Somatosensory System

The Integument (aka “Skin”)

- Giant, washable, stretchable, water-proof sensory organ…The boundary between “you” and “not-you”
- 6-10 pounds
- 12-20 sq-ft

The Integument

- Epidermis (Thin outer layer)
- Dermis (Thick inner layer)
- Humans “shed” 50 million epidermal cells per day
- Whole ecosystems are based upon the accumulations of household dander)

The Skin (Integument)

Glabrous Skin

Smooth, thick skin on palms and soles of our feet
Epidermis = 1.5 mm
Dermis = 3 mm

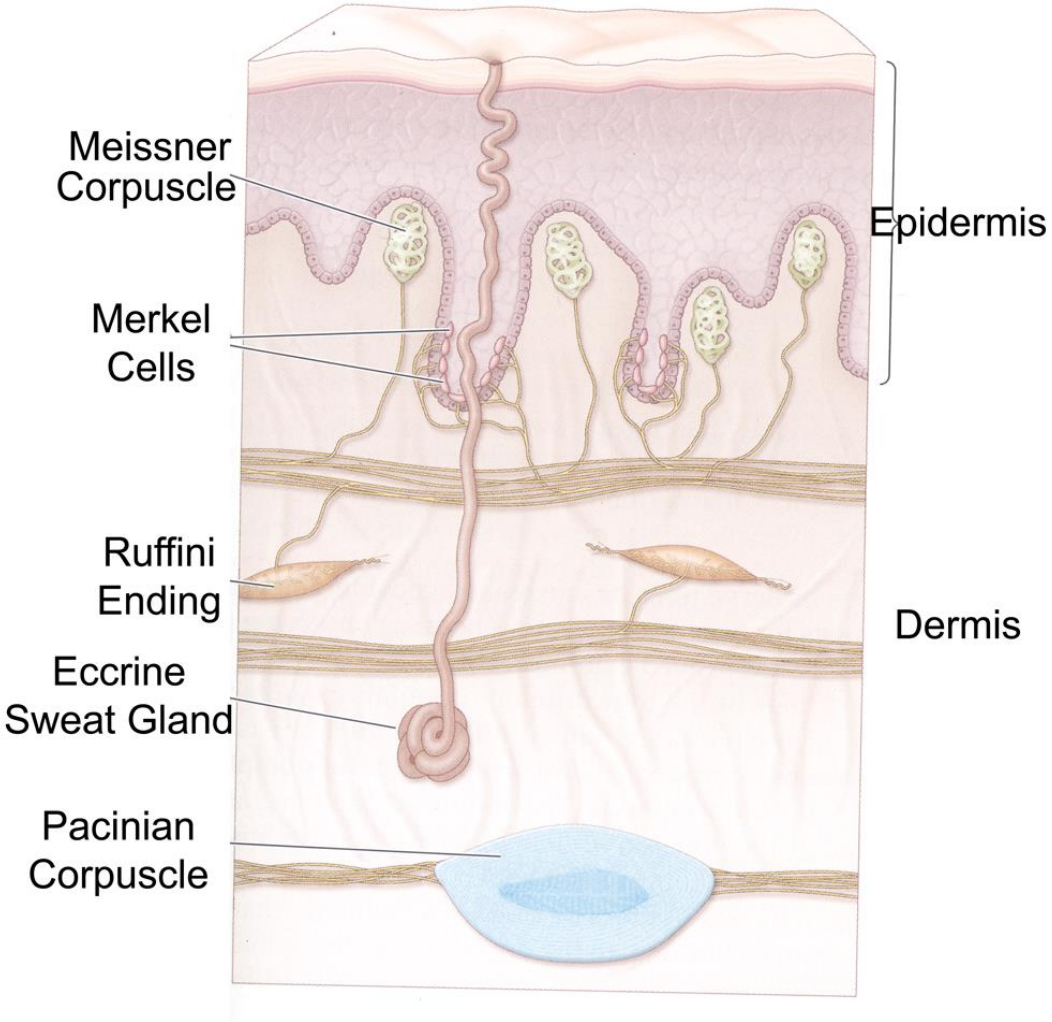
Hairy Skin

Thin skin populated with hair follicles
Epidermis = 0.1 mm
Dermis = 1-2 mm

Sweat Glands

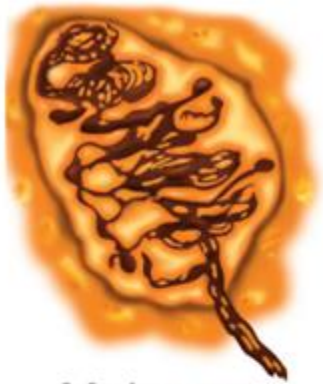
Eccrine – secrete saline (heat regulation)
Sebaceous – secrete complex cell cytoplasm (signaling?)
(Primary source of human body odor)

The Skin (Integument)

