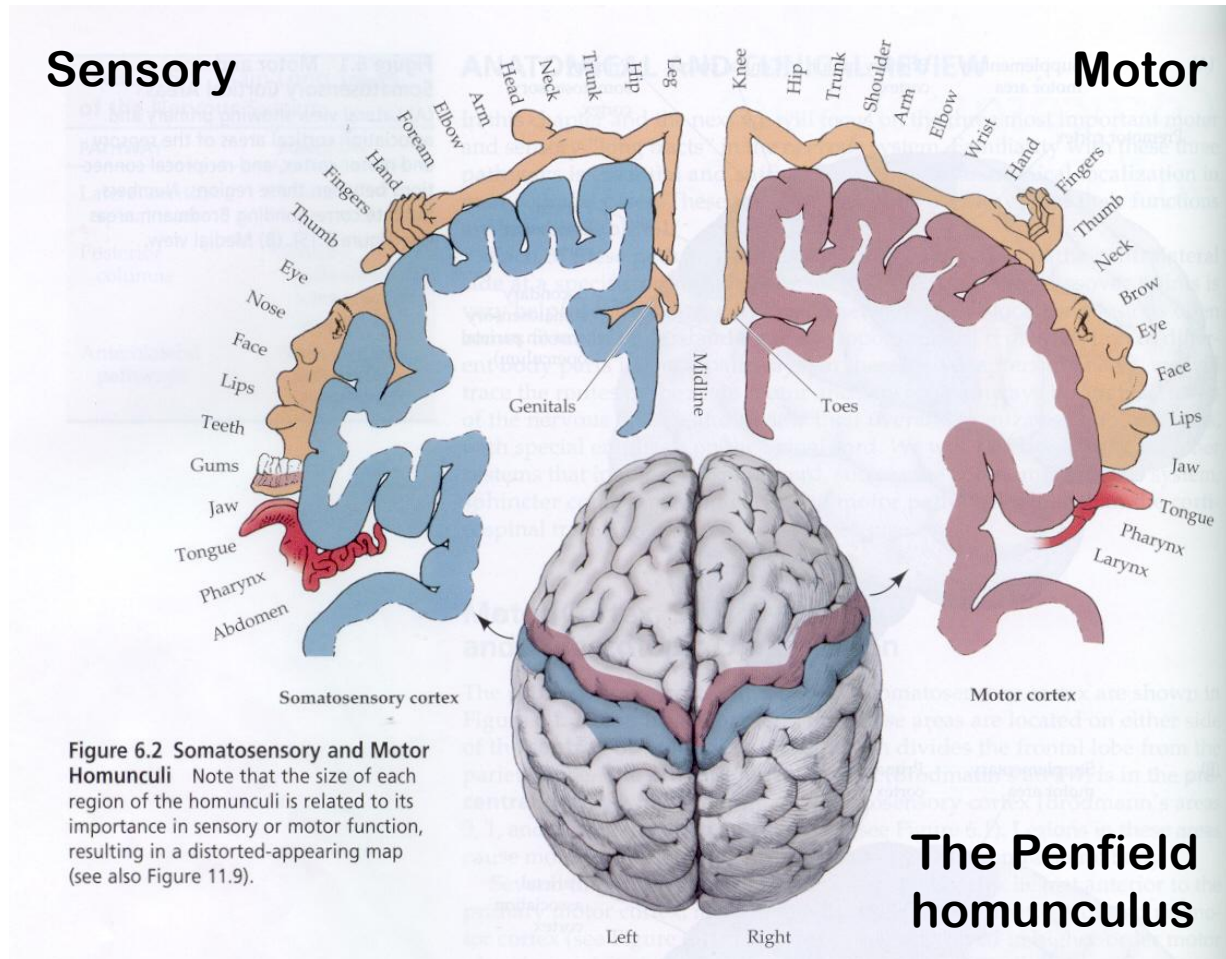
Born in Germany, he devote his life to neurology and psychiatry. In 1900-1901, Brodmann came into contact with Alois Alzheimer (1864-1915) who launched him into his life's work in neuroanatomy. Brodmann is responsible for establishing the basis upon which the present day science of comparative cytoarchitectonics of the mammalian cortex rests. All confusion of brain area nomenclature disappeared with Brodmann's contribution

DR. KORBINIAN BRODMANN
(1868-1918)

