

Neurophysiology

Somatic sensations

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Somatic sensory receptors

- Somatic sensations arise from stimulation of sensory **receptors embedded in** the:
 - Skin
 - Subcutaneous layer
 - Mucous membranes
 - Skeletal muscles
 - Tendons
 - Joints.

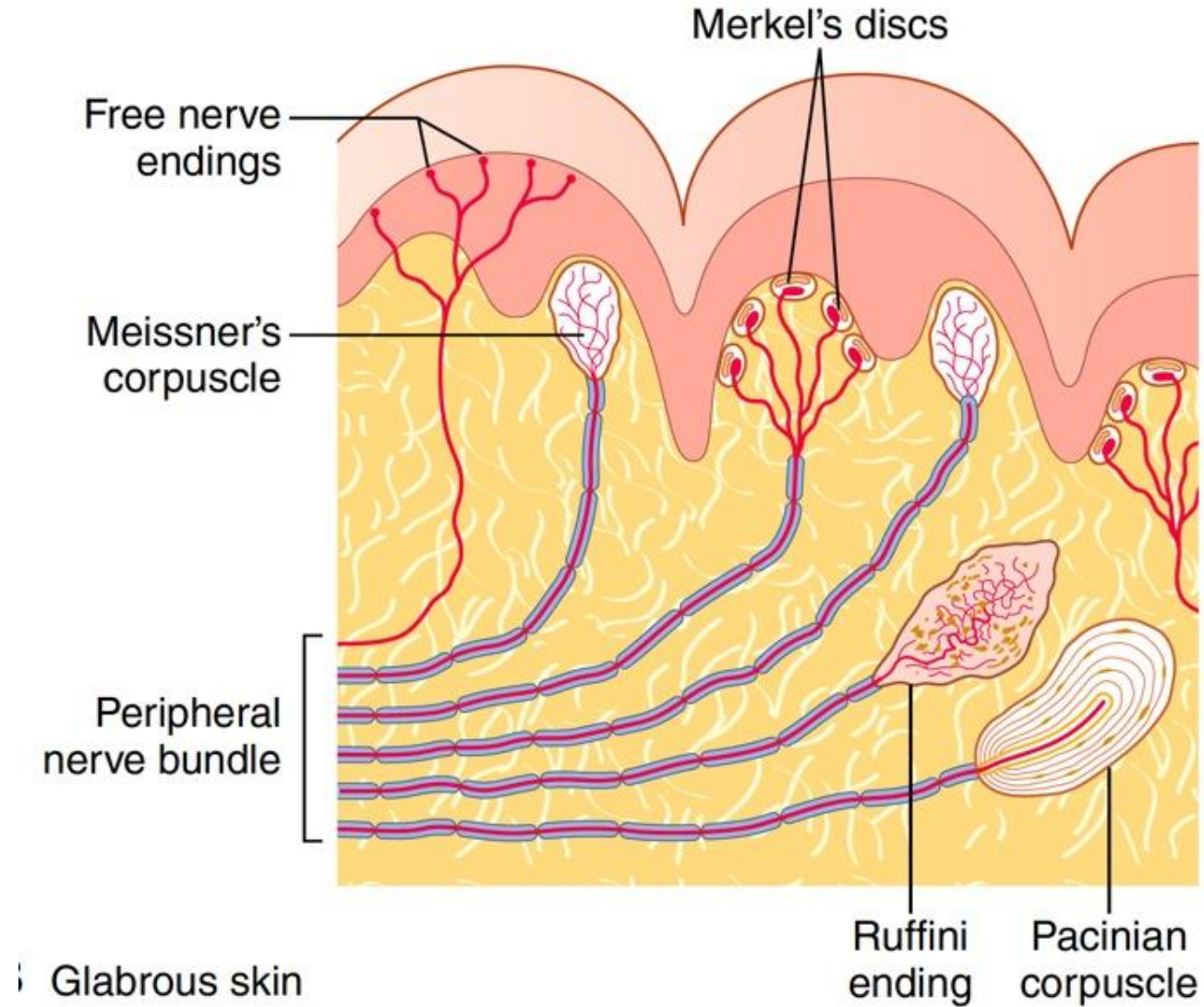
Classification of somatic senses

- **1- Mechanoreceptive senses:**
 - Tactile: touch, pressure, vibration, tickle, (itch).
 - Position: static position sense, rate of movement sense.
- **2- Thermoreceptive senses.**
- **3- Pain sense.**

Tactile senses

- **Touch:** the ability to perceive a stimulus that comes into contact with the surface of the skin (APA dictionary).
- generally results from stimulation of tactile receptors in the skin or in tissues immediately beneath the skin.
- **Pressure:** generally results from deformation of deeper tissues.
- **Vibration:** results from rapidly repetitive sensory signals.

