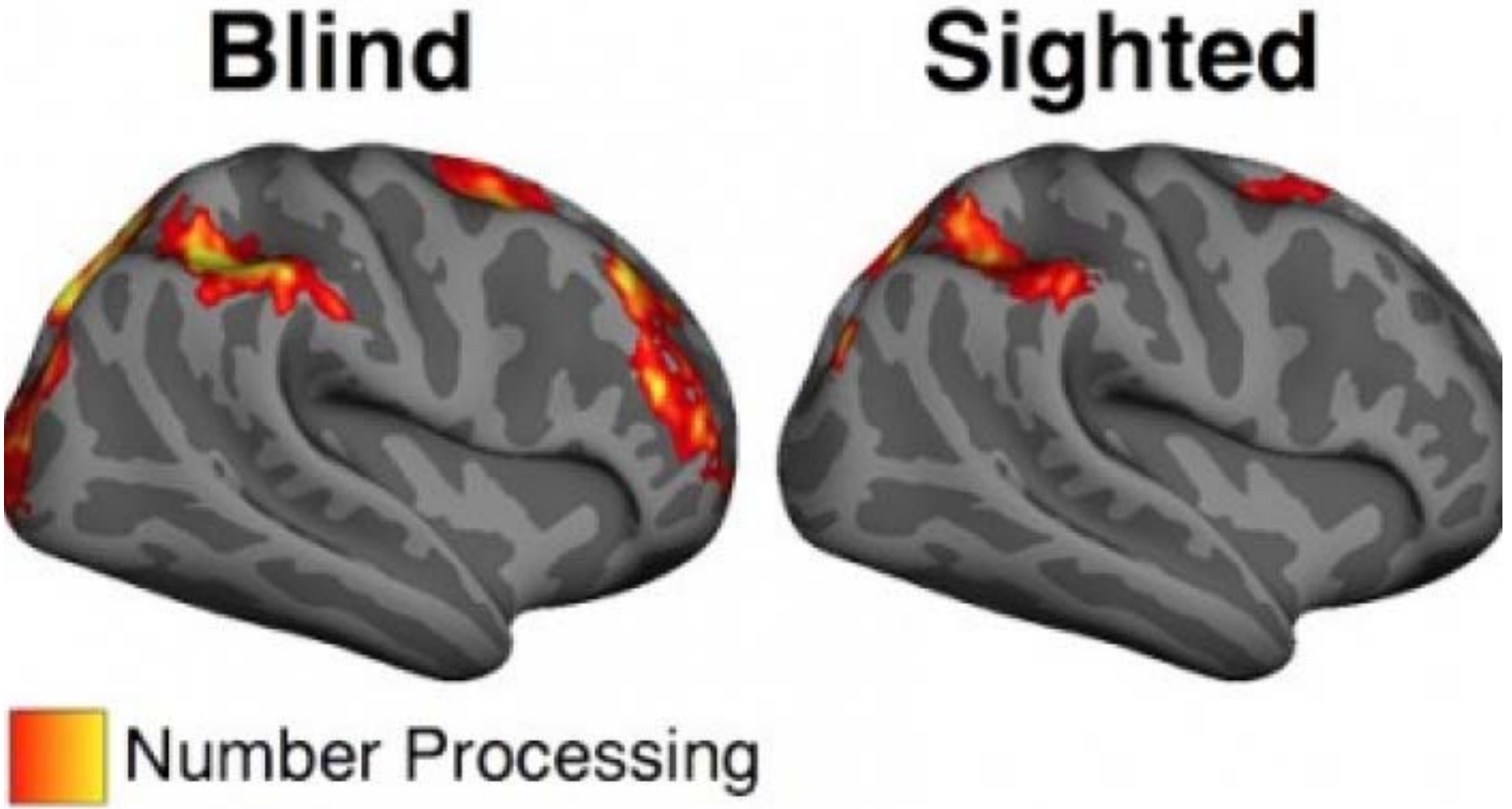
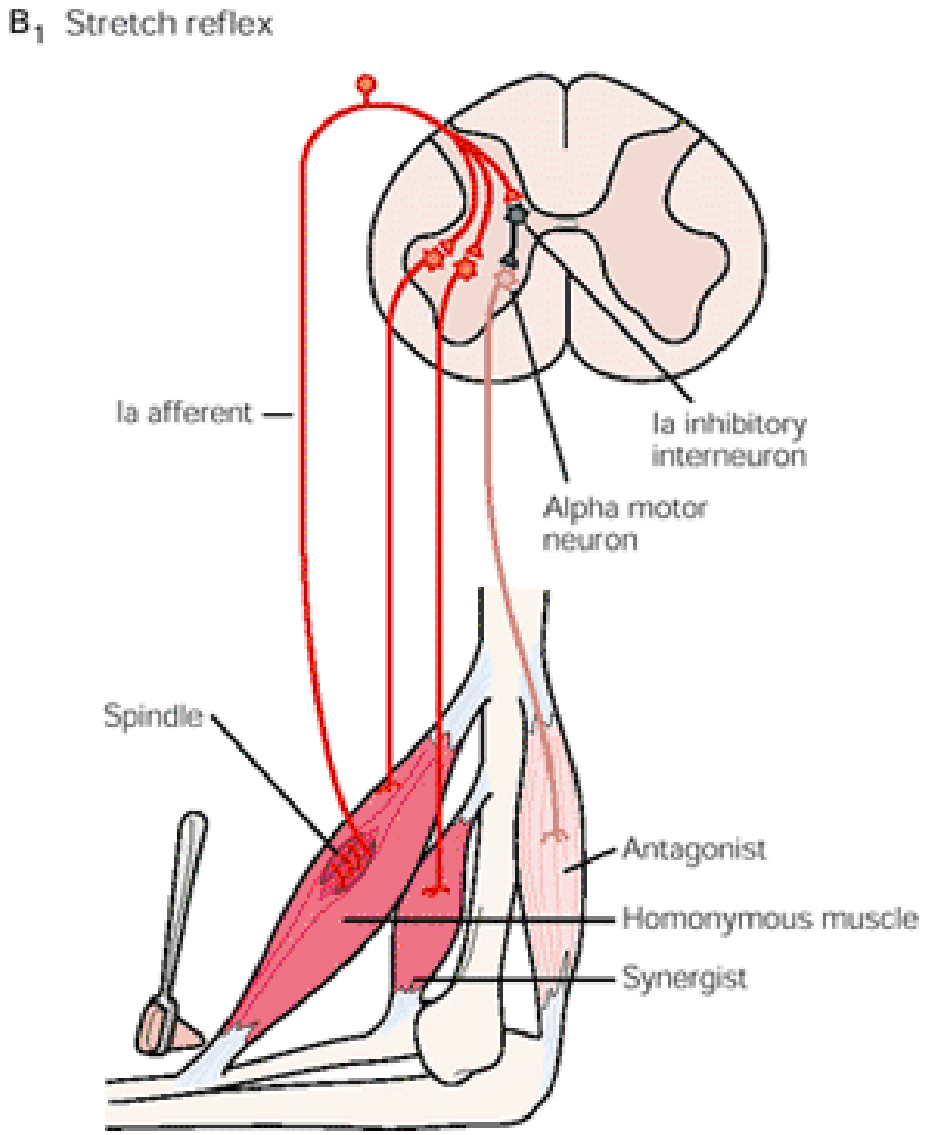
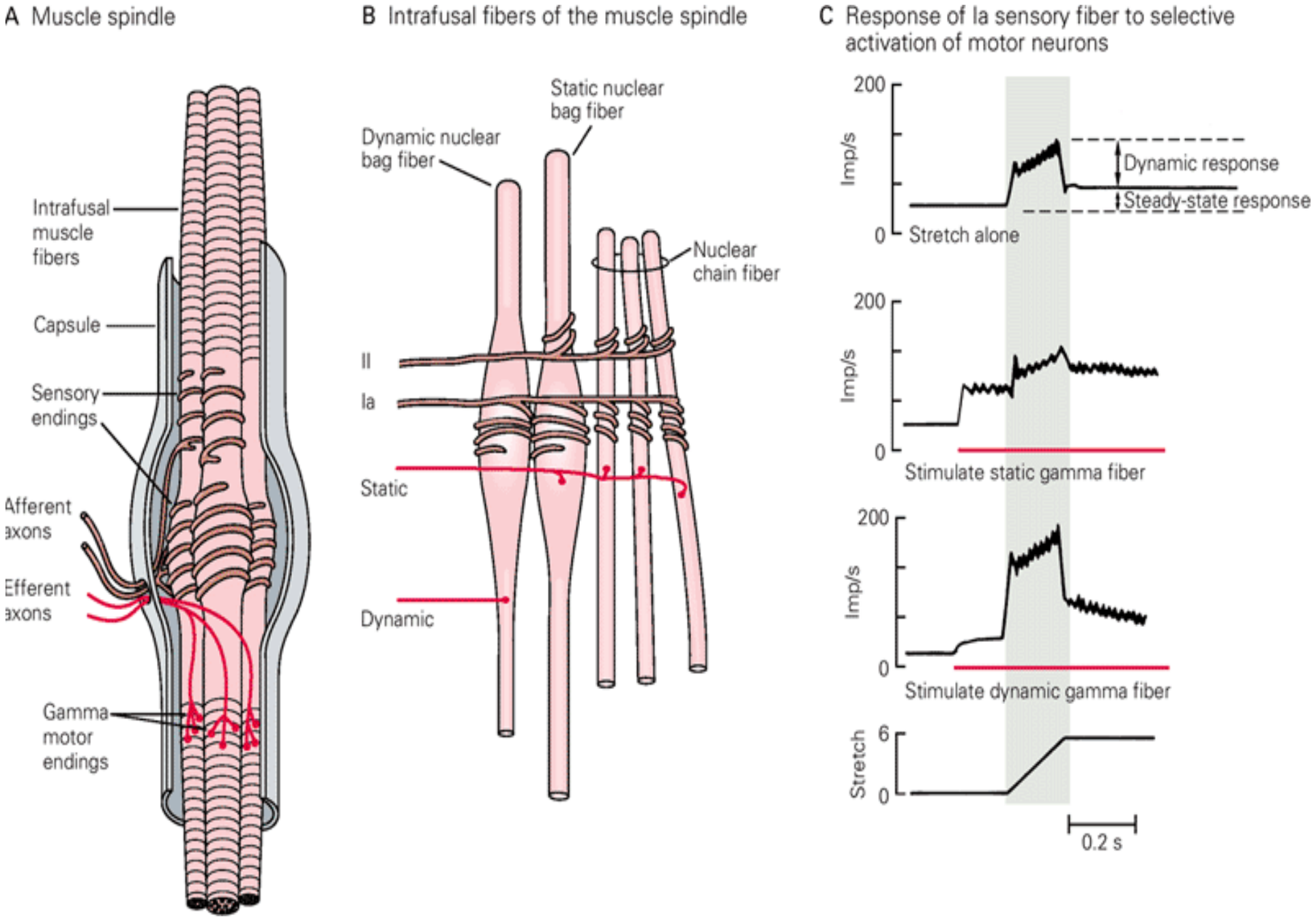