From Dep. of Neurology, U. of Illinois

OBJ. # 2 & 3





Cortical Somatotopic Organization

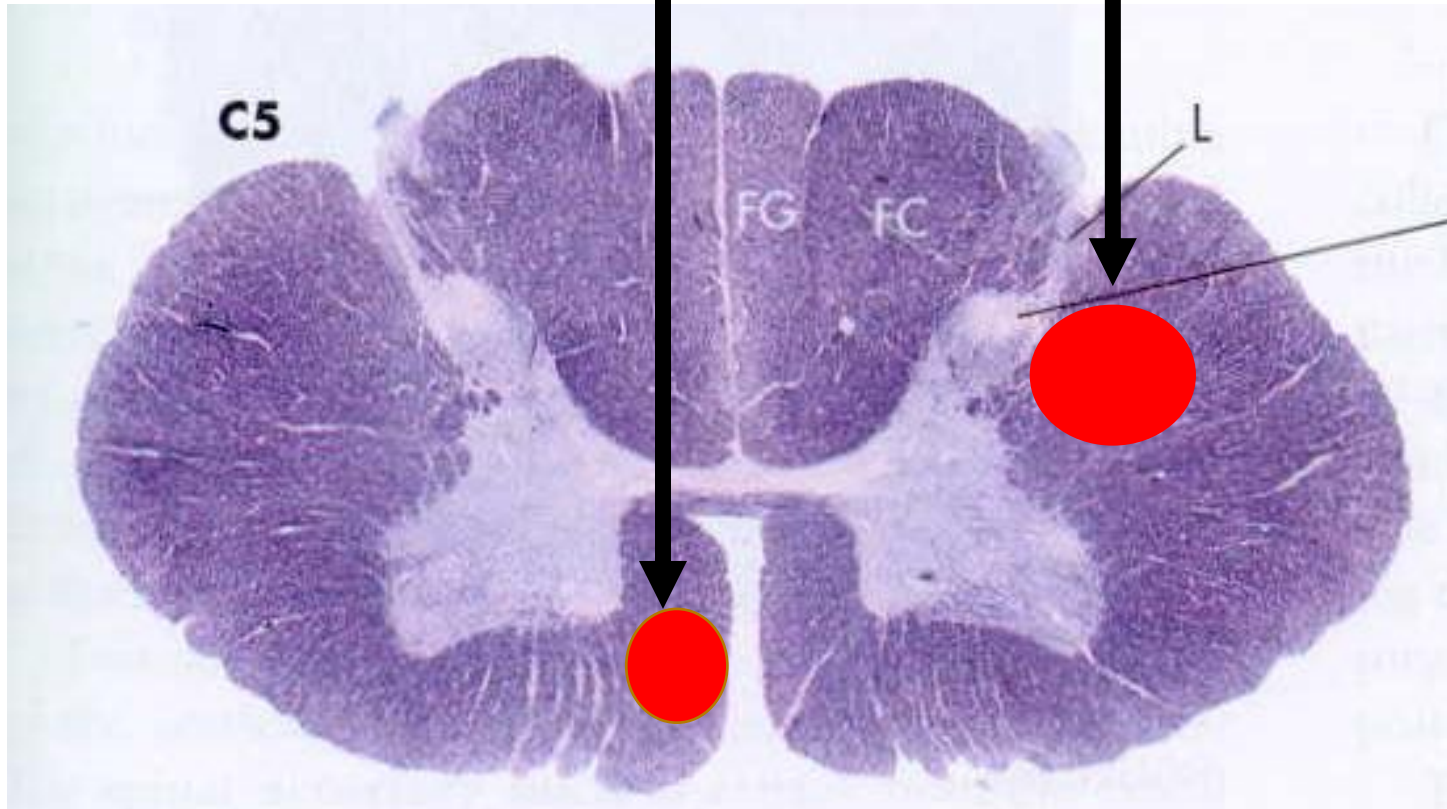
Corticospinal Tract

OBJ. # 2 & 3

- **Originate from Primary Motor Cortex, Supplementary Motor, Premotor, and Somatosensory Cortex**
- **85 % of fibers** decussate at spinomedullary junction **and form the** lateral corticospinal tract **in the spinal cord**
 - **Some of these fibers terminate directly on** α -motor neurons of the ventral horn **at all spinal cord levels for fine control of distal muscles**
 - **Most fibers terminate on** interneurons **at all spinal cord levels**
- **15 % of fibers descend into the spinal cord ipsilaterally and form the** anterior or ventral corticospinal tract
 - **These fibers terminate on** interneurons **at all spinal cord levels**

