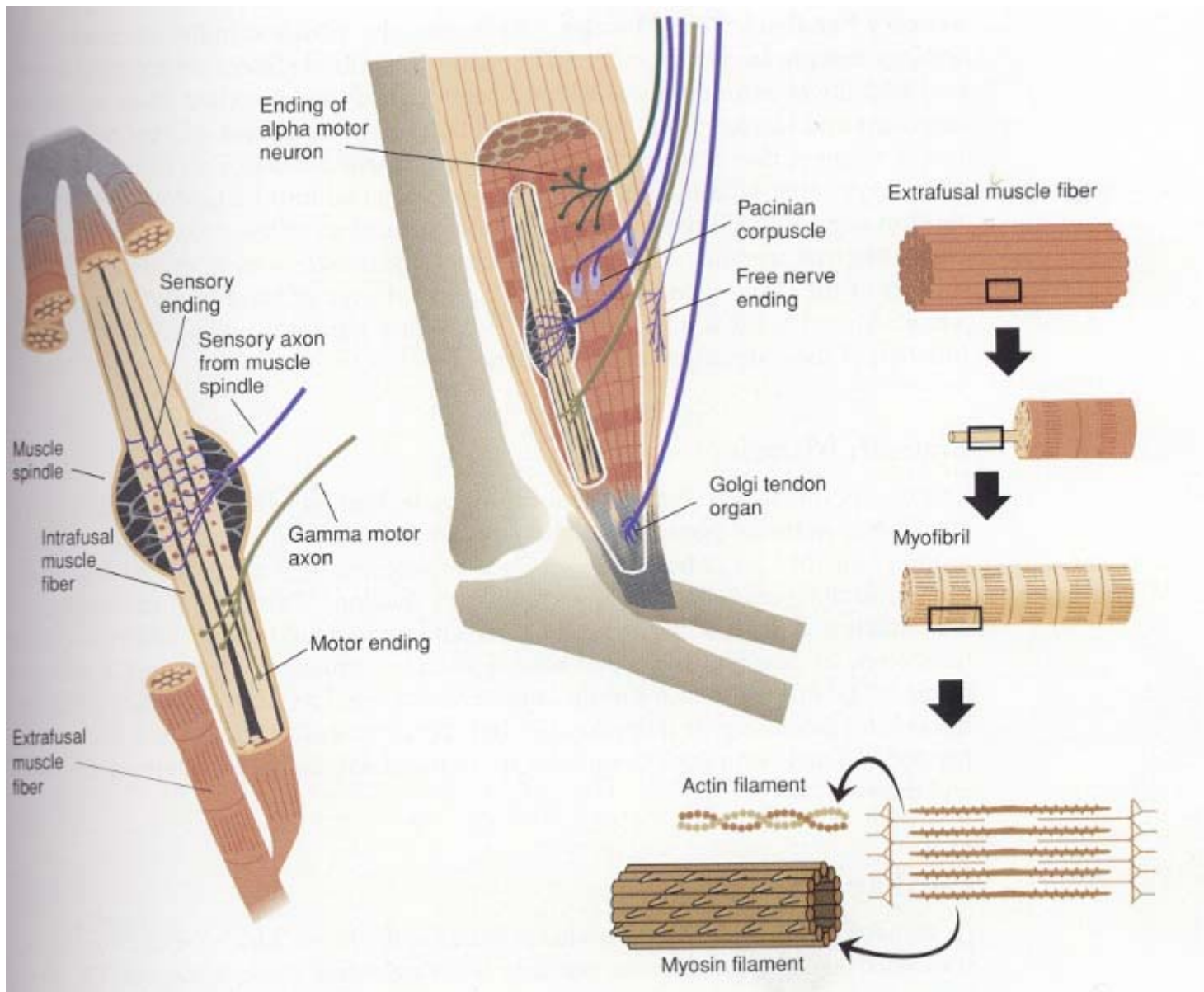


Chapter 8

Control of movement

1st Type: Skeletal Muscle

- Skeletal Muscle: Ones that moves us
 - Muscles contract, limb flex
 - Flexion: a movement of a limb that tends to bend its joints, contraction of a flexor muscle (bending)
 - Extension: movement of a limb that tends to straighten its joints, contraction of an extensor muscle (straightening)
 - Two fiber types of skeletal muscle
 - Extrafusal: exert force (alpha motor neurons)
 - Intrafusal: detect stretch of muscle (1 sensory & gamma motor axon)
 - Afferent sensory axon detects muscle length
 - Efferent gamma motor axon contracts intrafusal, adjust sensitivity
 - Myosin and actin
 - Golgi tendon organ: strength/stress detector