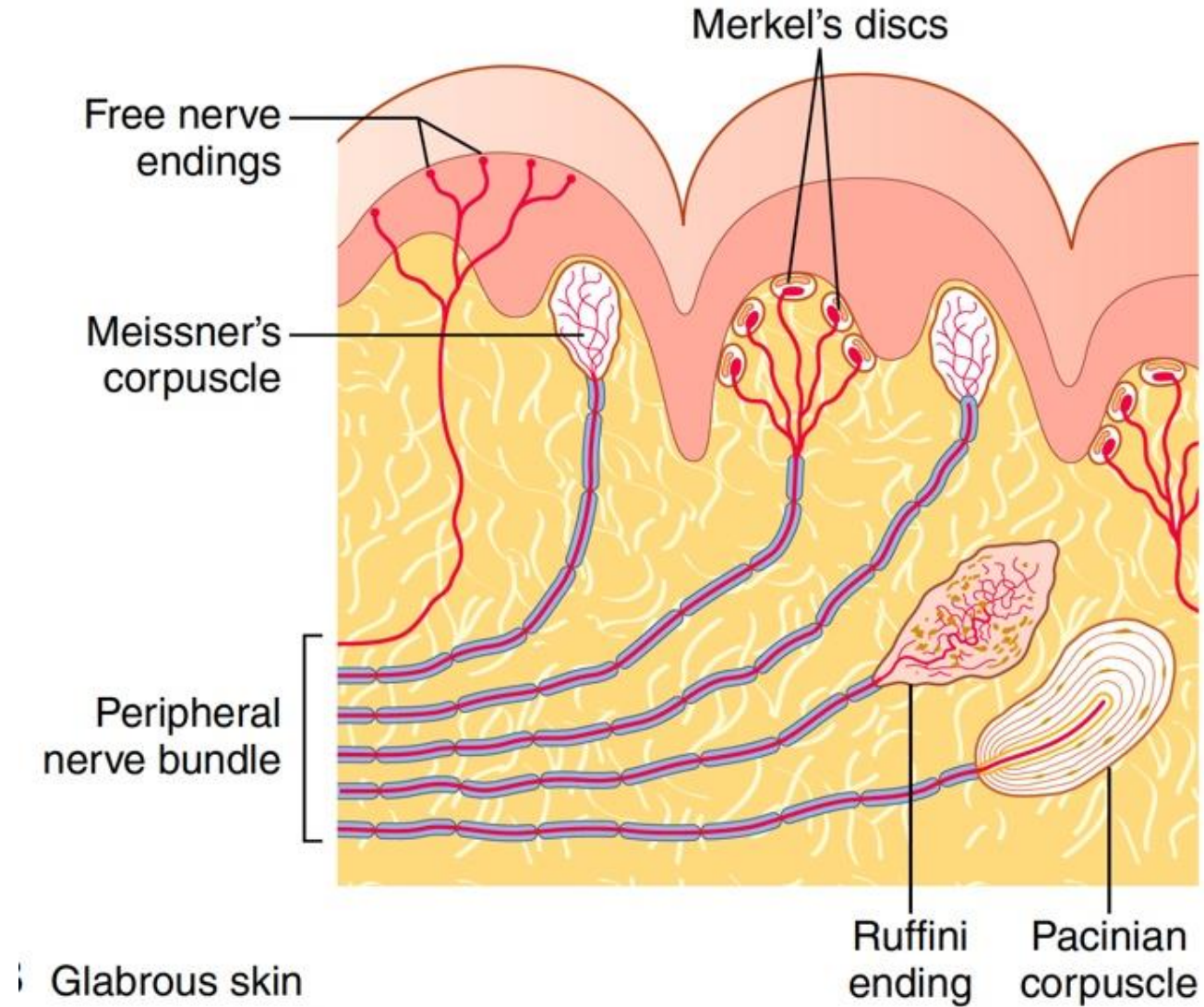
Tactile receptors



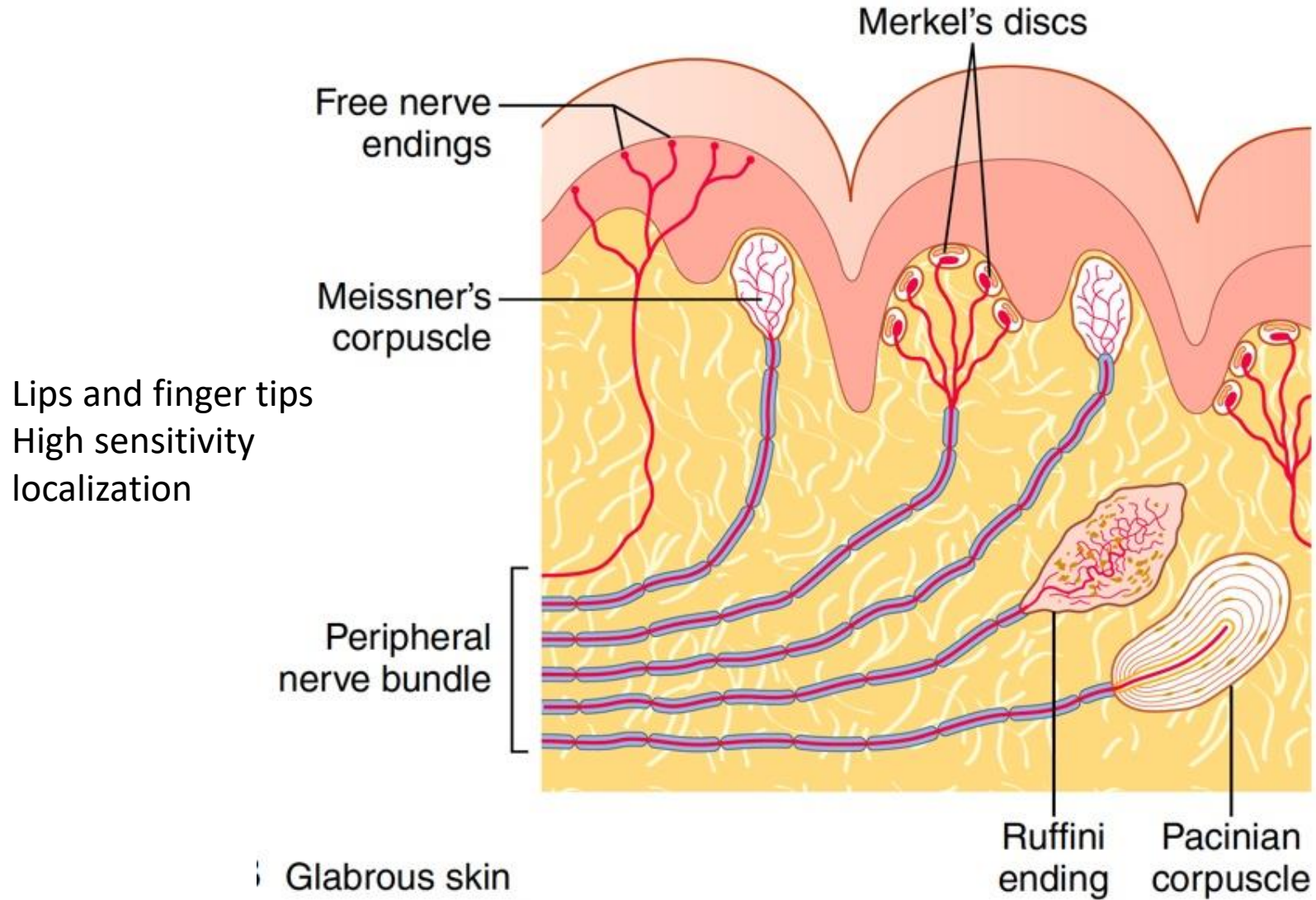
Tactile sensations

- Although touch, pressure, and vibration are classified as separate sensations, they are detected by the same types of receptors.
- All tactile receptors are involved in detection of vibration, although different receptors detect different frequencies of vibration.