Medial
corticospinal tract

Lateral corticospinal
tract



Cervical Spinal Cord

OBJ. # 2 & 3

Medial
corticospinal tract

Lateral corticospinal
tract



Cervical Spinal Cord

OBJ. # 2 & 3

Corticobulbar Tracts

OBJ. # 2 & 3

- Originate from Primary Motor Cortex, Supplementary Motor, Premotor, and Somatosensory Cortex
- Fibers descend in the cerebral peduncles and terminate:
 - In the red nucleus ipsilaterally
 - In the pontine nuclei ipsilaterally → Corticopontine fibers
 - In the motor nuclei of the reticular formation, bilaterally at all brainstem levels
 - In the motor nuclei of cranial nerves:

CN V → Motor nucleus, bilaterally

CN VII → Facial motor nucleus

- Bilateral for forehead area
- Contralateral for lower face area

CN IX and X → Nucleus ambiguus, predominantly contralateral

CN XI → Predominantly contralateral

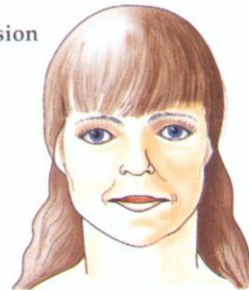
CN XII → Predominantly contralateral

Cortical Innervation of the Facial Nucleus

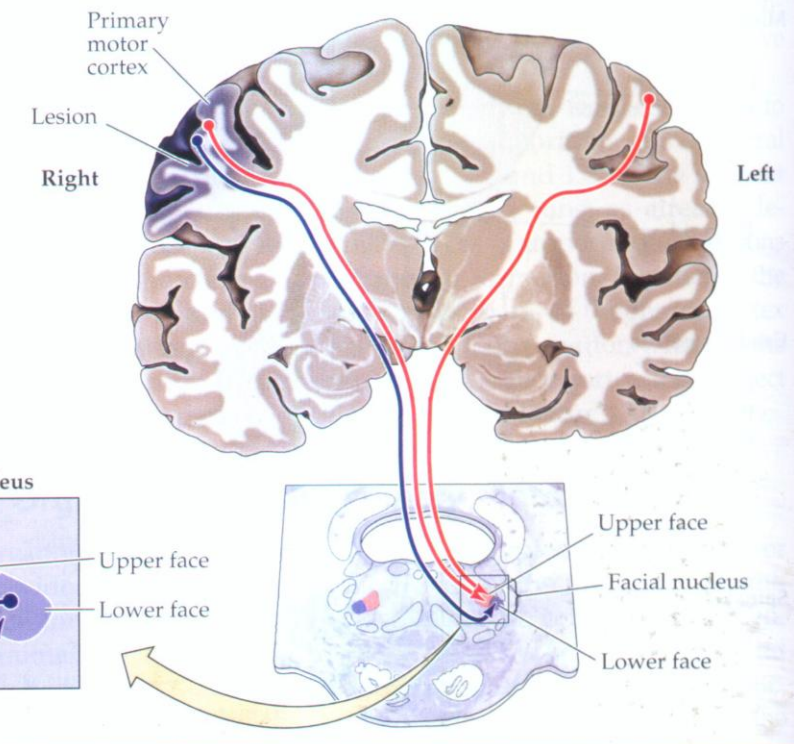
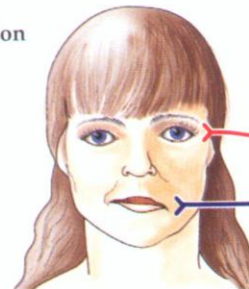
Very important clinically to differentiate an upper vs. lower motor neuron lesion

Organization of projections from the primary motor cortex to the motor nucleus of the facial nerve.

