

BIO-311 Neuroscience

The somatosensory system

Summary

Periphery (skin/muscle)

- Types of receptor
 - Proprioception
 - Touch
 - Temperature/Pain
- Conduction speed / axon diameter
- Adaptation/Sensitivity
- Pathway to spinal cord

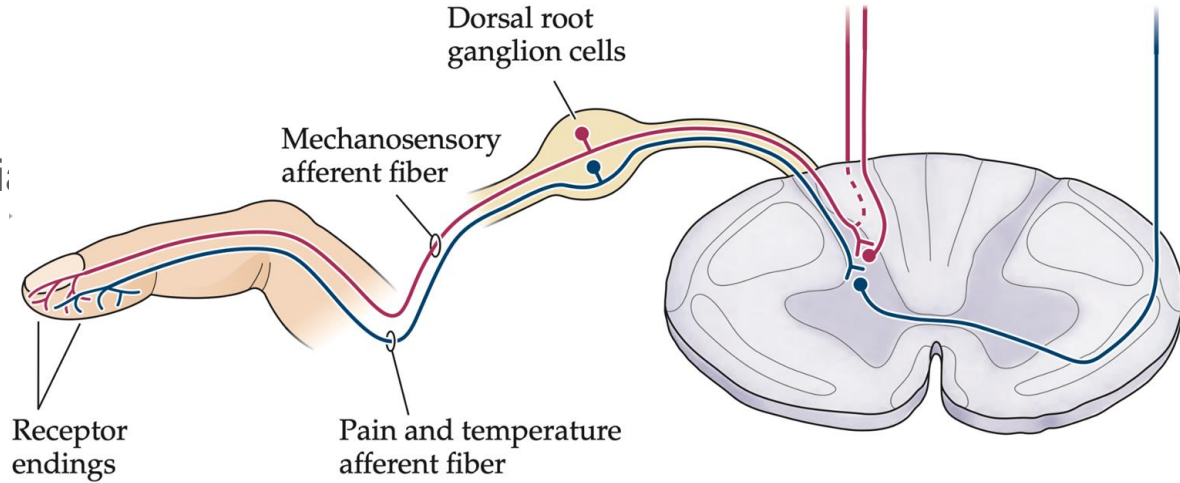
Spinal cord

- Myotatic reflex
- Pathway to brain

Brain

- Receptive field
- Plasticity of somatosensory mapping

Bottom-up and top-down pathways

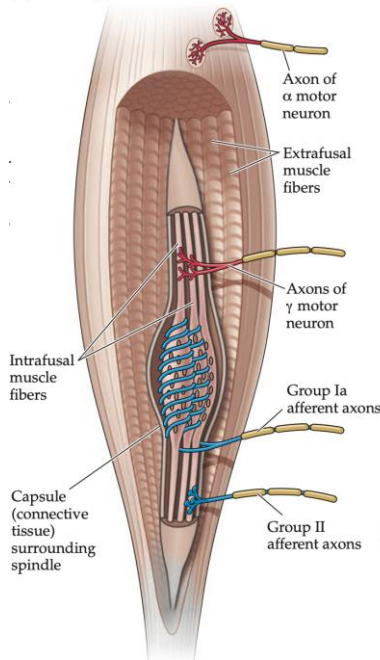


Periphery / Types of receptor

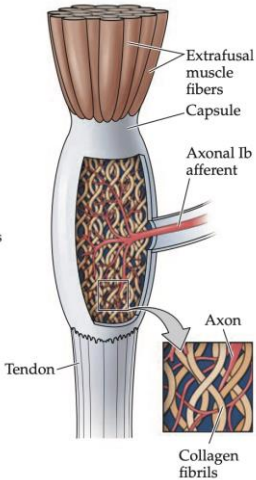
Proprioception

Muscle spindles

(A) Muscle spindle

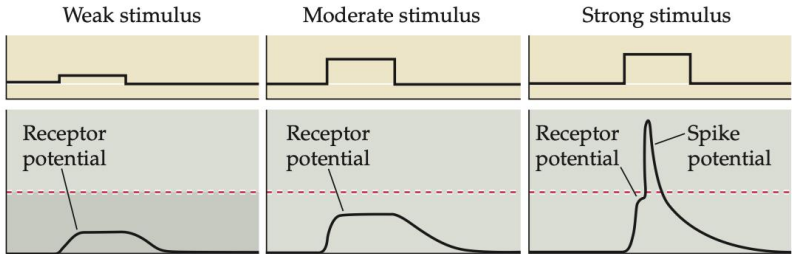
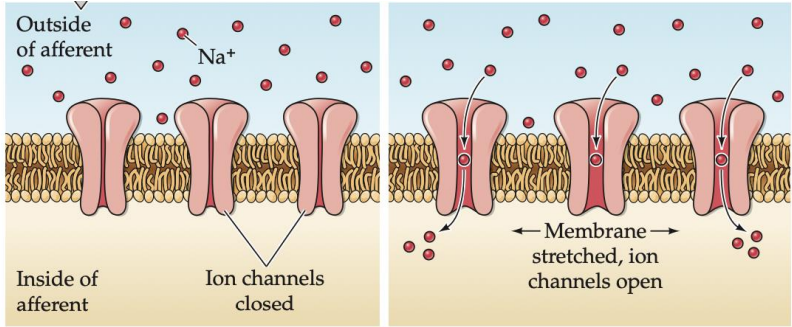


(B) Golgi tendon organ



Mechanoreceptors

Stretch, pressure, etc



Periphery / Conduction speed / Axon diameter

TABLE 9.1 ■ Somatosensory Afferents That Link Receptors to the Central Nervous System