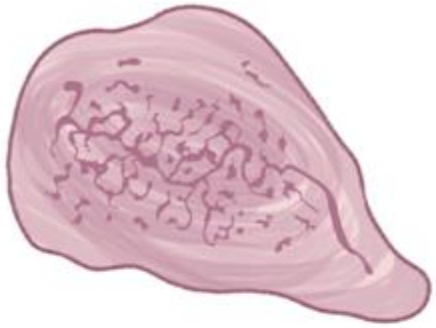


Cross-Section through Glabrous Skin

Mechanoreceptors



Meissner Corpuscle



Ruffini Ending

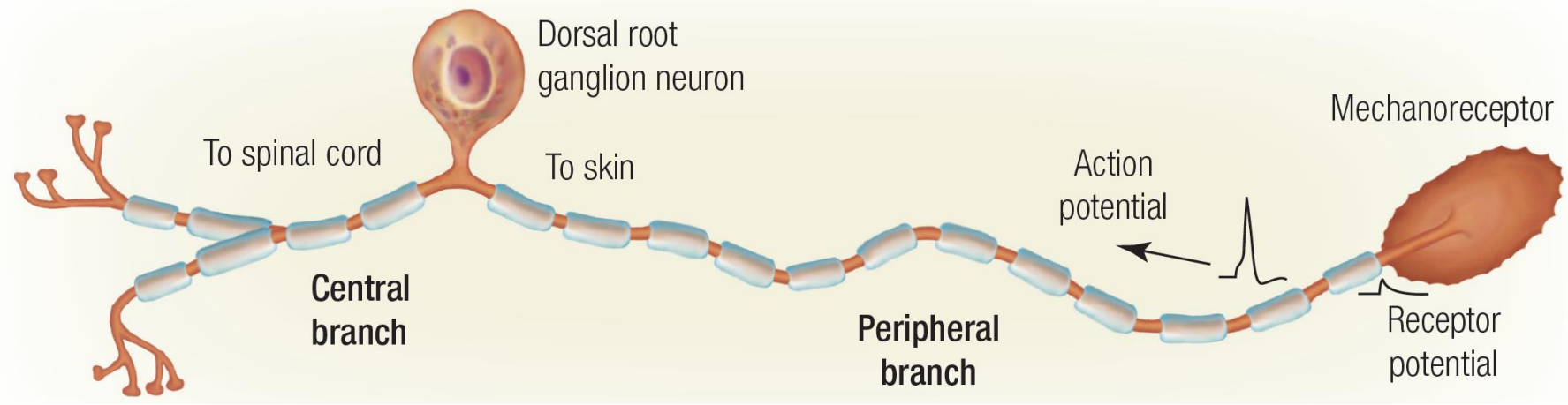
Merkel Cells

Pacinian Corpuscle

Other somatosensory transducers

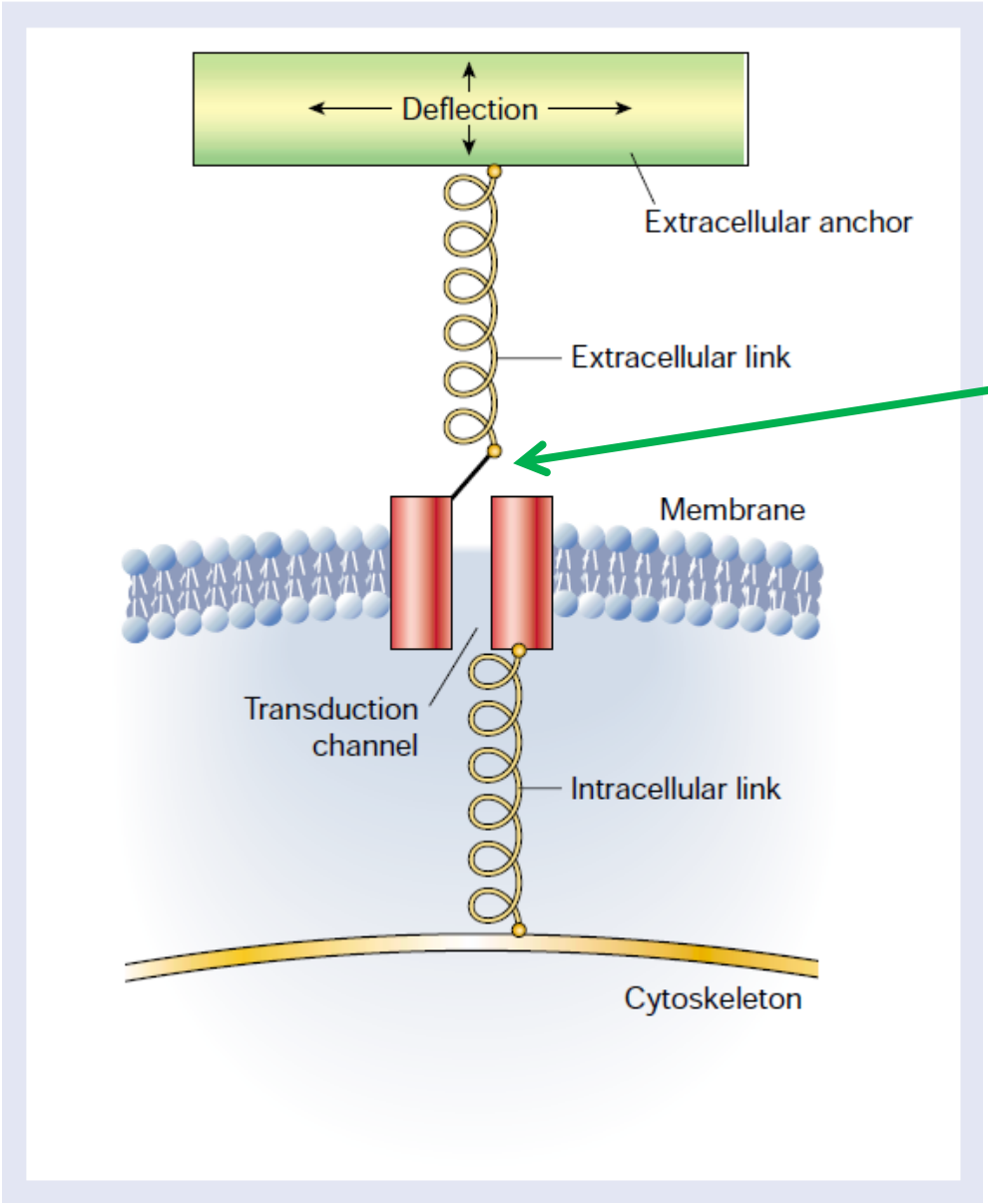
<u>Free nerve endings</u>:
Temperature (hot; cold)
Proprioception (limb/muscle state)
Nocioception (pain)