Neuromuscular junction: endplate potential

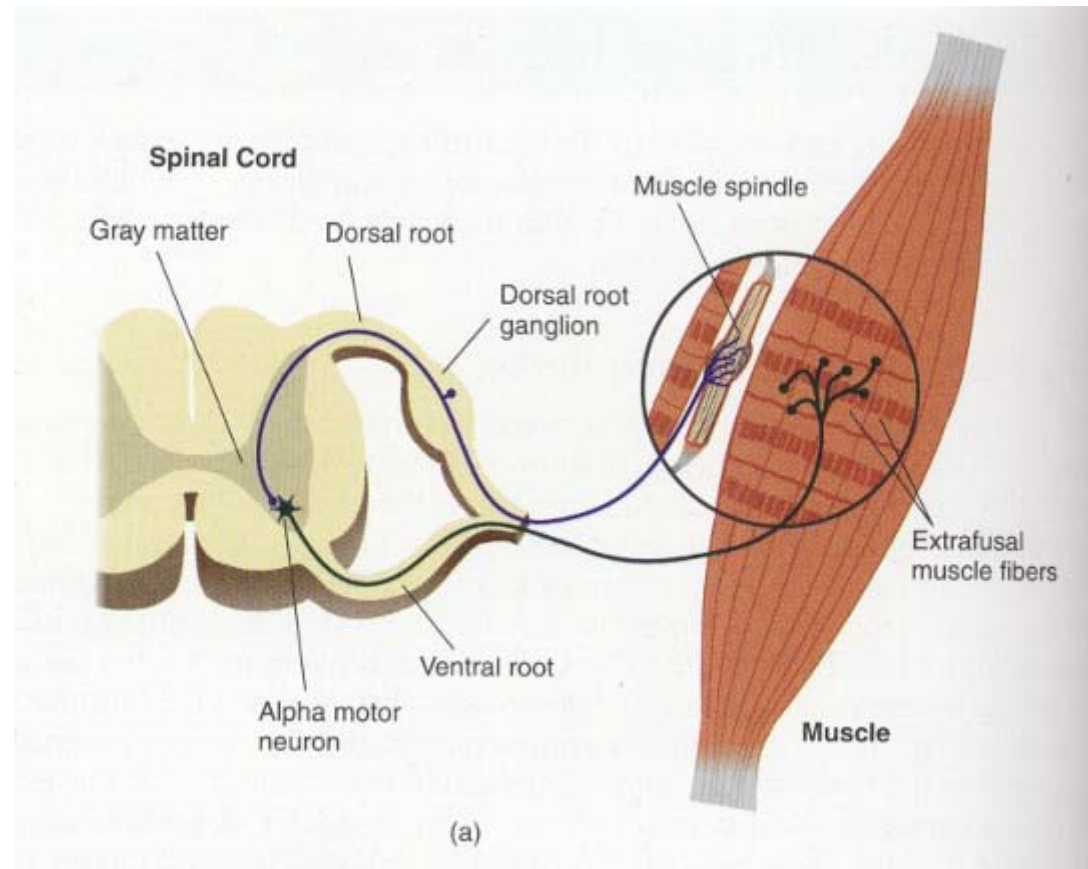
- The neuromuscular junction is point where the terminal buttons synapse with the motor endplates
 - Precision of muscle control
- Ach is the muscular neurotransmitter (animation)
 - Release of Ach produces a large endplate potential
 - Larger than EPSPs and always causes a muscle to fire
 - Open Ca^{2+} channels that trigger myosin-actin interaction (row action)
 - Contraction or muscular twitch
- Twitch lasts because of elasticity of muscle & time it takes calcium to leave the cell

Other two types of muscles

- Smooth muscle: controlled by ANS
 - Multiunit: inactive, large arteries, around hair and in the eye, responds to neural or hormonal stimulation
 - Single-unit: rhythmic, spontaneous pacemaker potentials, gastrointestinal tract, uterus
- Cardiac muscle: found in heart
 - Striated with rhythmic contractions, respond to hormone especially the catecholamines

