BIO-311 – Neuroscience

Spinal Cord & Cerebellum

Summary

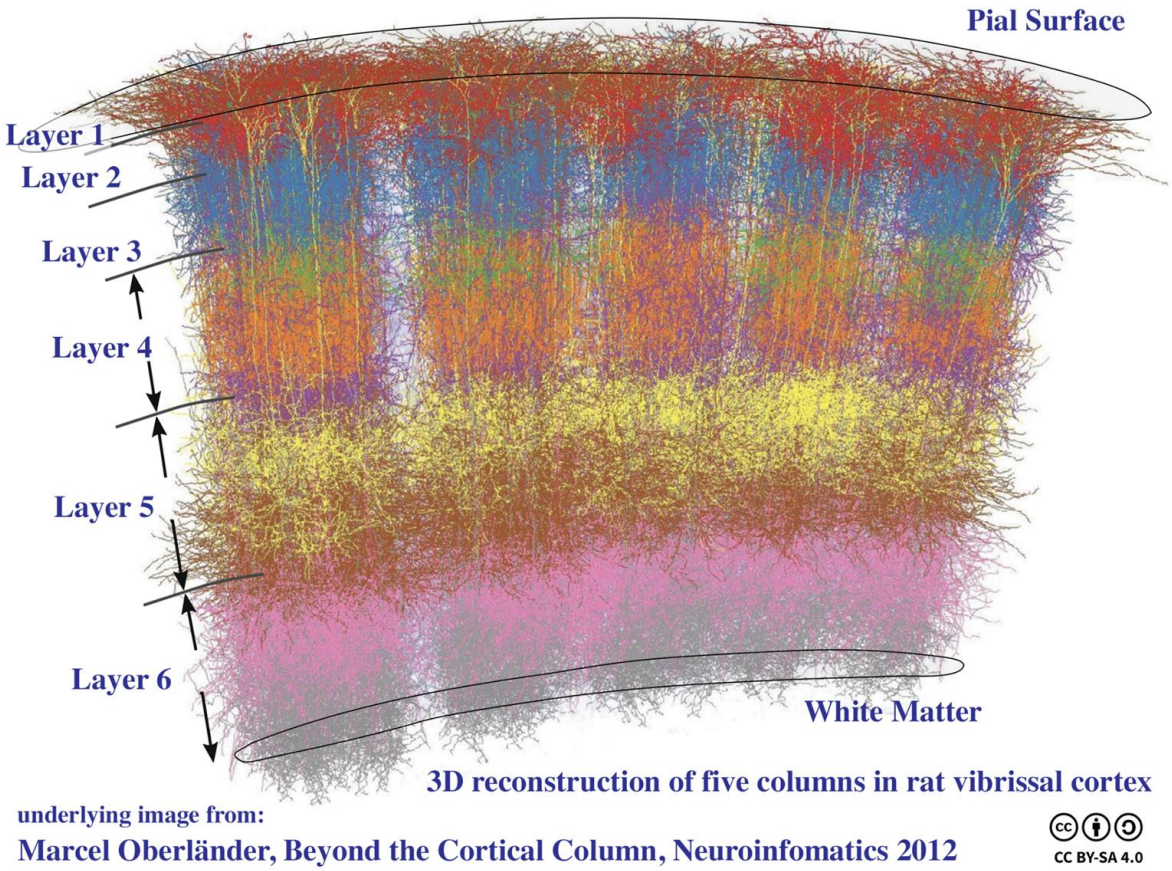
Chapter 16

- Diagram of upper / lower motor circuits
- Lower motor neurons and their topographic representation
- Motor units, types of motor units
- Motor circuitry under reflex

Chapter 19

- Components of cerebellum
- Cortical pathway to cerebellum
- Sensory pathway to cerebellum
- Topographic maps in cerebellum
- Outputs of cerebellum

