L2 Transduction of Sensory stimuli

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Objectives

1. sensory transduction
2. receptor potential
3. Adaptation of receptors.
4. types of nerve fibers
5. Types of tactile sensation
6. touch and position sensation

Sensory Transduction is the process by which an environmental stimulus activates a receptor and is converted into electrical energy.

- All sensory receptors have one feature in common.

- Whatever the type of stimulus that excites the receptor….its immediate effect is to change the membrane electrical potential of the receptor. This change in potential is called
- a *receptor potential.*

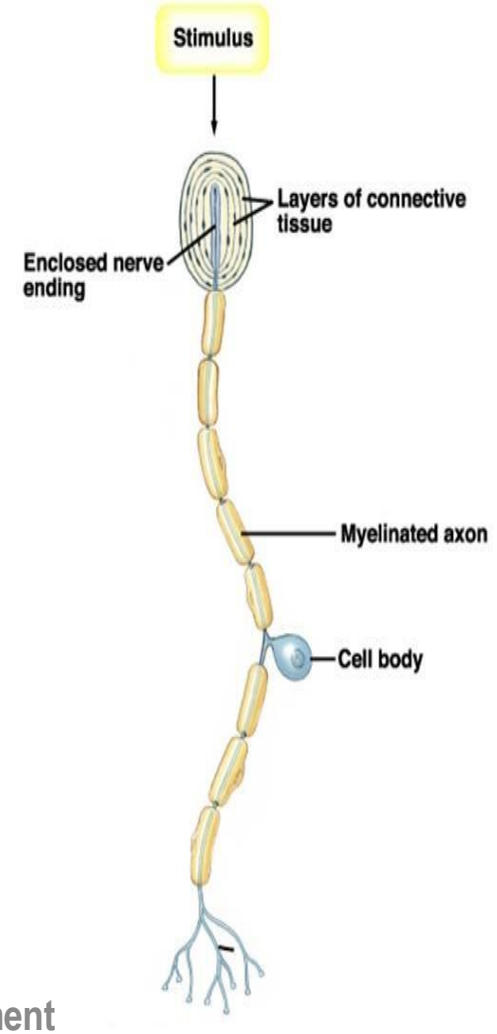
Receptors in general can be excited in one of several ways to cause receptor potentials

