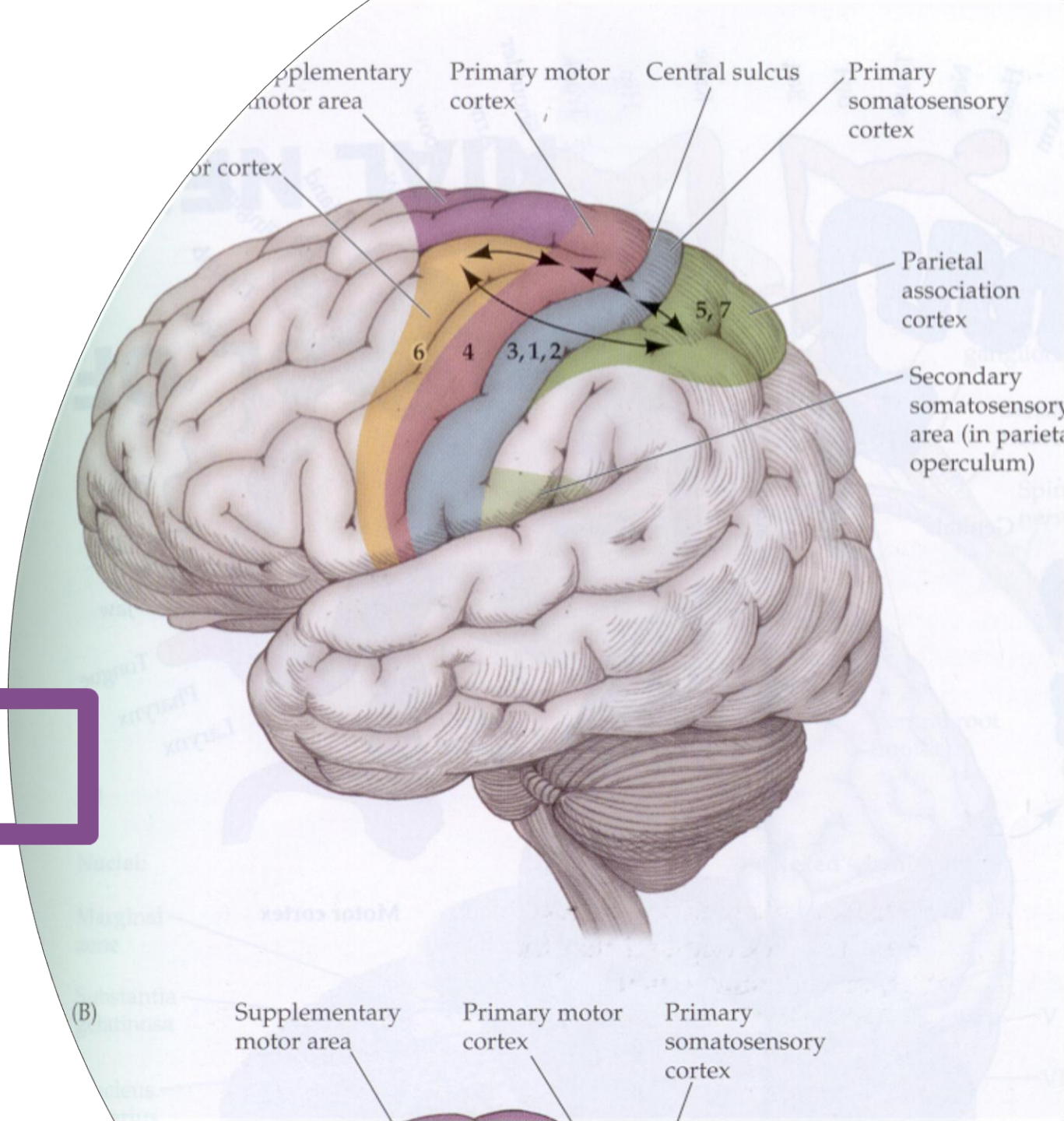
The Motor Pathways



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 → **Controlled by the cortex**
- Visceral or Autonomic → **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

