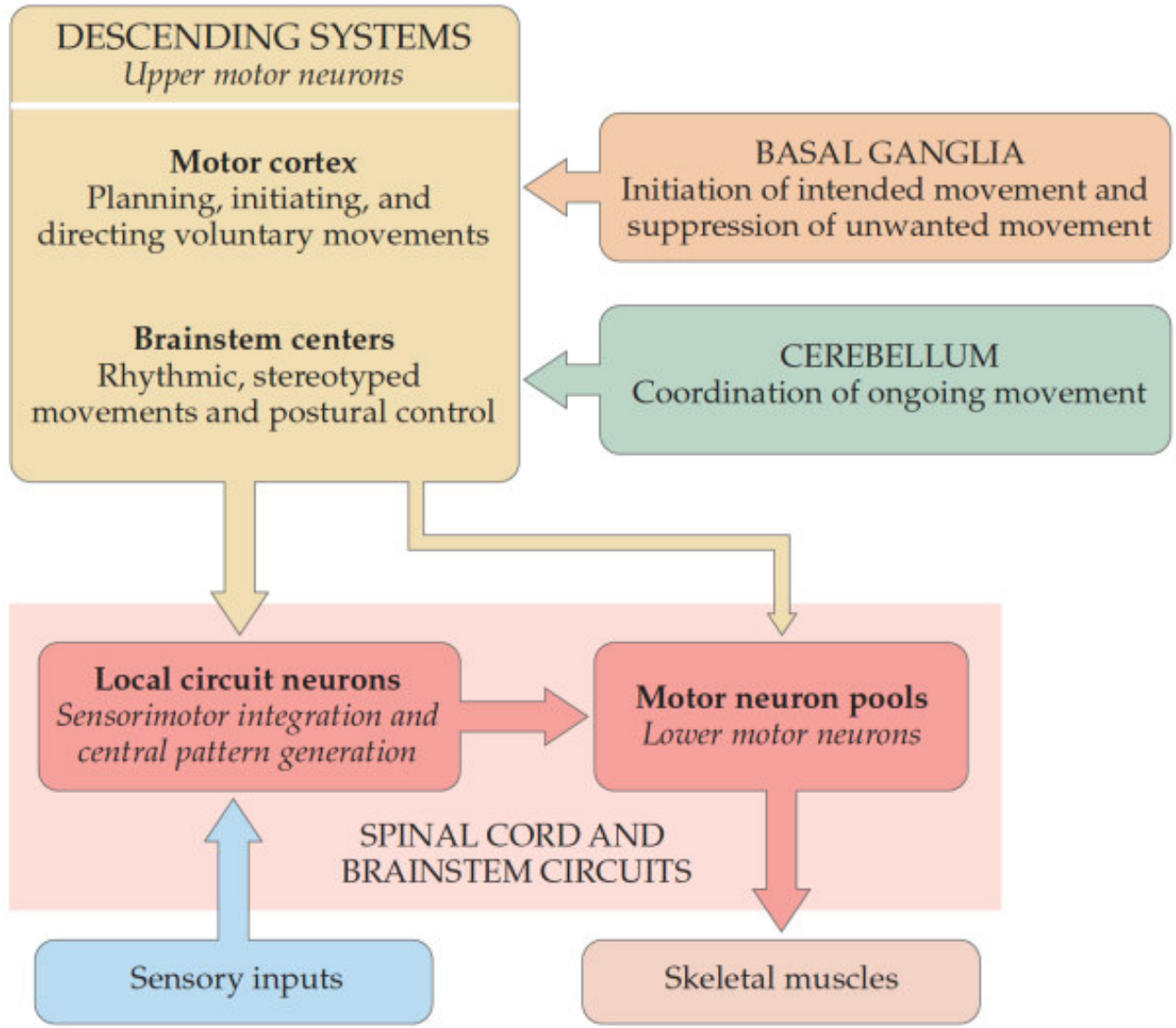
Organization of neural structures involved in the control of movement

Four systems make essential and distinct contributions to motor control:

- **Spinal cord** (and brainstem circuits)
- the **Cerebellum**
- Descending control centers in the **cerebral cortex** and **brainstem**
- **Basal ganglia**