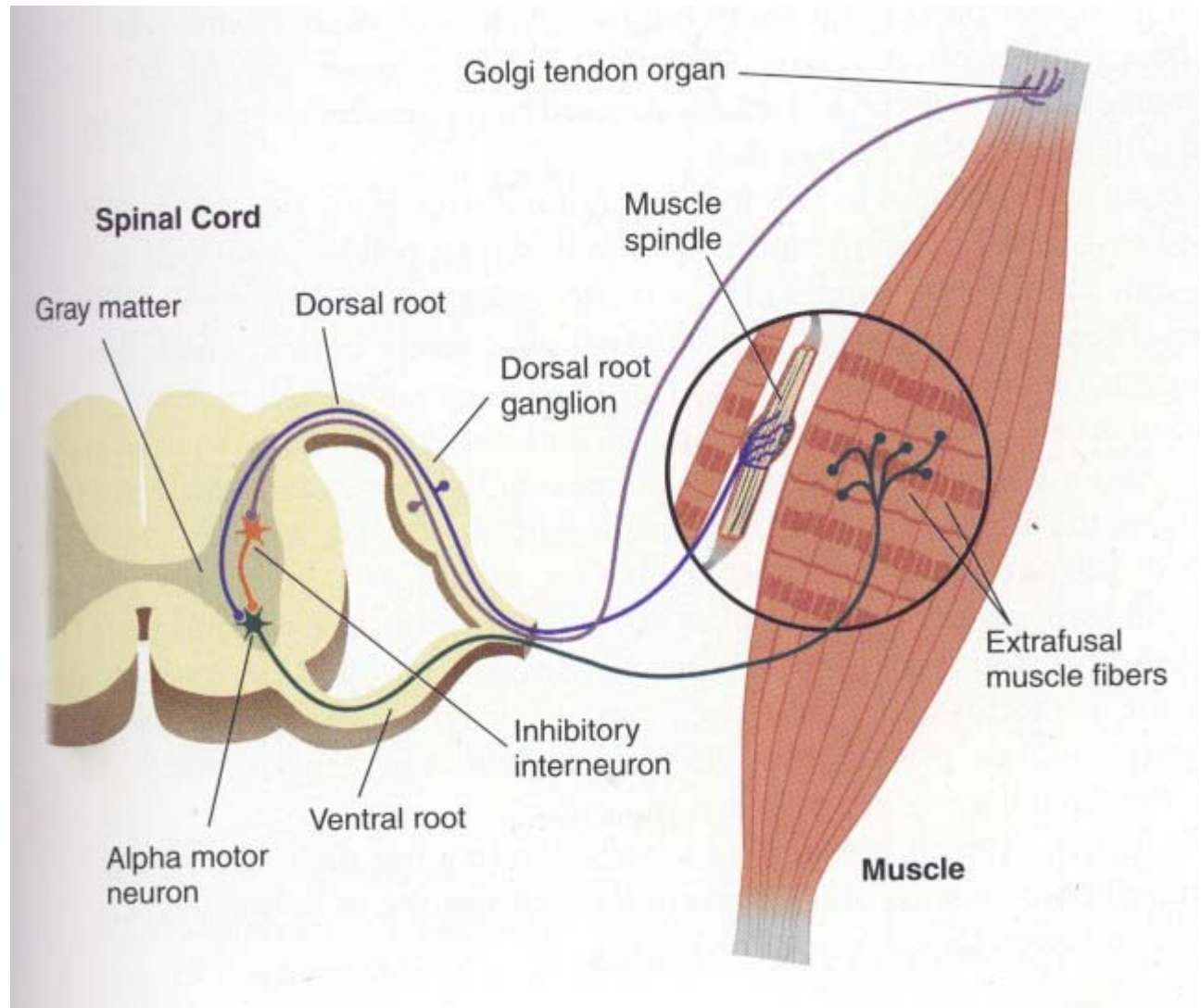
Monosynaptic stretch reflex

- Patellar reflex
- Involve single synapse
- Afferent sensory neuron in intrafusal fibers sends information to spinal cord
- Efferent alpha motor neurons in spinal cord innervates extrafusal fibers to contract
- Also found in weight holding and posture control



The Postsynaptic Reflexes

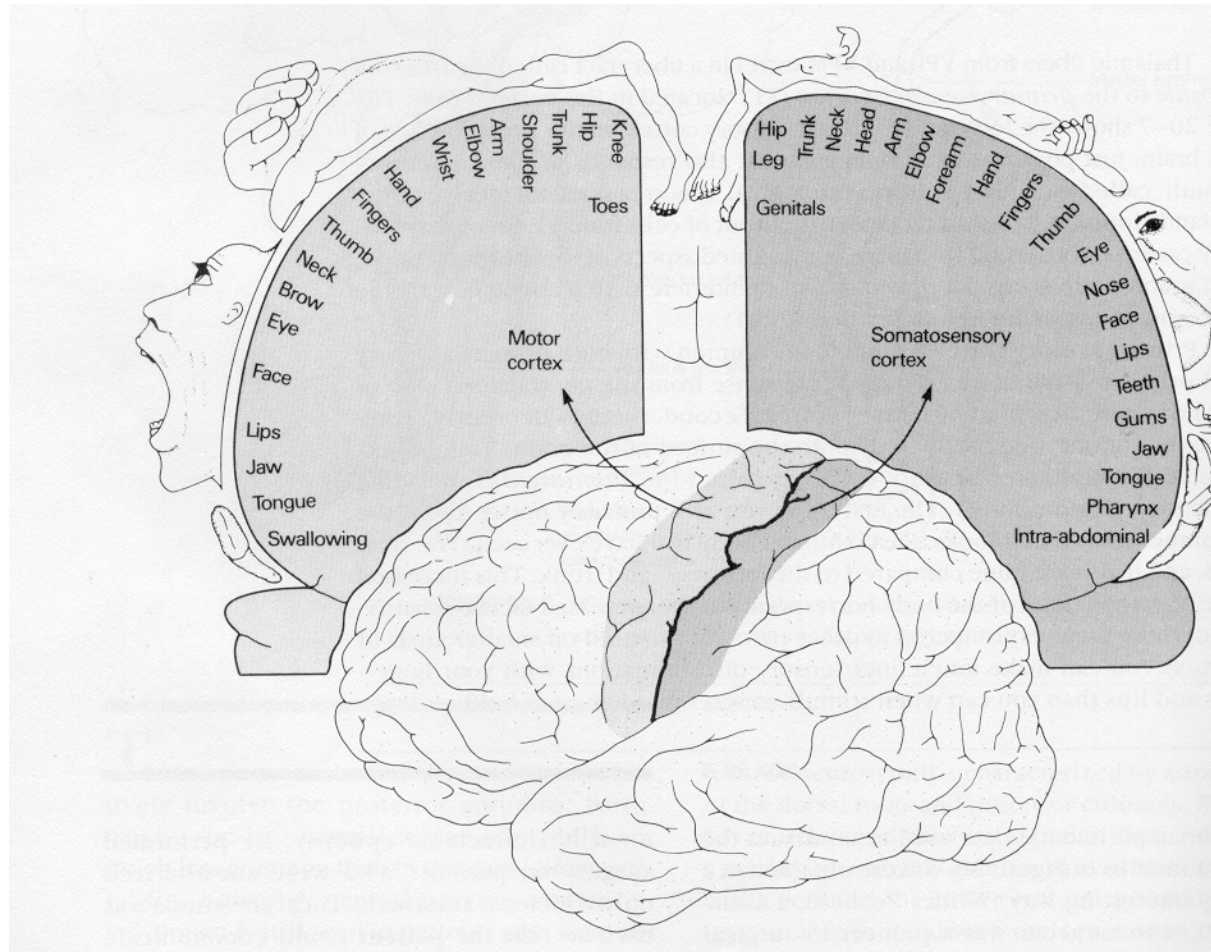
- Situation:
withdraw from
harmful muscle
movement
 - Afferent:
sensory
neuron + golgi
tendon organ
 - Interneuron—
inhibition
 - Efferent: alpha
neuron
- Weight lifter
- Agonist and
antagonist

