Physiology for medical students

Somatic sensations-I

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Overview of the lectures on sensory physiology

- Overview of the process of sensation.
- Somatic senses: mechanical (tactile and position), thermal and pain.
- Special senses: vision, hearing, taste and smell (balance was covered in previous lectures).

References

- Guyton and Hall, Textbook of Medical Physiology, 14th edition.
- Costanzo, Physiology Textbook, 6th edition.
- Costanzo, BRS Physiology, 7th edition.
- Tortora and Derrickson, Principles of Anatomy and Physiology Textbook, 14th edition.

Office hours

- Kindly send me a text on MS Teams so we can arrange for in-person meeting in my office (School of Medicine, building 1, 3rd floor).

Sensation

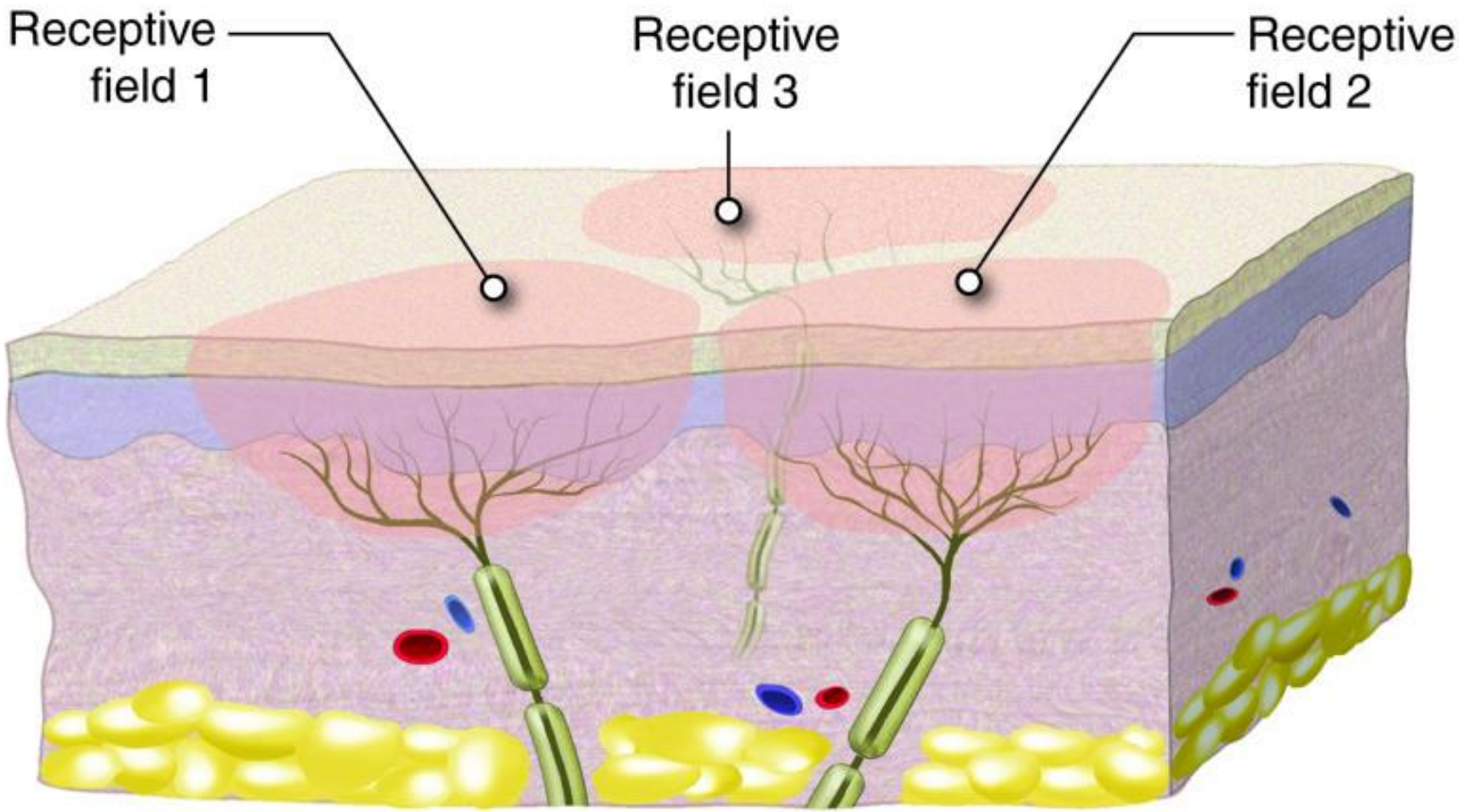
- **Sensation** is the conscious or subconscious awareness of changes in the external or internal environment.

- **Perception** is the conscious interpretation of sensations and is primarily a function of the cerebral cortex.

The process of sensation

- 1. **Stimulation of the sensory receptor**. An appropriate stimulus must occur within the sensory receptor's receptive field, that is, the body region where stimulation activates the receptor and produces a response.

- 2. **Transduction of the stimulus**. A sensory receptor converts the energy in the stimulus into a graded potential.



https://psychology.stackexchange.com/questions/13172/what-is-the-definition-of-a-receptive-field