OBJ. # 2 & 3

Descending Pathways From the Cortex

tract named for where they start and then where they go

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

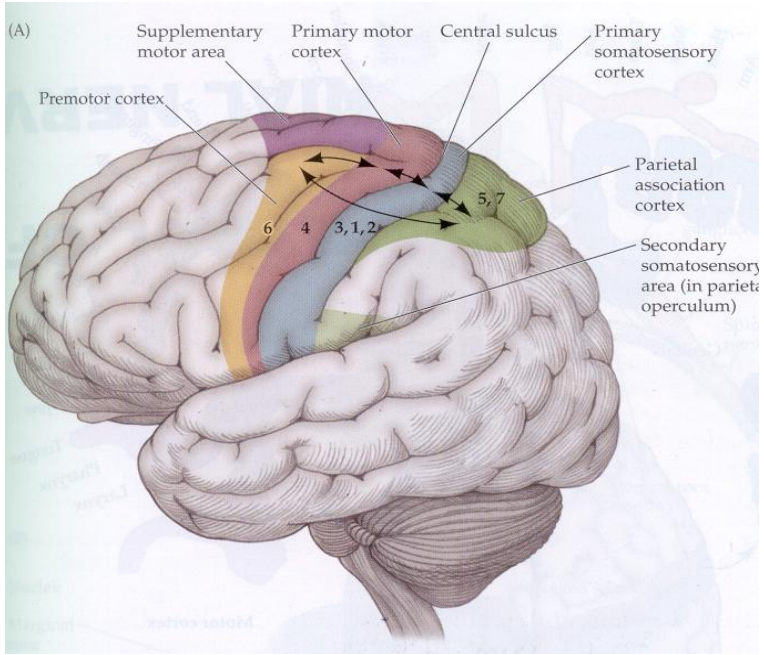
Descending Motor Pathway

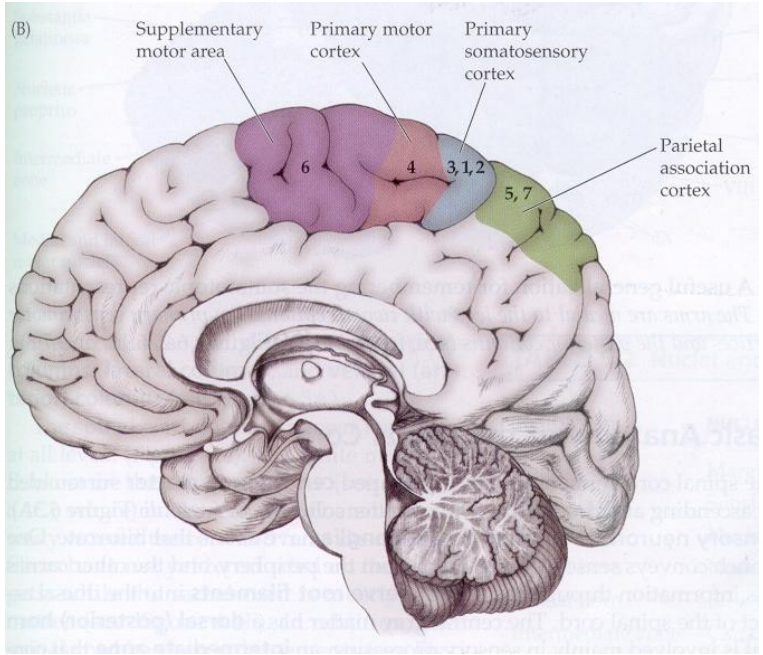
OBJ. # 2 & 3

Tracts from the cortex (betz cells)		TRACTS ORIGIN: these are the places in the cerebral cortex where all corticospinal and corticobulbar fibers originate
Corticospinal →	To the Spinal Cord	**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
Corticobulbar →	To the Brainstem	**35 % of fibers** • Primary sensory cortex / Brodmann's areas 3,1,2, postcentral gyrus
Corticopontine →	To the pons	**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

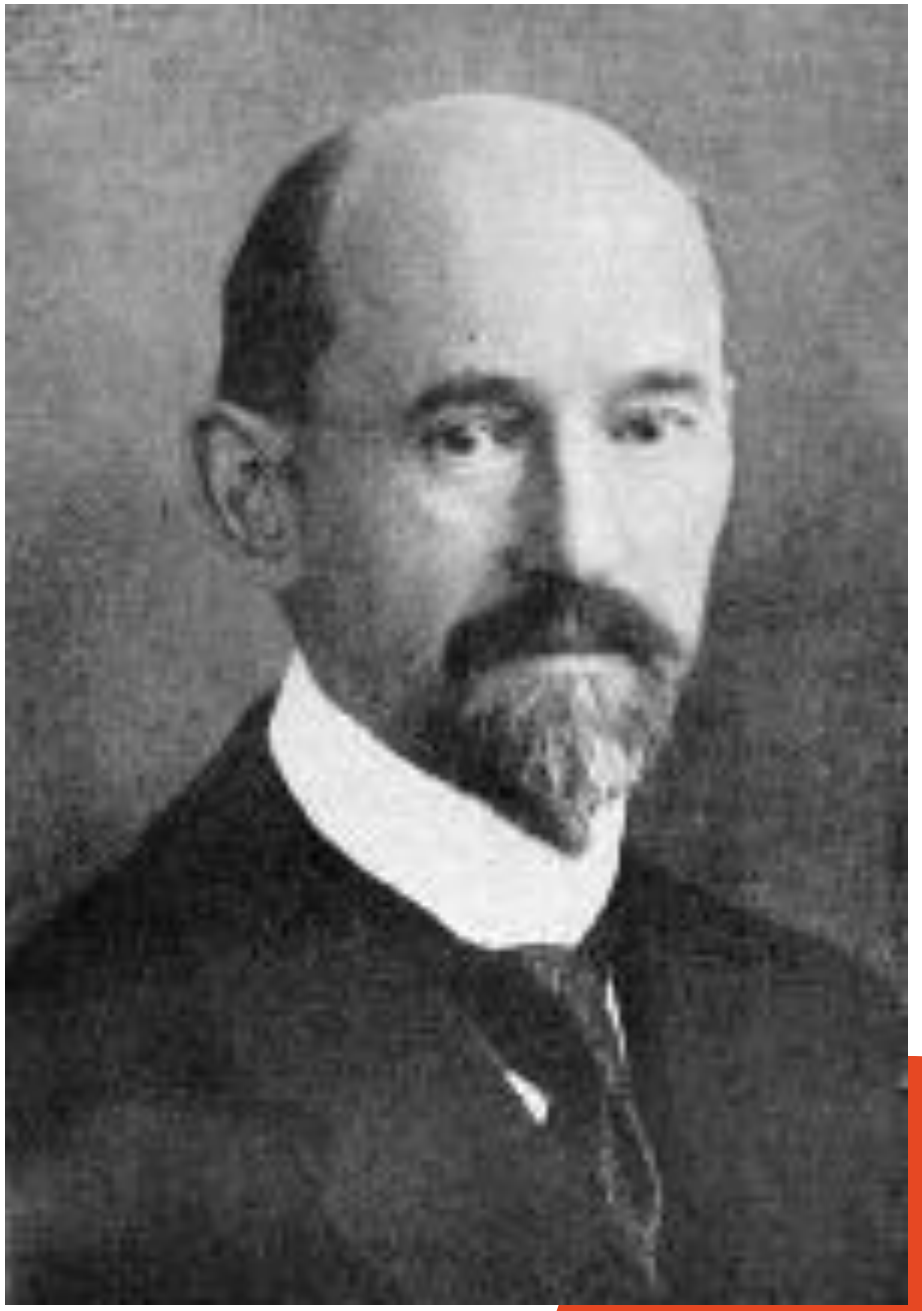
Brodmann's area 6 – Pre-motor and supplementary motor cortex