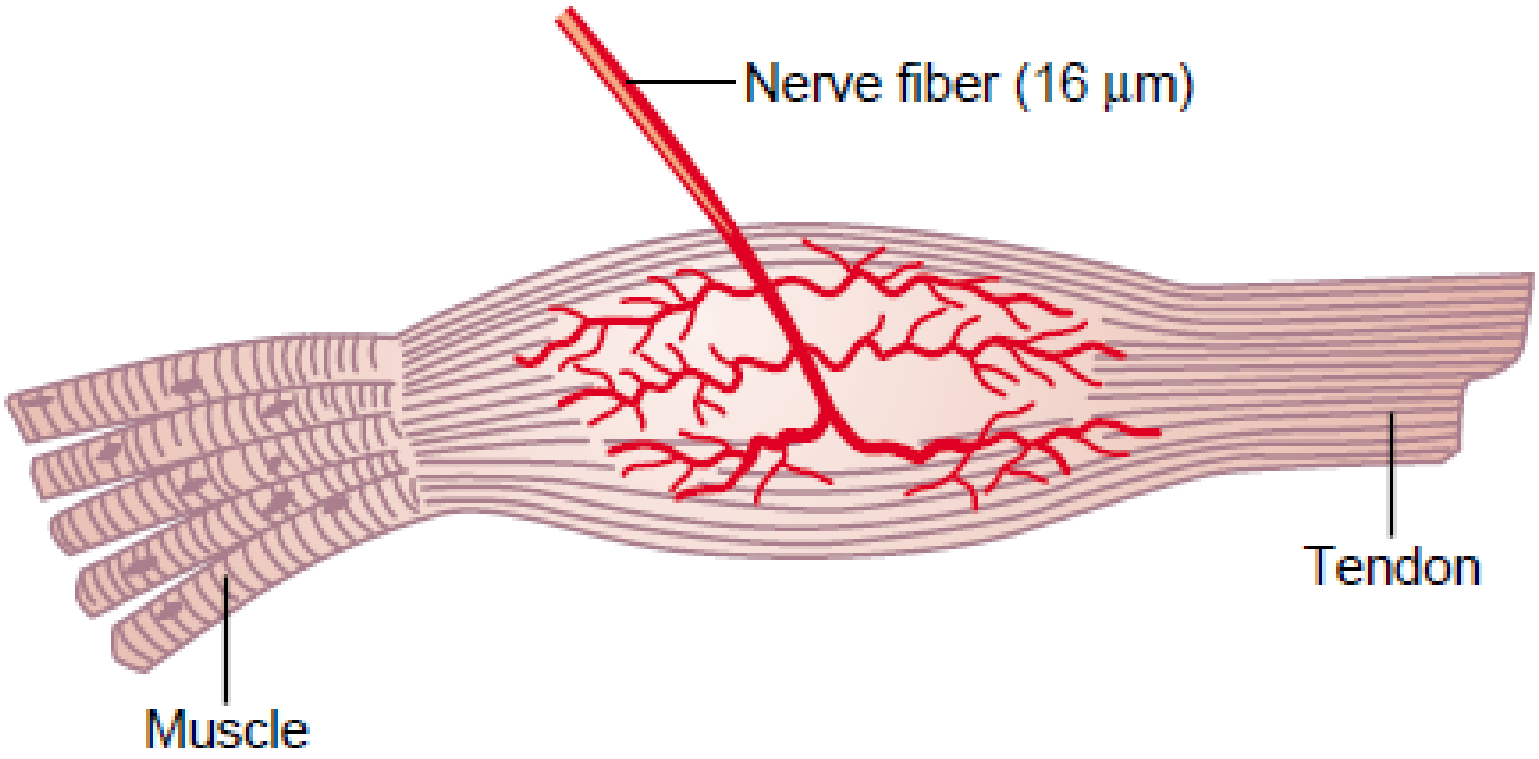
Blind since childhoodclip Marvels Daredevil - Season 1 (1).mp4-.mp4