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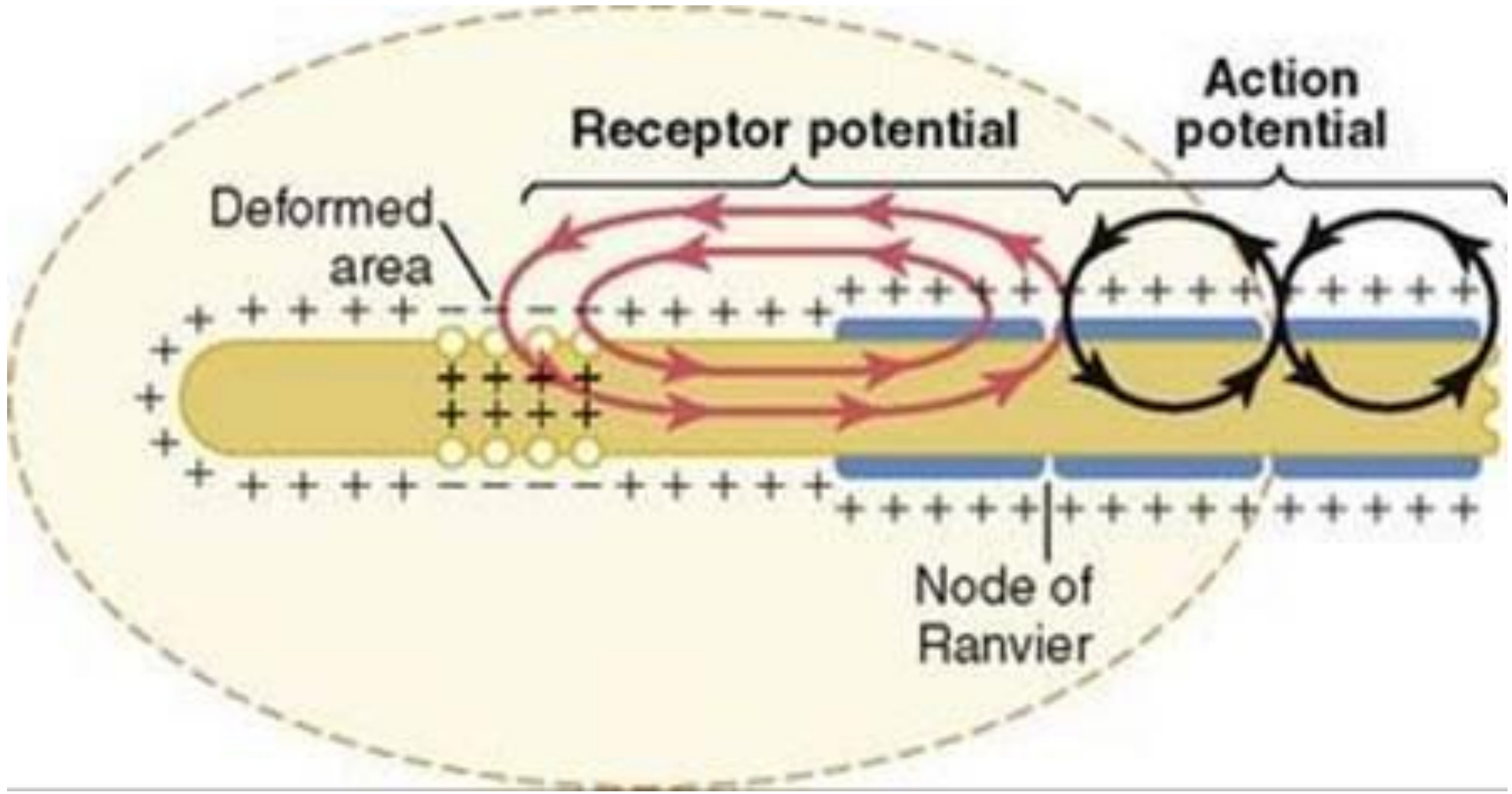
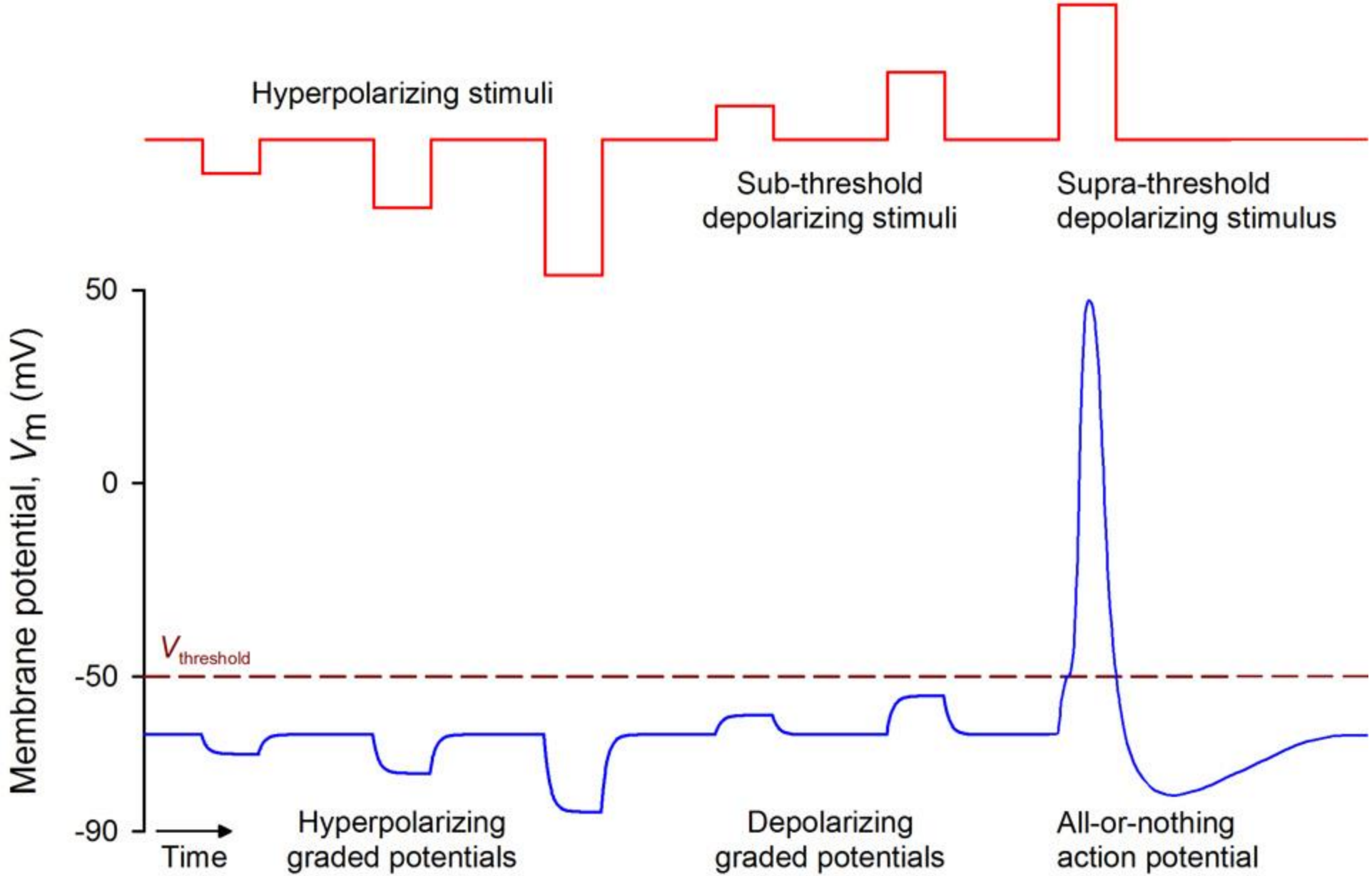

Receptor potential
Action potential
Deformed area
Node of Ranvier



The process of sensation

- 3. **Generation of nerve impulses**. When a graded potential in a sensory neuron reaches threshold, it triggers one or more nerve impulses, which then propagate toward the CNS.

- 4. **Integration of sensory input**. A particular region of the CNS receives and processes the sensory nerve impulses.

Somatic sensations

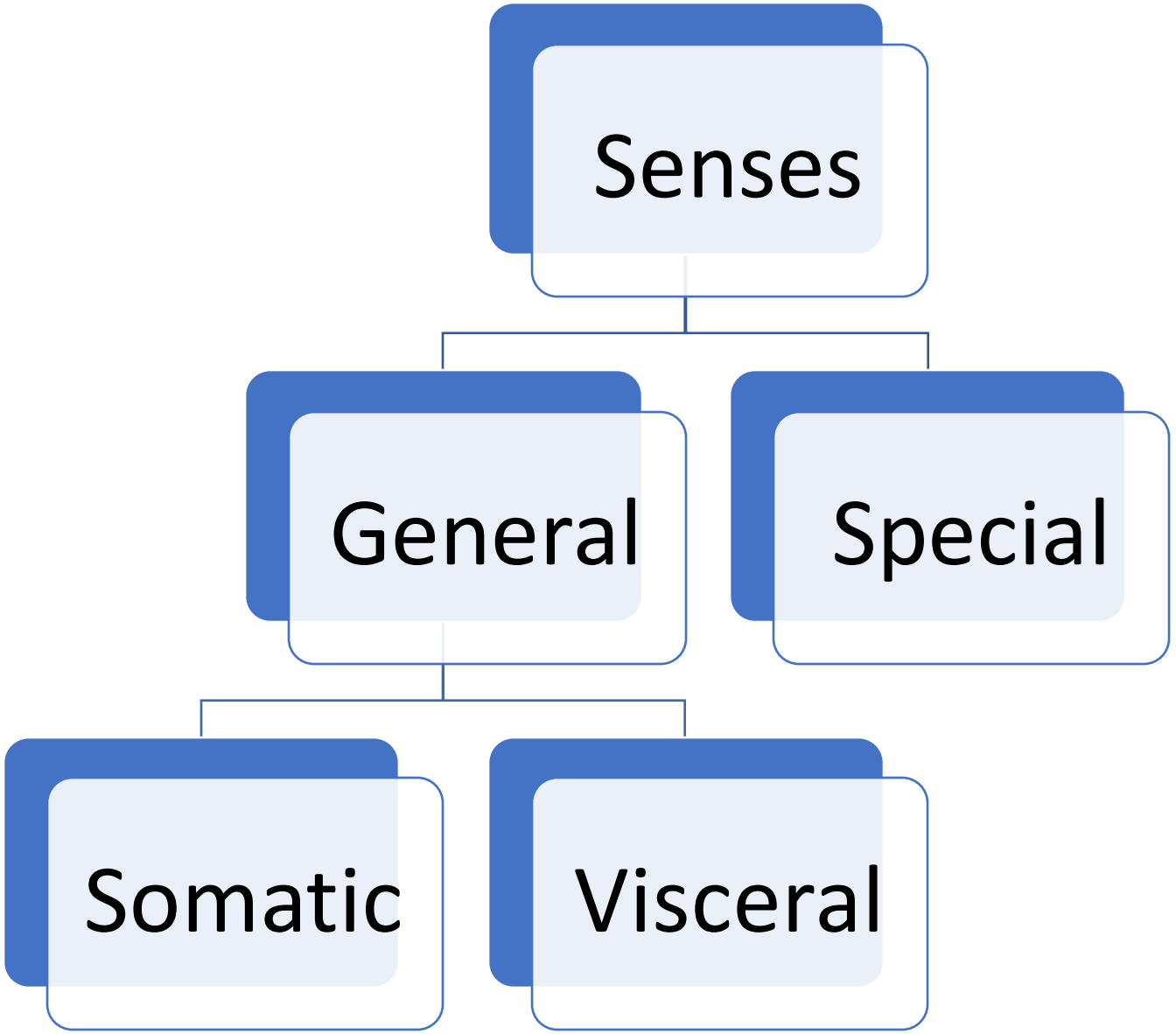
- Receptors are **distributed unevenly**.