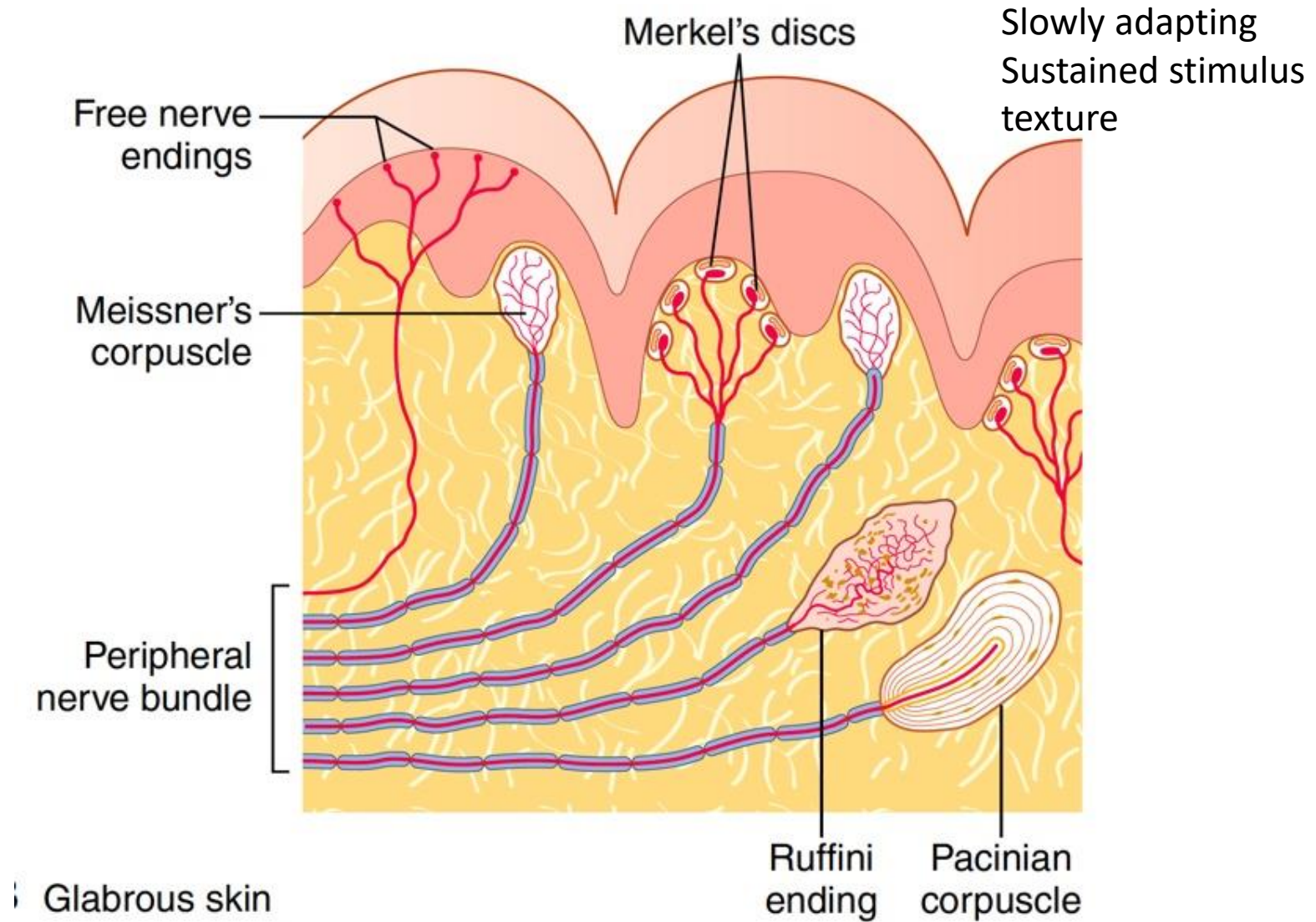
Tactile receptors



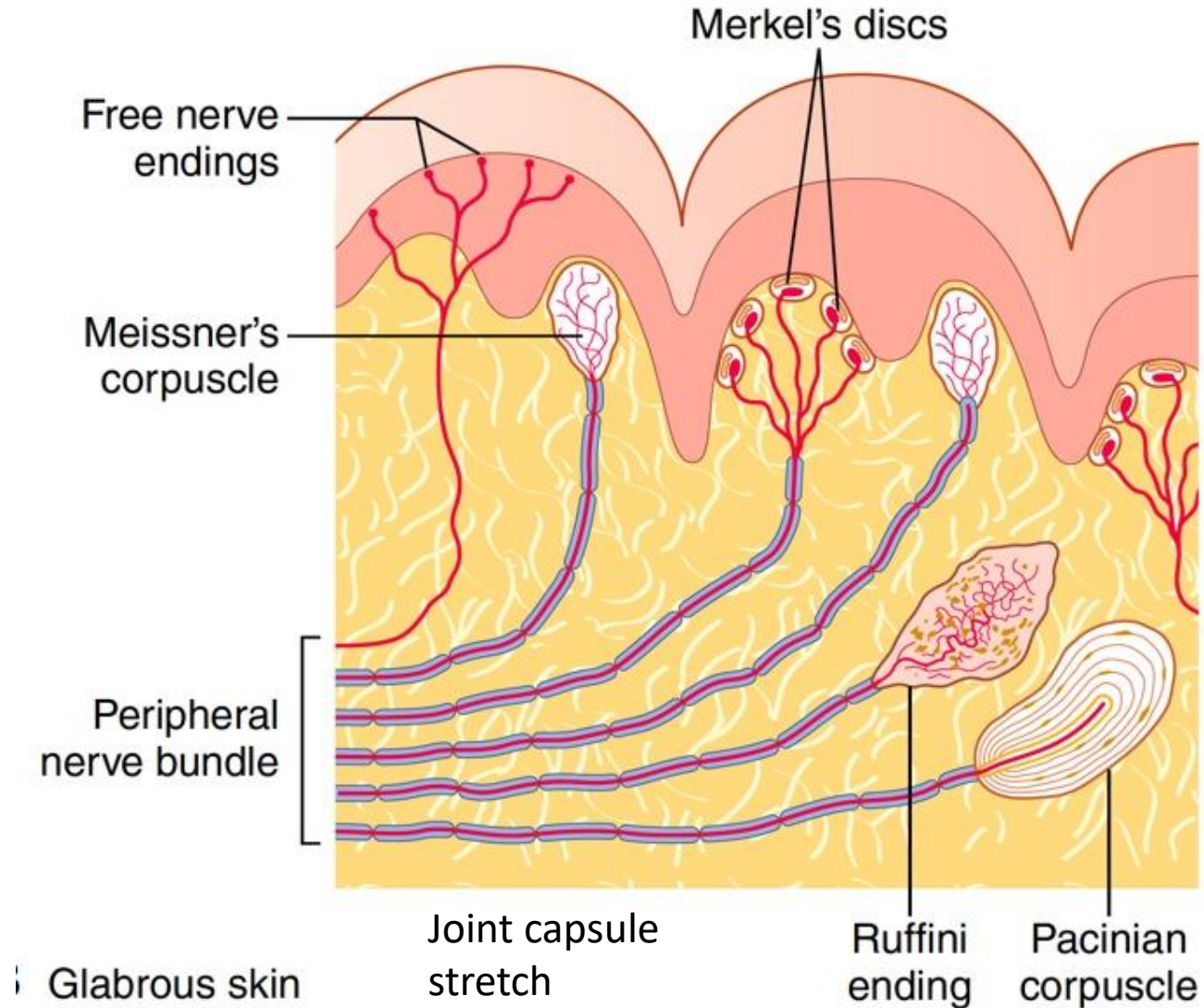
Tactile receptors



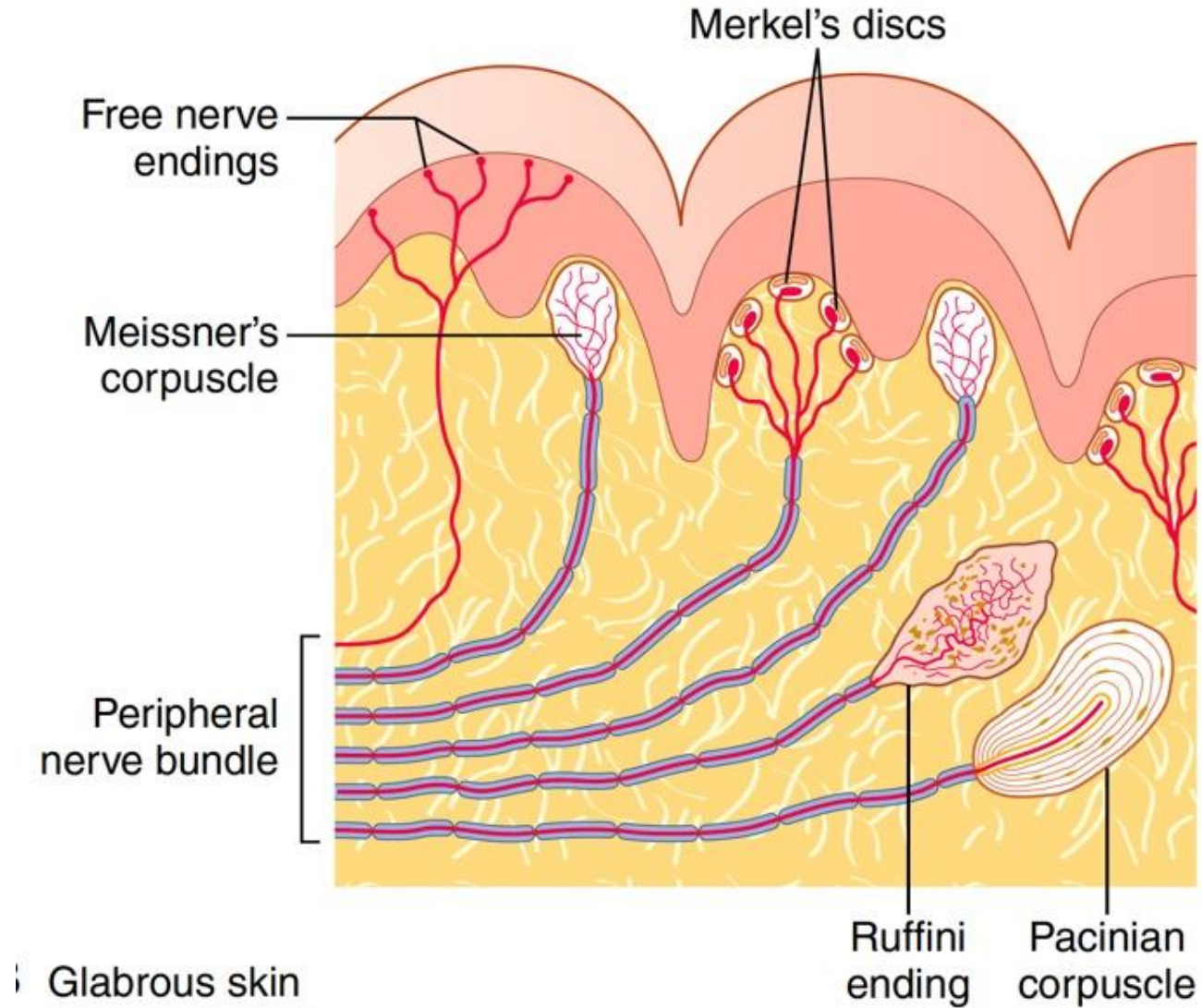
Tactile receptors



Tactile receptors



Tactile receptors



V rapid adaptation
vibration

Tactile sensory receptors

Which tactile receptor mainly involved in detecting the direction of object movement on the skin?

Tactile senses

- **Tickle:** Typically arises only when someone else touches you, not when you touch yourself.
- The reason could be due to the impulses to and from the cerebellum when you are moving your fingers and touching yourself that don't occur when someone else is tickling you.

Tactile receptors

- Tickle and **itch** are elicited by very sensitive, rapidly adapting mechanoreceptive free nerve endings, that are located in the superficial layers of the skin. Or chemically induced (such as antigens, histamine... for itch)
- The purpose of the itch sensation is presumably to call attention to mild surface stimuli such as a flea crawling on the skin (or chemical stimuli).