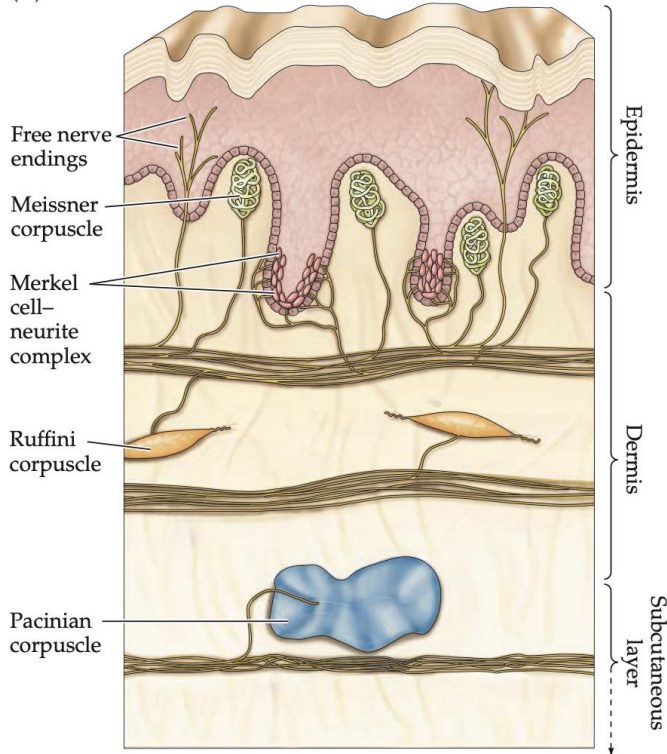
Sensory function	Receptor type	Afferent axon type ^a	Axon diameter	Conduction velocity
Proprioception	Muscle spindle	Ia, II	13–20 μm	80–120 m/s
Touch	Merkel, Meissner, Pacinian, and Ruffini cells	A β	6–12 μm	35–75 m/s
Pain, temperature	Free nerve endings	A δ	1–5 μm	5–30 m/s
Pain, temperature, itch, non-discriminative touch	Free nerve endings (unmyelinated)	C	0.2–1.5 μm	0.5–2 m/s



Larger diameter provides more room for ions to flow thus it's faster

Periphery / Adaptation/sensitivity

(A) Glabrous skin



Free nerve endings
(esp. important for *pain* sensation)

Meissner's corpuscles
3-40 Hz (low frequency)

Merkel cell afferents
slowly adapting; highest spatial resolution

Ruffini's endings
(- corpuscles)

Pacinian corpuscles
(250 -350 Hz)
High sensitivity (10 nm)

Each receptor has its own most effective stimuli:

Meissner -> Skin motion

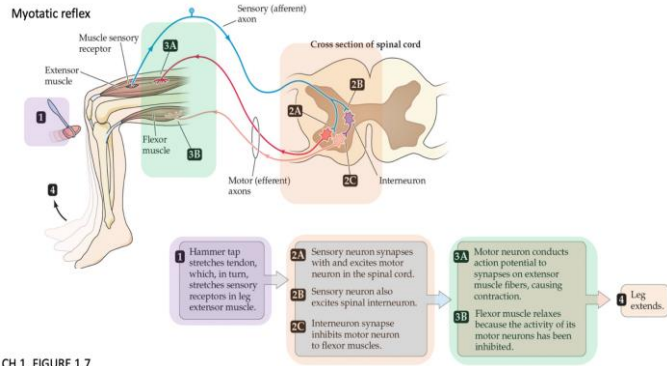
Merkel -> shape and texture

Ruffini -> skin stretch

Pacinian -> vibration

And varying sensitivity and receptive fields.

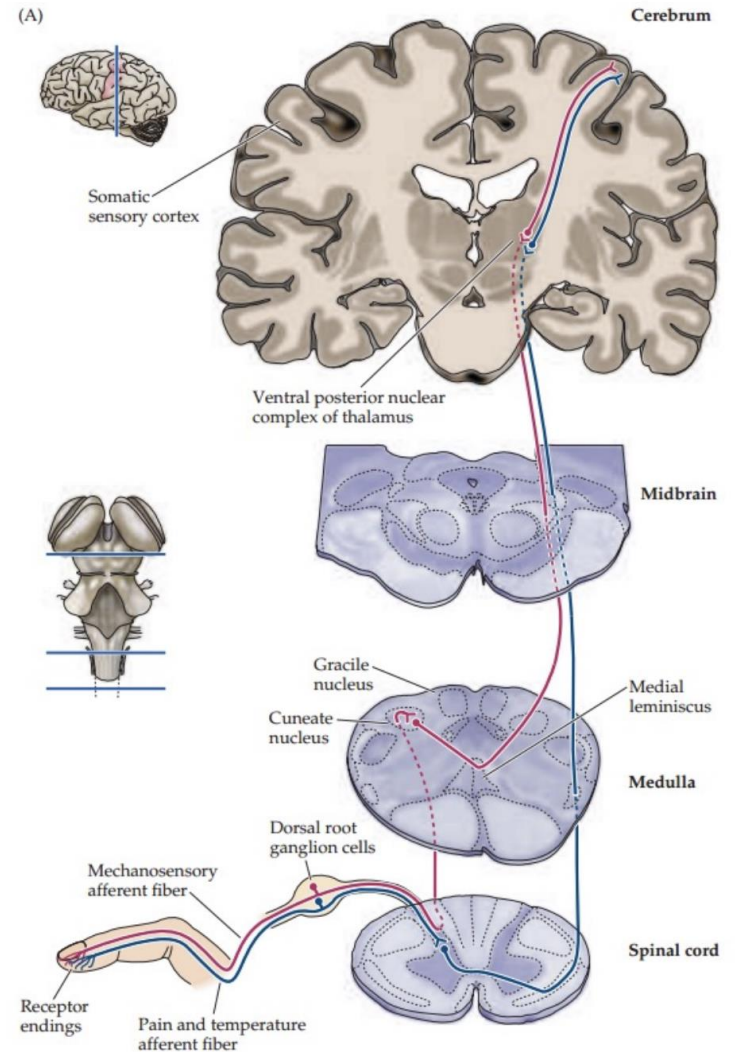
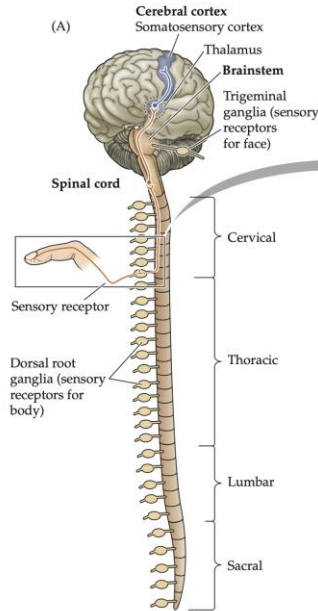
Pathway to spinal cord