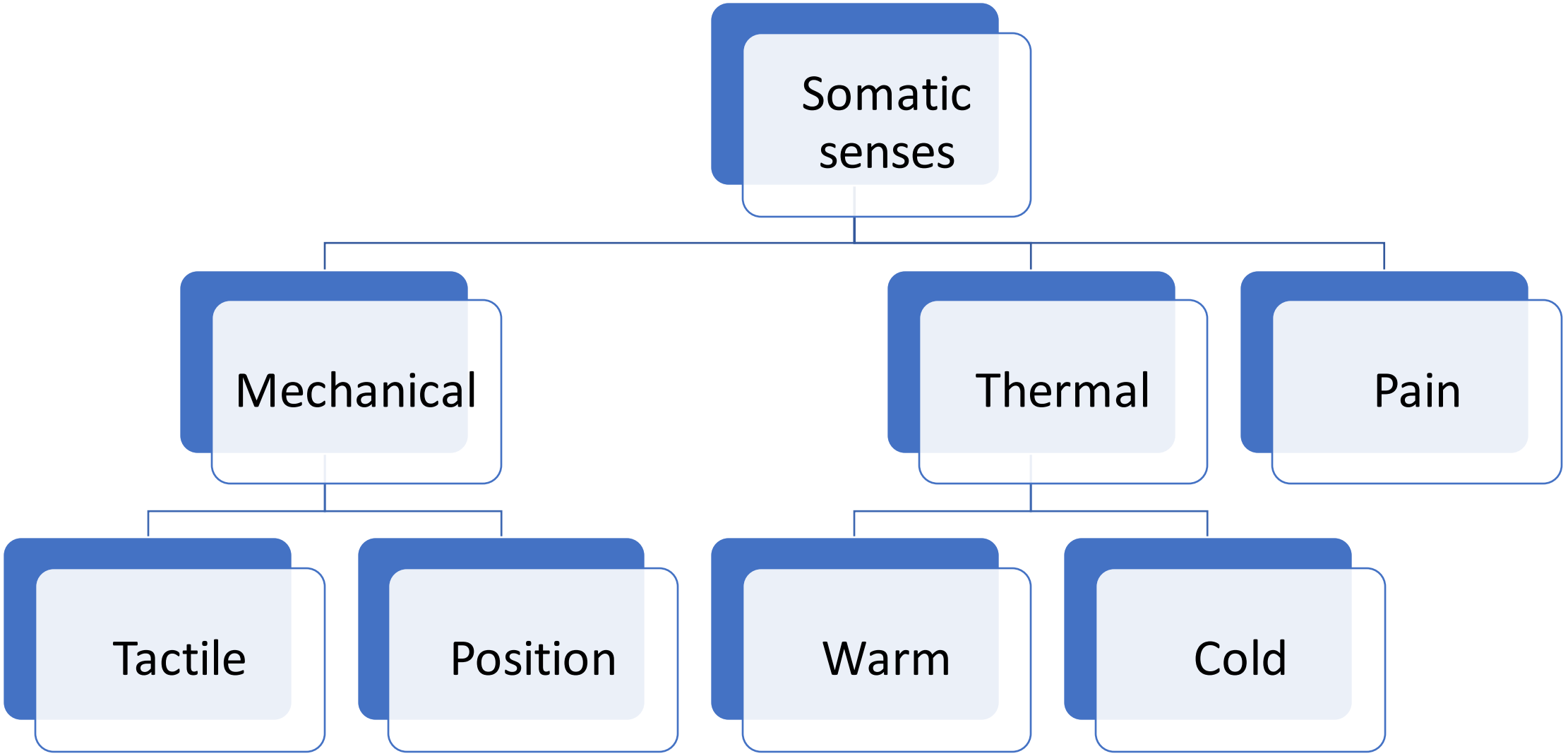
- The areas with the highest density of somatic sensory receptors are the tip of the tongue, the lips, and the fingertips.