Blind
Sighted
Number Processing

Stretch Reflex




A Muscle spindle
Intrafusal muscle fibers
Capsule
Sensory endings
Afferent axons
Efferent axons
Gamma motor endings
B Intrafusal fibers of the muscle spindle
Static nuclear bag fiber
Dynamic nuclear bag fiber
Nuclear chain fiber
II
Ia
Static
Dynamic
C Response of Ia sensory fiber to selective activation of motor neurons
200
Imp/s
0
Dynamic response
Steady-state response
Stretch alone
Stimulate static gamma fiber
Stimulate dynamic gamma fiber
Stretch
6
0
0.2 s

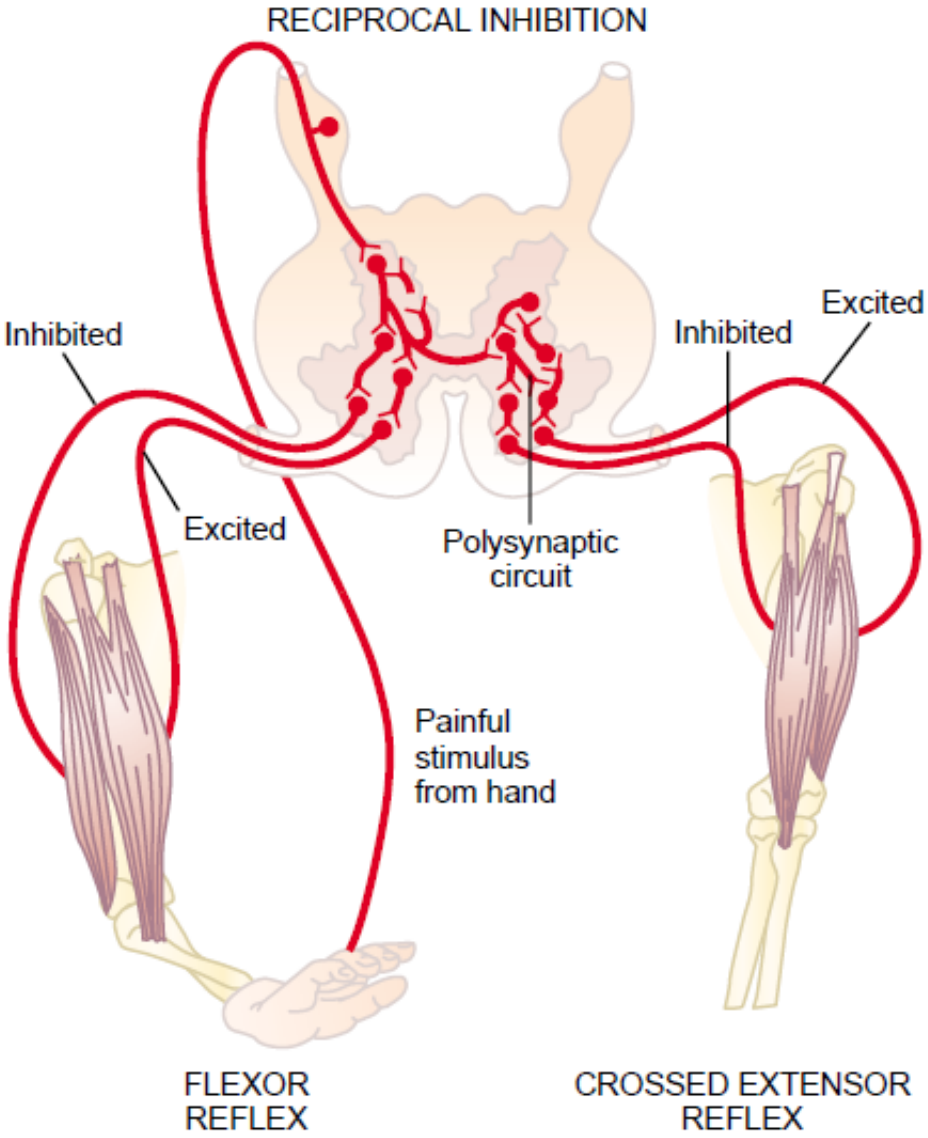

Nerve fiber (16 µm)
Tendon
Muscle

- Reflex arc –components and properties
- Flexor reflex/withdrawal reflex
- Crossed extensor reflex
- Muscle tone
- Clonus
- Renshaw cell inhibition

Stretch reflex

- Stabilization of joints during movement
- Damping function
- Antigravity muscles
- Feedback to higher centres –spino cerebellar and spinoreticular tracts
- Maintenance of length

Withdrawal reflex



WR…

- Divergence
- Reciprocal innervations
- After discharge

Movement

- Reflexes
- Rhythmic movement &
- Voluntary movement

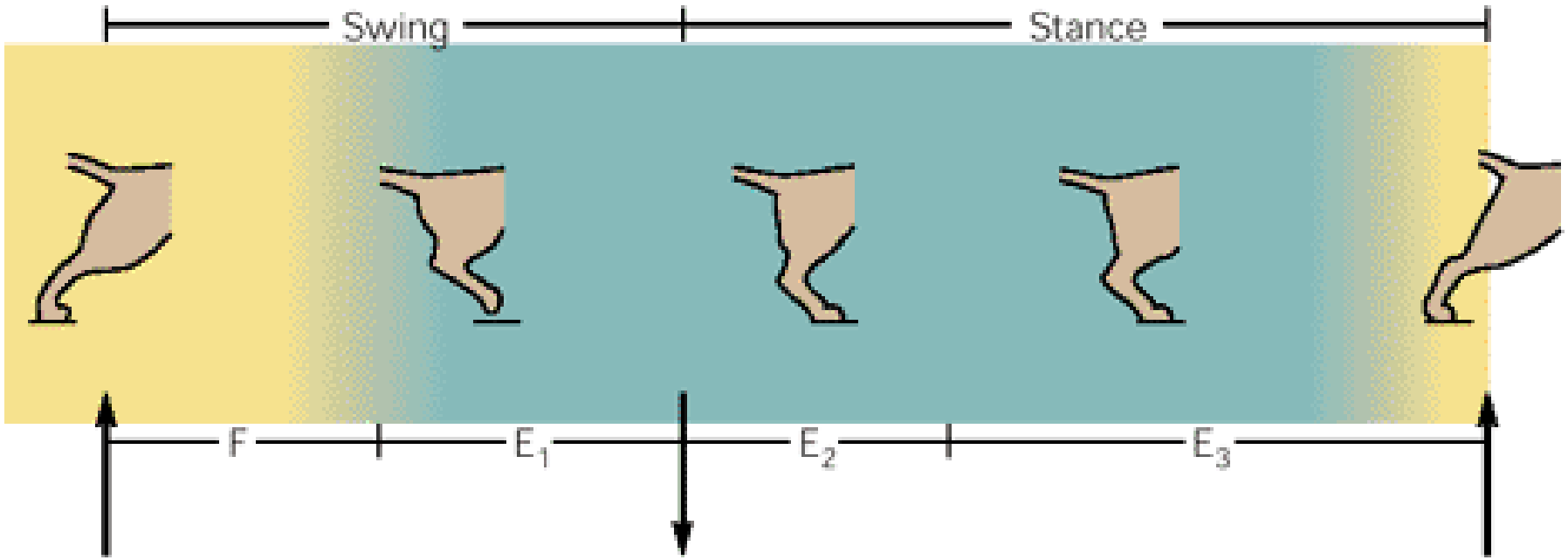
STEPPING

- **Step cycles in cat and humans**
- Four distinct phases
- Flexion (F)
- First Extension(E1)
- Second Extension (E2)
- Third Extension (E3)
- **F and E1- Swing phase – foot is off ground**
- **Rest – Stance – foot in contact with ground**