Cortical columns and layers



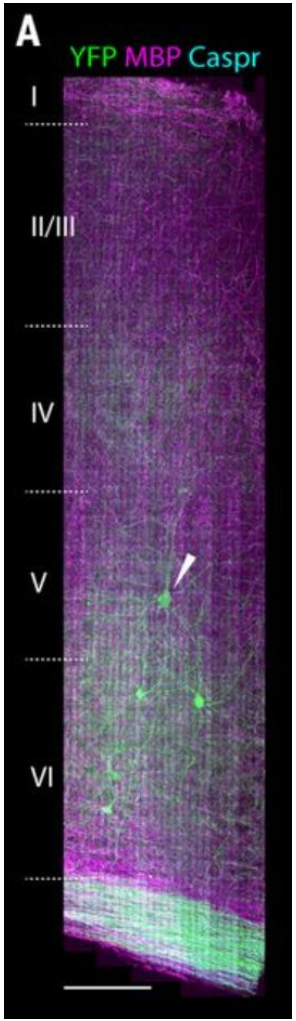
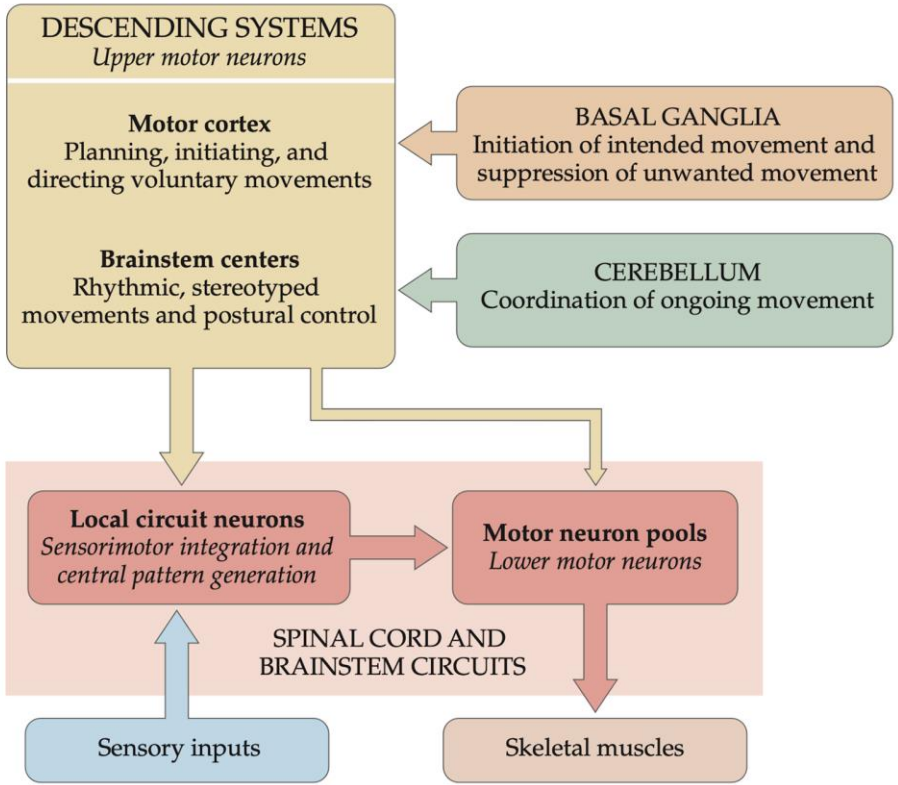


Image from Gao et al.

DOI: 10.1126/science.aau8302

Lower Motor Neuron Circuits and Motor Control



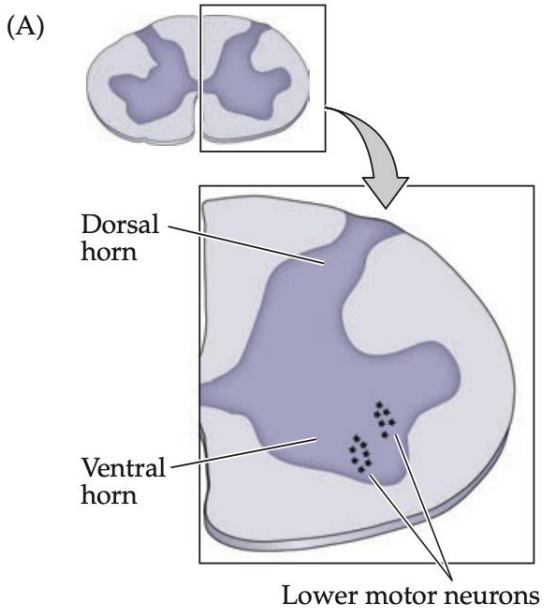
Lower motor neuron: Motor neurons that innervate skeletal muscles

Organization of neural structures involved in the control of movement.