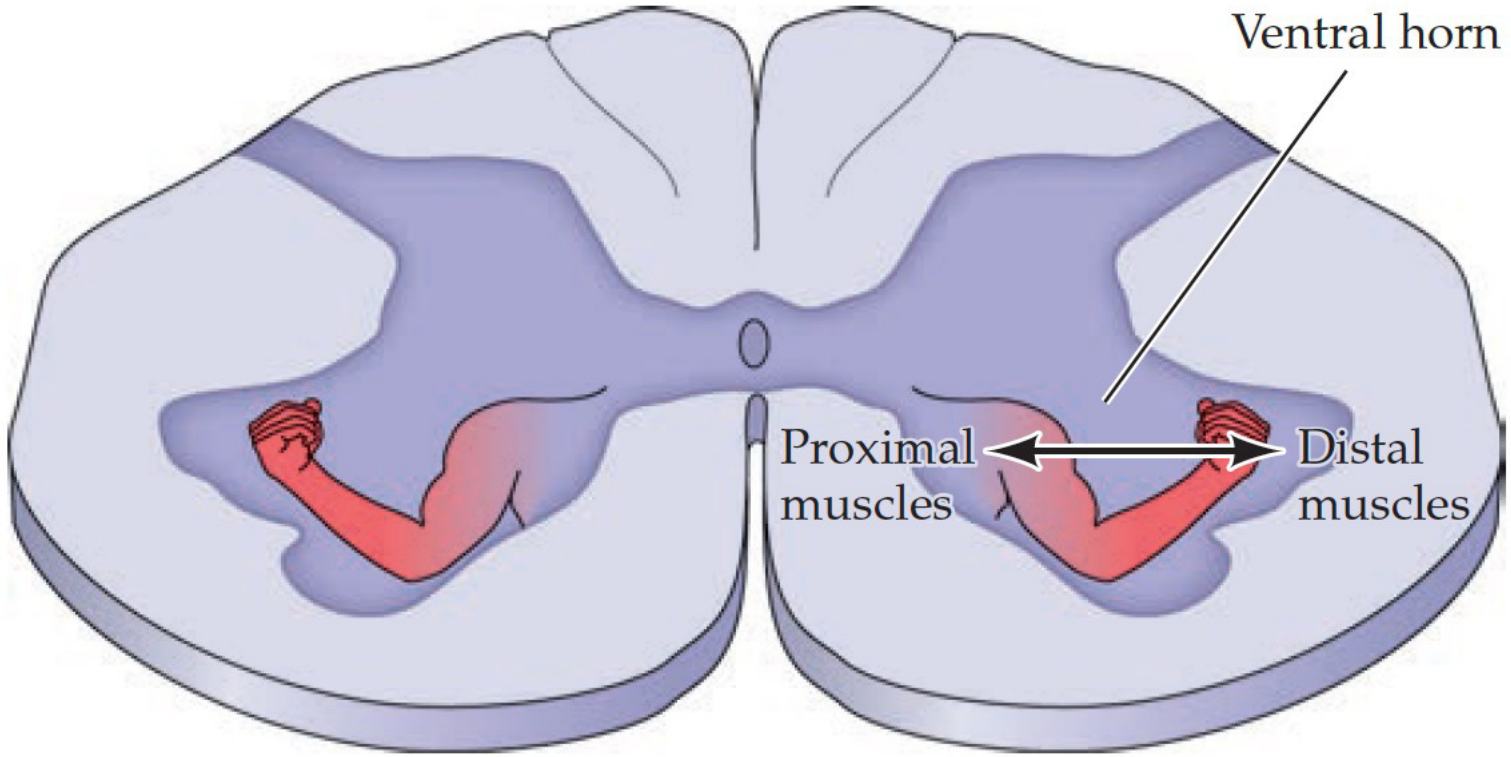
Purves, Figure 16.1

Summary: Spinal cord and cerebellum

Important concepts and keywords

- Four main motor pathways: Upper motor neurons (cortex/brainstem); Basal Ganglia, Cerebellum, Spinal Cord
- Spinal cord – somatotopic organization (mediolateral and rostrocaudal)
- Henneman's size principle
- Stretch reflex circuit function including roles of Group 1a sensory & alpha motor neurons
- Golgi tendon organ function including roles of Group 1b sensory, inhibitory, & motor neurons
- Flexion-crossed extension reflex and relevant components
- Rhythmic movements and how they arise from "central pattern generator" circuit
- Role and organization of cerebellum (input and output regions).
- Organization of the cerebellar circuit: granule cells, Purkinje cells, parallel fibers
- How cerebellar circuit computes and corrects motor errors (examples in saccades and VOR)

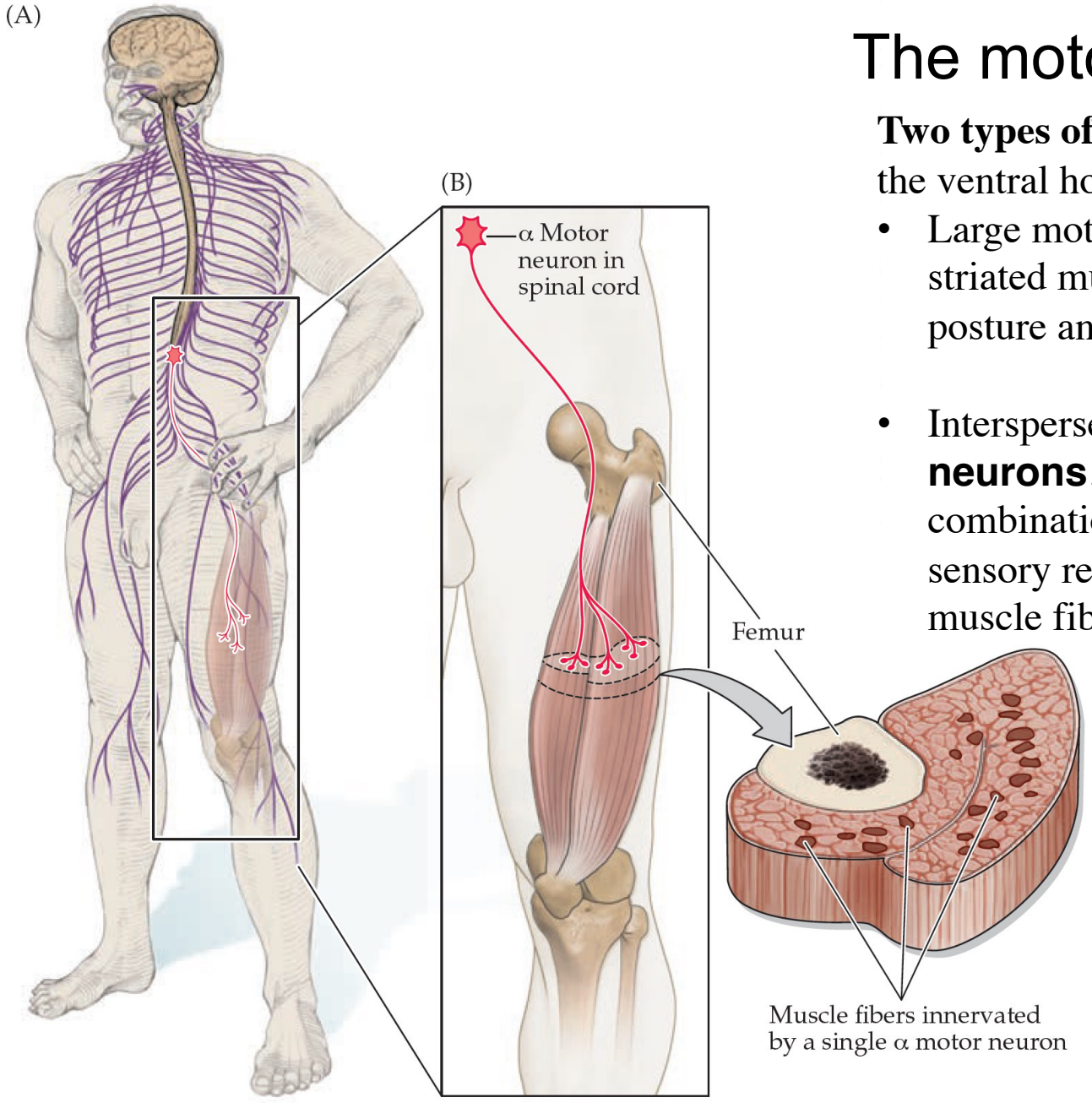
Somatotopic organization of lower motor neuron pools