Tactile receptors

- This activates scratch reflex. And if the scratch is strong enough, it will elicit pain.
- The pain signals are believed to suppress the itch signals in the spinal cord by lateral inhibition.

Transmission of tactile signals in peripheral nerve fibers

- Almost all specialized sensory receptors, such as Meissner's corpuscles, transmit their signals in type A β nerve fibers.
- Free nerve ending tactile receptors transmit signals mainly via the small type A δ myelinated fibers.
- Some tactile free nerve endings transmit via type C unmyelinated fibers such as in itch and tickle senses.

Position senses (Proprioceptive senses)

Position senses

- They are divided into two subtypes:
- (1) static position sense, which means conscious perception of the orientation of the different parts of the body with respect to one another.
- (2) rate of movement sense, also called kinesthesia or dynamic proprioception.

Position sensory receptors

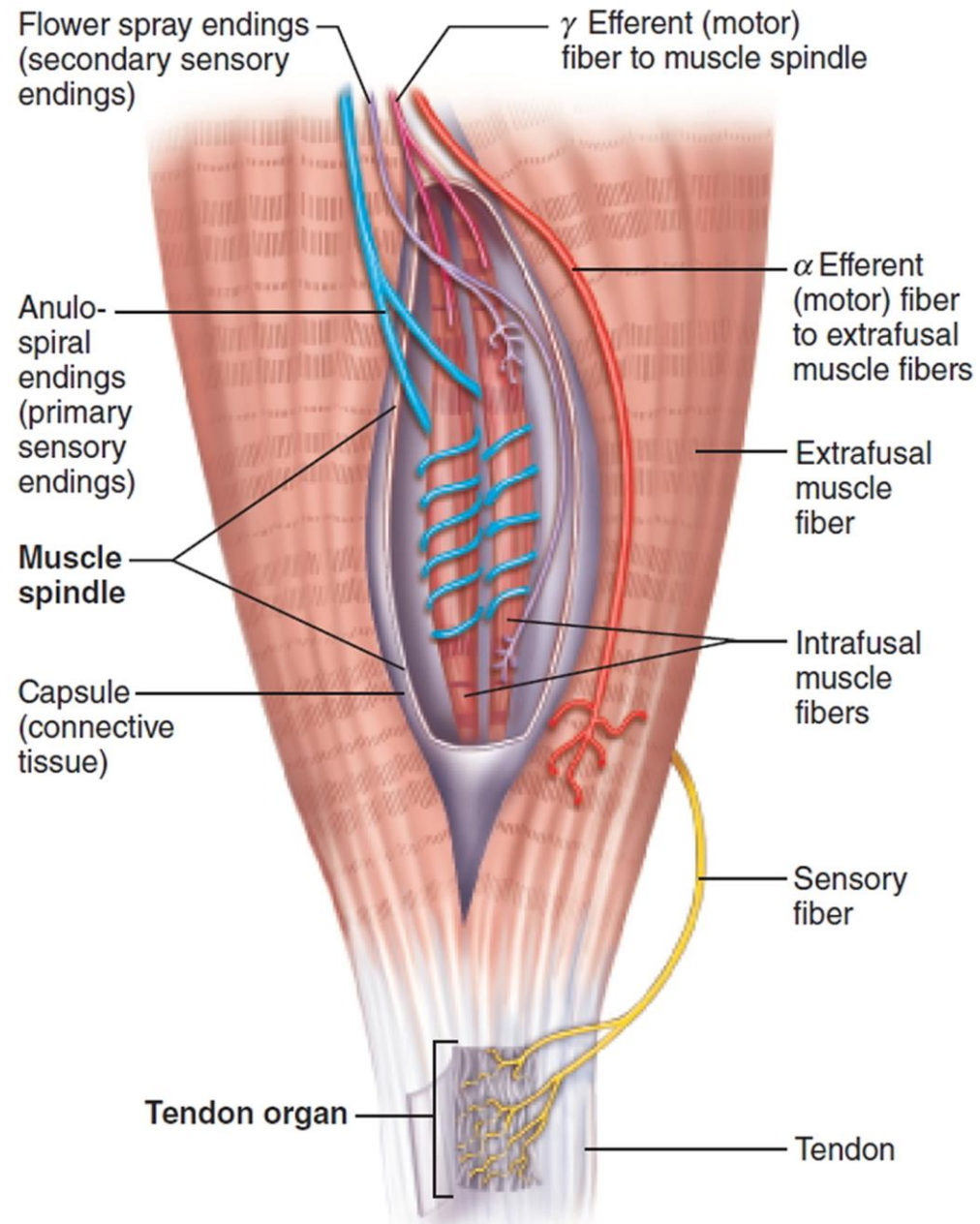
- Knowledge of position, both static and dynamic, depends on knowing the degrees of angulation of all joints in all planes and their rates of change.
- Therefore, multiple different types of receptors help to determine joint angulation and are used together for position sense.

Position sensory receptors

- Both skin tactile receptors and deep receptors near the joints are used.
- For determining joint angulation in midranges of motion, the muscle spindles are among the most important receptors.
- At the extremes of joint angulation, stretch of the ligaments and deep tissues around the joints is an additional important factor in determining position. Types of sensory receptors used for this are Ruffini's endings and Golgi tendon receptors.