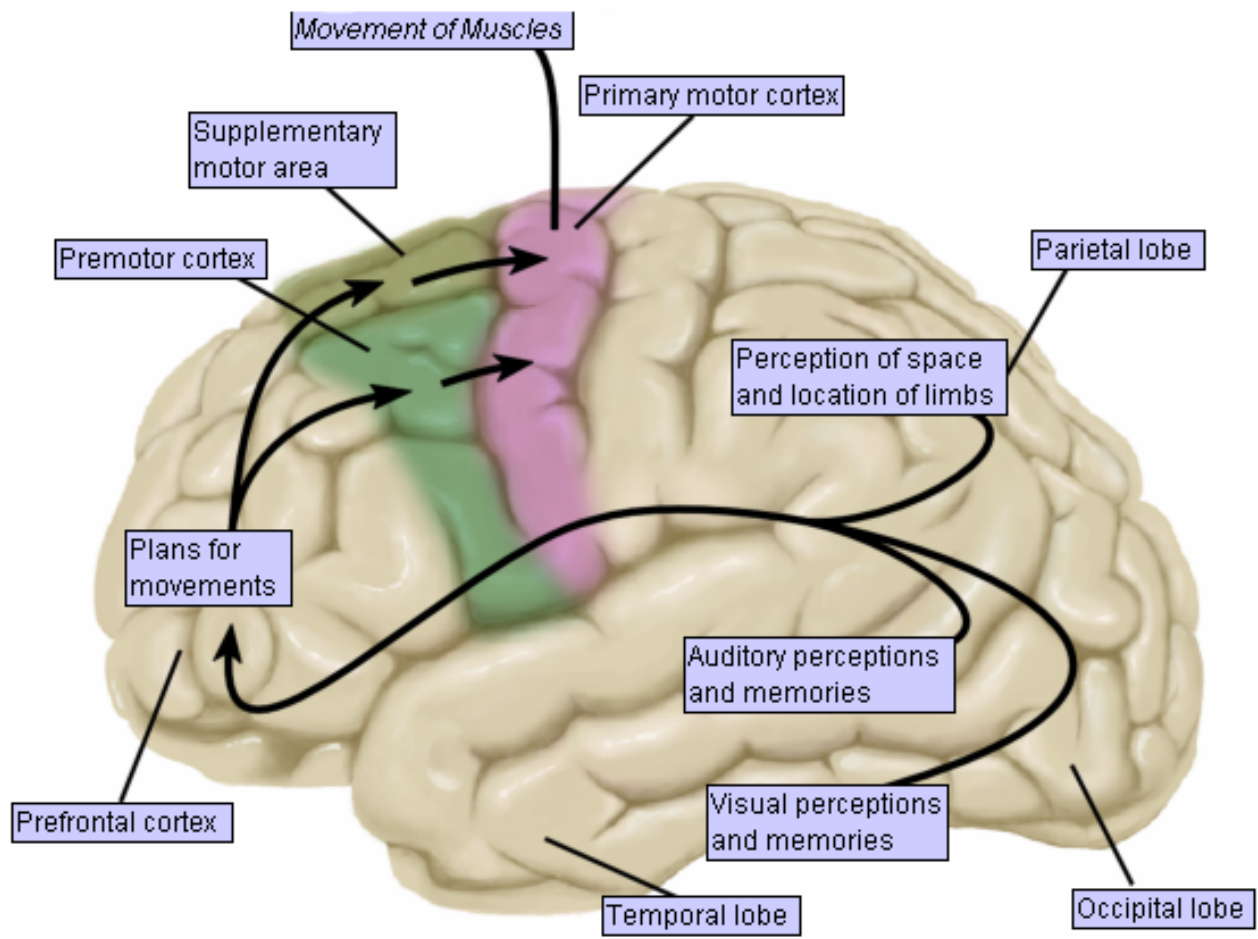


Cortical Controls of Movement

- Multiple motor systems control body movements
 - Walking, talking, postural, arm and finger movements
- Primary motor cortex is located on the precentral gyrus
 - Motor cortex is somatotopically organized (motor homunculus)
 - Motor cortex communicates with
 - Primary somatosensory cortex (same body part)
 - Supplemental motor area
 - Premotor cortex
 - Prefrontal cortex
- Supplemental motor area (SMA)
 - Learning and performing behaviors that consist of sequences of movements
- Premotor cortex
 - Arbitrary stimuli
 - Imitating and understanding other individual's movement---Mirror neurons