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



OBJ. # 2 & 3

Cortical Somatotopic Organization

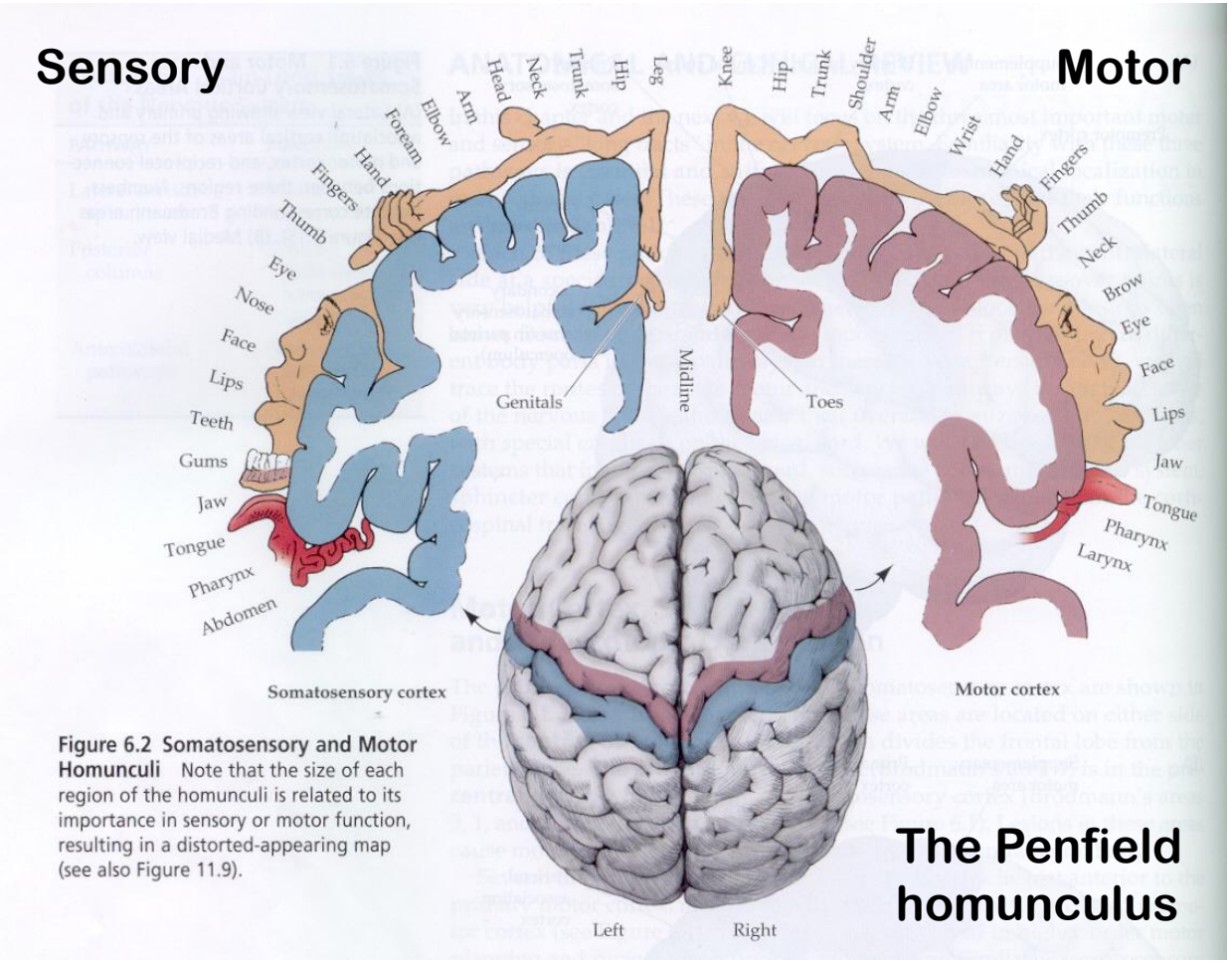


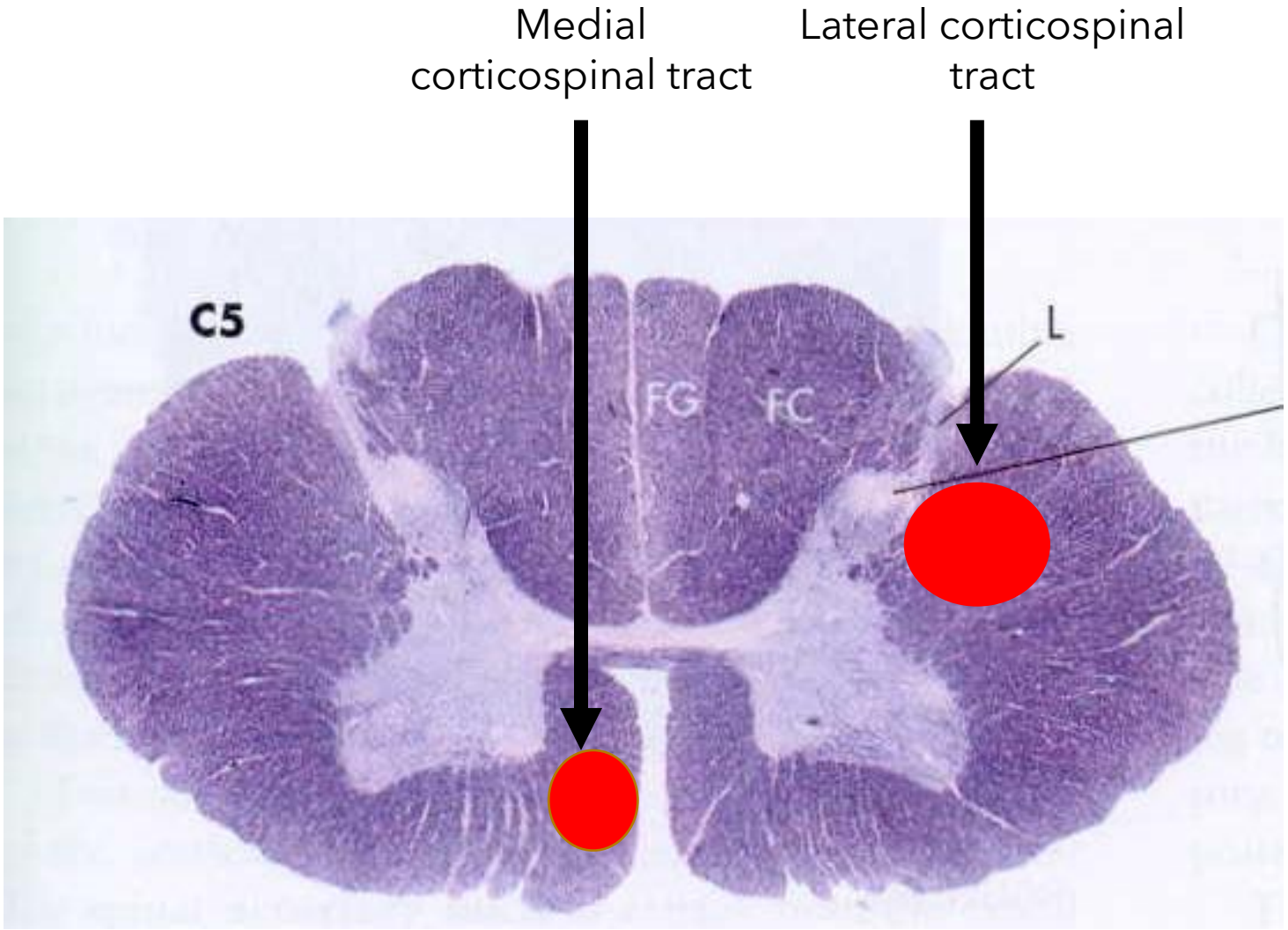
Figure 6.2 Somatosensory and Motor Homunculi Note that the size of each region of the homunculi is related to its importance in sensory or motor function, resulting in a distorted-appearing map (see also Figure 11.9).