There is a Topographic distribution:

- Medial spinal cord gray matter is postural/locomotion
- Lateral spinal cord is fine control of distal extremeties (e.g., fingers)

Purves, Figure 16.3



Purves, Figure 16.5

The motor unit

Two types of lower motor neurons are found in the motor neuron pools of the ventral horn:

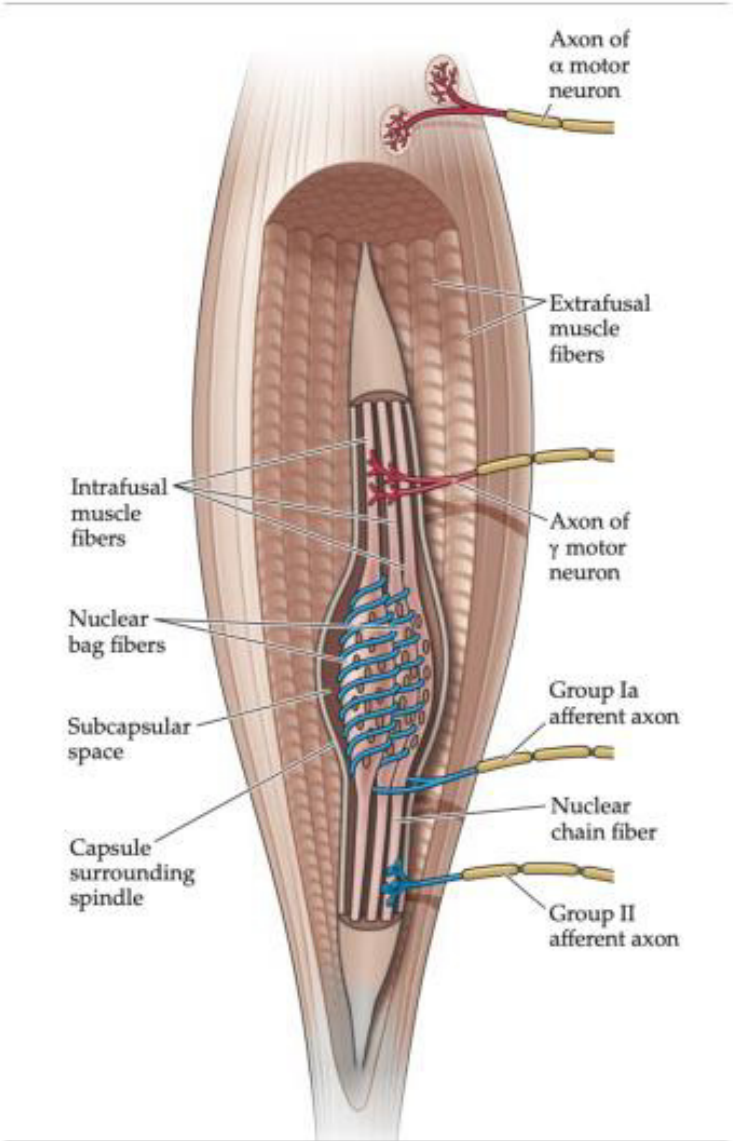
- Large motor neurons are called **α motor neurons**; they innervate the striated muscle fibers that actually generate the forces needed for posture and movement.

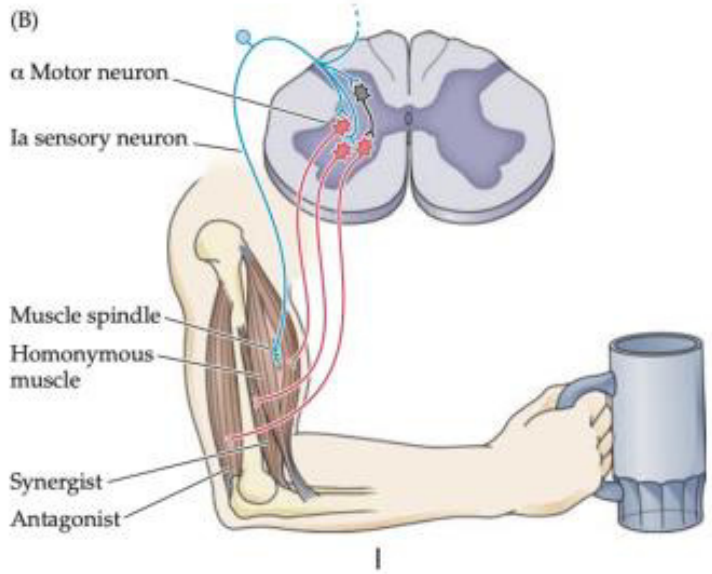
- Interspersed among the α-motor neurons are smaller **γ motor neurons**, which innervate specialized muscle fibers that, in combination with the nerve fibers that innervate them, are actually sensory receptors arranged in parallel with the force-generating striated muscle fibers.