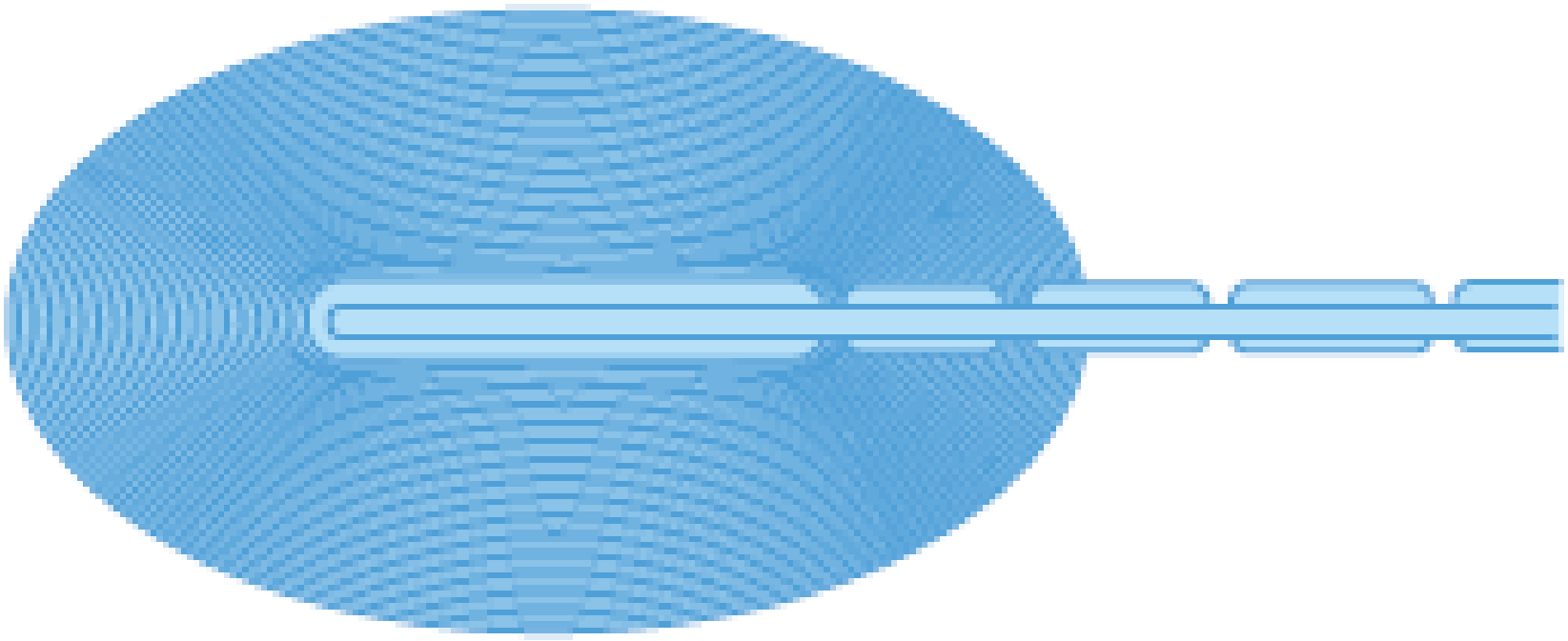
Receptor Potential

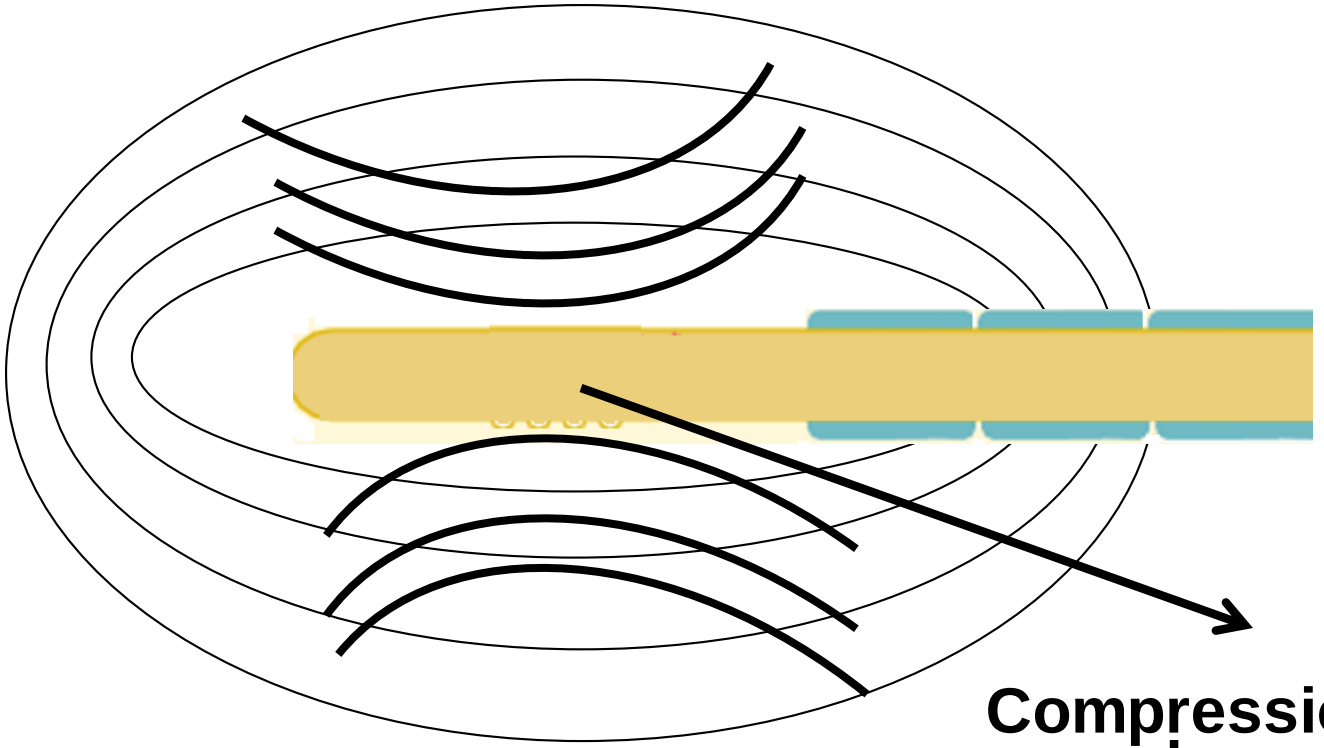
Mechanical deformation	Application of a chemical to the membrane,	Change the temperature of the membrane,	Electromagnetic radiation,
stretches the receptor membrane	opens ion channels	which alters the permeability of the membrane	such as light on a retinal visual receptor
opens ion channels			