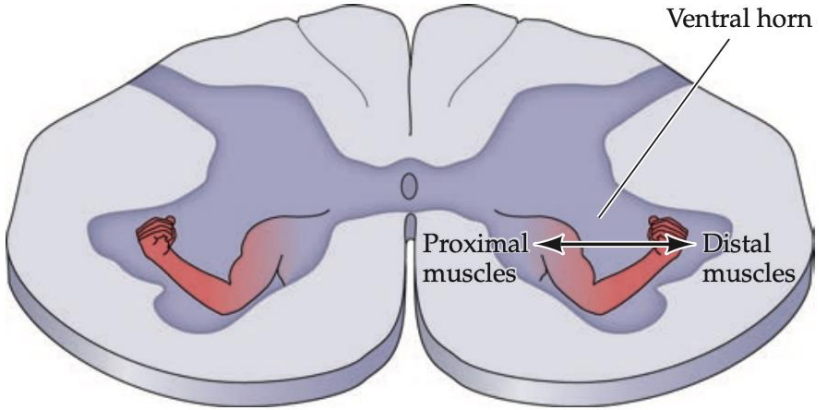
4 systems:

- **Spinal cord**
- **Cerebellum**
- *Descending control centers in cortex/brainstem*
- *Basal ganglia*

Motor Neuron-Muscle relationship



Lower motor neurons that innervate skeletal muscles can be seen in histology, in the **ventral horn.**



Topography: Mapping of skeletal muscles in the ventral horn.

Distal muscles: **Lateral**

Proximal muscles: **Medial**

Two types of lower motor neurons

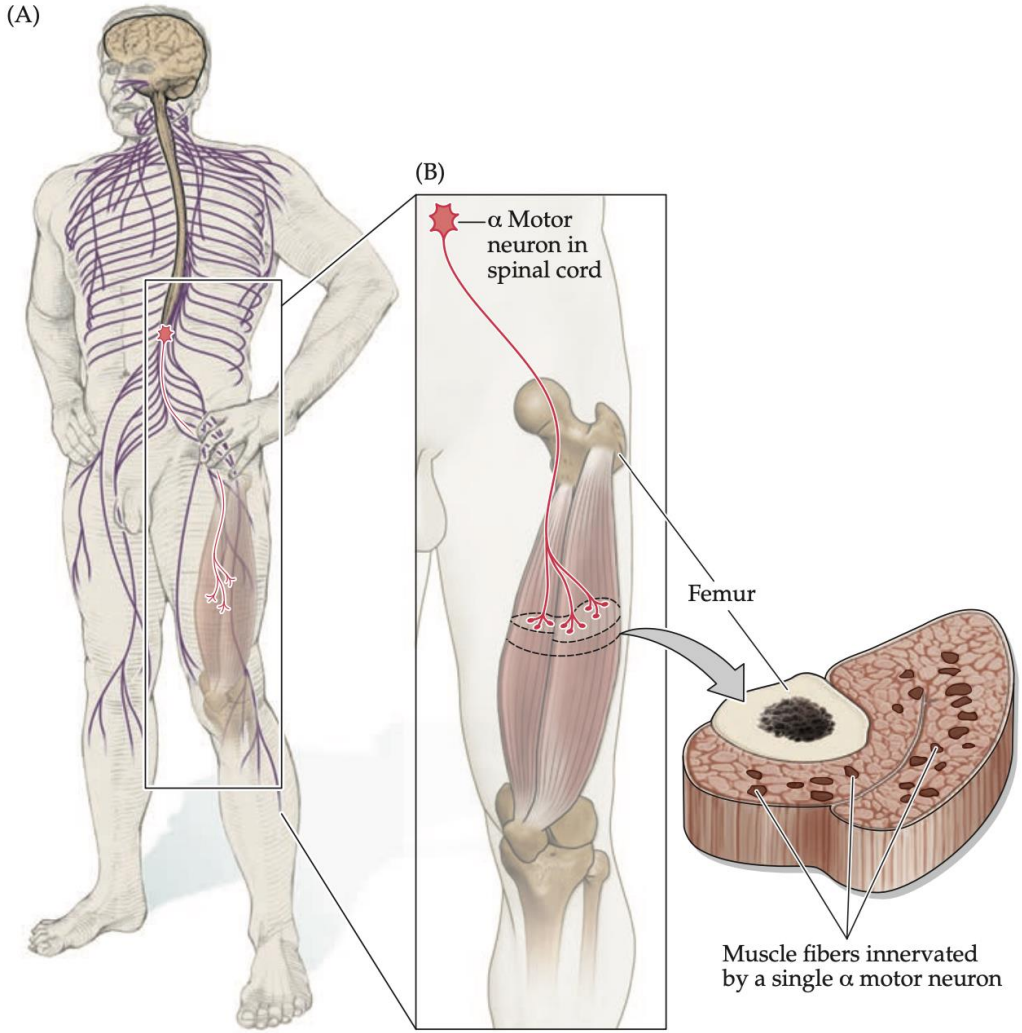
- **Alpha** motor neurons: Innervate striated muscle fibers (force needed for posture and movement)
- **Gamma** motor neurons: Innervate specialized muscle fibers that, in combination with the nerve fibers that innervate them, are actually sensory receptors arranged in parallel with force generating striated muscle fibers (muscle spindles).