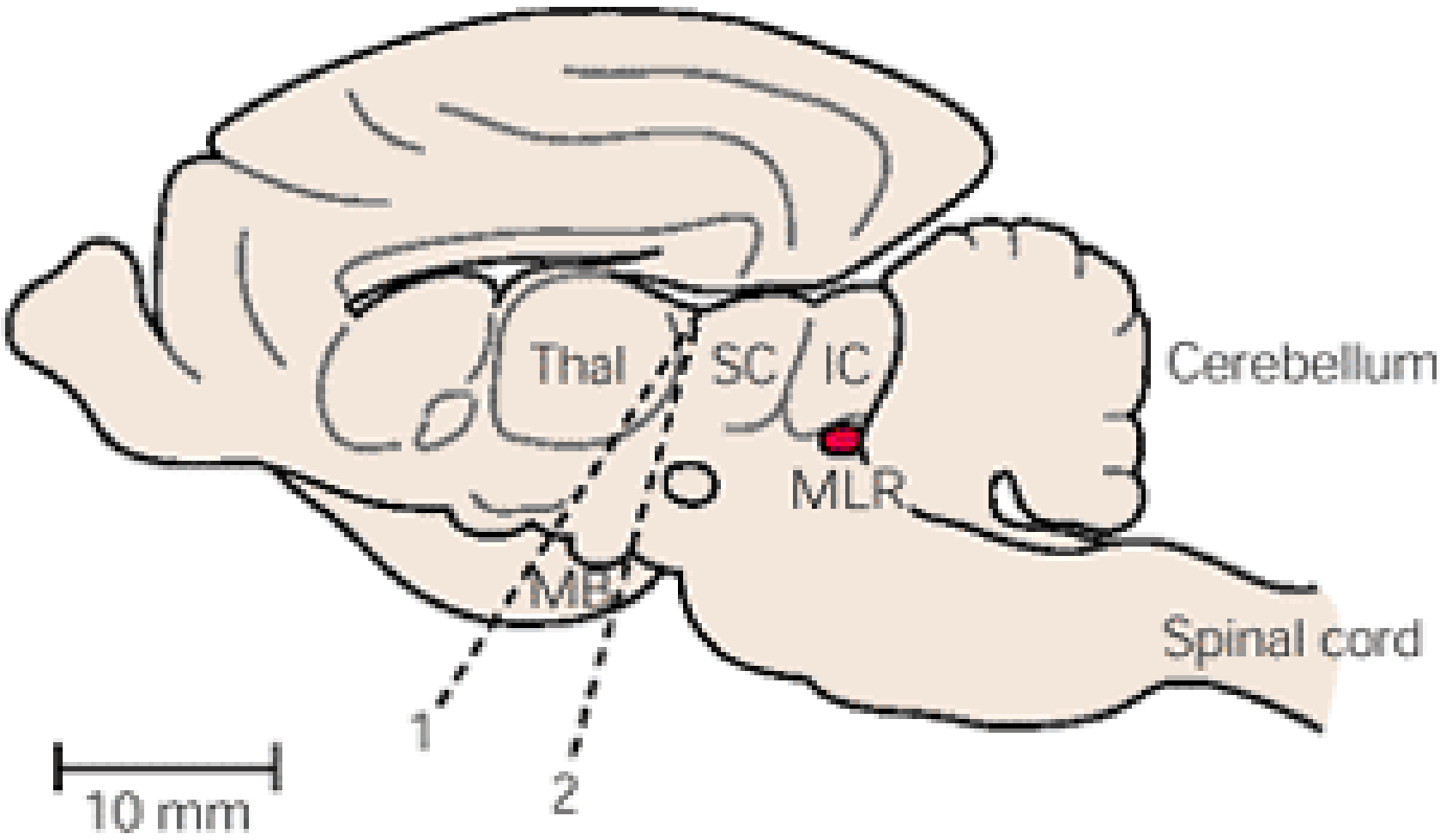
- **Swing (F)** – flexion at hip, knee and ankle
- **Stance**
  - Midway- knee and ankle extend (E1)
    - *Extension of knee and ankle move the foot ahead and prepare the leg to accept weight of the body*
  - E2 –Flexion of knee and ankle with contraction of extensors
    - **Lengthening contraction of ankle and knee extensors because weight is being transferred to the leg**
    - **Spring like yielding move the body over foot**

  E3 – late stance – extension of hip, knee and ankle → provide a propulsive forward movement to the body

Four phases of the step cycle



B Transection of brain stem



DIFFERENT ANIMAL PREPARATIONS

- **Spinal Preparations –** Transaction at lower thoracic level
- **Decerebrate Preparation**
- **Premammillary preparations** -the brain stem is transected from the anterior margin of the superior colliculi to a point immediately rostral to the mammillary bodies → ***spontaneous locomotion***
- **Post mammillary Preparationor Mesencephalic preparation** – transection caudal to the mammillary bodies.
  - Electrical stimulation of mesencephalic locomotor region is required

- **Deafferented Preparation – Loss of tonic sensory inputs**
  - Transection of all the dorsal root supplying the limb muscles
- **Immobilized Preparations - Removal of proprioceptive reflex**
  - Immobilizing the animal by paralyzing the muscles with d-tubocurarine
  - For the study of synaptic events associated with locomotion and
  - Central and reflex pathways controlling locomotion

- Locomotor pattern generated in these preparation – simpler than the normal stepping pattern
  - Alternating burst of activity in flexors and extensors
- Contraction of flexors and extensors – controlled by two system of neurons – Half centers
- Activity alternates between two half centers because fatigue of inhibitory connections

CENTRAL PATTERN GENERATORS

- Neuronal network in the spinal cord , capable of generating rhythmic motor activity in the absence of input from peripheral receptors
- Can initiate variety of motor patterns
- Depends upon the supraspinal and tonic sensory input to the spinal pattern generators
- Sensory input are used to adjust the stepping pattern
  - Three sensory system – Visual, somatosensory and vestibular
  - Proprioceptors regulate the timing and amplitude of stepping