Before lesion



After lesion





The Brainstem – Spinal Cord Connection



Descending Motor Pathway From the Brainstem

OBJ. # 4

There are 4 main fiber tracts that originate in the brainstem and innervate spinal cord neurons:

- Rubrospinal tract
- Reticulospinal tract
- Vestibulospinal tract
- Tectospinal tract

Descending Motor Pathway

OBJ. # 4

Tracts from the brainstem to the spinal cord

- **Rubrospinal tract:** Originates in the red nucleus and terminates in the spinal cord contralaterally
- **Vestibulospinal tracts:** Originates in the vestibular nuclei
 - **Lateral vestibulospinal tract:** From lateral vestibular nucleus, ipsilaterally to all levels of the spinal cord
 - **Medial vestibulospinal tract:** Mostly from medial vestibular nucleus bilaterally to cervical spinal cord levels. Travels with MLF
- **Reticulospinal tracts:** From the reticular formation to the spinal cord
- **Tectospinal tract:** From the superior colliculi to the spinal cord contralaterally



Descending Motor Pathway

OBJ. # 5

There are 2 major motor pathways to the spinal cord

- **The lateral motor system:**
Lateral Corticospinal Tract
Rubrospinal Tract
- **The anterior, medial, or ventral motor system:**
Medial Corticospinal Tract
Reticulospinal Tract
Vestibulospinal Tract
Tectospinal Tract

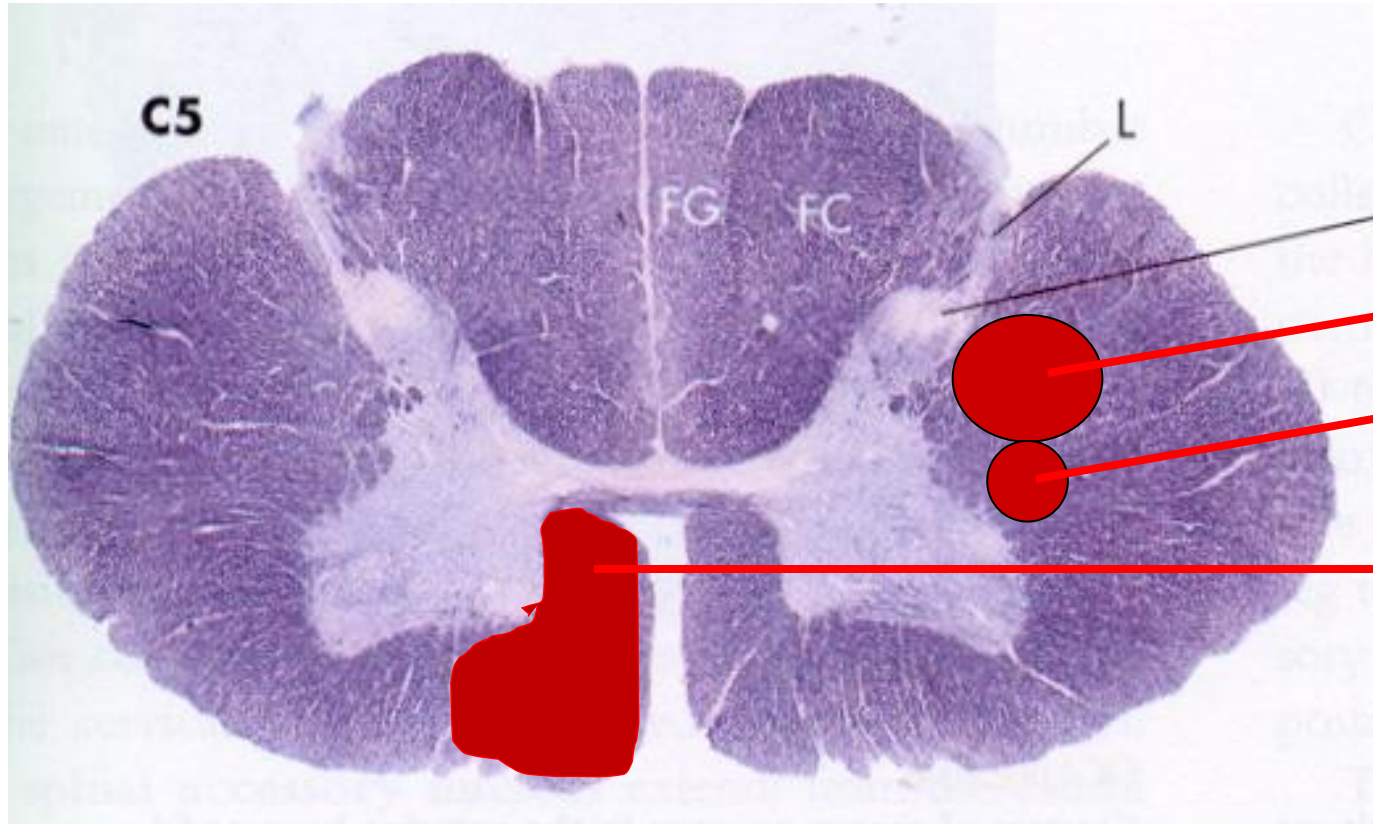
There is 1 major motor pathways to the brainstem