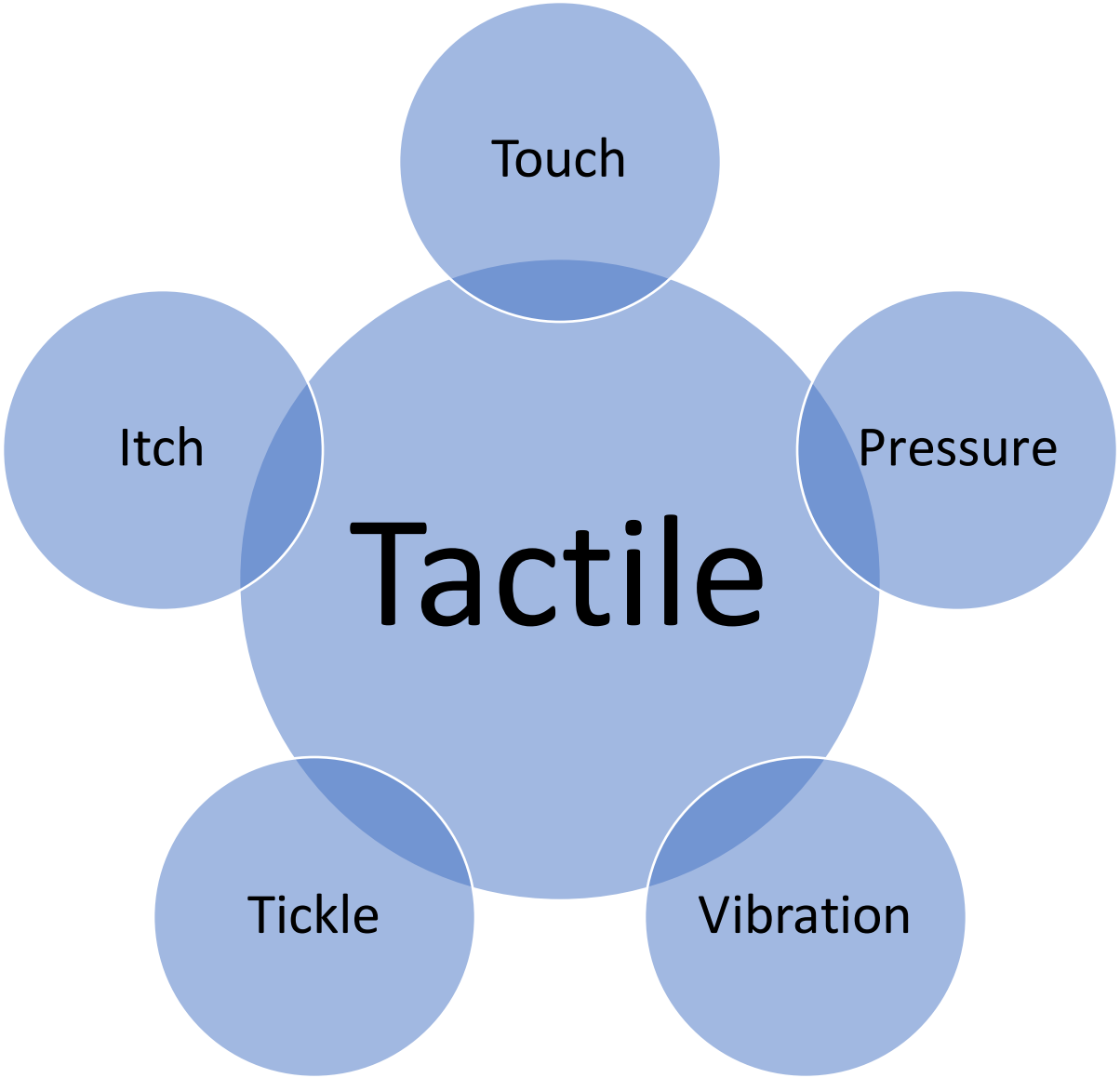
Adaptation in sensory receptors

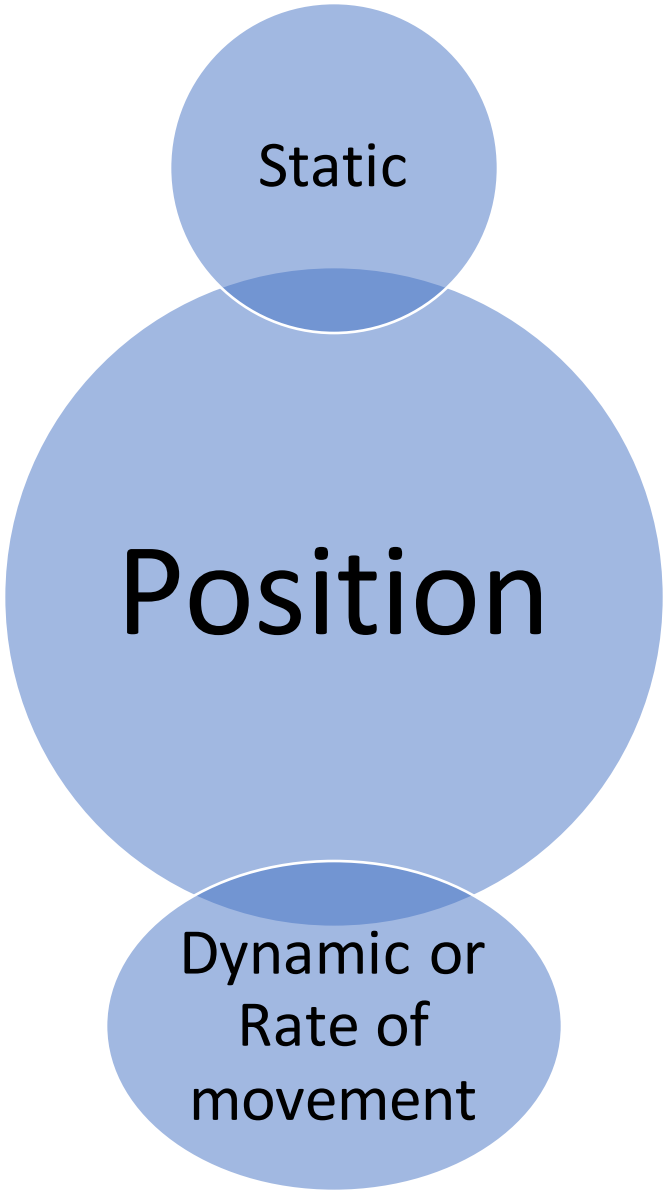
- A characteristic of most sensory receptors is **adaptation**, in which the receptor potential decreases in amplitude during a maintained, constant stimulus.

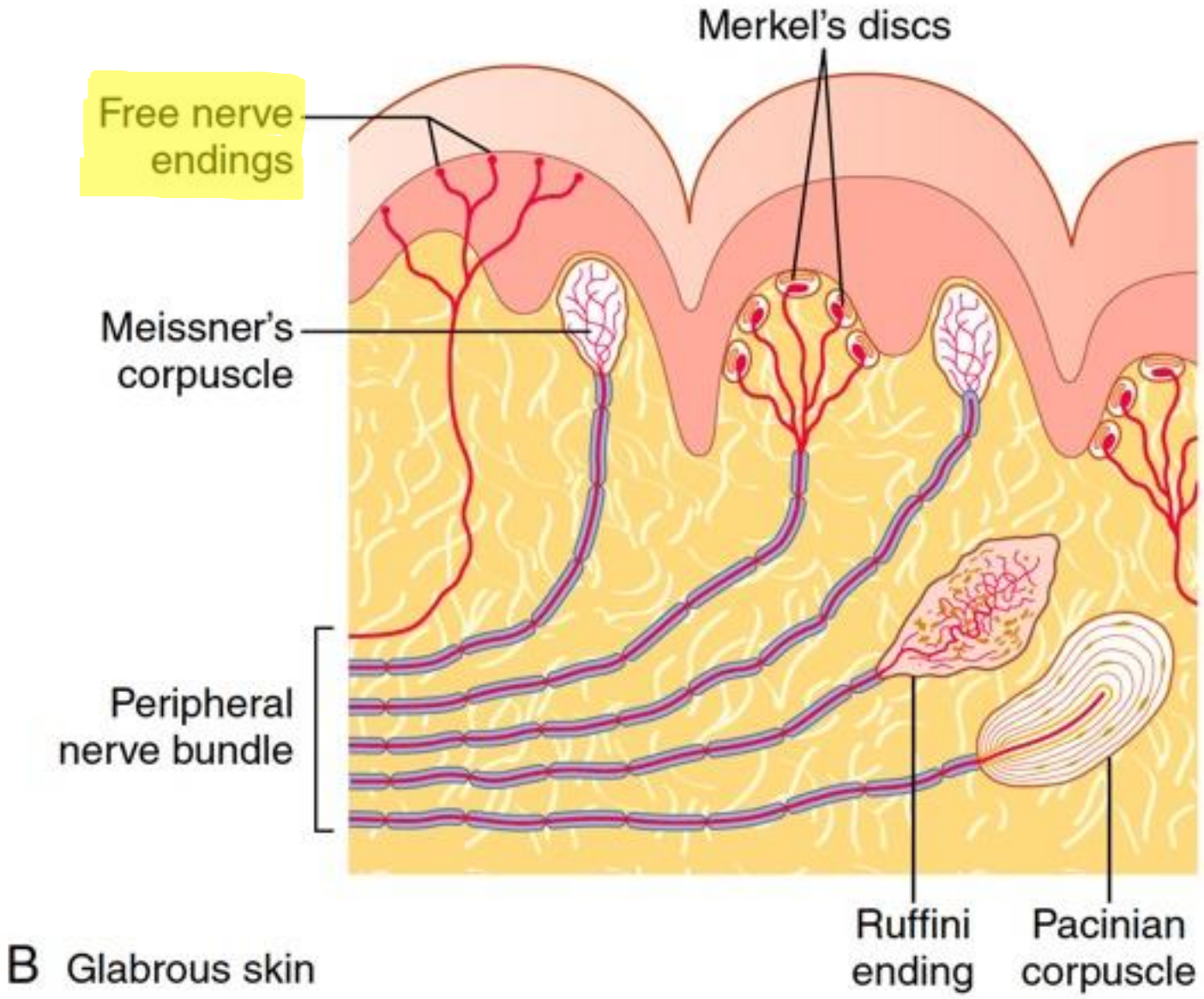
- Because of adaptation, the perception of a sensation may fade or disappear even though the stimulus persists.