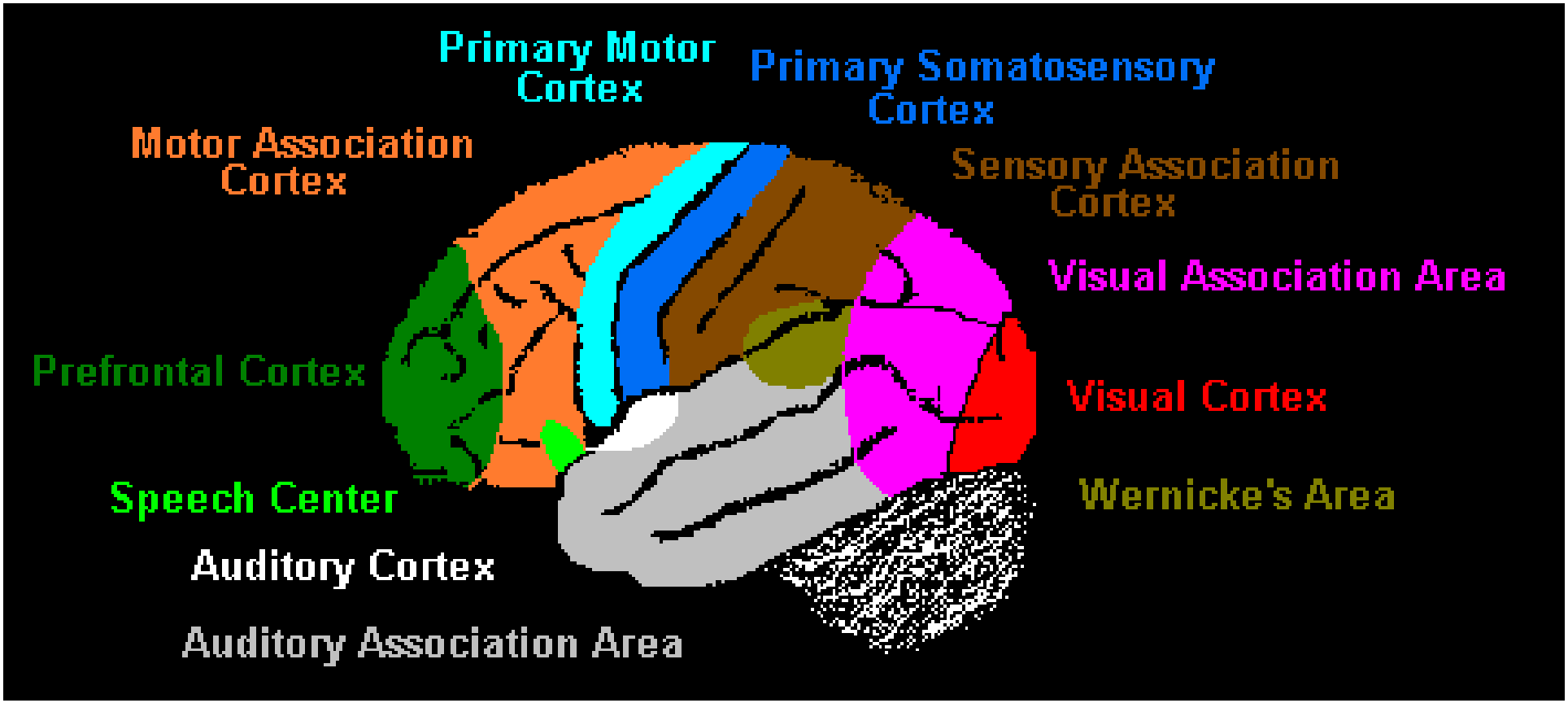
Motor Cortex for Voluntary Movement

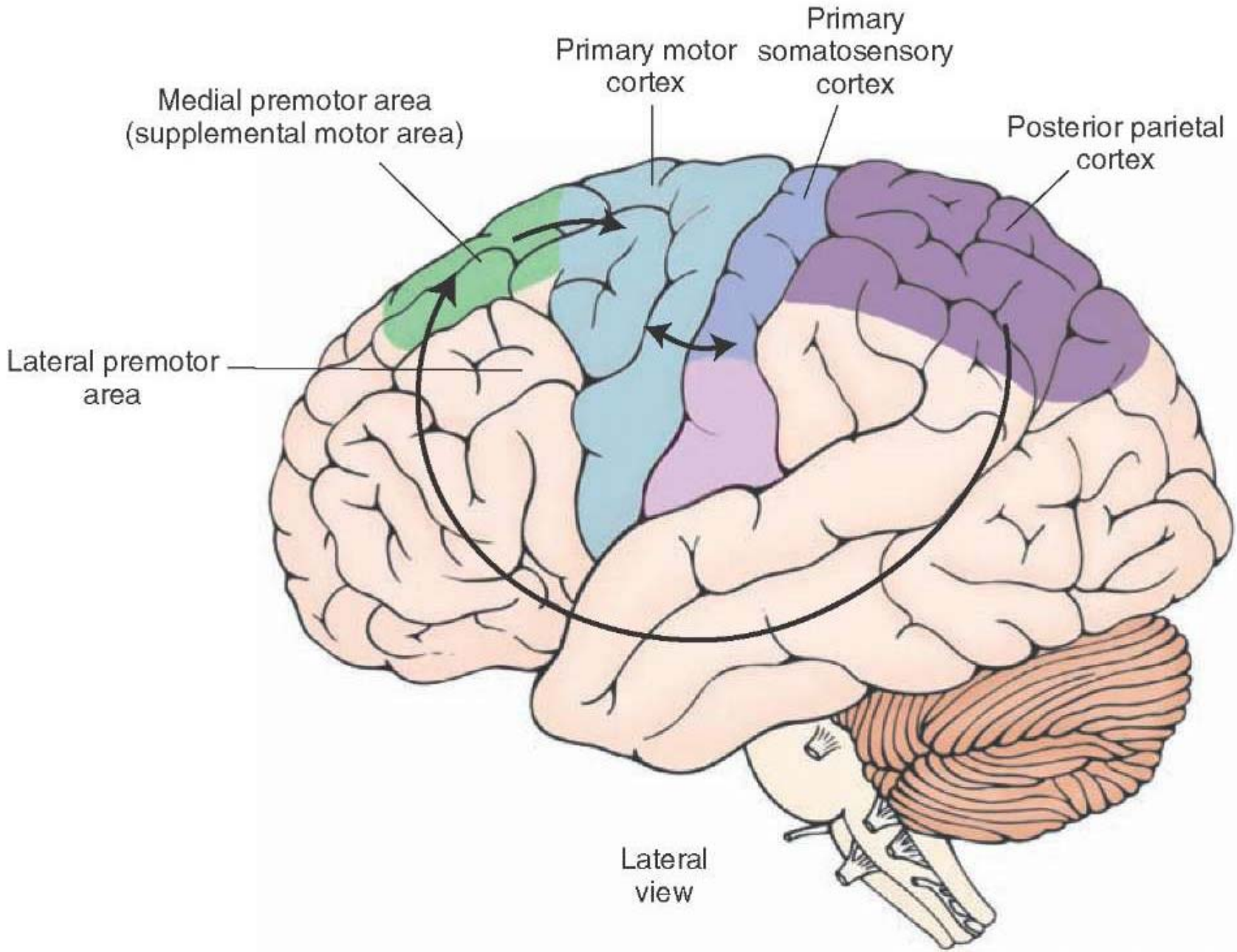
- **Intentional**
  - Initiated by an internal decision to act→ have choices
  - Can change depending upon the context and experience
  - Can improve with experience
  - Involve processes that are sensory, perceptual and cognitive

- John Hughlings Jackson
- Pierre paul Broca
- Karl Wernicke
  - In 19th century
- Fritsch, Hitzig and Ferrier – *electric stimulation of surface of limited area of cortex → evoked movement of contralateral part of body*

Voluntary Motor Control Requires Serial Processing

- Sequential stages
  - **Perception** –sensory information regarding external world and within the individual
  - **Cognition** – Internal representation of the world to decide a course of action
  - **Implementation** – selection of motor plans and its relay to action system
  - **Final Stage -** Execution of the chosen plan
- All three stages have their own serial processing .