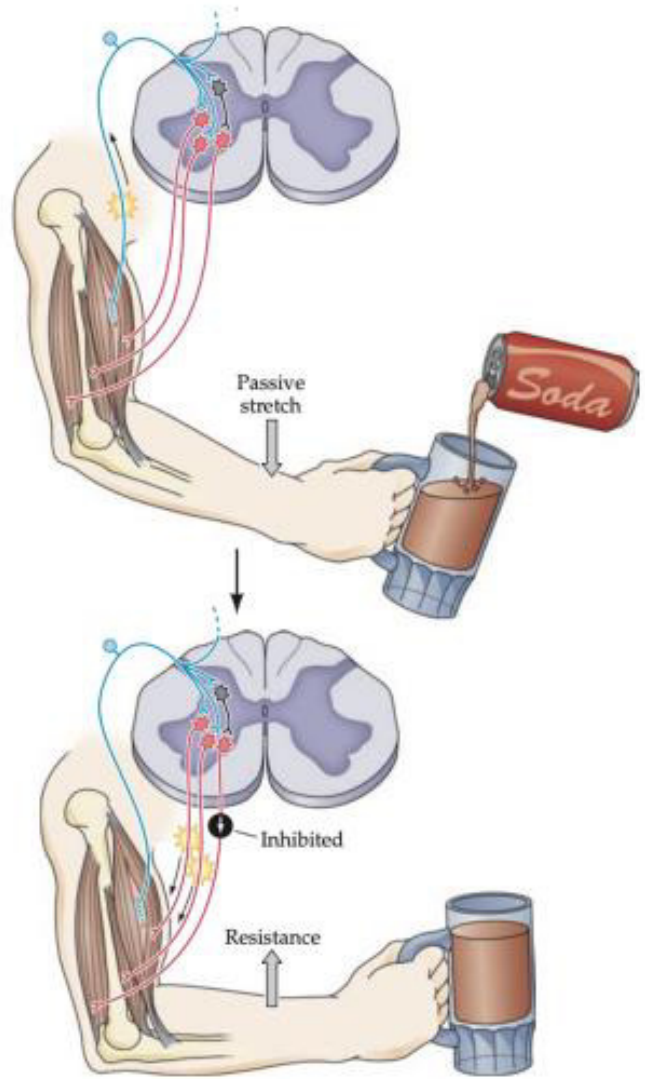
Motor unit: All muscle fibers innervated by a single motor neuron (~ 3 – 500 muscle fibers)

Extrafusal skeletal muscle fibers in mature mammals are innervated by only a **single α motor neuron**

The spinal cord circuitry underlying muscle stretch reflexes



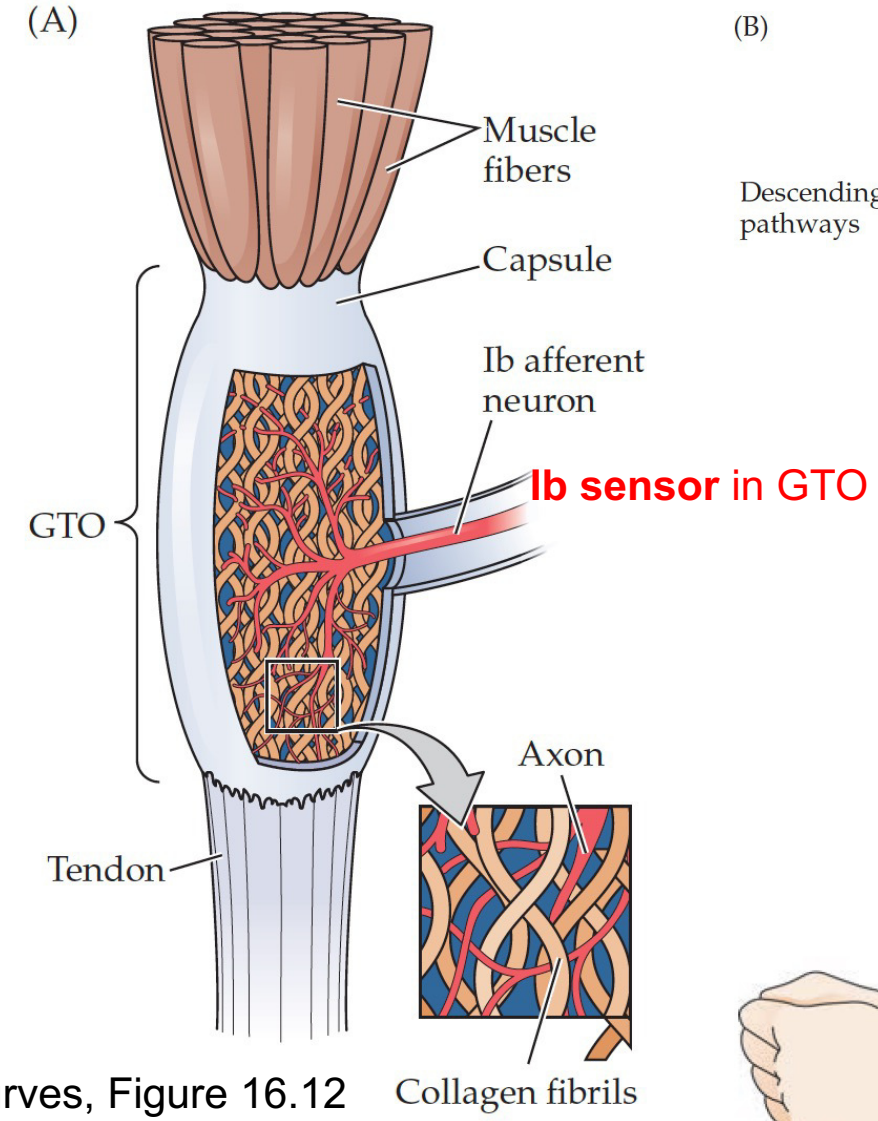




From the same muscle spindle:

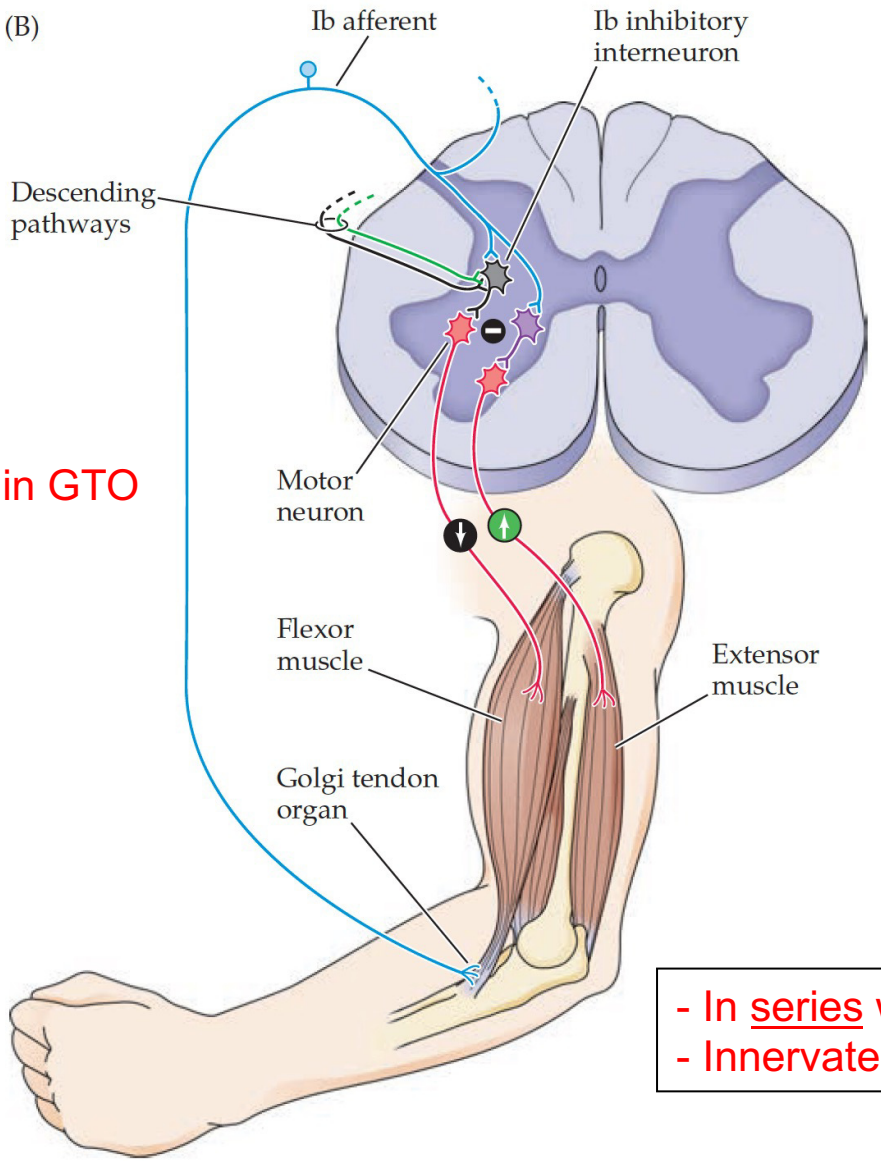
- Flexor muscle gets excited
- Extensor muscle gets inhibited

Golgi tendon organs and their role in the negative feedback regulation of muscle tension



Purves, Figure 16.12

Ib sensor in GTO

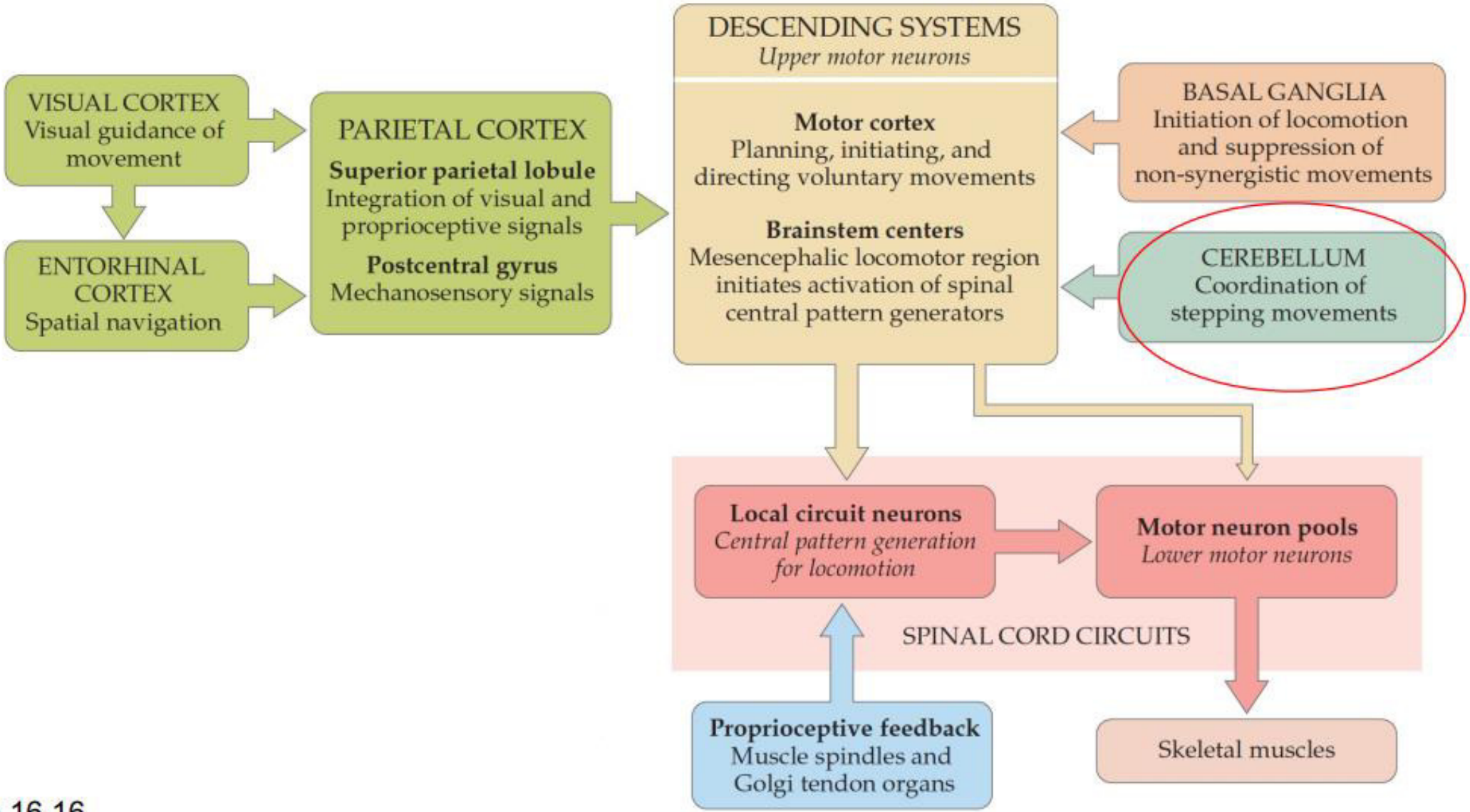


The GTO operates as a negative feedback loop to limit muscle force:

- Active force generated
- GTO stretches Ib sensor
- 1b sensor inhibits motor neurons
- Force is reduced

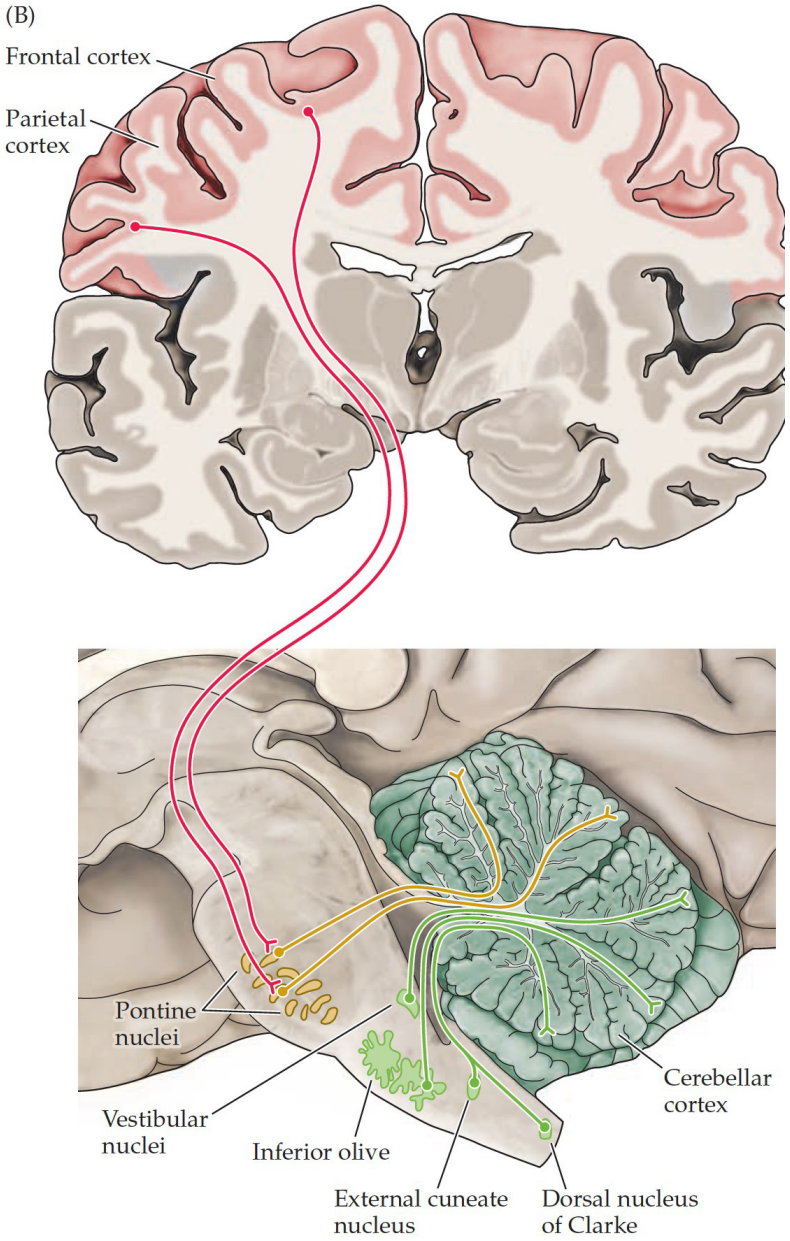
- In series with muscle
- Innervated by smaller Ib fibers

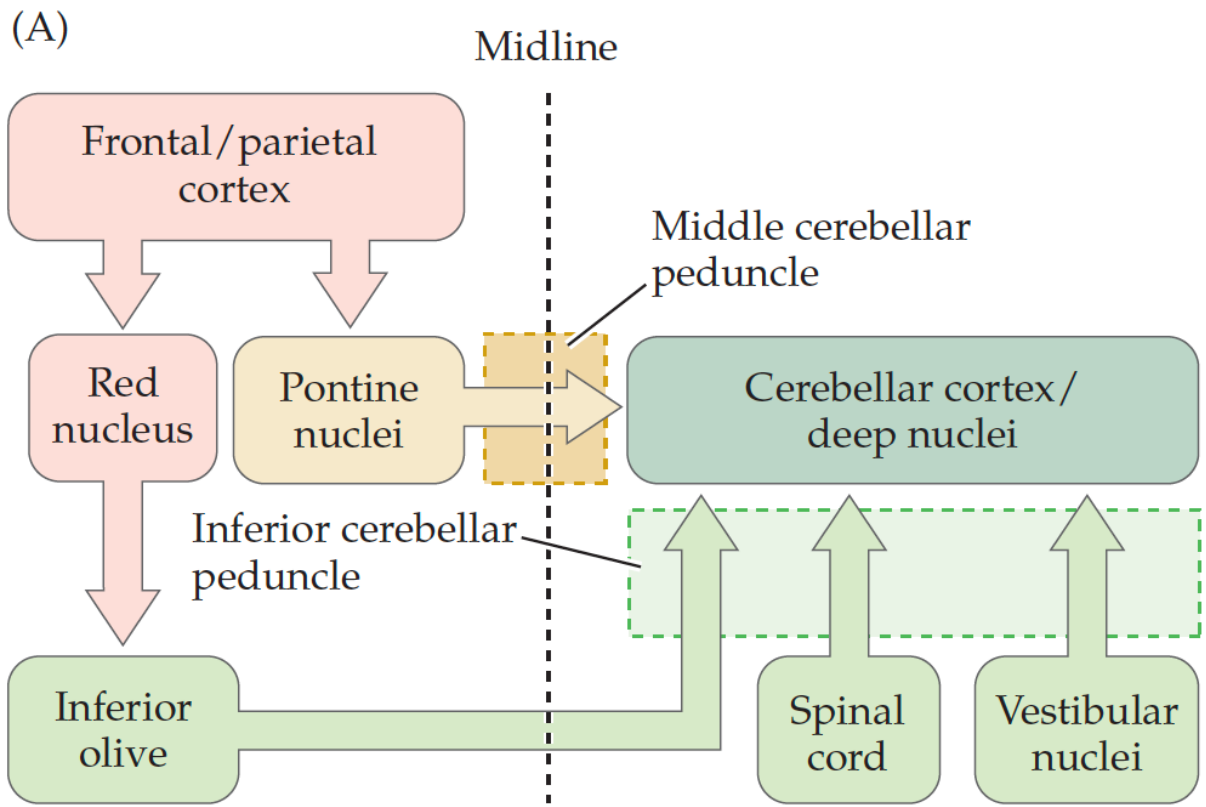
Organization of neural structures involved in the control of locomotion