The Motor Unit

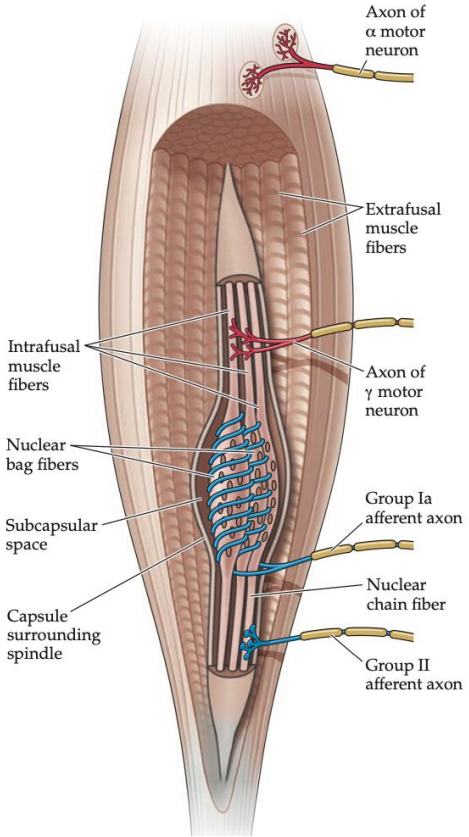
Each alpha motor neuron synapses with multiple fibers in **one** muscle.

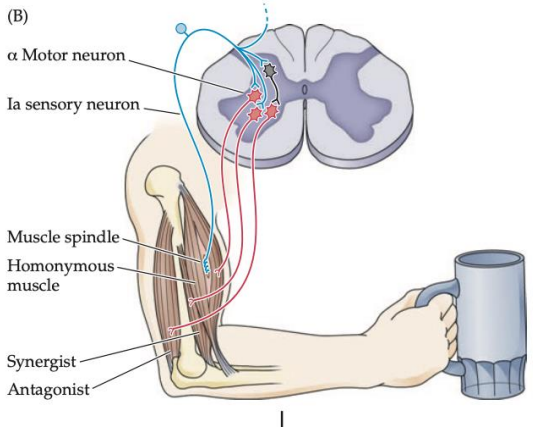
Motor unit: Alpha neuron + muscle fibers it contacts