Primary Motor Cortex
Primary Somatosensory Cortex
Motor Association Cortex
Sensory Association Cortex
Visual Association Area
Prefrontal Cortex
Visual Cortex
Speech Center
Wernicke's Area
Auditory Cortex
Auditory Association Area


Primary motor cortex
Primary somatosensory cortex
Medial premotor area (supplemental motor area)
Posterior parietal cortex
Lateral premotor area
Lateral view

- **Precentral Cortex --** Brodmann area 4 & 6
  - Caudal part
    - Control motor apparatus of spinal cord
  - Rostral part
    - For higher aspect of motor movement
    - More complex, conditional and voluntary
      - Influence primary motor area → **premotor Cortex**
- Part of the Premotor cortex on the medial surface **Supplementary motor area**
  - Can also produce movement which is less detailed as compared to primary motor cortex

PREMOTOR CORTEX

- Complex task related processing
- Neurons fire before onset of actual movement- **Motor Set Neurons**
- Neurons are direction specefic
- Select appropriate movement in a particular context
- **Sends axons to**
  - Motor cortex – reciprocally connected
  - Spinal cord
  - More than 30% of fibres arise from premotor cortex

- Important for conditional tasks
- Encode the intention to performance
- Select appropriate movement based on internal cue as well as external cue
- **Activated when a person perform sequence of movement on memory**
- Damage
  - Inability to perform conditional movement or movement on verbal command
  - Inability to initiate self initiated movement or spontaneous movement

SUPPLEMENTAL MOTOR CORTEX

- Somatotopically organized
- Do not receive prefrontal inputs
- Directly project to
  - Motor cortex
  - Spinal cord
- Language generation
- Movement recognition and ideation

Rostral part of SMA known as PRE-SMA – recieves extensive input from prefrontal cortex and supplementary eye field

- Visuo- motor association
- Learning and performing sequential movement
- Internally guided action
- Switching between action sets
- Choice of action – one set of action is favoured over others

- Lacks the enlarged distal arm and hand representation
- Stimulation evoke movement of both side of body
- Can halt ongoing movement

- **Organization of motor cortex**
  - Consists of several distinct subarea
  - These subareas have specefic connections among themselves and other cortical areas
  - Each subarea separately control movements of some or all parts of body
  - Properties of neurons in different subarea are different from each other

- Neurons in all these different areas have unique properties and interact with each other to select ,plan and generate actions most suited to external and internal conditions

- Cortical motor areas are interconnected by complex pattern of reciprocal, convergent and divergent pathways
- Supplemental motor area , dorsal and ventral premotor area → have somatotopically organized reciprocal connection with primary motor cortex and with each other
- These primary and supplemental motor areas receive somatotopically organized inputs from primary sensory cortex and rostral parietal cortex
- Premotor cortex receive inputs from caudal part of parietal cortex

Corticospinal Tract

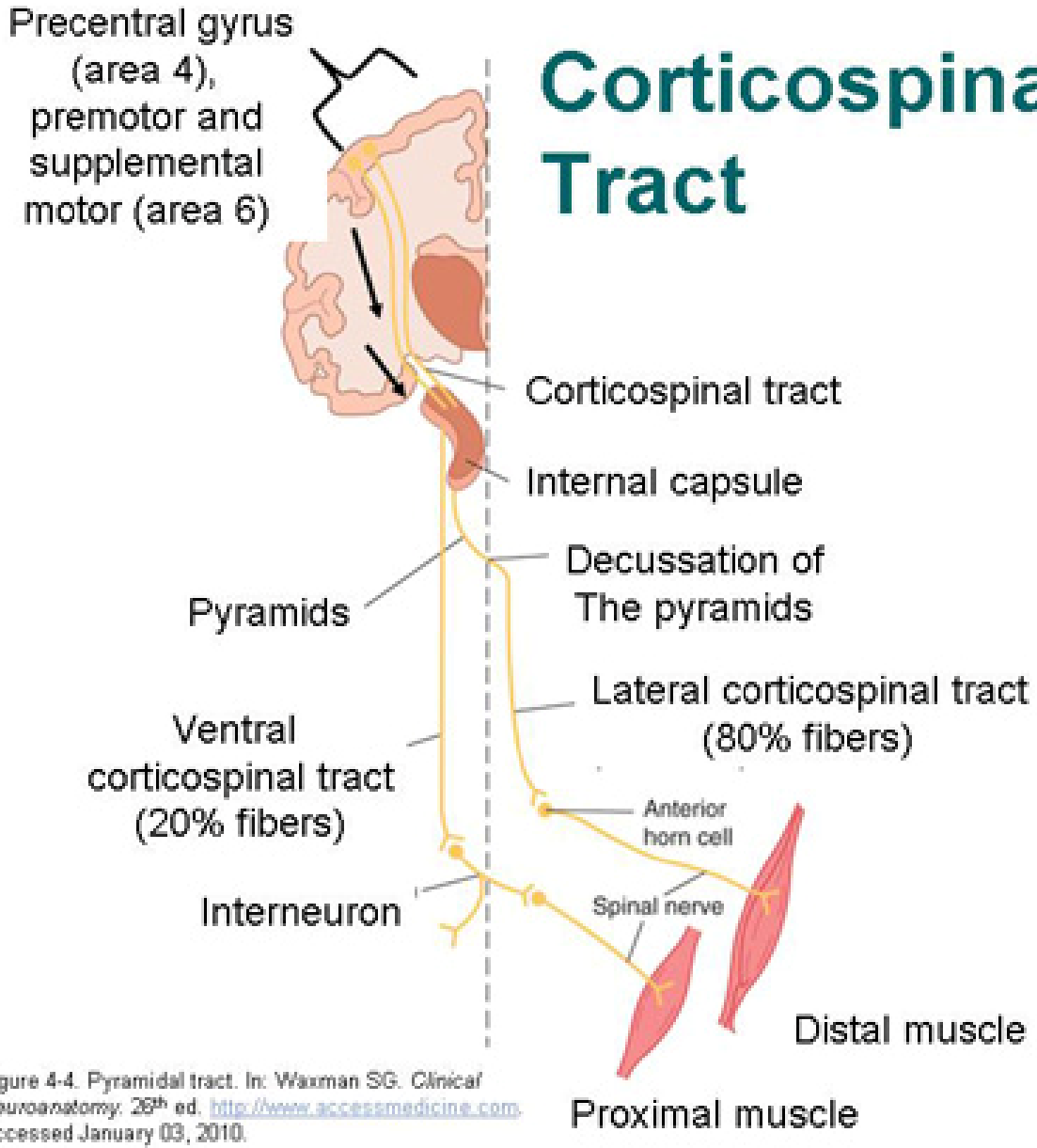
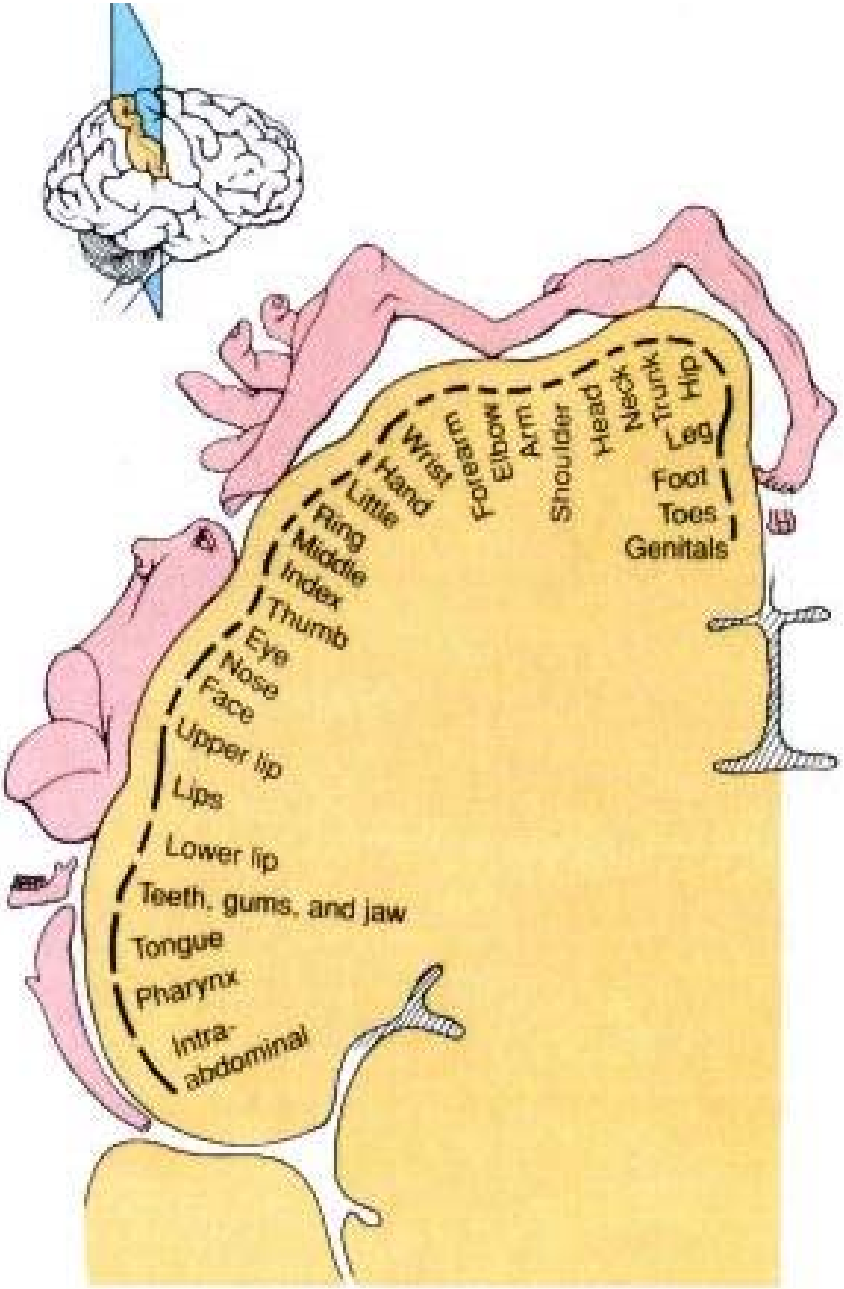
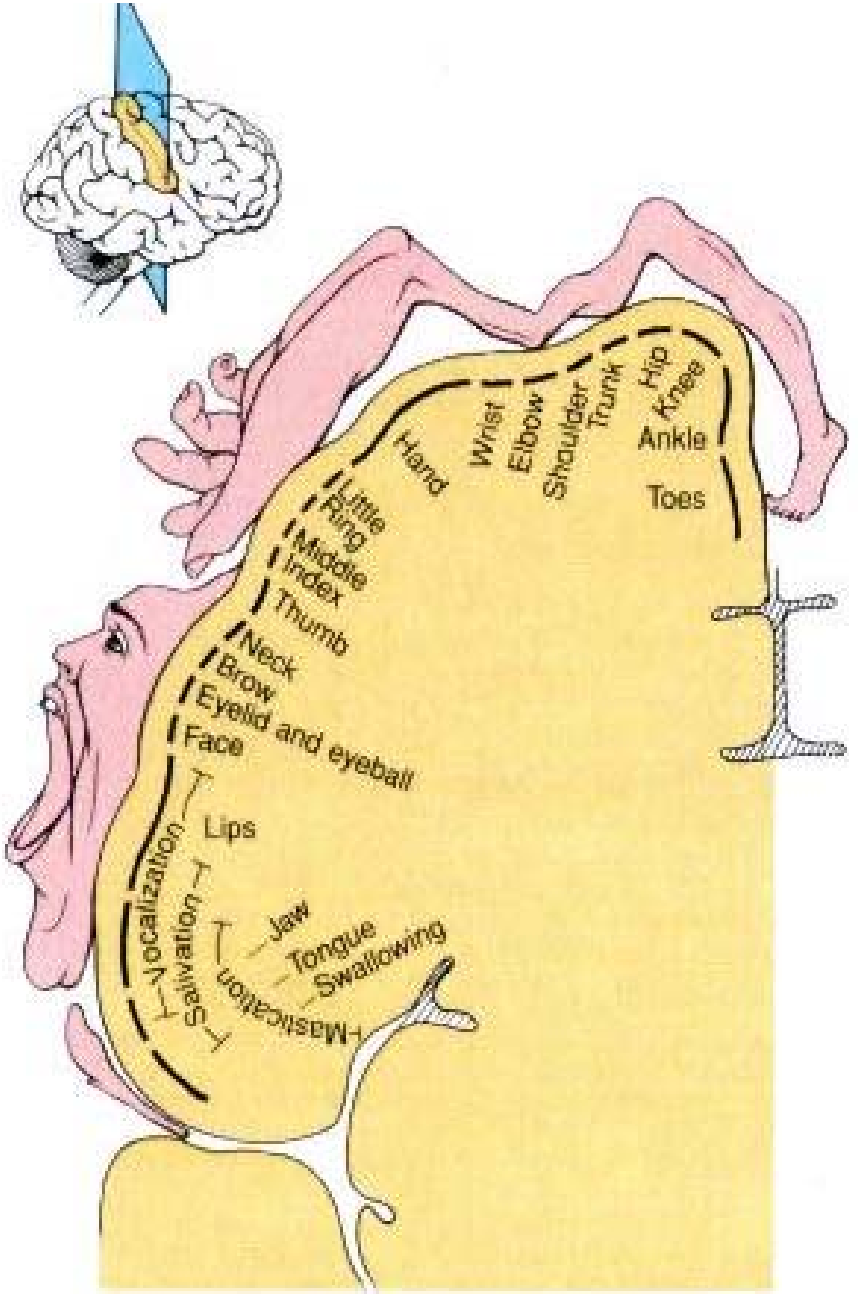