Purves, Figure 16.16

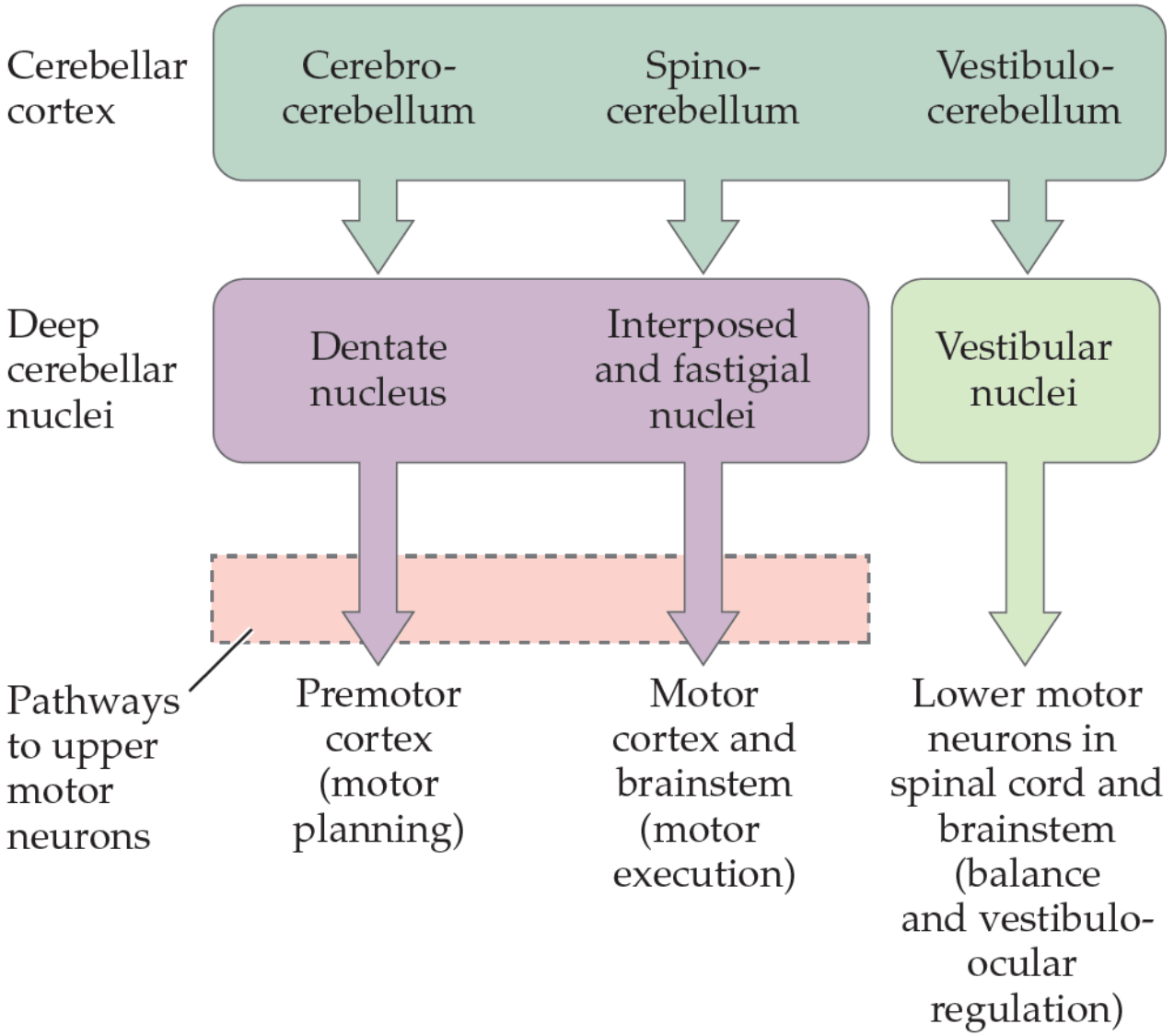
Functional organization of the inputs to the cerebellum