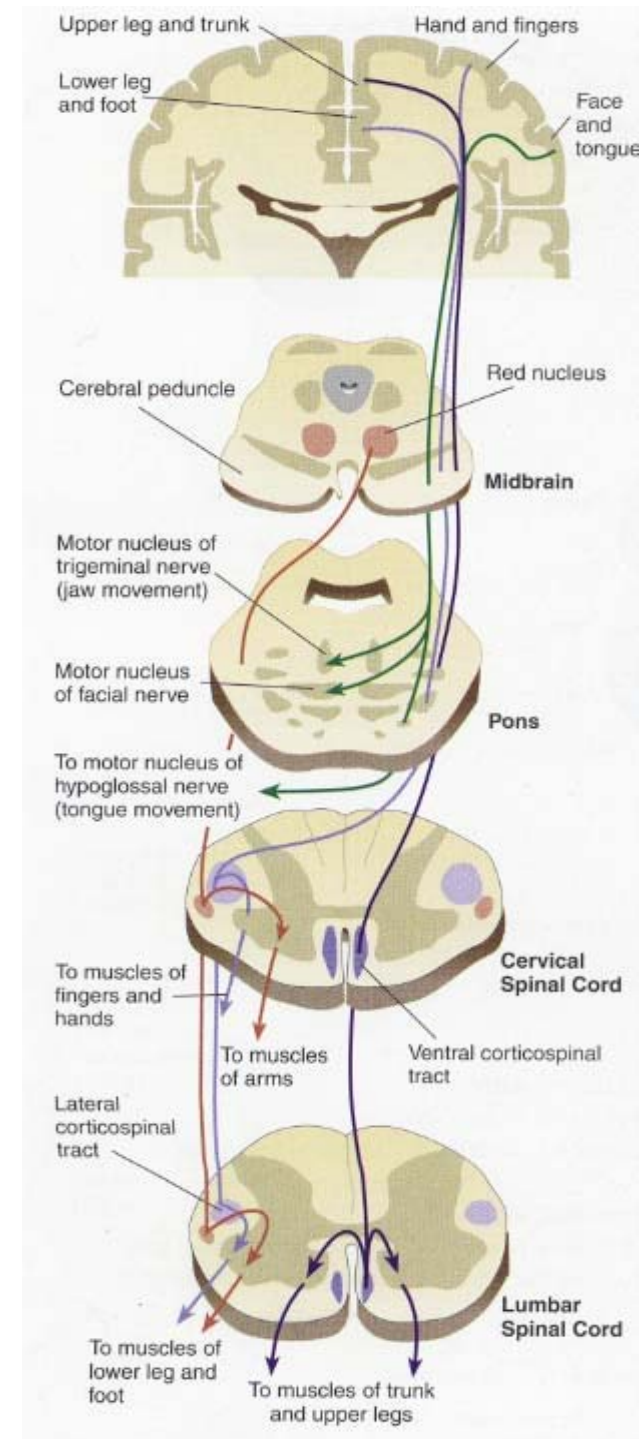
Somatotopic organization of primary motor cortex