Bipolar Neurons



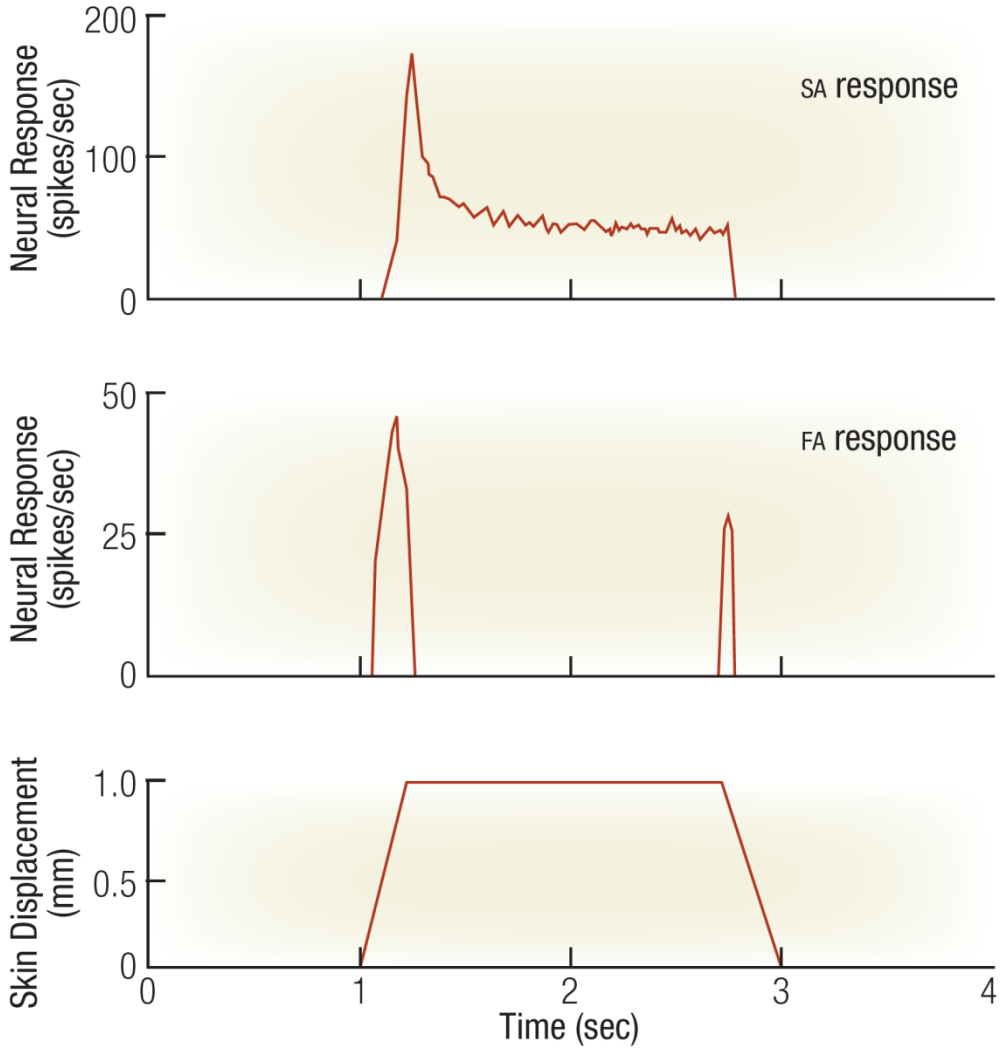
① Physical "strain" at the nerve terminus forces Na+ ion channels to open.
② Influx of sodium results in rapid depolarization of the resting potential.
③ Depolarization triggers an "action potential" at the nerve terminus.
④ Conduction velocity depends upon diameter and myelinization.
(mechanoreceptor αβ axons are long, wide and fast)

Mechanoreceptor Transduction

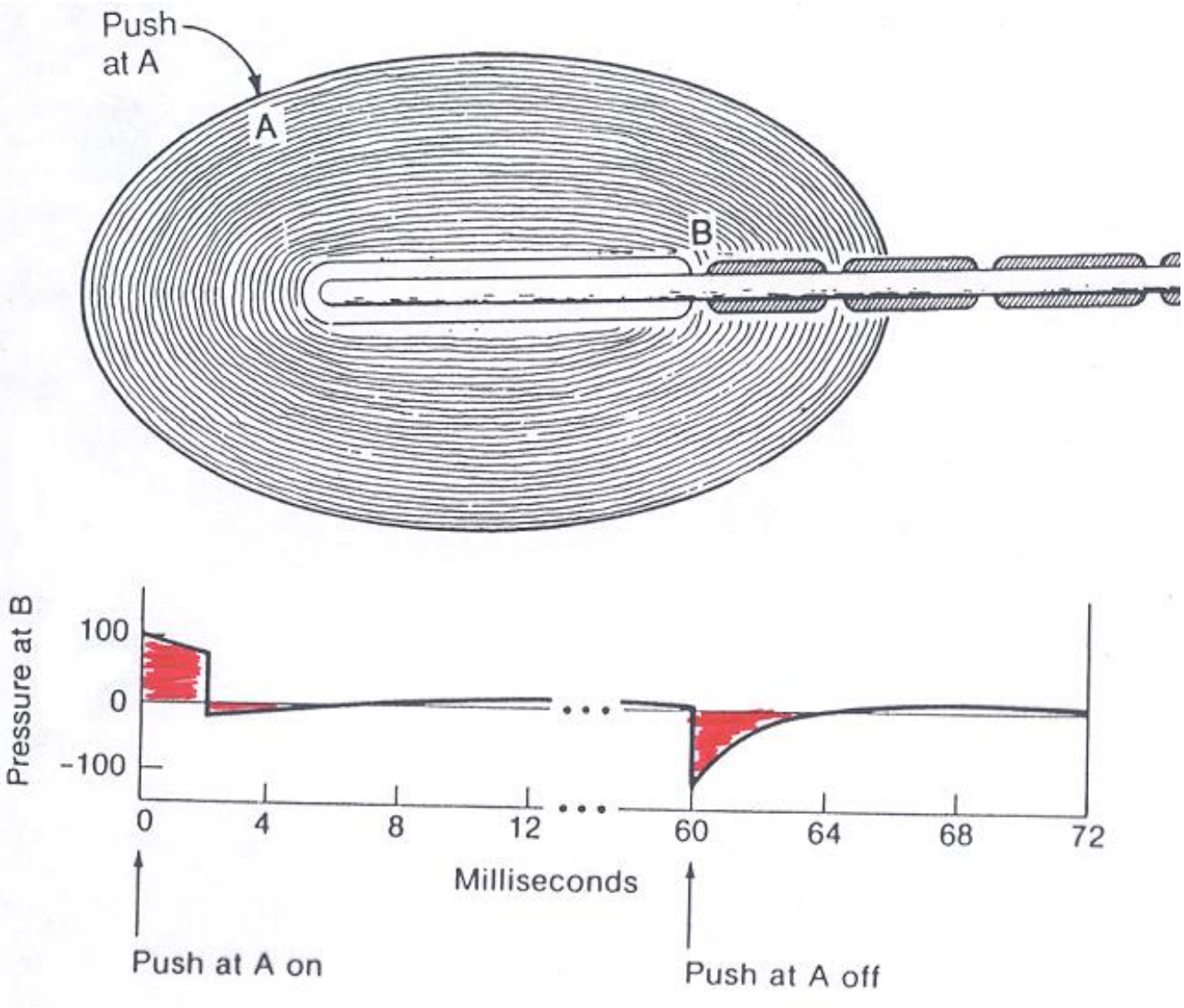


Na+ ion influx (depolarization)