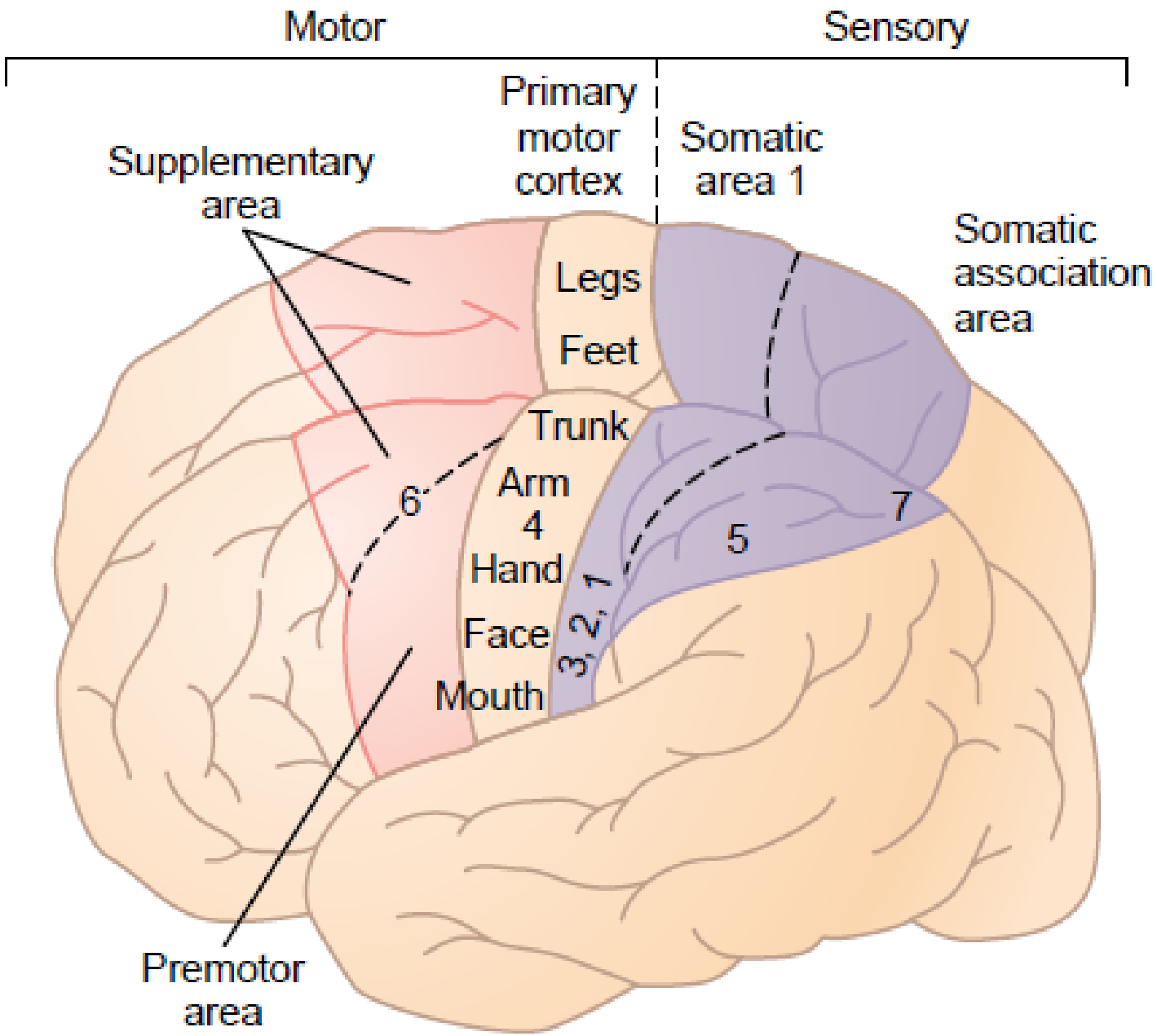
Figure 4-4. Pyramidal tract. In: Waxman SG. *Clinical Neuroanatomy*. 26th ed. http://www.accessmedicine.com. Accessed January 03, 2010.