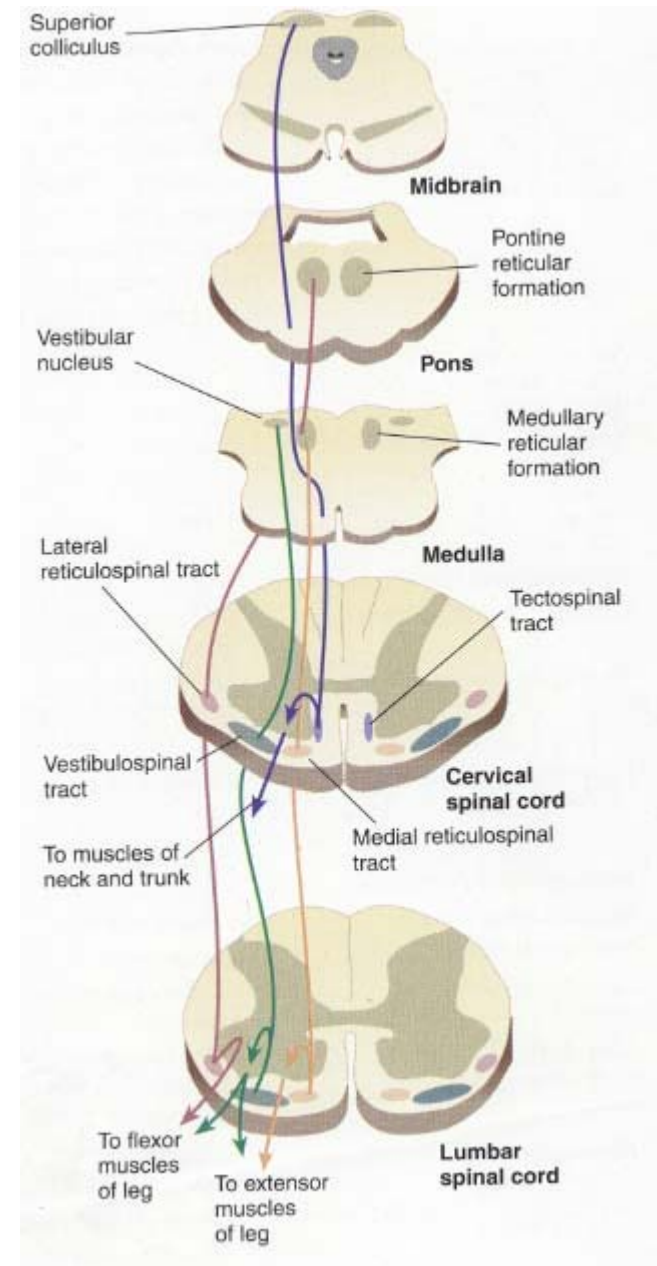
Lateral Group

- Originates from cortex, most of them end in spinal cord
- Lateral corticospinal tract (light blue)—finger, hands, arm
- Rubrospinal tract (red)—hands (no fingers), lower arms, feet and lower legs
- Corticobulbar tract (green): face and tongue, ends in cranial nerve
- [ventral corticospinal tract (dark blue): hands (no finger), lower arms, feet and lower legs]



Ventromedial group

- Originates in subcortical region and ends in spinal cord
- Tectospinal tract (blue)—neck and trunk
- Lateral reticulospinal tract (purple)—flexor muscles of legs
- Medial reticulospinal tract (orange)—extensor muscles of legs
- Vestibulospinal tract (green)—trunk and legs

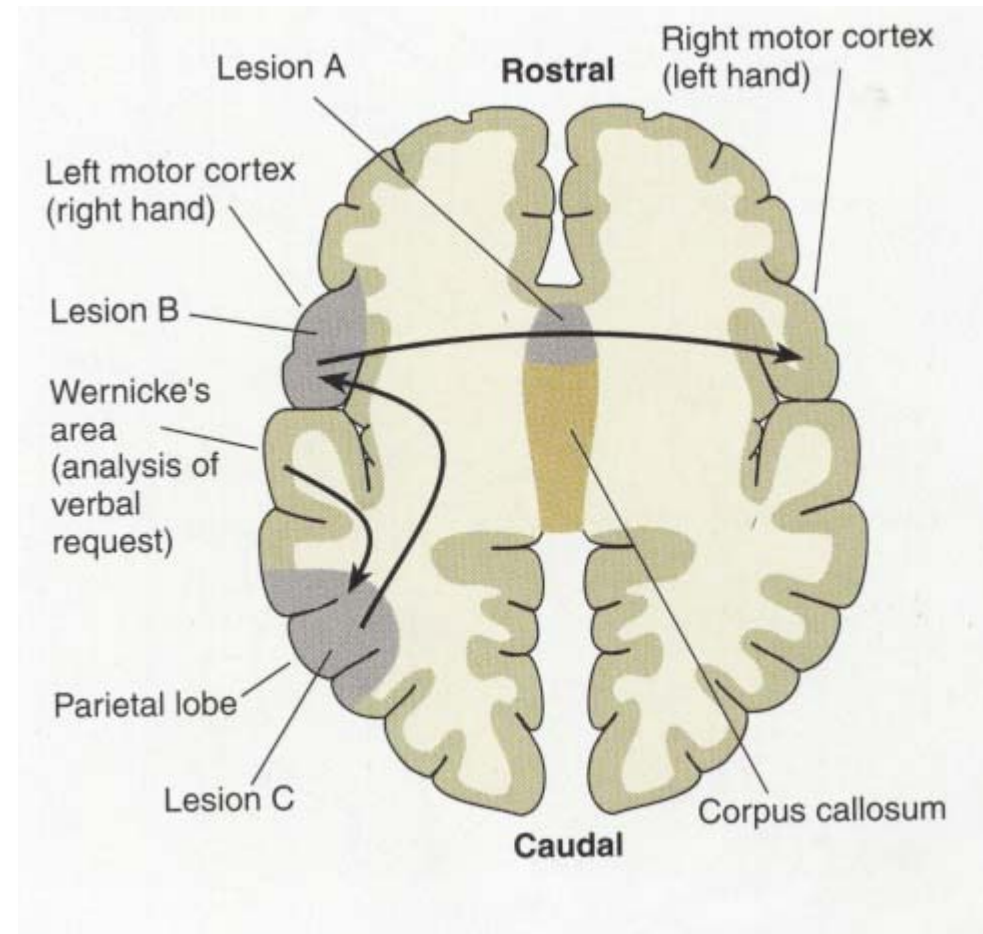


The apraxias

- Paralysis or weakness: damage to motor structure (perceptual gyrus, basal ganglia, brainstem or spinal cord)
- Apraxia: an inability to properly execute a learned skilled movement following brain damage, in absence of paralysis or muscular weakness: damage to corpus callosum, frontal lobe or parietal lobe
- Limb apraxia: incorrect movements of arms, hands or fingers