Senses
General
Special
Somatic
Visceral


Somatic senses
Mechanical
Thermal
Pain
Tactile
Position
Warm
Cold

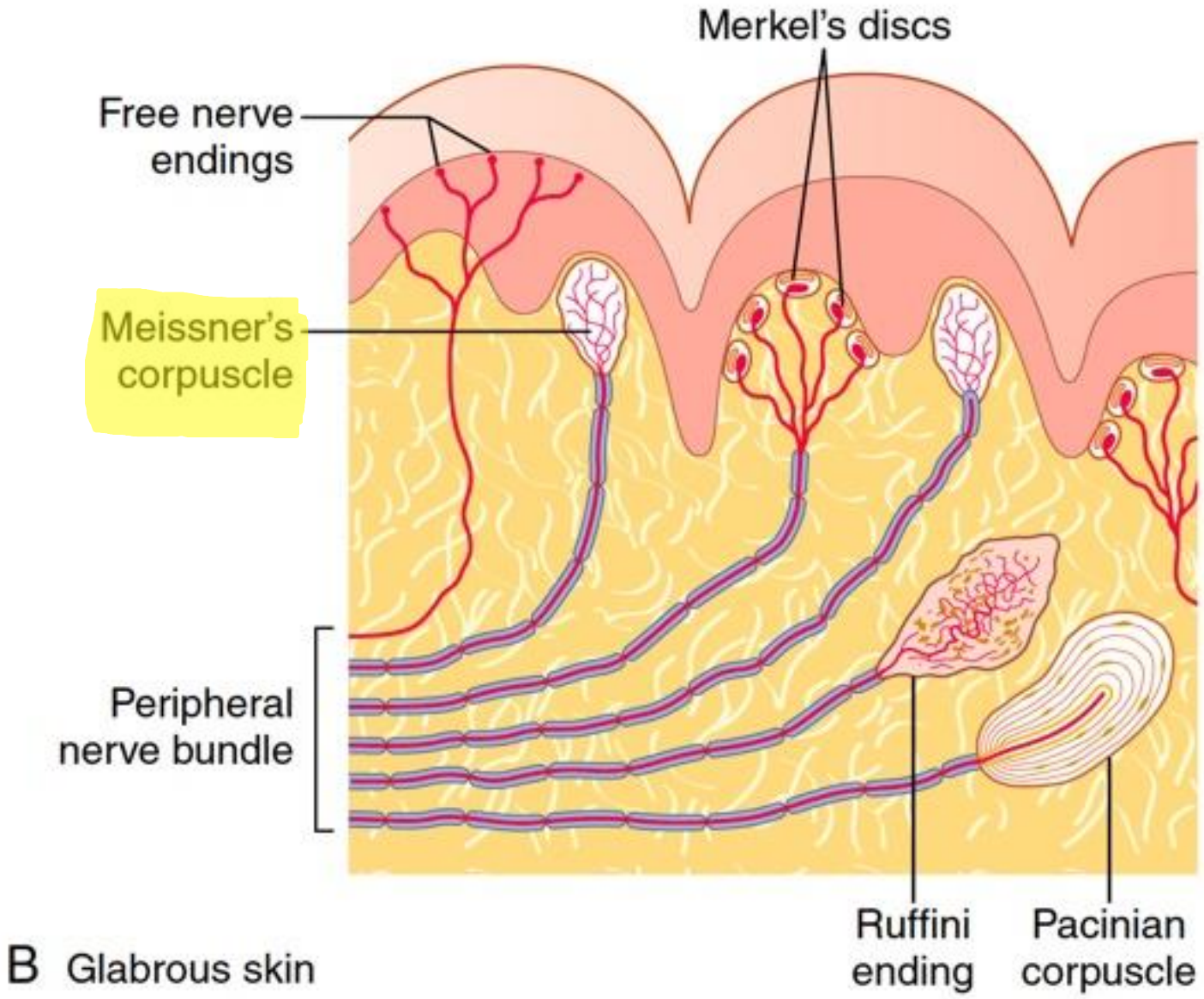

Touch
Itch
Pressure
Tactile
Tickle
Vibration


Static
Position
Dynamic or
Rate of
movement



In the skin and other tissues.

Detects touch and pressure.



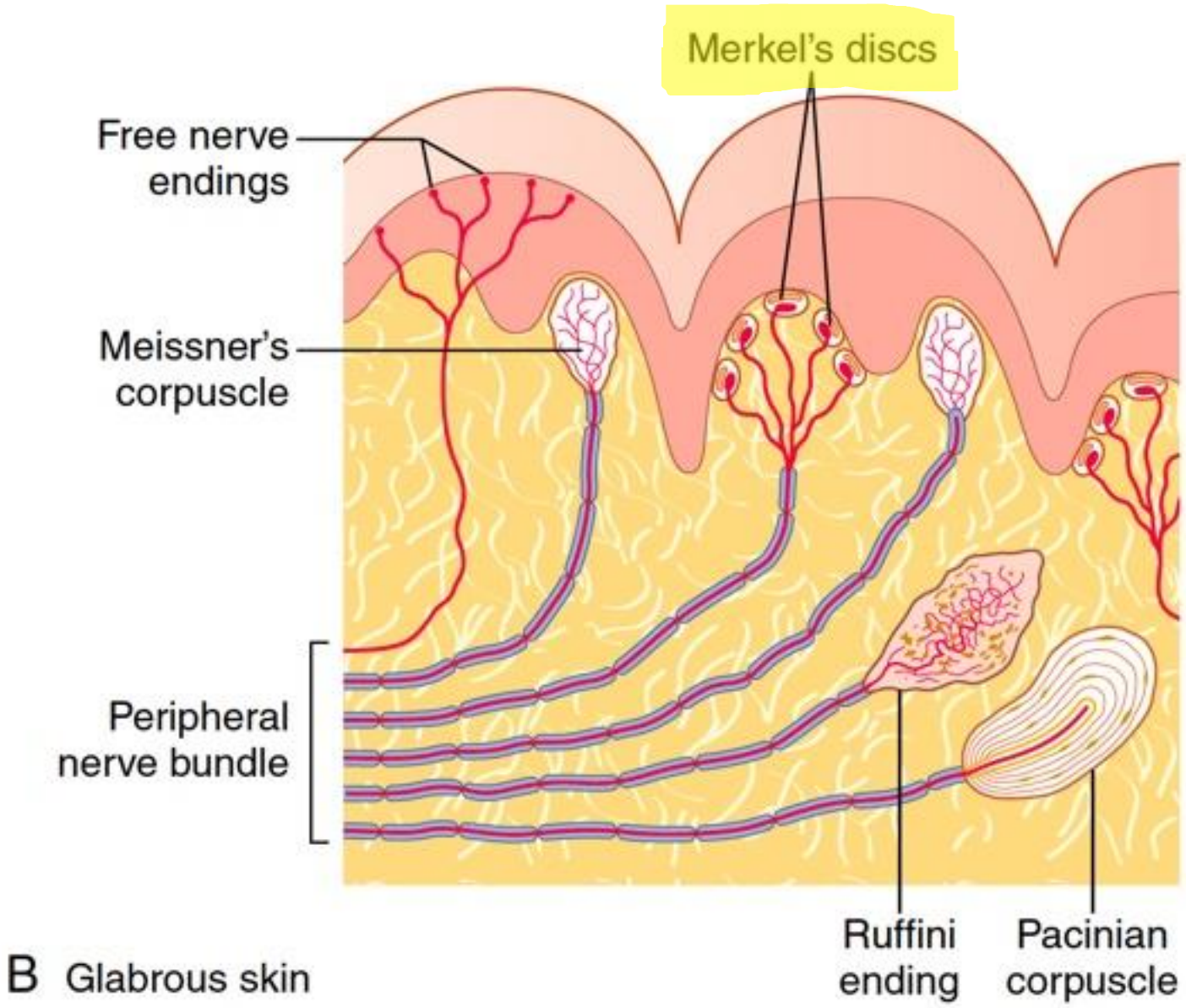
Encapsulated nerve ending.