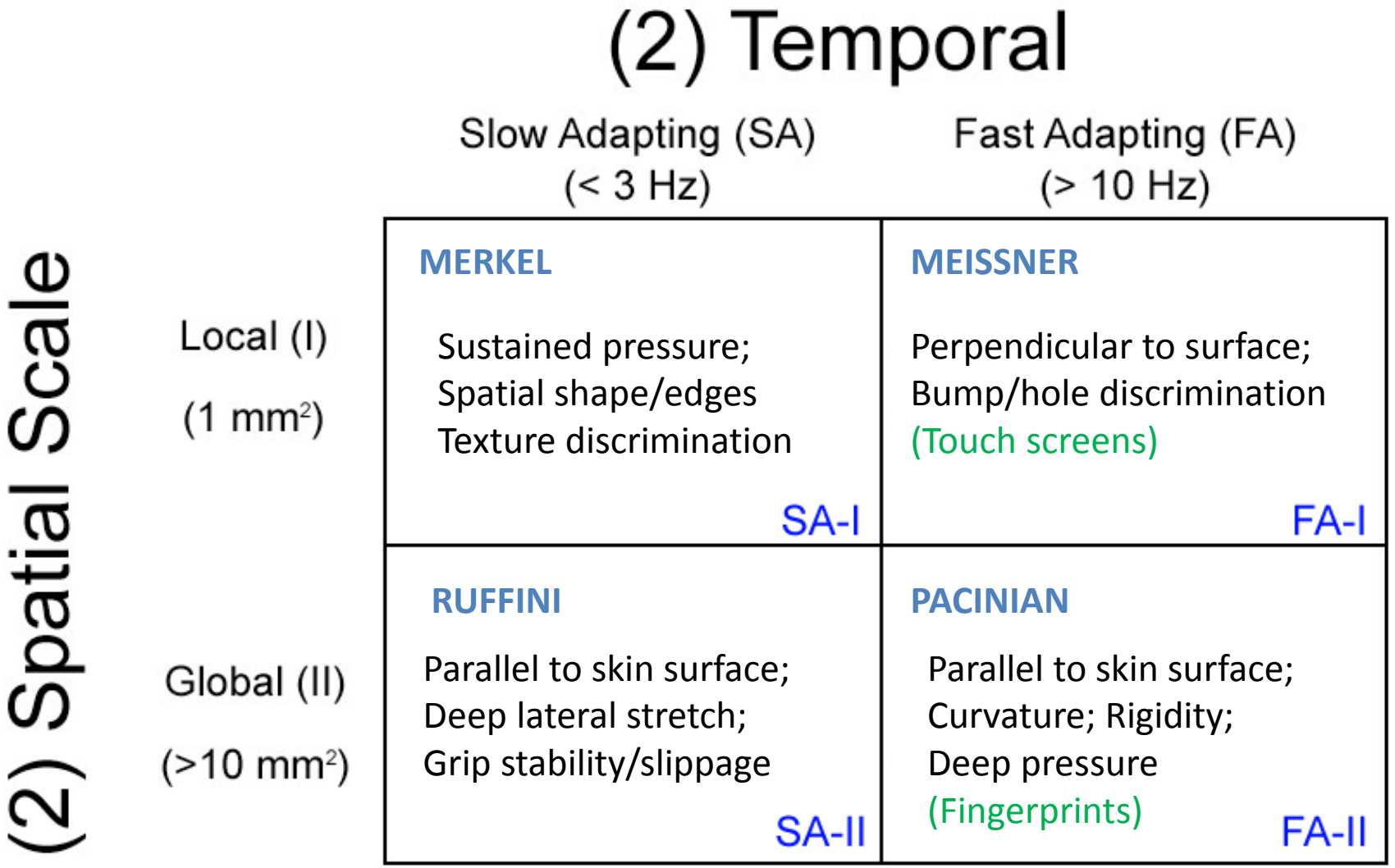
Slow-Adapting vs. Fast-Adapting



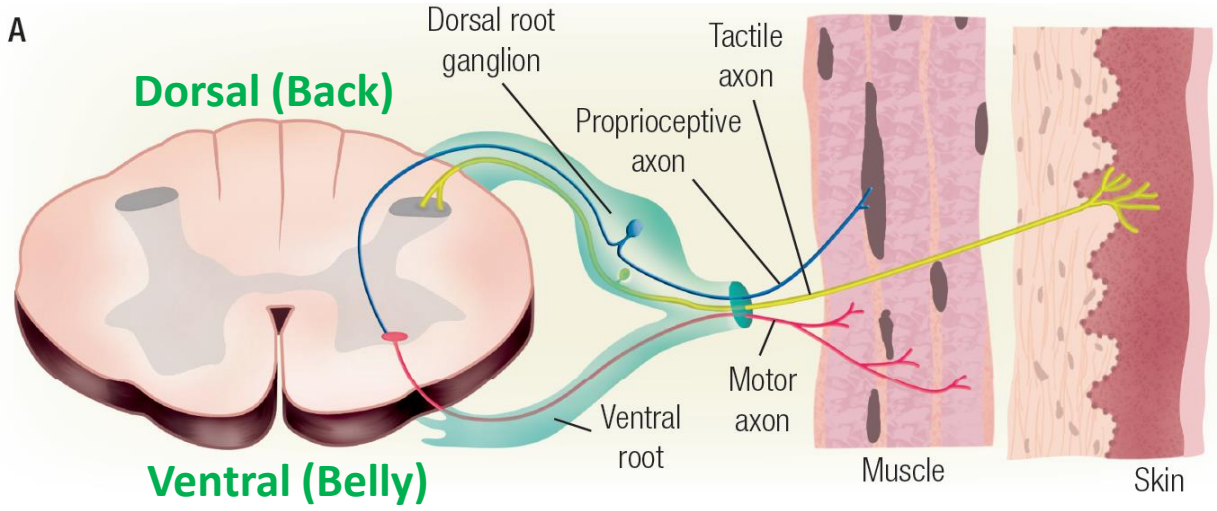
Pacinian Corpuscle as Temporal Differentiation Machine