Limb Apraxia

- **Callosal apraxia**
 - Damage: Anterior corpus callosum
 - Apraxia of the left limb
- **Sympathetic apraxia**
 - Damage: Left frontal lobe
 - Paralysis of right;
Apraxia of the left limb
- **Left parietal apraxia**
 - Damage: Left intraparietal sulcus
 - Apraxia in both limbs

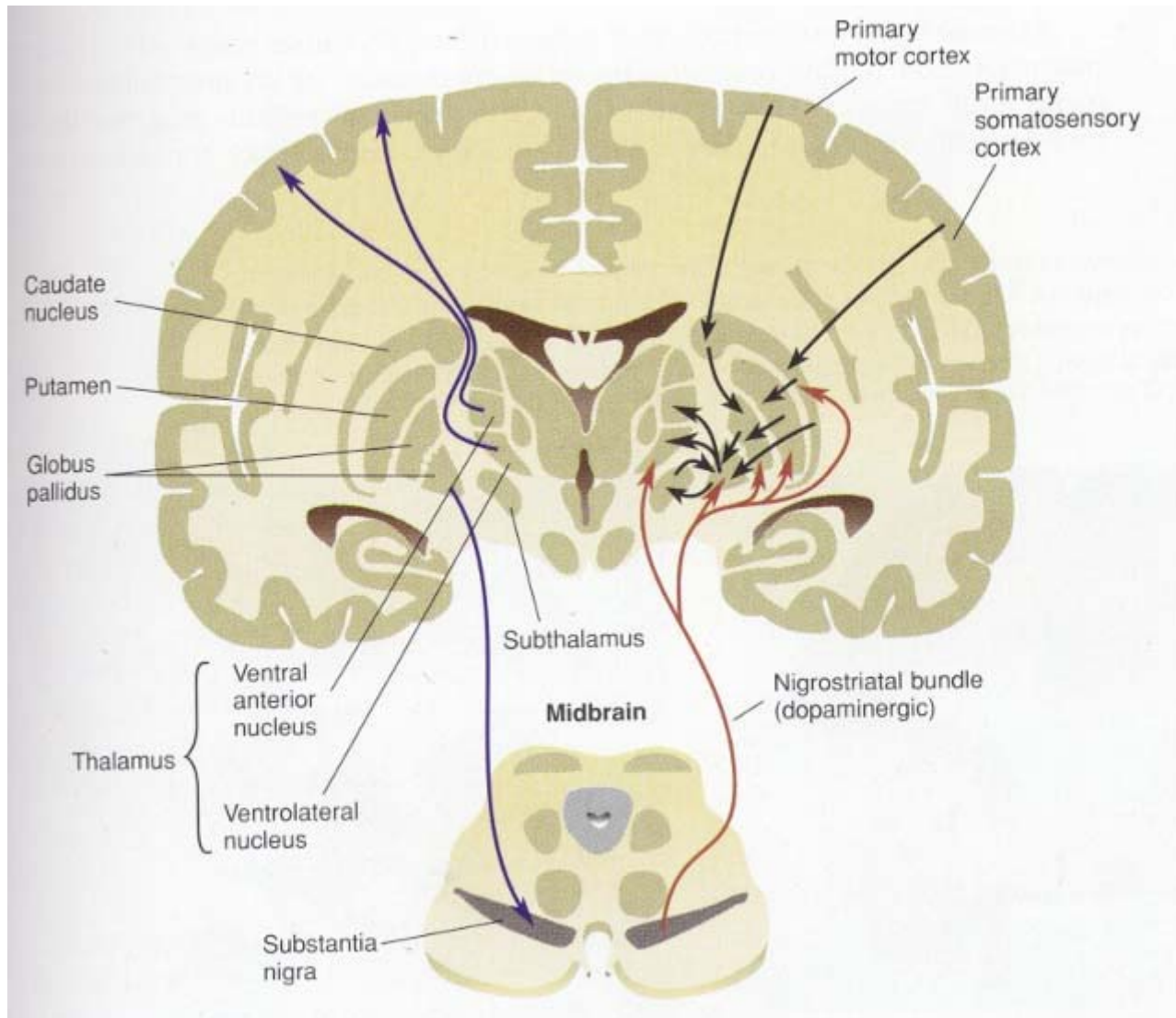


Construction Apraxia

- Damage: right parietal lobe
- Deficits in ability to perceive and imagine geometrical relations
- Trouble drawing pictures or assembling objects from elements

The Basal Ganglia

- Basal ganglia consist of the caudate nucleus, the putamen and globus pallidus
 - Input to the basal ganglia is from primary motor & somatosensory cortex and the substantia nigra
 - Excitatory neurons: glutamate; inhibitory neurons: GABA
 - Direct pathway: excitatory effect on movement
 - Caudate nucleus and putamen, GPi, thalamus
 - Indirect pathway: inhibitory effect on movement
 - Caudate nucleus and putamen, GPe, subthalamic nucleus, GPi, thalamus
 - Output is to motor areas & brainstem motor nuclei
- Influence movement and some direct control, slower than the movements controlled by cerebellum
- If dopamine pathway from substantia nigra to basal ganglia is degenerated---Parkinson's disease