The receptor potential can be demonstrated in pacinian corpuscles :

Pacinian corpuscle

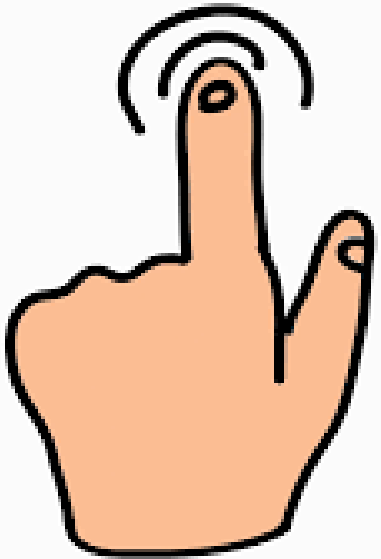






Compression

indentation



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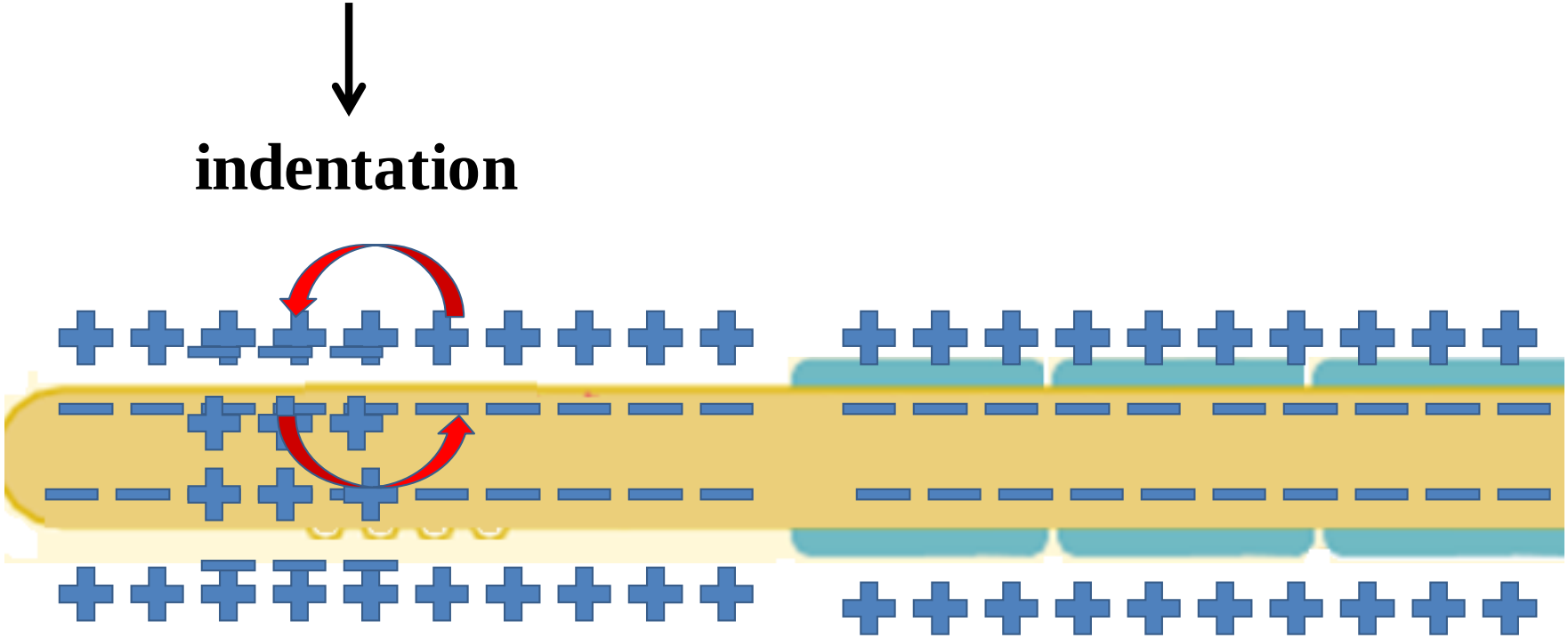