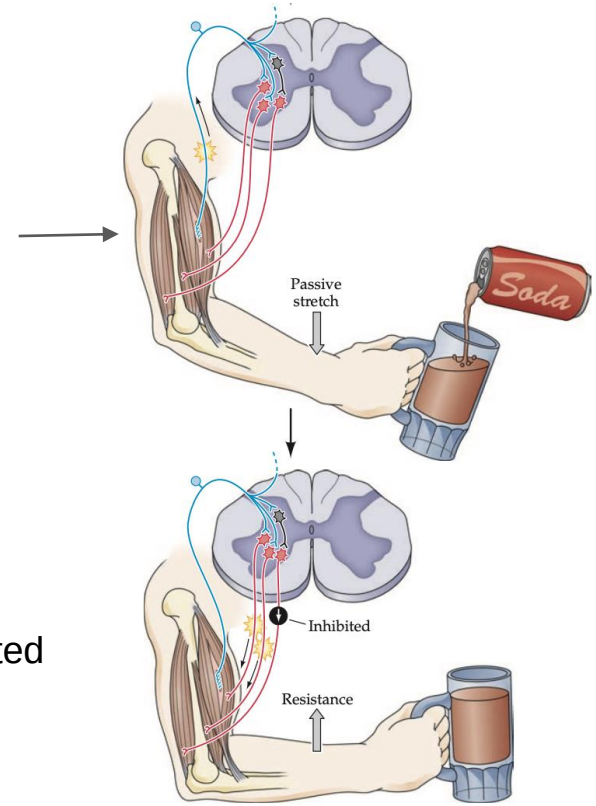
NT at NMJ: **Acetylcholine**



The spinal cord circuitry underlying muscle stretch reflexes



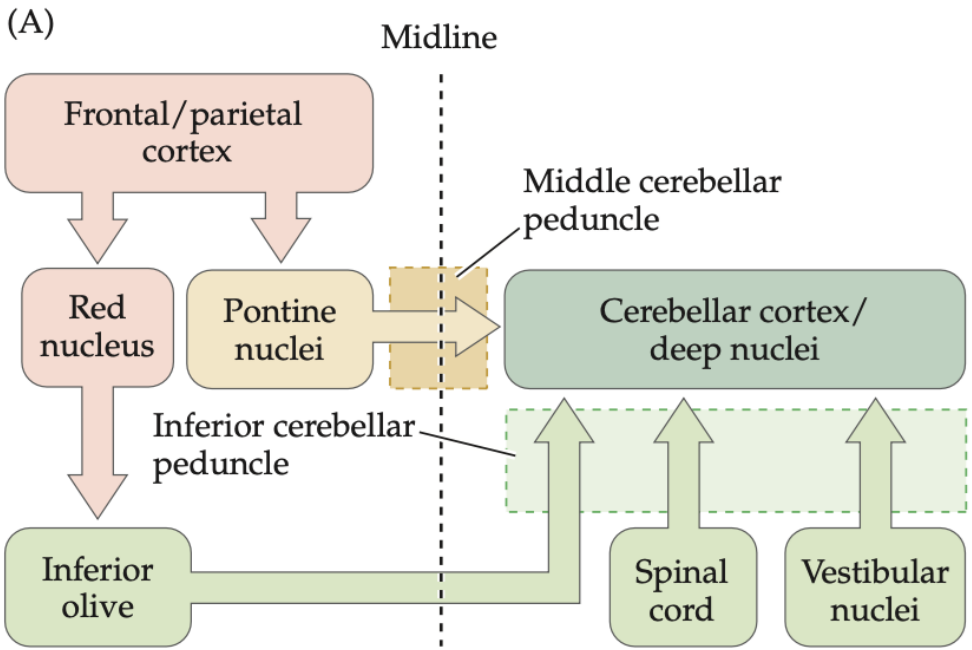




From the same muscle spindle:

- Flexor muscle gets excited
- Extensor muscle gets inhibited

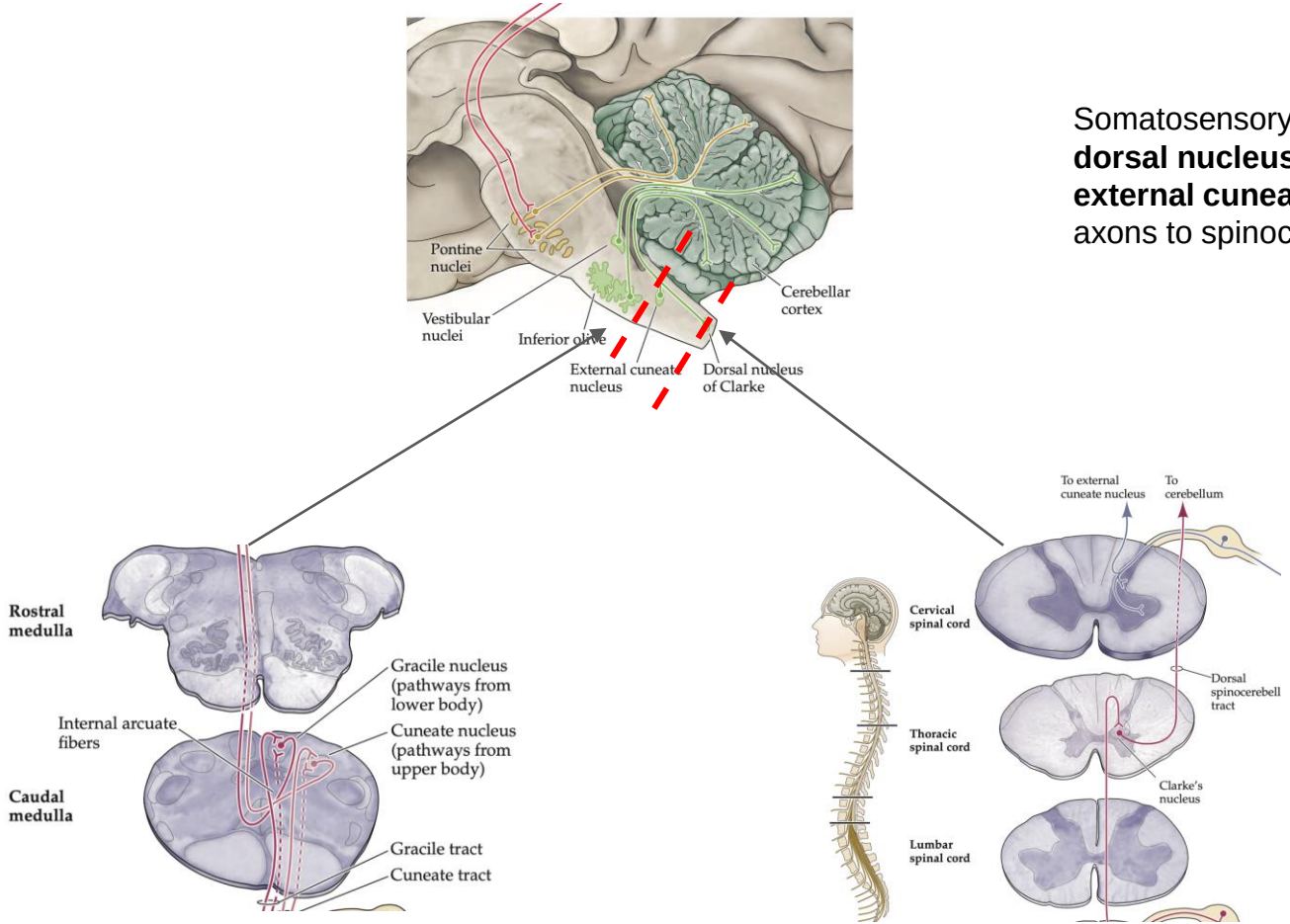
Cortical pathway to cerebellum



Cerebellum takes inputs from cerebral cortex via pontine nuclei - middle peduncle pathway and inferior olive-inferior peduncle pathway