Position sensory receptors

- The Pacinian corpuscles and muscle spindles are especially adapted for detecting rapid rates of change.
- It is likely that these are the receptors most responsible for detecting rate of movement.



Thermal sensations

Thermoreceptors

- Cold receptors
- Warmth receptors
- Pain receptors (stimulated only by extreme degrees of heat or cold).

- They are located immediately under the skin at discrete separated spots.
- Most areas of the body have more cold receptors than warmth.
- The number of receptors in different areas of the body varies.

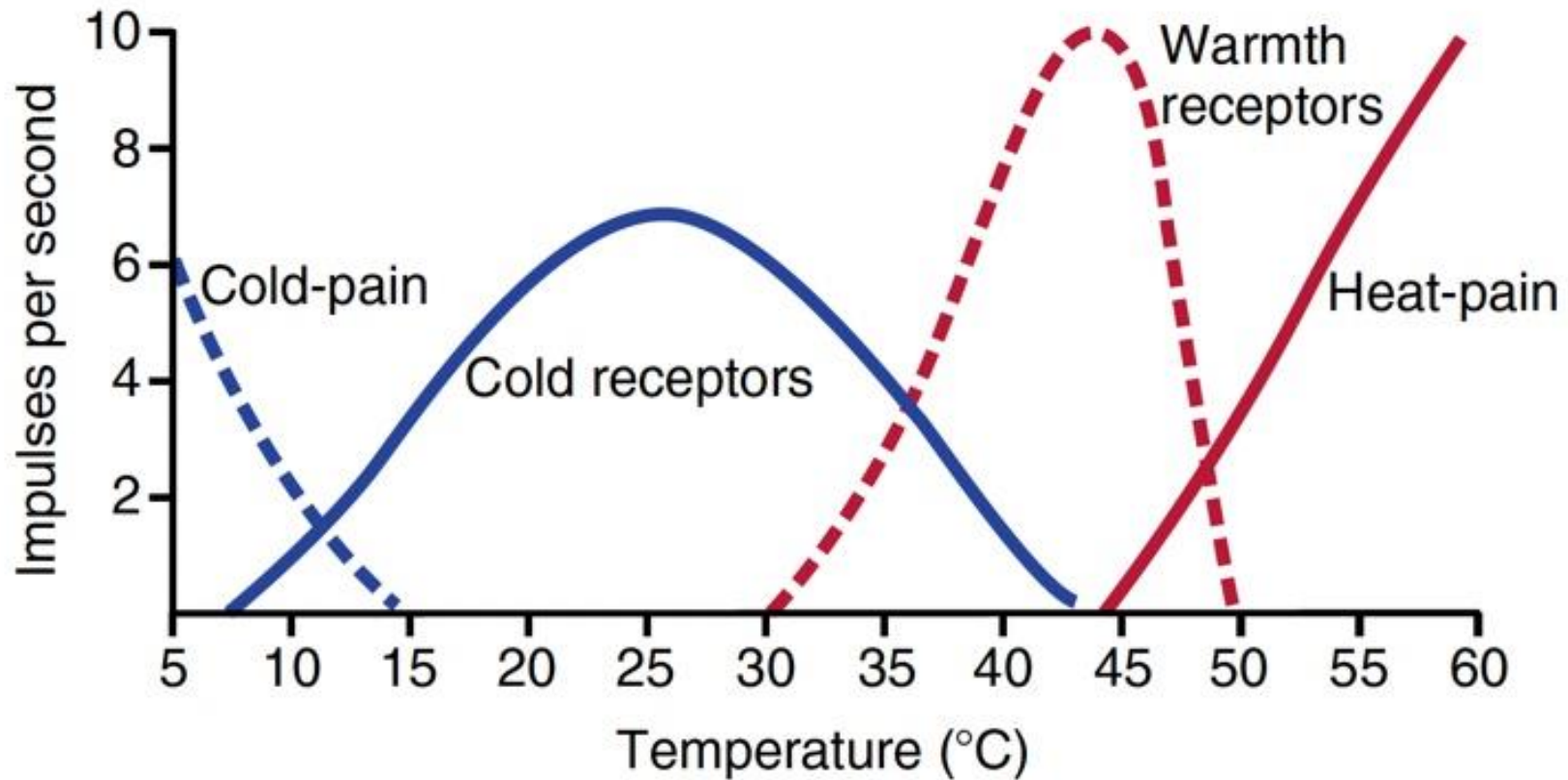
Thermoreceptors

- Free nerve endings.
- Warmth signals are transmitted mainly over type C nerve fibers.
- Cold signals are transmitted mainly via type $A\delta$ nerve fibers.
- In general, thermal signals are transmitted in pathways parallel to those for pain signals.

Thermoreceptors

- It is believed that thermal detection probably results not from direct physical effects of heat or cold on the nerve endings but from chemical stimulation of the endings as modified by temperature (change in metabolic rates, which alters the rate of intracellular chemical reactions).