Parkinson's Disease

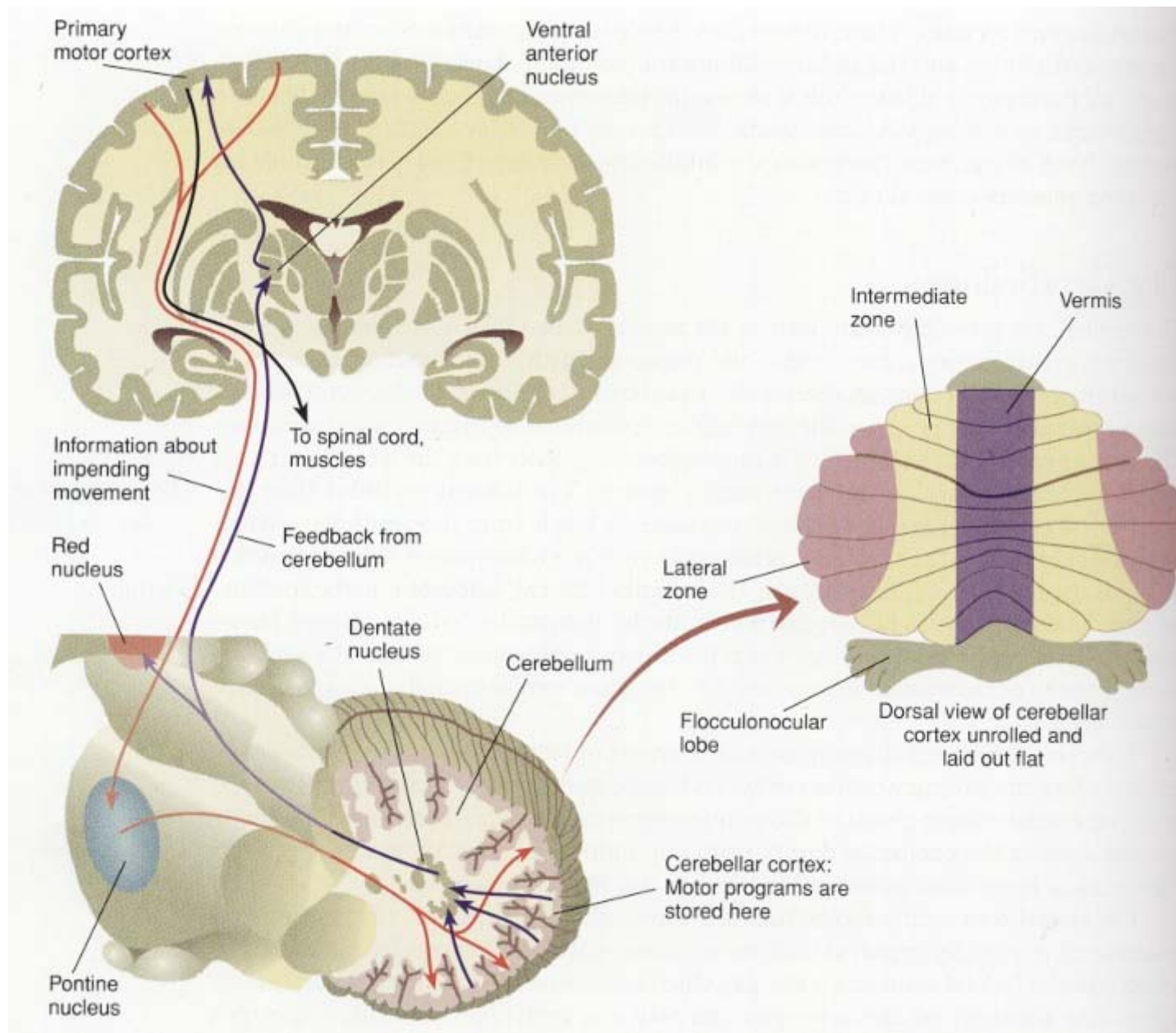
- Parkinson's disease (PD) involves muscle rigidity, resting tremor, slow movements & postural instability
 - Parkinson's results from damage to dopamine neurons within the nigrostriatal bundle
 - Caused by toxins, faulty metabolism, infectious disorder or rare juvenile genetic component
- Treatment for PD
 - Dopaminergic agonists (increase NT) like L-DOPA
 - Stem cell research: transplants of dopamine-secreting neurons (fetal substantia nigra cells)
 - Lesions of the globus pallidus alleviates some symptoms of Parkinson's disease

Huntington's Disease

- Huntington's disease (HD) involves uncontrollable, jerky movements of the limbs
 - HD is caused by degeneration of the caudate nucleus and putamen
 - Degeneration of GABA & Ach neurons
- HD is hereditary disorder (30-40 yrs ago) caused by a dominant gene on chromosome 4
 - This gene produces a faulty version of the protein huntington
 - May interfere with glucose metabolism

The Cerebellum

- Cerebellum consists of two hemispheres with associated deep nuclei
 - 50 billion neurons with output to every major motor structure
 - The butt (caudal) involved in postural reflexes (communicates with vestibular system): flocculonodular lobe
 - The middle (midline) receives visual & auditory info and cutaneous & kinesthetic info: The Vermis
- Damage to the cerebellum generally results in jerky, erratic and uncoordinated movements



Reticular formation

- Gamma motor system
- Pons and medulla, respiration, sneezing, coughing and vomiting
- Postural control
- locomotion