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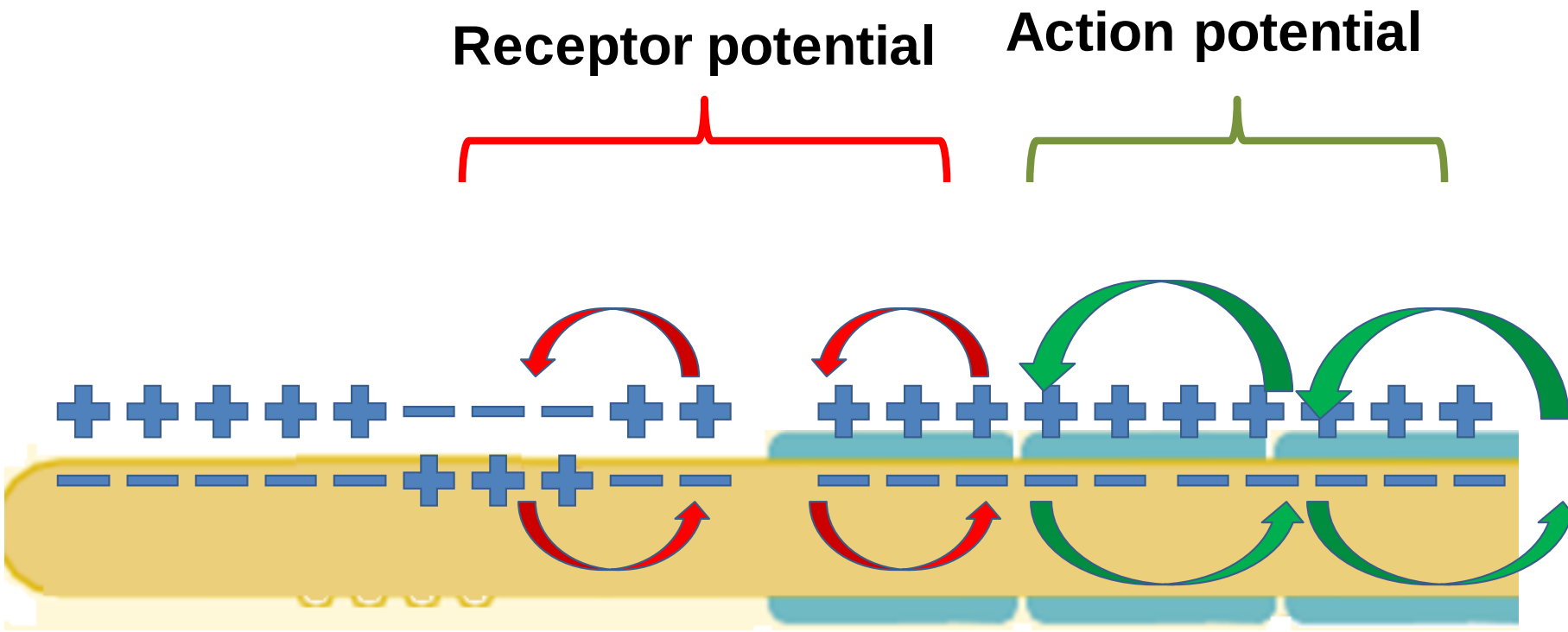
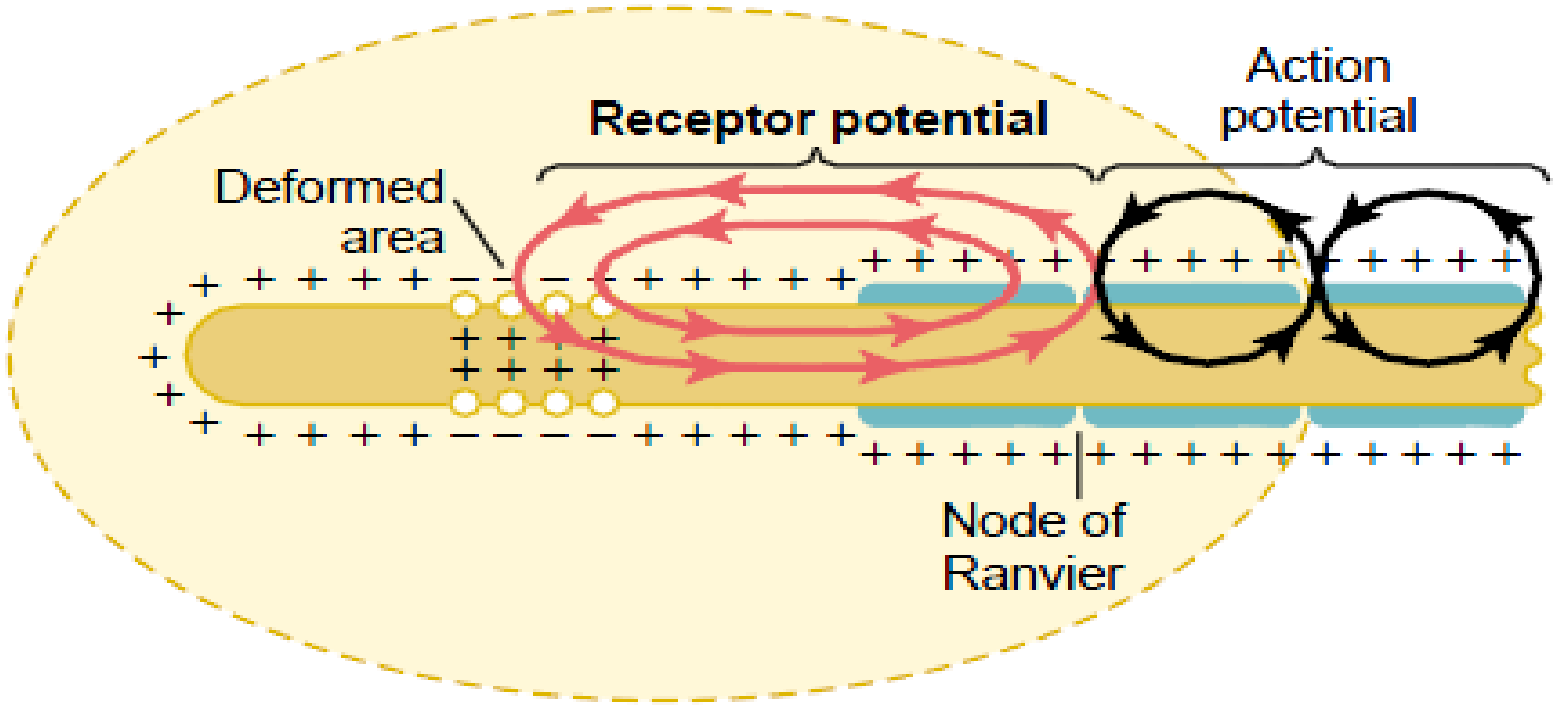