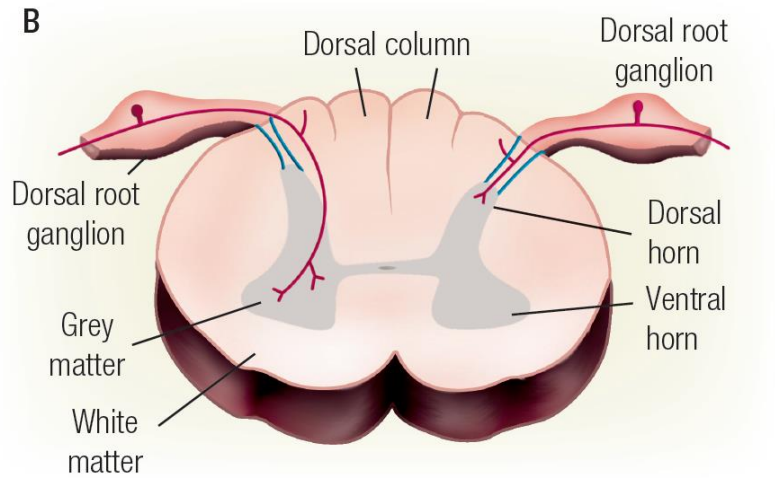


4-Channel Model of Touch Perception



Innervation via Spinal Nerves



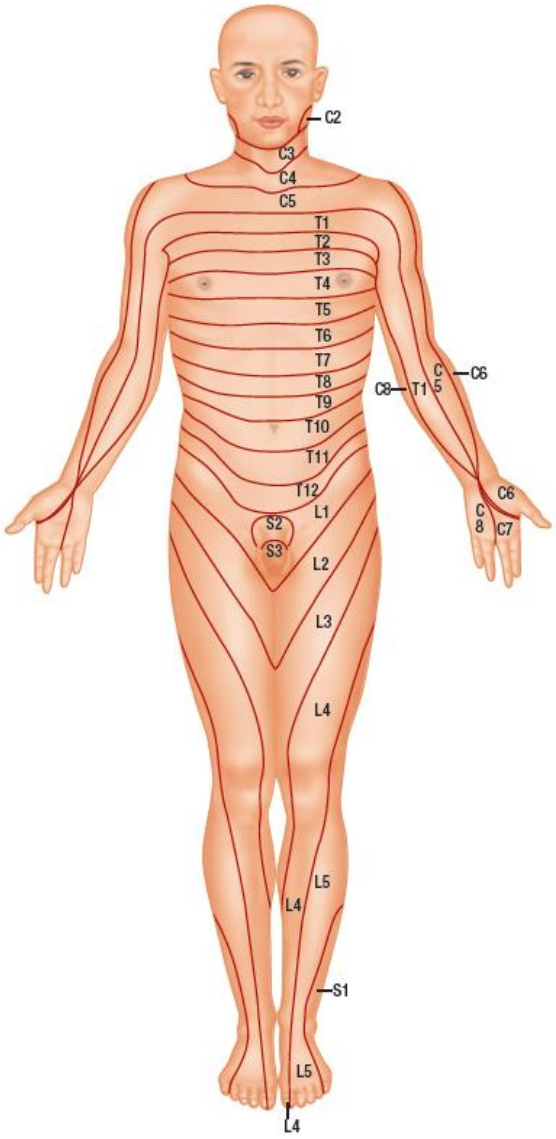


Bell-Megendie Law

dorsal = sensory afferents

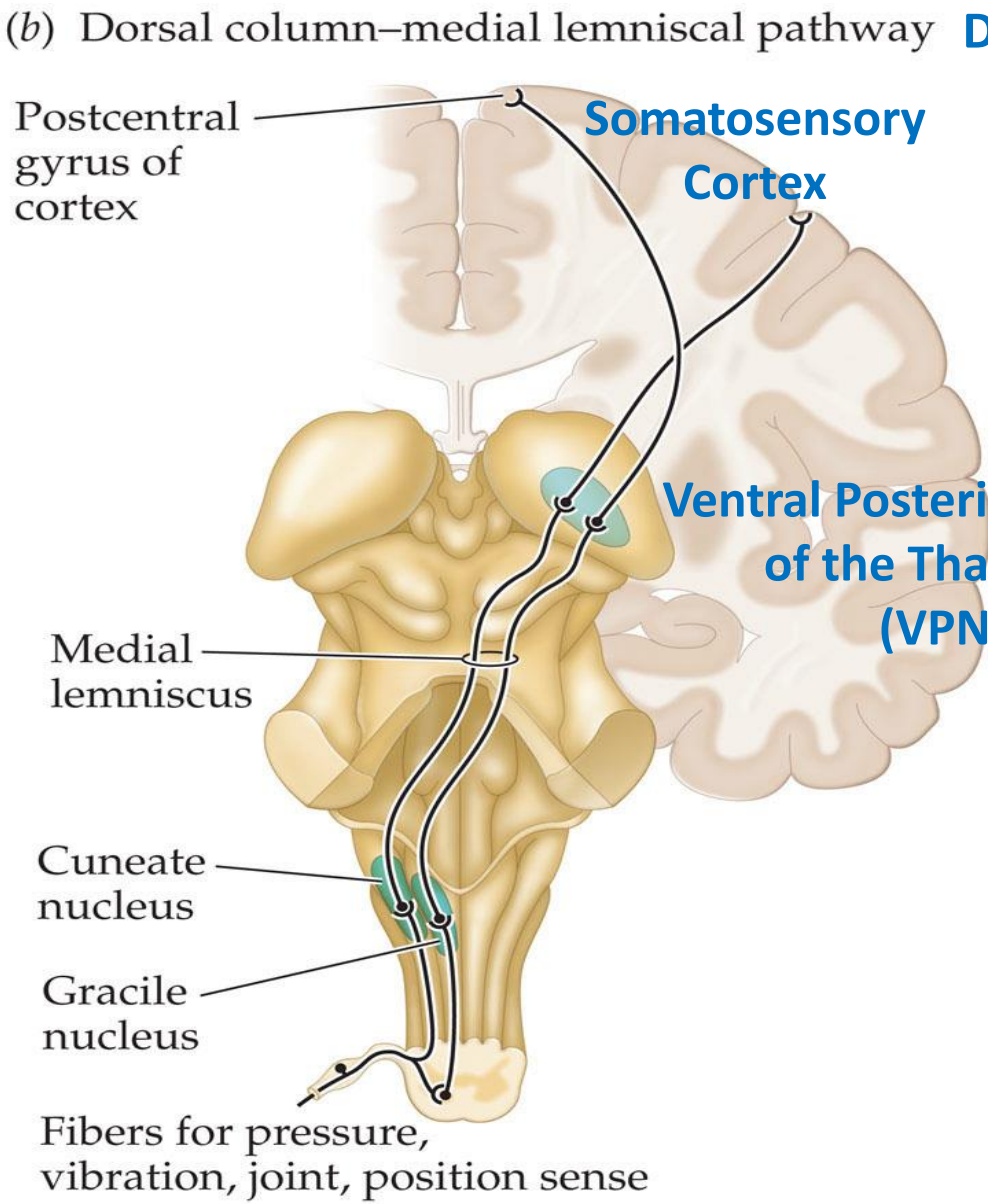
ventral = motor efferents

Diagnostic Dermatomes



e.g.,
“Shingles” eruption
(Latent herpes virus)