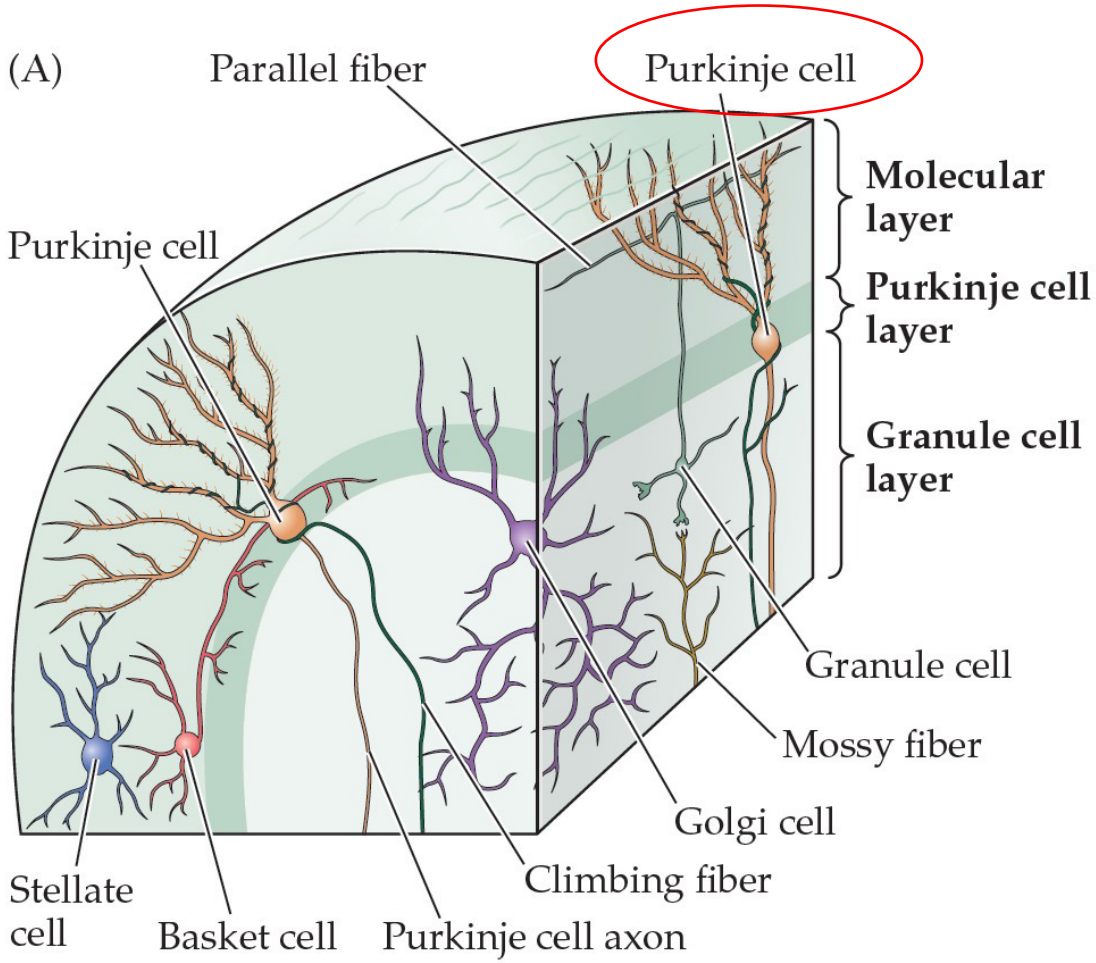
Purves, Figure 19.3

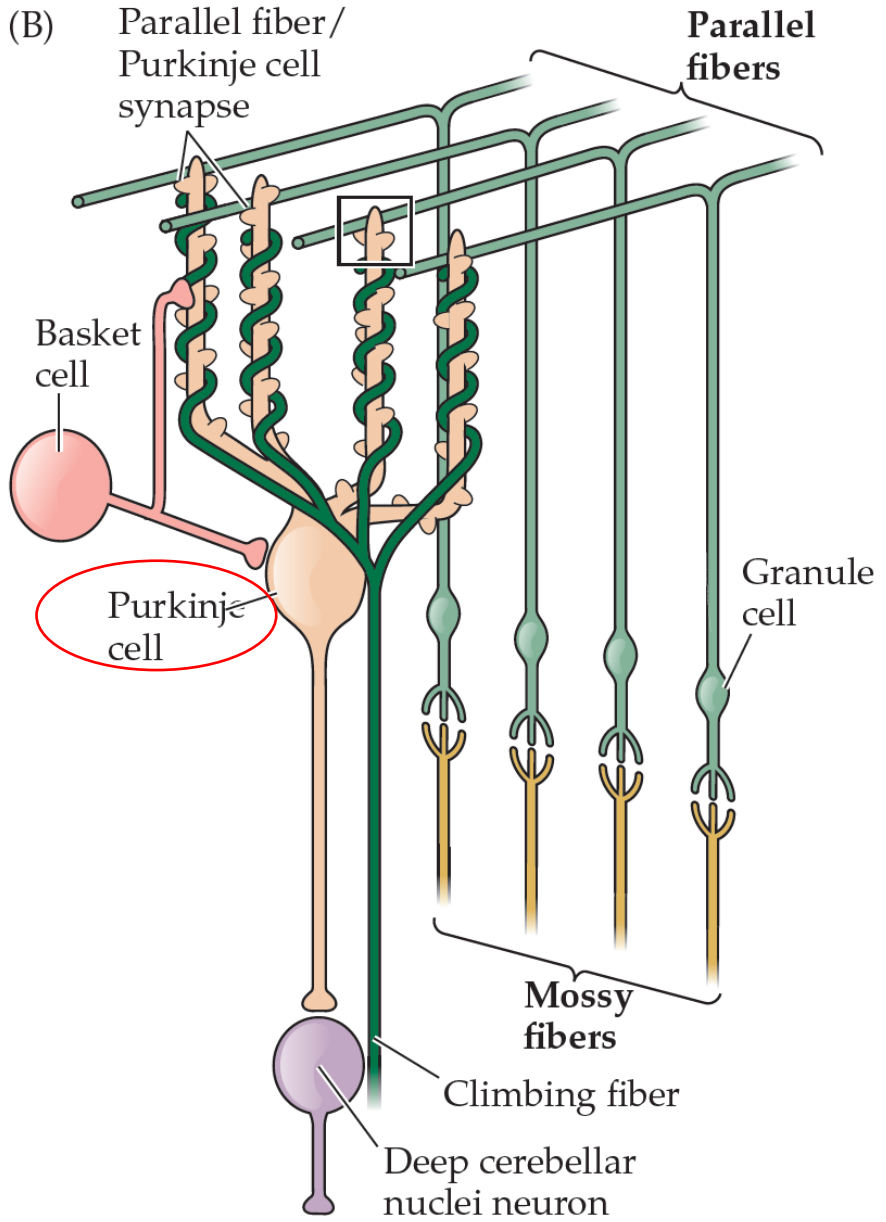
Functional organization of cerebellar outputs



Purves, Figure 19.5

Neurons and circuits of the cerebellum





Purkinje Neuron: the principle output of the cerebellum

Purves, Figure 19.9