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**

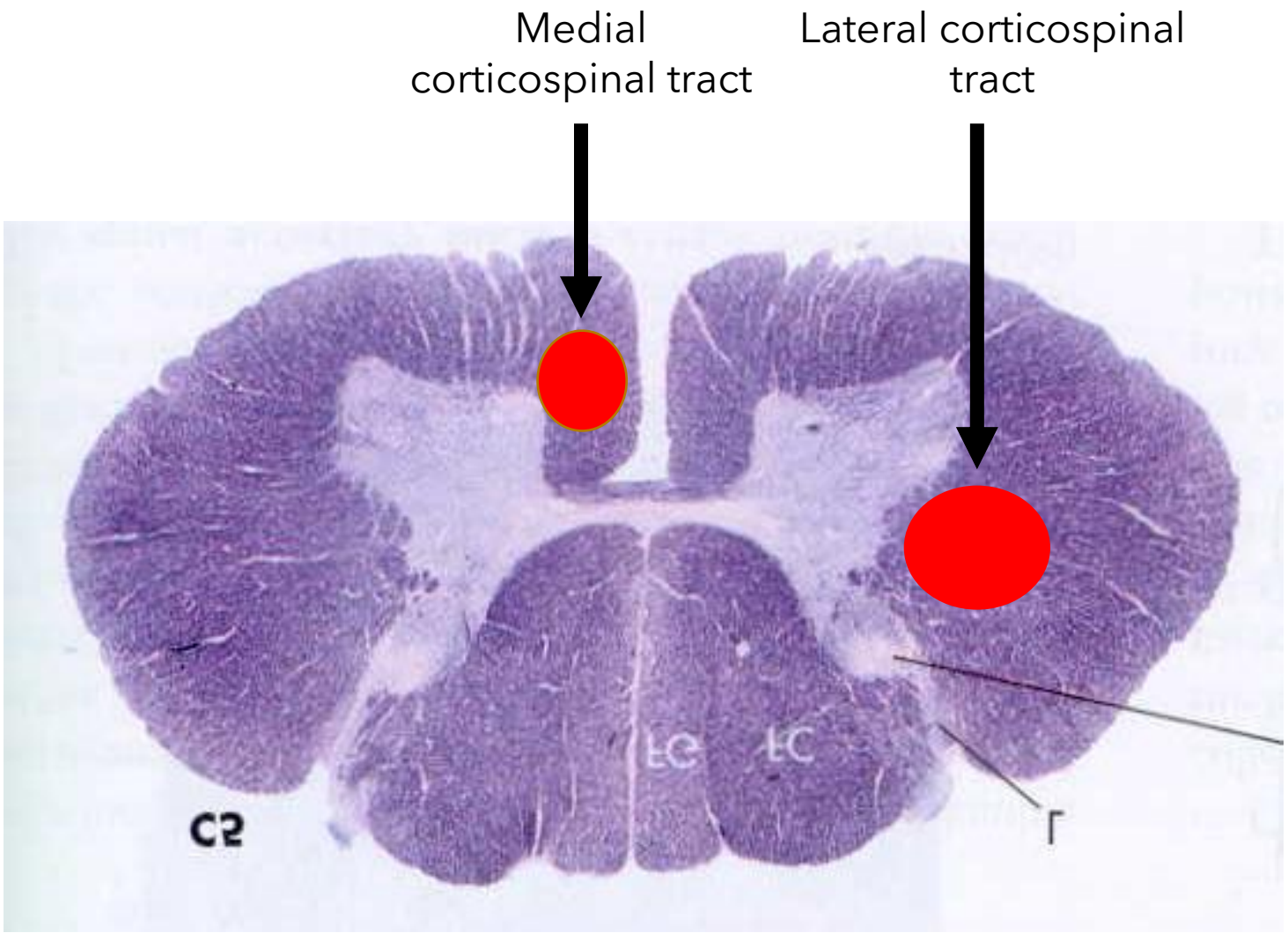
pyramidal decussation



Cervical Spinal Cord

OBJ. # 2 & 3

clinical - sitting at pt feet looking up



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:

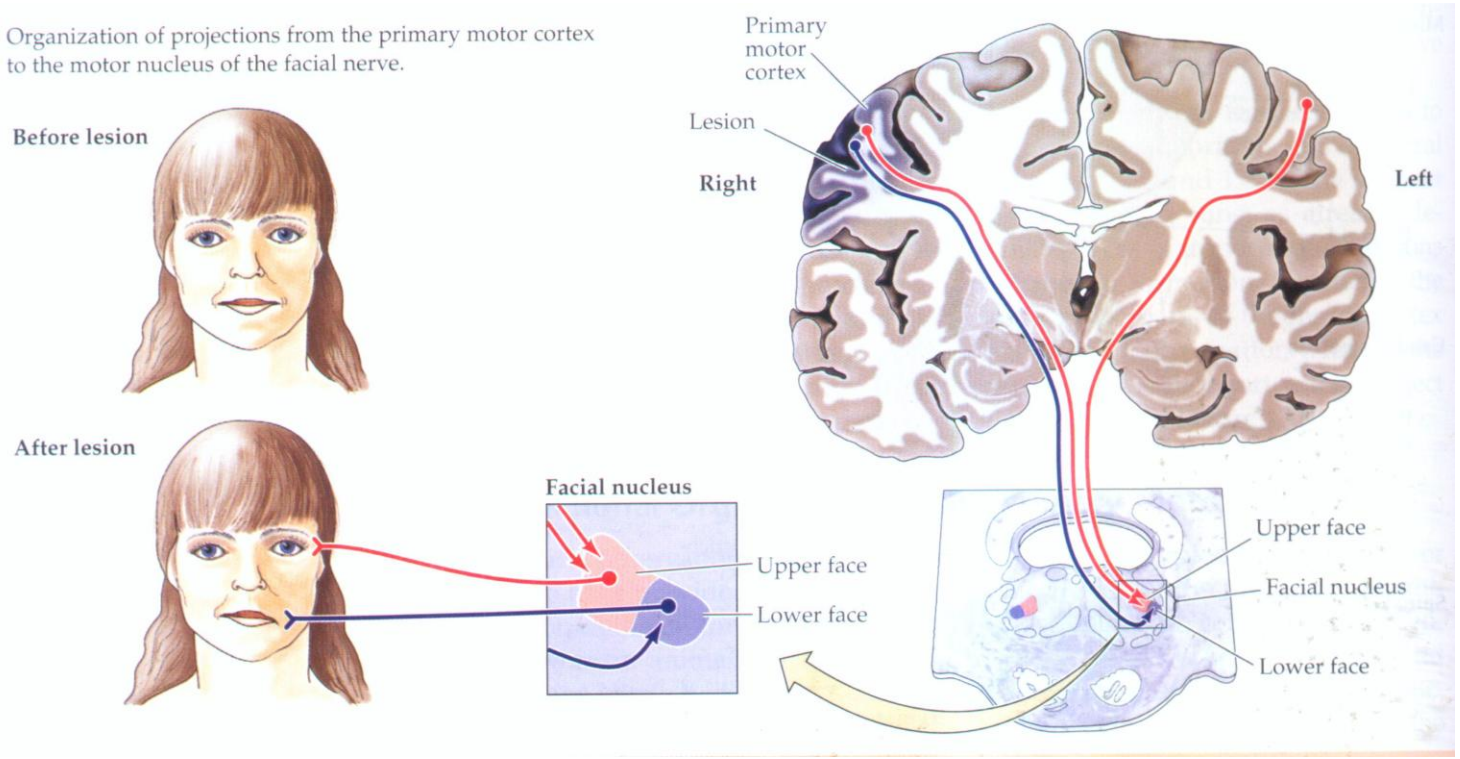
CN V	→	Motor nucleus, bilaterally
CN VII	→	Facial motor nucleus → Bilateral for forehead area; Contralateral for lower face area
CN IX and X	→	Nucleus ambiguus, predominantly contralateral
CN XI	→	Predominantly contralateral
CN XII	→	Predominantly contralateral

OBJ. # 2 & 3

Cortical Innervation of the Facial Nucleus

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

forehead-sparing lesion bc forehead gets bilateral innervation (redundancy)