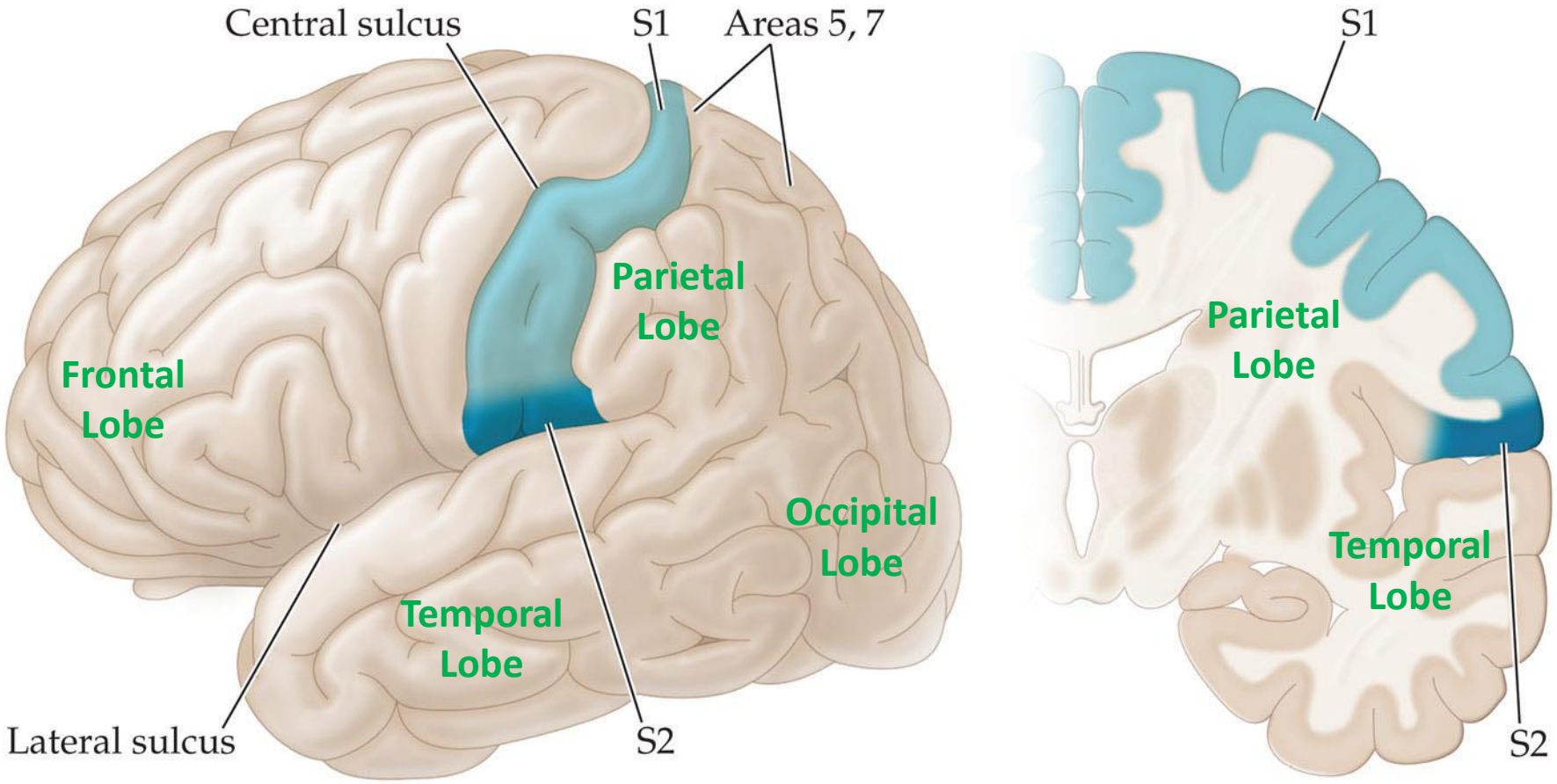
Ascending Pathways



SENSATION & PERCEPTION 4e, Figure 13.6 (Part 2)

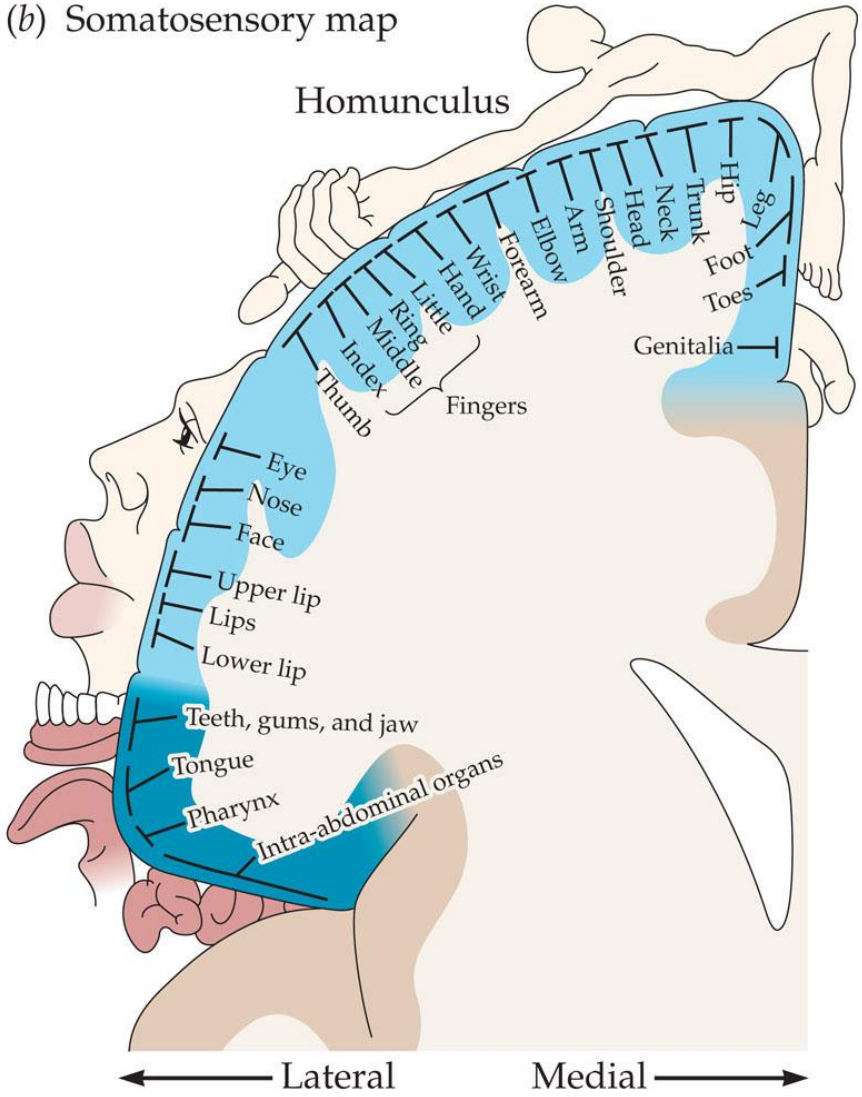
Somatosensory Cortex

(Postcentral Gyrus)