Rapidly adapting.

Small receptive field.

In the dermis of nonhairy skin: lips and fingertips (locations where tactile discrimination is especially good).

Sensitive to moving objects on skin and low-frequency vibrations.



Expanded tip tactile receptors.

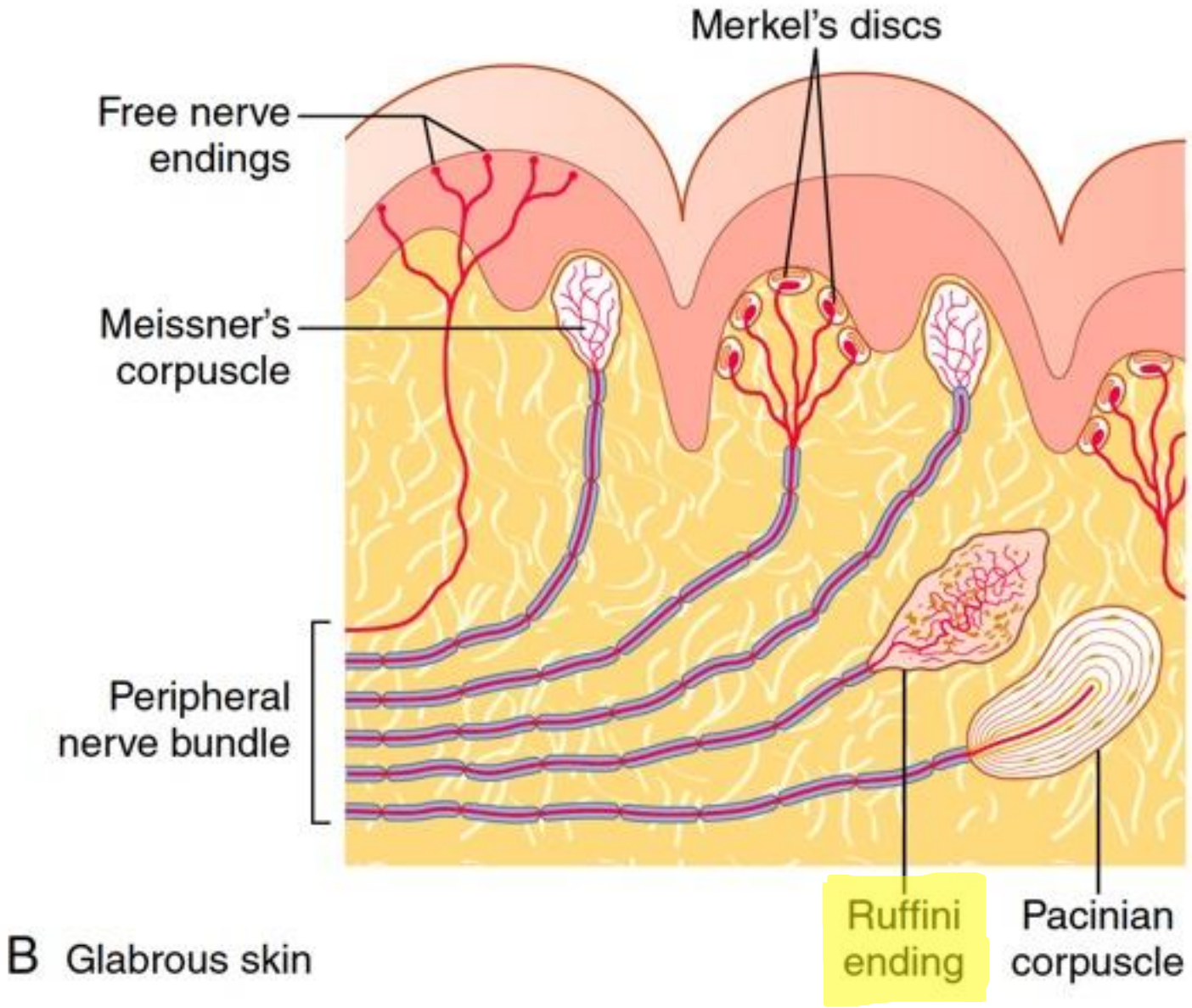
Grouped in touch domes.

Fingertips and hairy skin.

Slowly adapting.

Small receptive field.

determine continuous touch of objects against the skin.



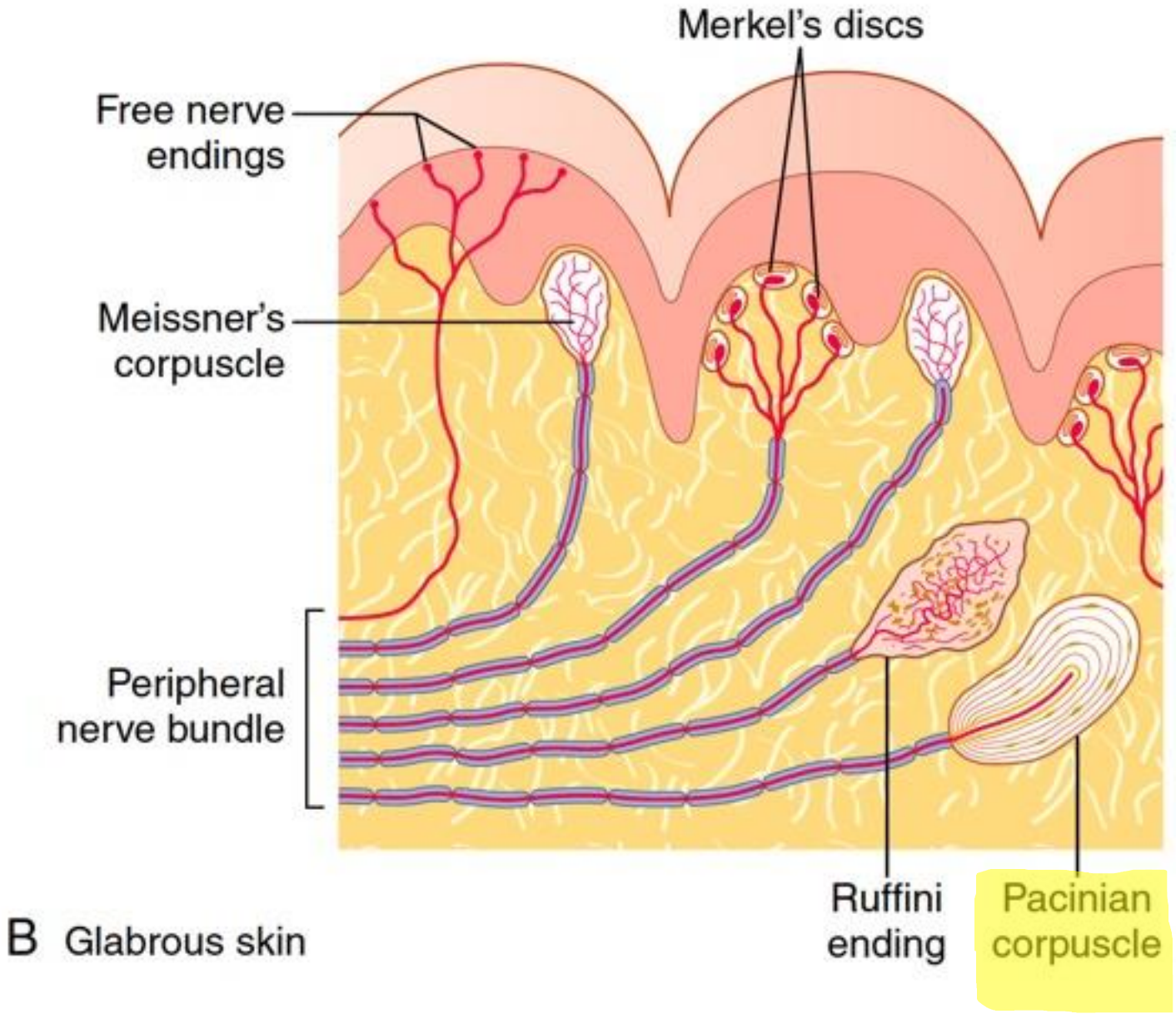
Multibranched encapsulated nerve endings.