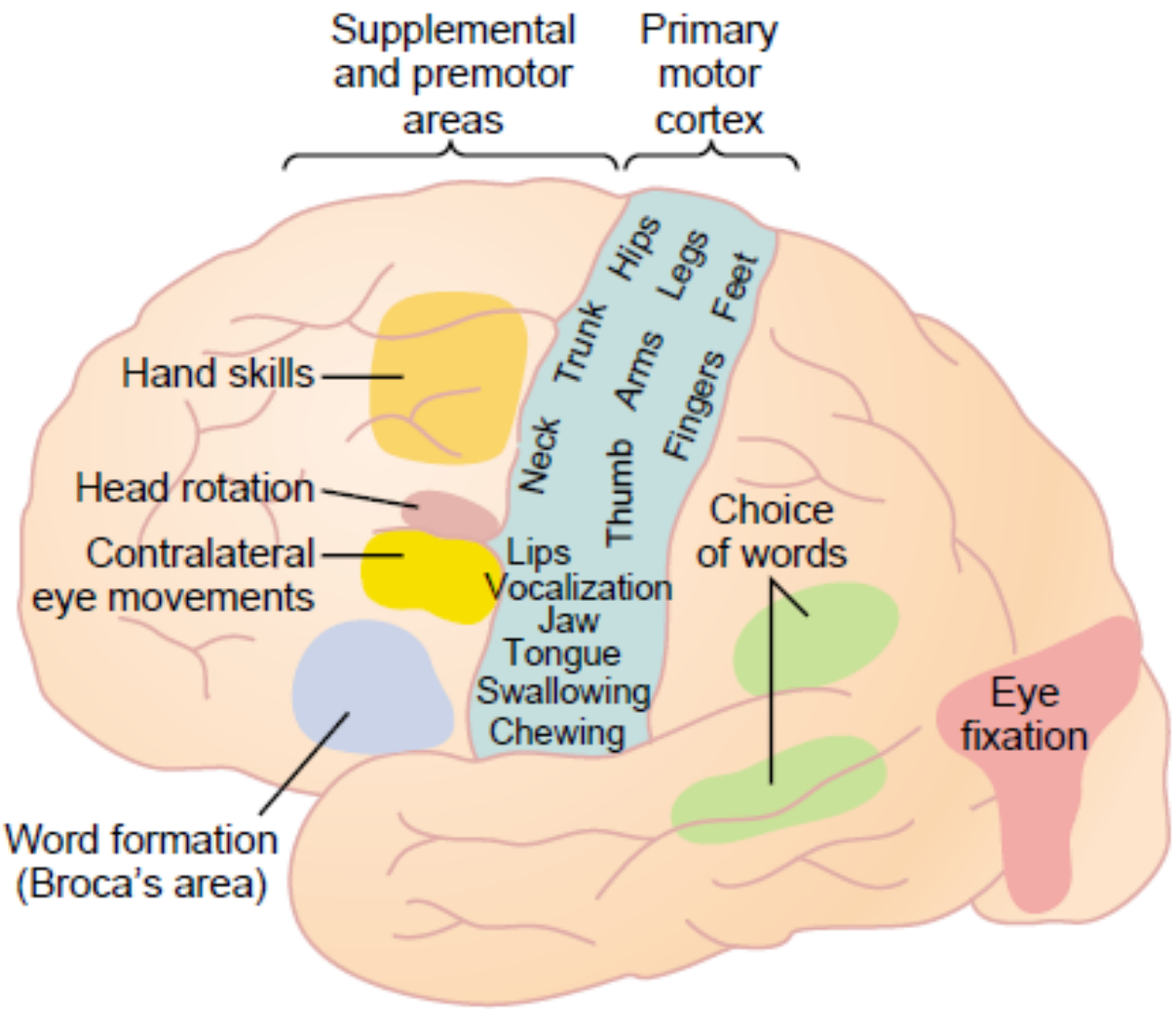


(a) Somatosensory cortex in right cerebral hemisphere



(b) Motor cortex in right cerebral hemisphere


Motor
Sensory
Primary motor cortex
Somatic area 1
Supplementary area
Somatic association area
Legs
Feet
Trunk
Arm
Hand
Face
Mouth
6
4
3, 2, 1
5
7
Premotor area


Supplemental and premotor areas
Primary motor cortex
Hips
Legs
Feet
Trunk
Arms
Fingers
Neck
Thumb
Hand skills
Head rotation
Contralateral eye movements
Lips
Vocalization
Jaw
Tongue
Swallowing
Chewing
Choice of words
Eye fixation
Word formation (Broca's area)

COTICOSPINAL TRACT

- Primary motor areas – 30%
- Pre motor cortex and supplemental motor areas – 30%

  pre motor cortex and supplemental motor areas → no direct fibers to spinal cord ..
- Sends axons to subcortical areas → ends on spinal cord neurons
- Primary somatosensory cortex and adjacent parts of posterior parietal cortex – 40%

- Fibres from the giant pyramidal cells (Betz cells)-fastest to spinal cord (70m/s)
- It sends inhibitory collaterals to other areas of brain
- 80% fibres cross the midline at the medullary pyramid and end monosynaptically on the anterior horn cells – **Lateral corticospinal tract**
- 20% remain uncrossed, pass ipsilaterally and cross at the level of spinal cord – **Ventral corticospinal tract**

- Outgoing fibres from motor cortex
  - Caudate nucleus ,putamen
  - Red nuclei- rubrospinal tract
  - Reticular substance & vestibular nuclei – reticulo & vestibulospinal tract
  - Cerebellum- Reticulocerebellar and vestibulocerebellar tracts
  - Pons →Pontocerebellar fibres
  - Olivocerebellar tracts
  - ,

INCOMING FIBRES TO MOTOR CORTEX

- Somatosensory area, frontal cortex ,audio and visual cortex
- **Through corpus callosum** –from other corresponding side of cortex
- **Somatosensory fibres** –directly from tactile and joint and muscle signal(proprioceptors)
- **Basal ganglia and cerebellum via thalamus** (ventral nuclei)
- **Intralaminar nuclei of thalamus –for general level of excitability**

Extrapyramidal tract