- **The corticobulbar tract that includes the corticopontine fibers**



Spinal Cord

OBJ. # 5



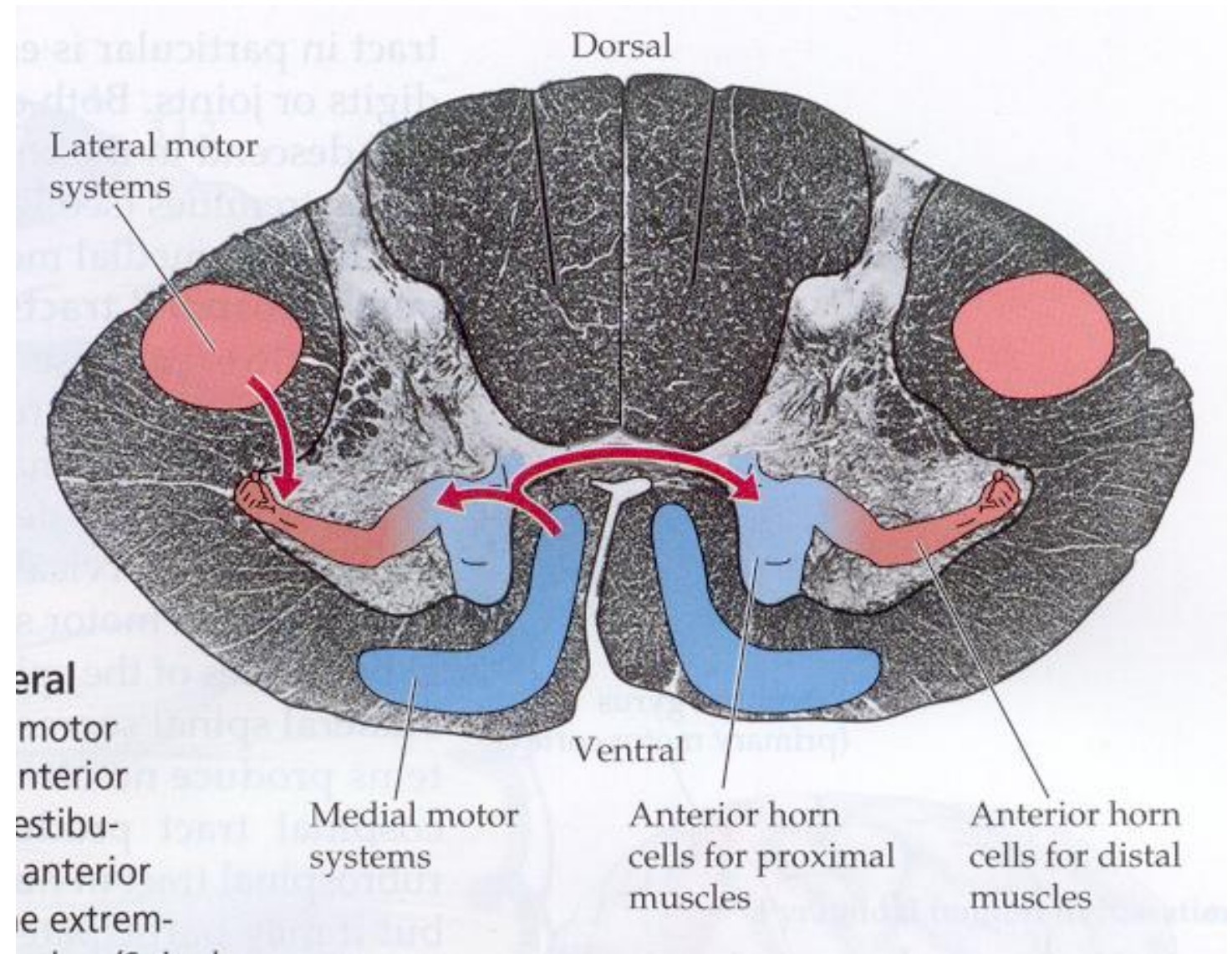
Lateral Corticospinal tract

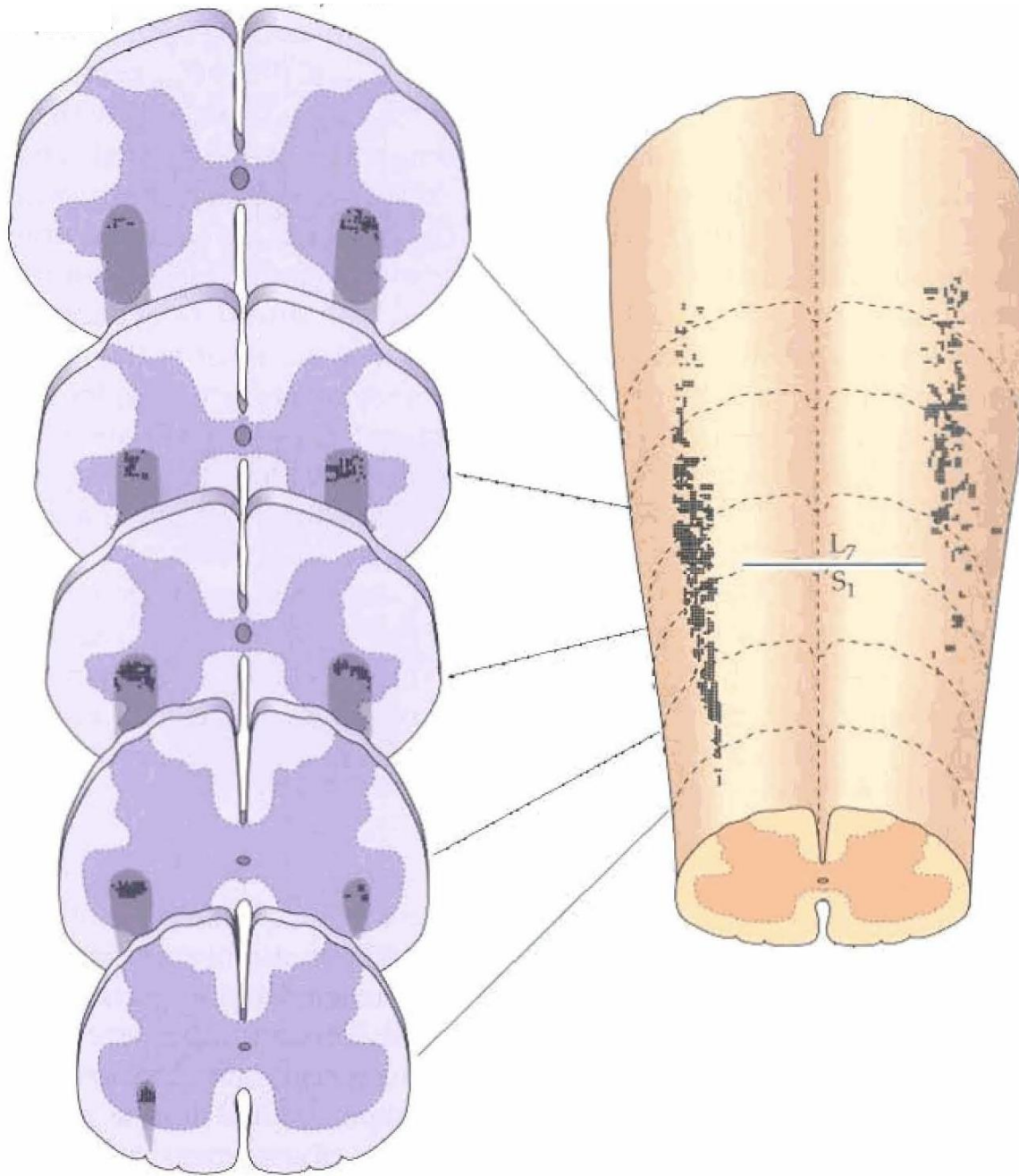
Rubrospinal tract

Anterior or ventral motor System:
reticulospinal tracts; vestibulospinal
tracts; tectospinal tracts and
anterior corticospinal tracts

Somatotopic Organization of Motor Neurons in the Spinal Cord

OBJ. # 6





The collection of α -motor neurons that innervate a single muscle or group of muscles is called a **motor neuron pool**

OBJ. # 6