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

damage to one location becomes less conspicuous

be familiar with trajectory

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 mostly extensor muscles
  - **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

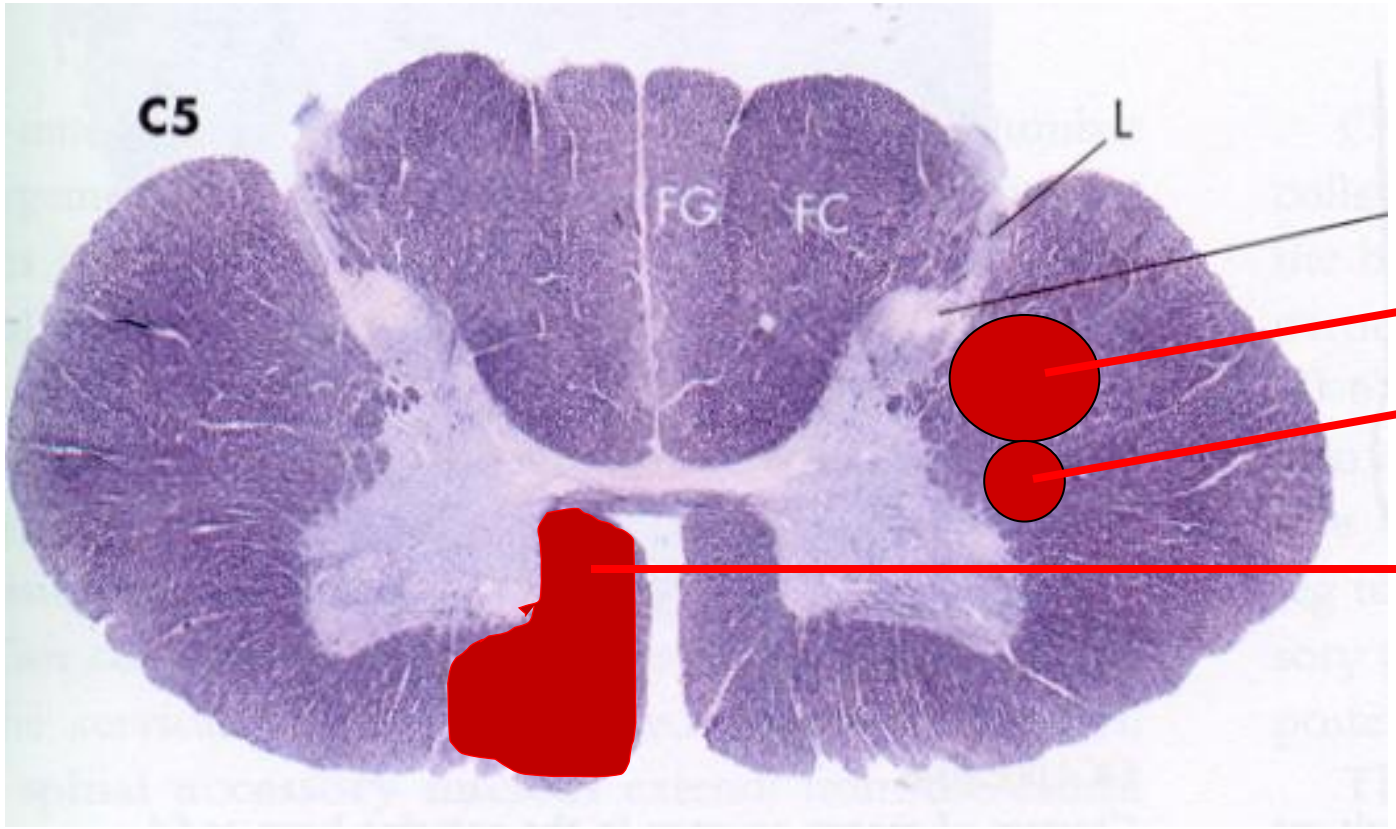
- **The lateral motor system:**
  Lateral Corticospinal Tract
  Rubrospinal Tract
- **The anterior, medial, or ventral motor system:**
  Medial Corticospinal Tract
  Reticulospinal Tract
  Vestibulospinal Tract
  Tectospinal Tract