CH 1, FIGURE 1.7

Signals from the periphery are conveyed/routed to the dorsal root ganglion cells

Dorsal column-medial lemniscus pathway ->



Brain & receptive fields

Neuron in the somatosensory cortex

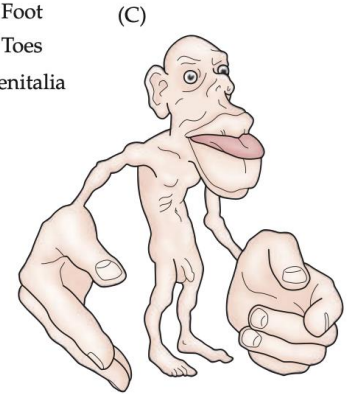
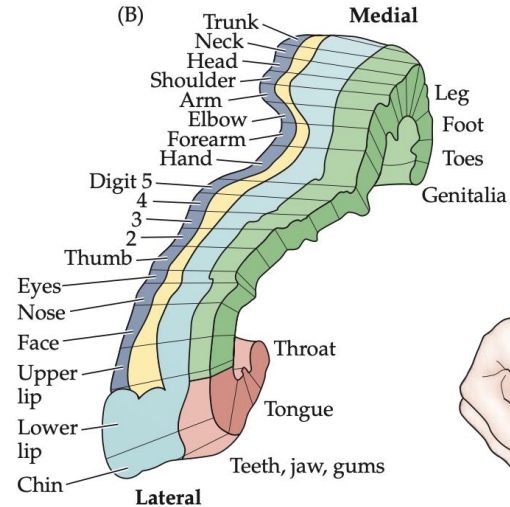
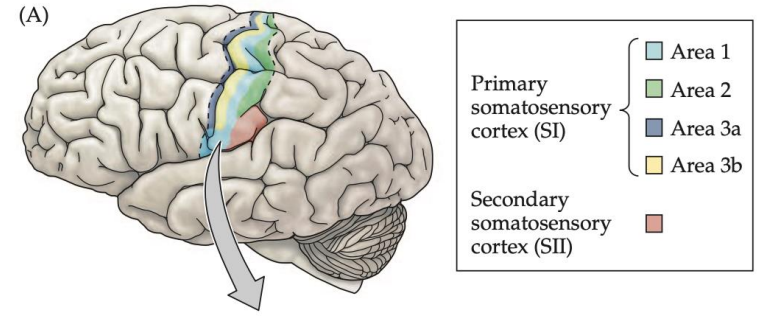
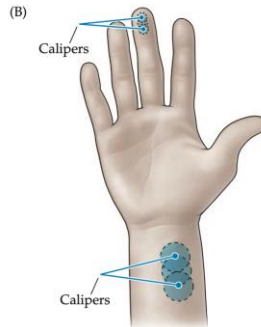
Receptive field have 2 properties:

1) Spatial distribution

- Somatosensory cortex, each cell encodes a specific area of the body
- Within a **receptive field**, stimuli cannot be distinguished
- Non-uniform distribution depending on importance

2) Functional distinction

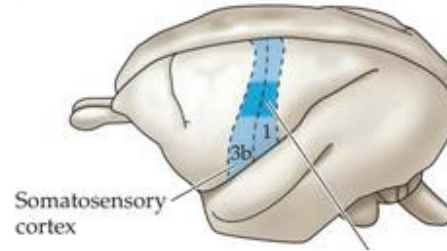
- Vision receptive field
- Touch receptive field



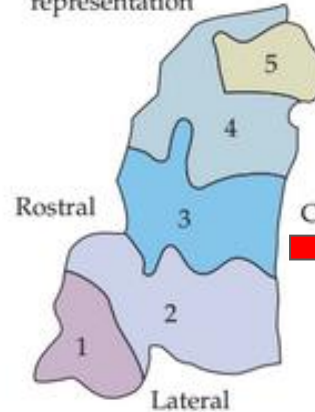
Plasticity in the cortex

- Sensory representations in the brain can evolve, e.g. after the loss of a body part
- Changes in cortical representation also can occur in response to physiological changes in sensory or motor experience.

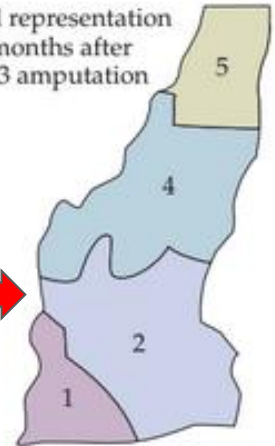
(A) Owl monkey brain



(B) Normal hand representation



(C) Hand representation two months after digit 3 amputation



Example of brain plasticity :
functional remapping