In the dermis of hairy and nonhairy skin and joint capsules.

Slowly adapting.

Large receptive field.

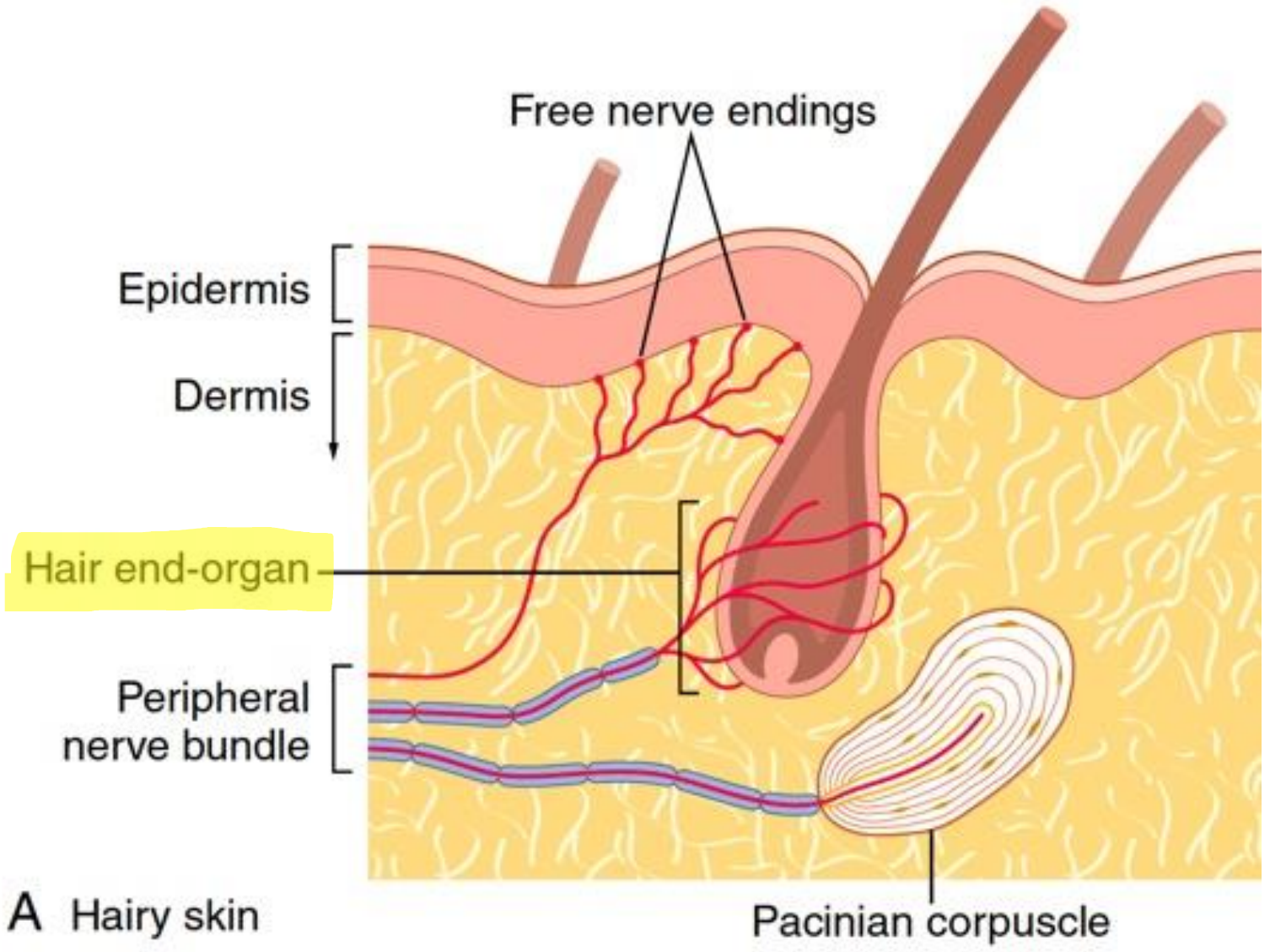
Detects heavy prolonged touch and pressure signals, stretch and joint rotation.



In the dermis, subcutaneous layers of hairy, nonhairy skin and muscles.