SENSATION & PERCEPTION 4e, Figure 13.7

Somatosensory Cortex



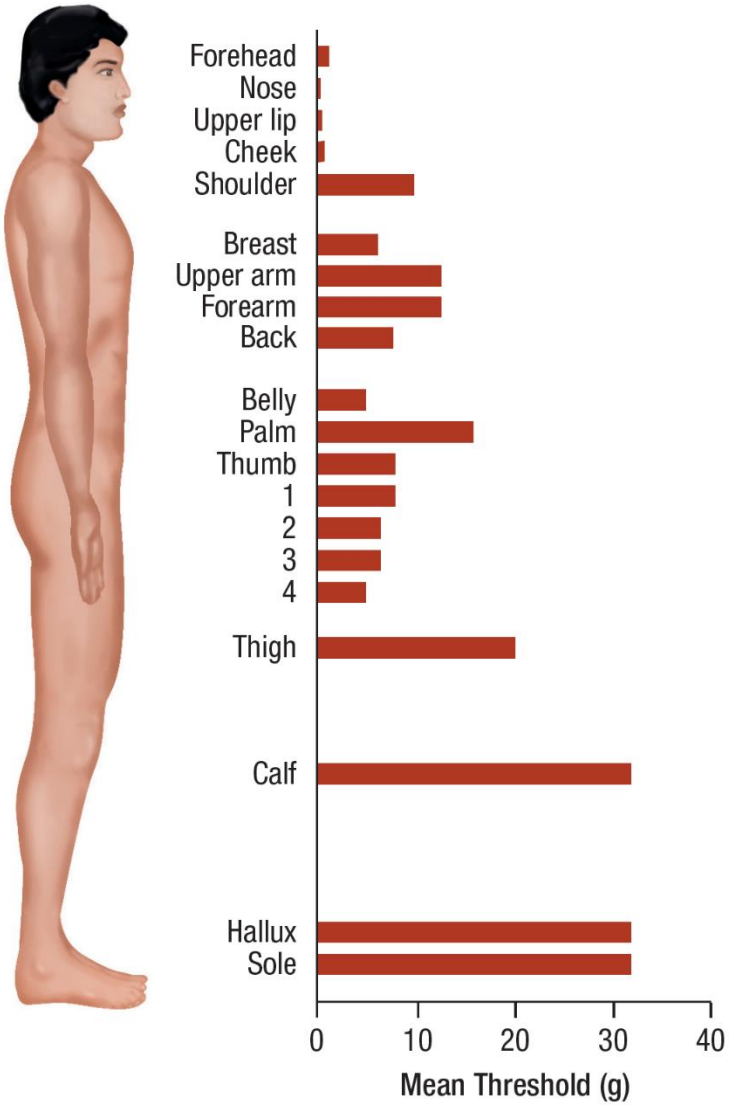
***SENSATION & PERCEPTION 4e*, Figure 13.8 (Part 2)**

Parallel to pre-central motor cortex

<u>Somatosensory map</u>:
Cortical volume changes with mechanoreceptor density variation across skin regions