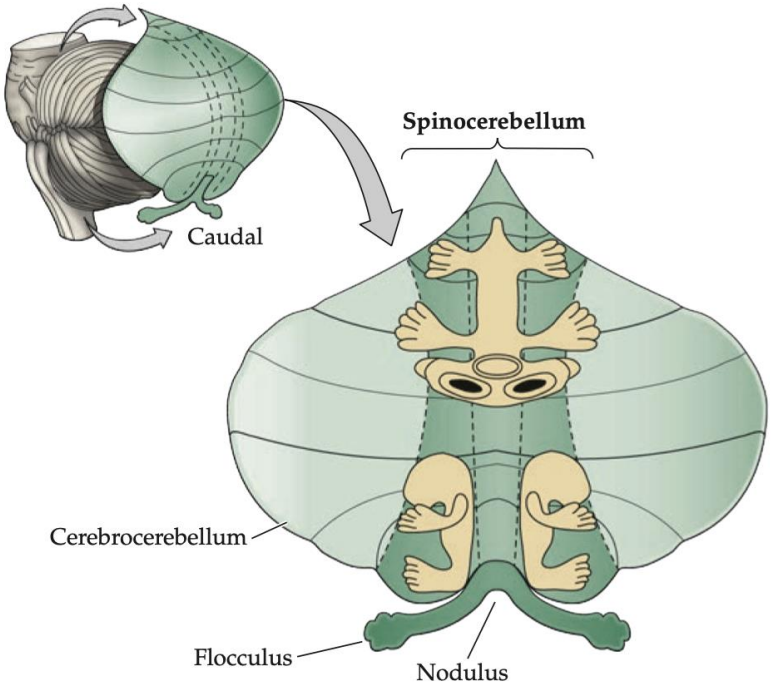
Transverse pontine fibers, starting from pontine nuclei, crossing midline and entering cerebellum at middle cerebellar peduncle.
This is the means by which signal from one side of cerebral hemisphere is sent to the **opposite cerebellar hemisphere**

Sensory pathway to cerebellum



Somatosensory relay neurons in **dorsal nucleus of Clarke** and **external cuneate nucleus** send axons to spinocerebellum.

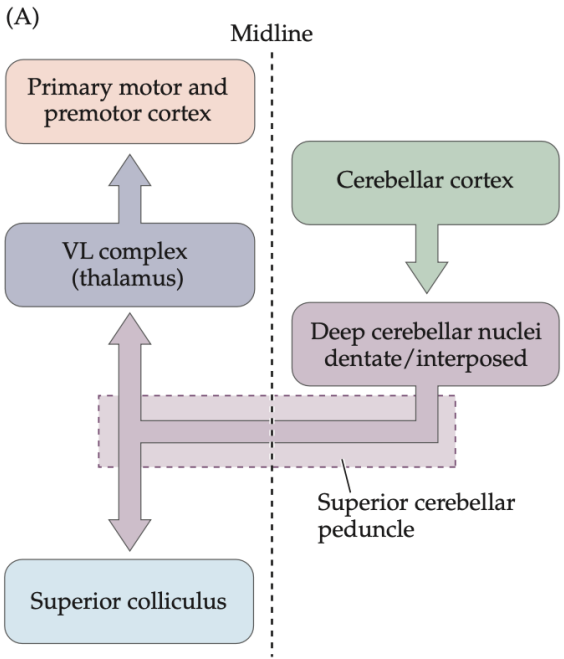
Topographic maps in cerebellum



Somatosensory input is **topographically mapped** in spinocerebellum.
However, these maps are **fractured (**meaning each body area can be represented multiple times by separated clusters)

This map is **ipsilateral** unlike most other areas in the brain that has contralateral map

Outputs of cerebellum

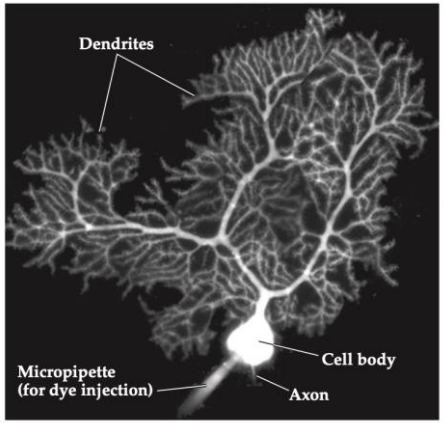


Efferent neurons of cerebellar cortex project to the **deep cerebellar nuclei**, which in turn, to upper motor neurons in brainstem and thalamic nuclei.

Pathway to cortices via **VL complex (thalamus)**

Has to cross midline again because cerebellar cortex has ipsilateral map while cortices have contralateral map.

Purkinje Neurons are the principle output of the cerebellar cortex!



Research in Spinal Cord Injury

@EPFL, restoring locomotion through spinal cord stimulation around partial spinal cord section location.

- https://www.youtube.com/watch?v=ejwEqpV8ak4
- https://www.youtube.com/watch?v=4wUADfnCMdc