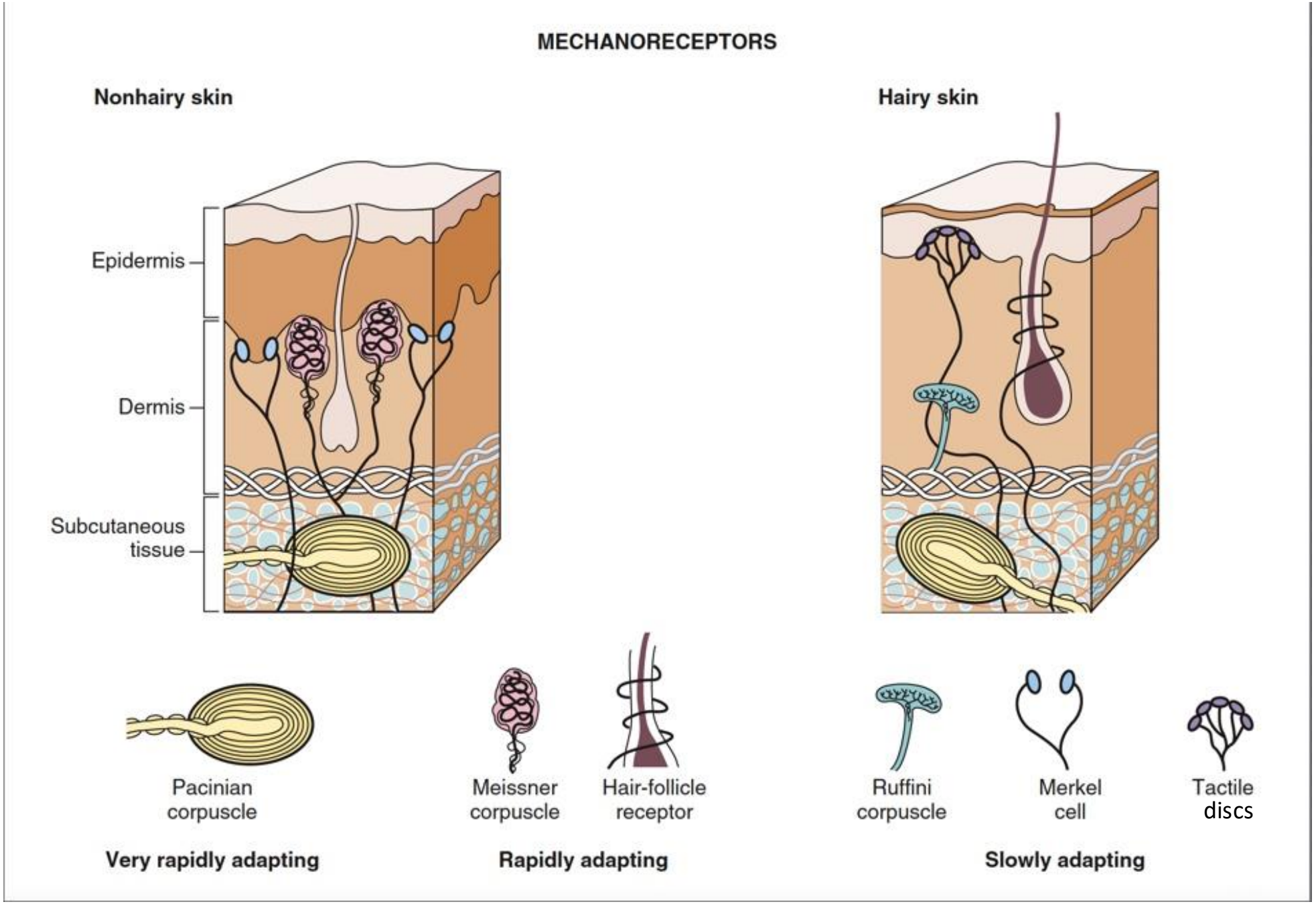
The most rapidly adapting of tactile receptors.

Detects tissue vibration or other rapid changes in the mechanical state of the tissues (velocity).



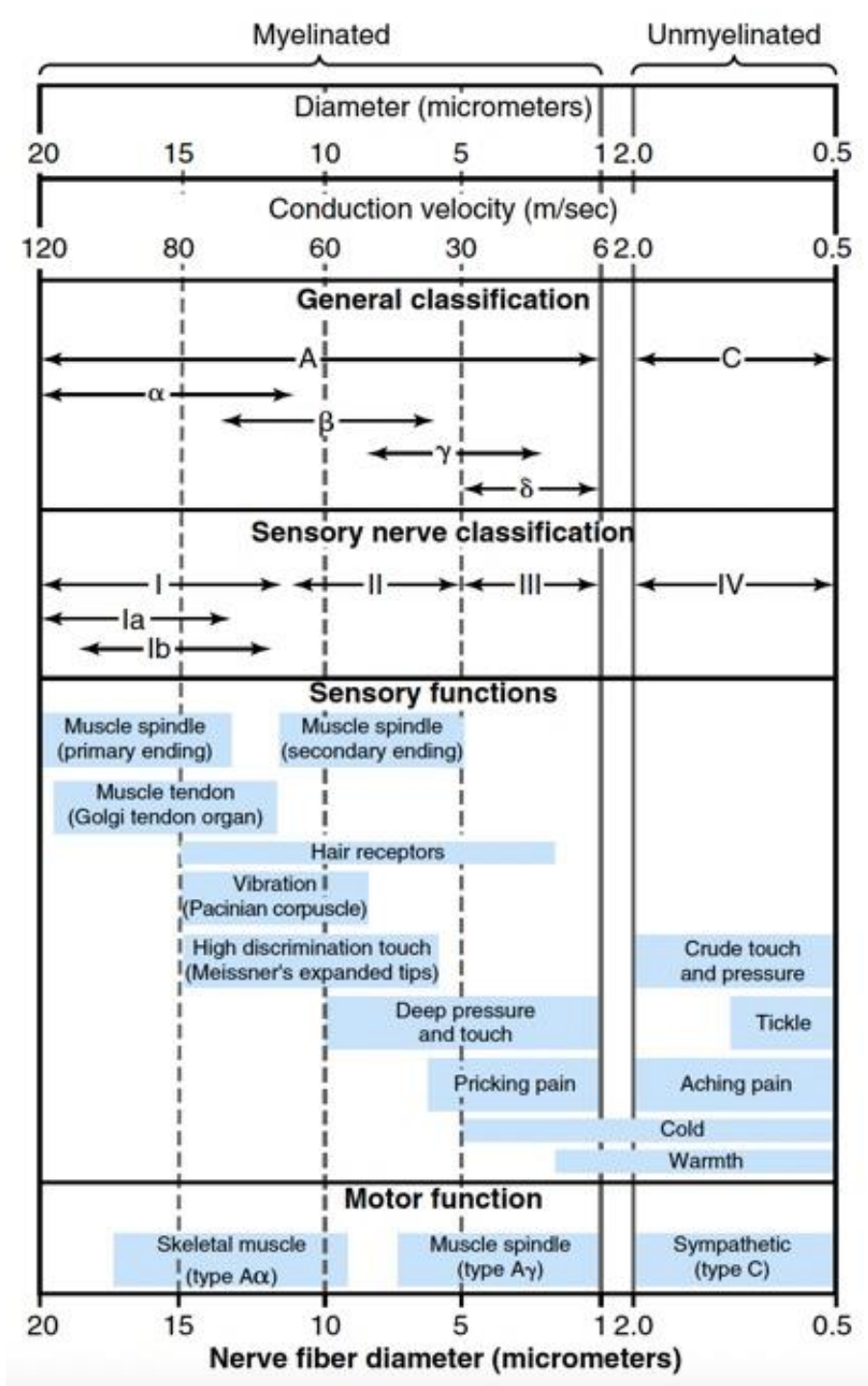
Adapt quickly.

Detects velocity and direction of movement across the skin.


MECHANORECEPTORS
Nonhairy skin
Hairy skin
Epidermis
Dermis
Subcutaneous tissue
Pacinian corpuscle
Meissner corpuscle
Hair-follicle receptor
Ruffini corpuscle
Merkel cell
Tactile discs
Very rapidly adapting
Rapidly adapting
Slowly adapting

Conduction velocity of tactile signals

- Almost all specialized sensory receptors transmit their signals in type Aβ nerve fibers (30 to 70 m/sec).
- Free nerve ending tactile receptors transmit signals mainly via type Aδ myelinated fibers (5 to 30 m/sec).
- Some tactile free nerve endings transmit via type C unmyelinated fibers at velocities from a fraction of a meter up to 2 m/sec, such as tickle sensory fibers.


Myelinated
Unmyelinated
Diameter (micrometers)
20 15 10 5 1 2.0 0.5
Conduction velocity (m/sec)
120 80 60 30 6 2.0 0.5
General classification
A
C
α
β
γ
δ
Sensory nerve classification
I
II
III
IV
Ia
Ib
Sensory functions
Muscle spindle (primary ending)
Muscle spindle (secondary ending)
Muscle tendon (Golgi tendon organ)
Hair receptors
Vibration (Pacinian corpuscle)
High discrimination touch (Meissner's expanded tips)
Crude touch and pressure
Deep pressure and touch
Tickle
Pricking pain
Aching pain
Cold
Warmth
Motor function
Skeletal muscle (type Aα)
Muscle spindle (type Aγ)
Sympathetic (type C)
20 15 10 5 1 2.0 0.5
Nerve fiber diameter (micrometers)

Thank you