Homunculus

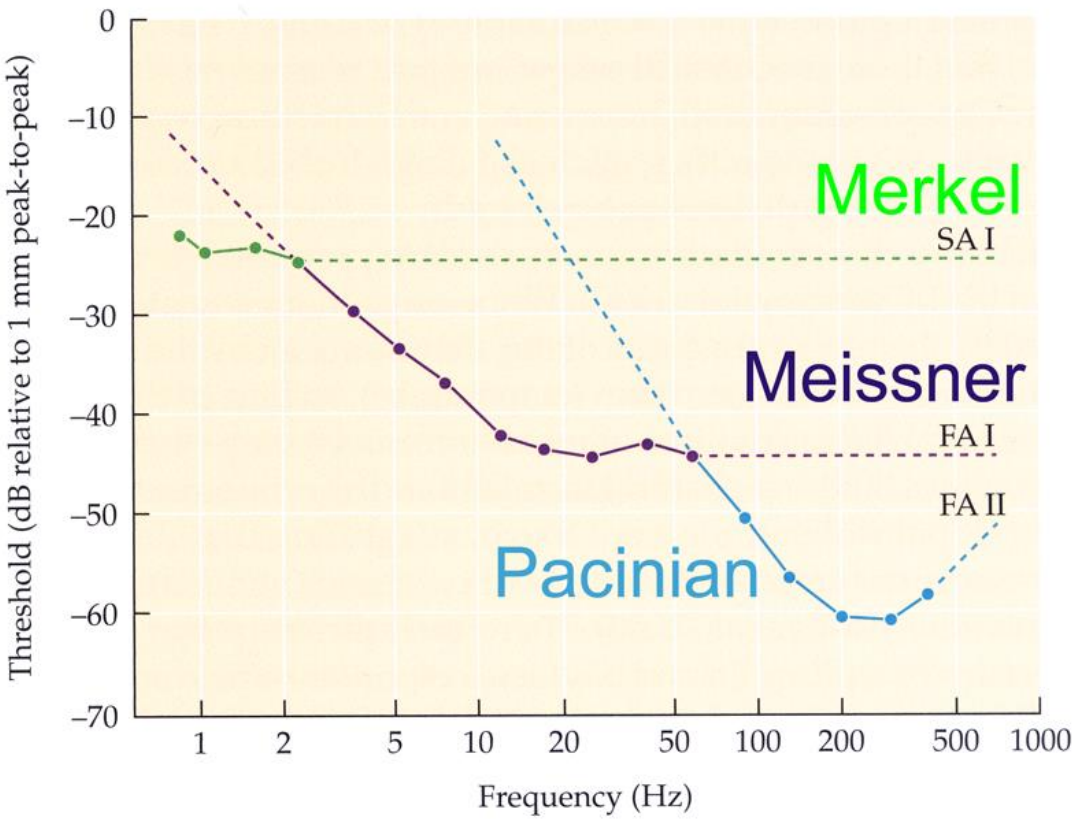
Absolute Threshold Map



Von Frey Hair

Sensitivity co-varies with cortical magnification in the somatosensory area

Touch Thresholds depend upon Vibrotactile Frequency

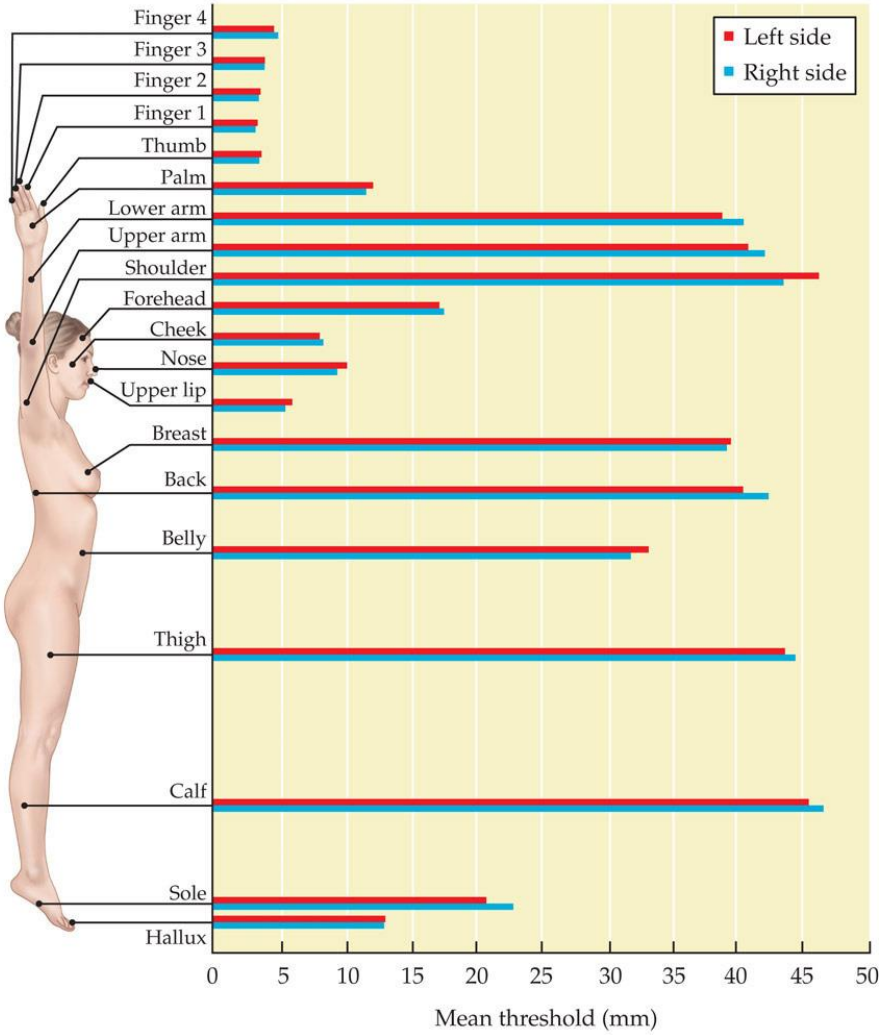


Touch detection thresholds vary with vibrotactile stimulus frequency and probe area consistent with the 4-channel model.

This figure depicts how vibrotactile frequency maps to the different classes of mechanoreceptors.

Vibrotactile stimulator is a “work horse” tool in the arsenal of neurologists.

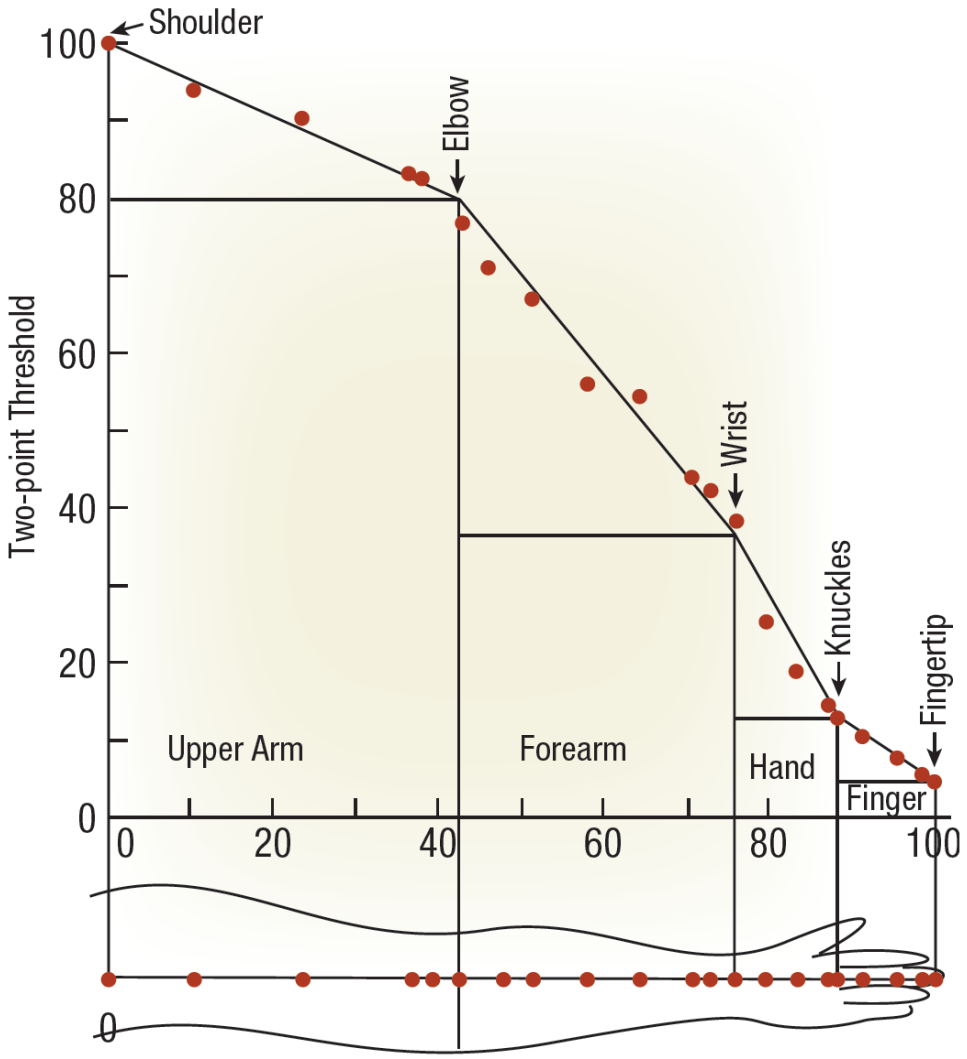
Two-Point Threshold



***SENSATION & PERCEPTION 4e*, Figure 13.15**

Relationship between mechanoreceptor receptive field size and the 2-point threshold

Two-Point Threshold



Sensitivity drops 20-fold from finger-tip to shoulder