There is 1 major motor pathways to the brainstem

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

Spinal Cord

OBJ. # 5



Lateral Corticospinal tract

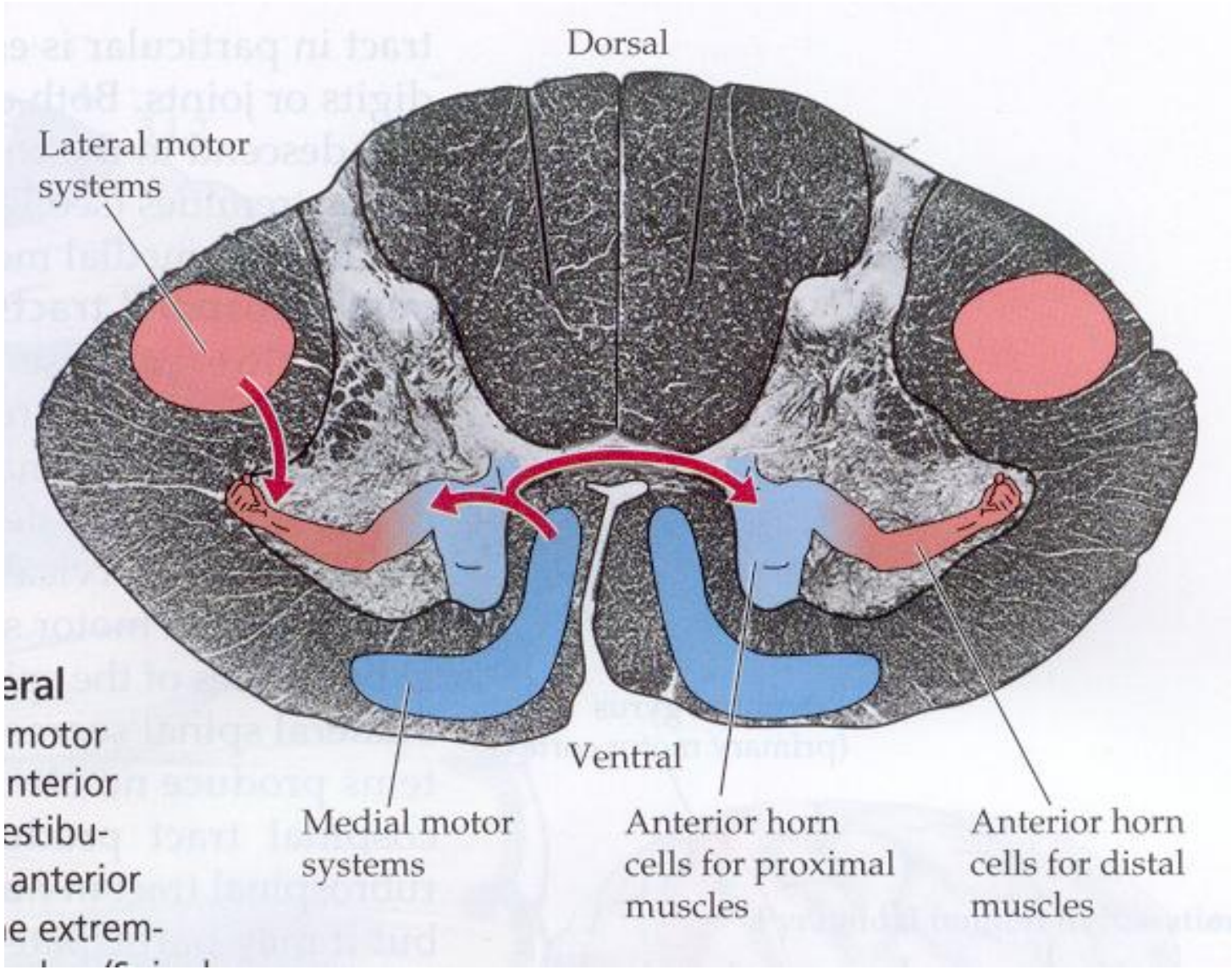
Rubrospinal tract

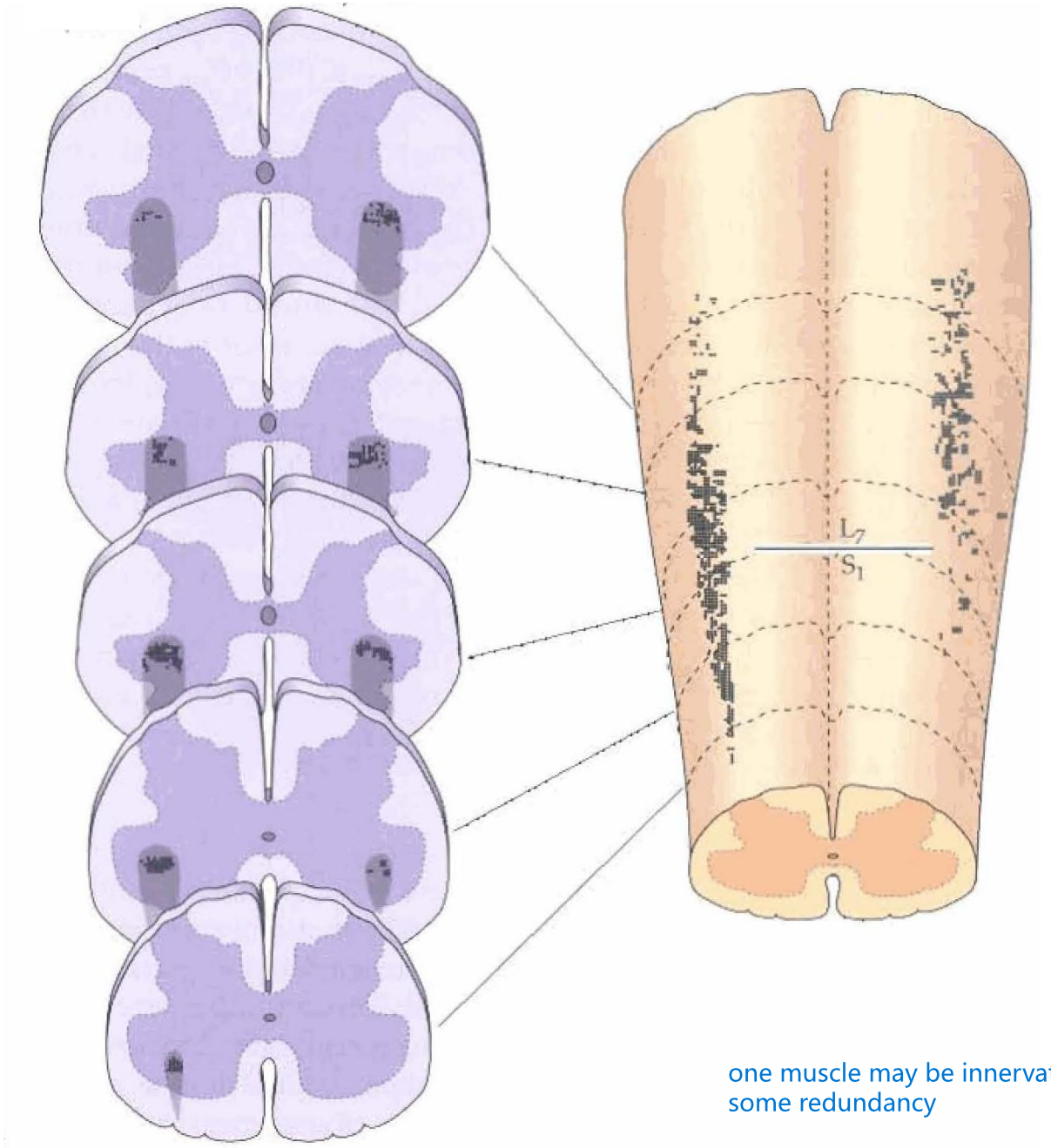
Anterior or ventral motor System: reticulospinal tracts; vestibulospinal tracts; tectospinal tracts and anterior corticospinal tracts

Somatotopic Organization of Motor Neurons in the Spinal Cord

OBJ. # 6

lateral parts = LCST
medial parts = more medial





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

OBJ. # 6

one muscle may be innervated by several spinal levels - weakness but not paralysis if there is weakness to the ne
some redundancy