Thermal sensations



Thermal sensations

- The different gradations of thermal sensations can be determined by the relative degrees of stimulation of the different types of thermoreceptors and nociceptors.
- It is difficult to judge gradations of temperature when small skin areas are stimulated.
- However, when a large skin area is stimulated all at once, the thermal signals from the entire area are cumulative.
- For example, rapid changes in temperature as little as 0.01°C can be detected if this change affects the entire surface of the body simultaneously. Conversely, temperature changes 100 times as great often will not be detected when the affected skin area is only 1 square centimeter in size.

Adaptation in thermal receptors

- Thermal senses respond markedly to changes in temperature than to steady states of temperature.
- This means that when the temperature of the skin is actively falling, a person feels much colder than when the temperature remains cold at the same level.

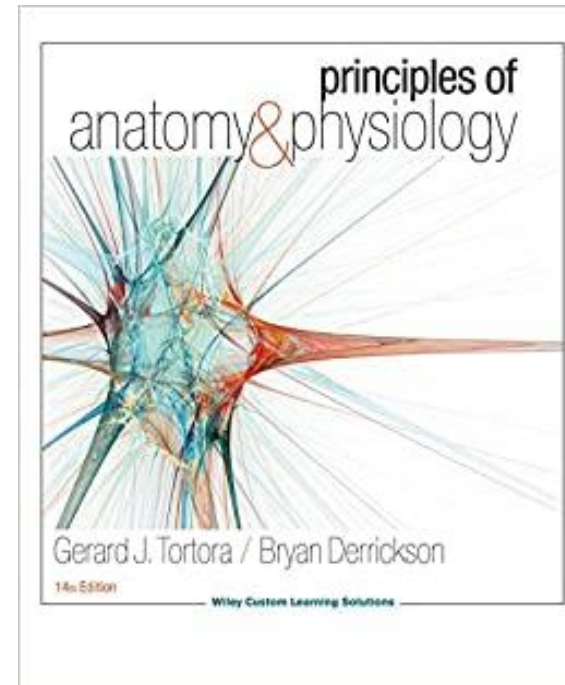
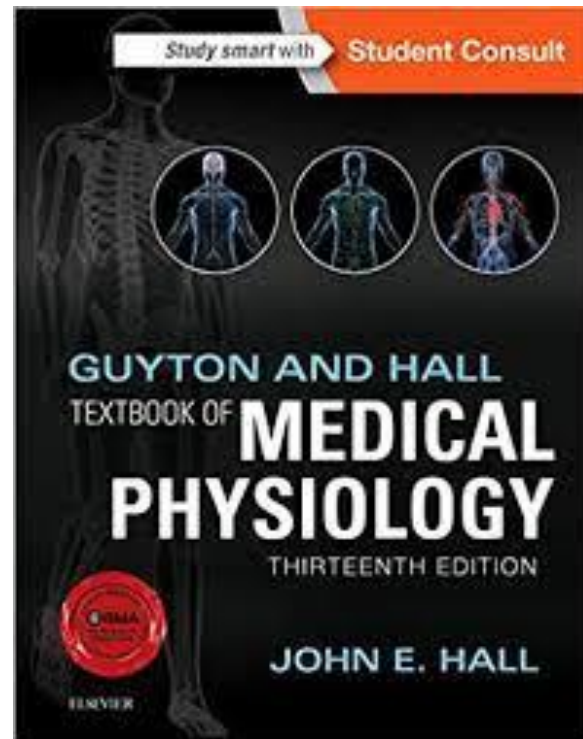
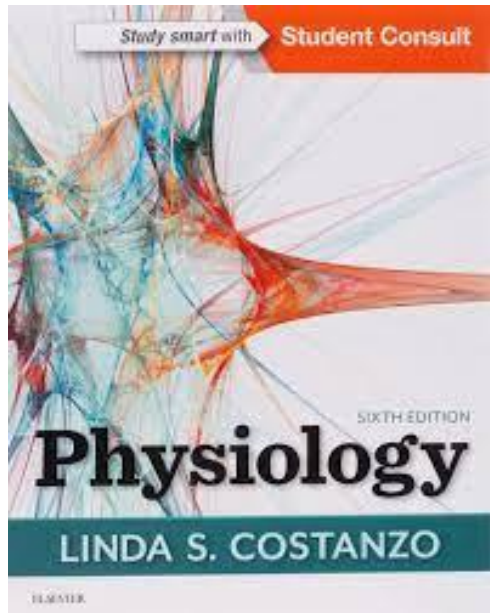
Thermal receptors

- Transduction of warm temperatures involves transient receptor potential (TRP) channels in the family of vanilloid receptors (TRPV).
- These channels are activated by compounds in the vanilloid class, which includes capsaicin, an ingredient in spicy foods. (This phenomenon explains why people describe the taste of chili peppers as “hot.”)

Thermal receptors

- Transduction of cold temperatures involves a different TRP channel, TRPM8, which is also opened by compounds like menthol (which gives a cold sensation).

References



9TH
Edition

Human Physiology From Cells to Systems

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