Receptor potential
Action potential



Excitation of a sensory nerve fiber by a receptor potential produced in a pacinian corpuscle.

- The conversion typically involves:
  - opening of sodium ion channels
  - flow of sodium ions across the membrane
  - change in membrane potential called generator potential or receptor potential
  - current flow depolarizes the first node of Ranvier.
  - when the firing level is reached,action potential developed
  - transmitted along the nerve fiber toward the CNS.

The mechanism of receptor adaptation

❑The mechanism of receptor adaptation is different for each type of receptor.

❑ In the case of the mechanoreceptors adaptation occur in this receptor in two ways.

1.fluid within the corpuscle redistributes, so that the receptor potential is no longer elicited.

2. accommodation occur in the nerve fiber itself results from progressive inactivation of the sodium channels in the nerve fiber membrane.

Types of nerve Fibers

Nerve fiber types in mammalian nerve.[a]

Fiber Type	Function	Fiber Diameter (μm)	Conduction Velocity (m/s)
A			
α	Proprioception; somatic motor	12–20	70–120
β	Touch, pressure	5–12	30–70
γ	Motor to muscle spindles	3–6	15–30
δ	Pain, cold, touch	2–5	12–30
B	Preganglionic autonomic	<3	3–15
C			
Dorsal root	Pain, temperature, some mechano-reception	0.4–1.2	0.5–2
Sympathetic	Postganglionic sympathetic	0.3–1.3	0.7–2.3

[a]A and B fibers are myelinated; C fibers are unmyelinated.

Type A fibers — large and medium-sized myelinated fibers conduct impulses at great velocities

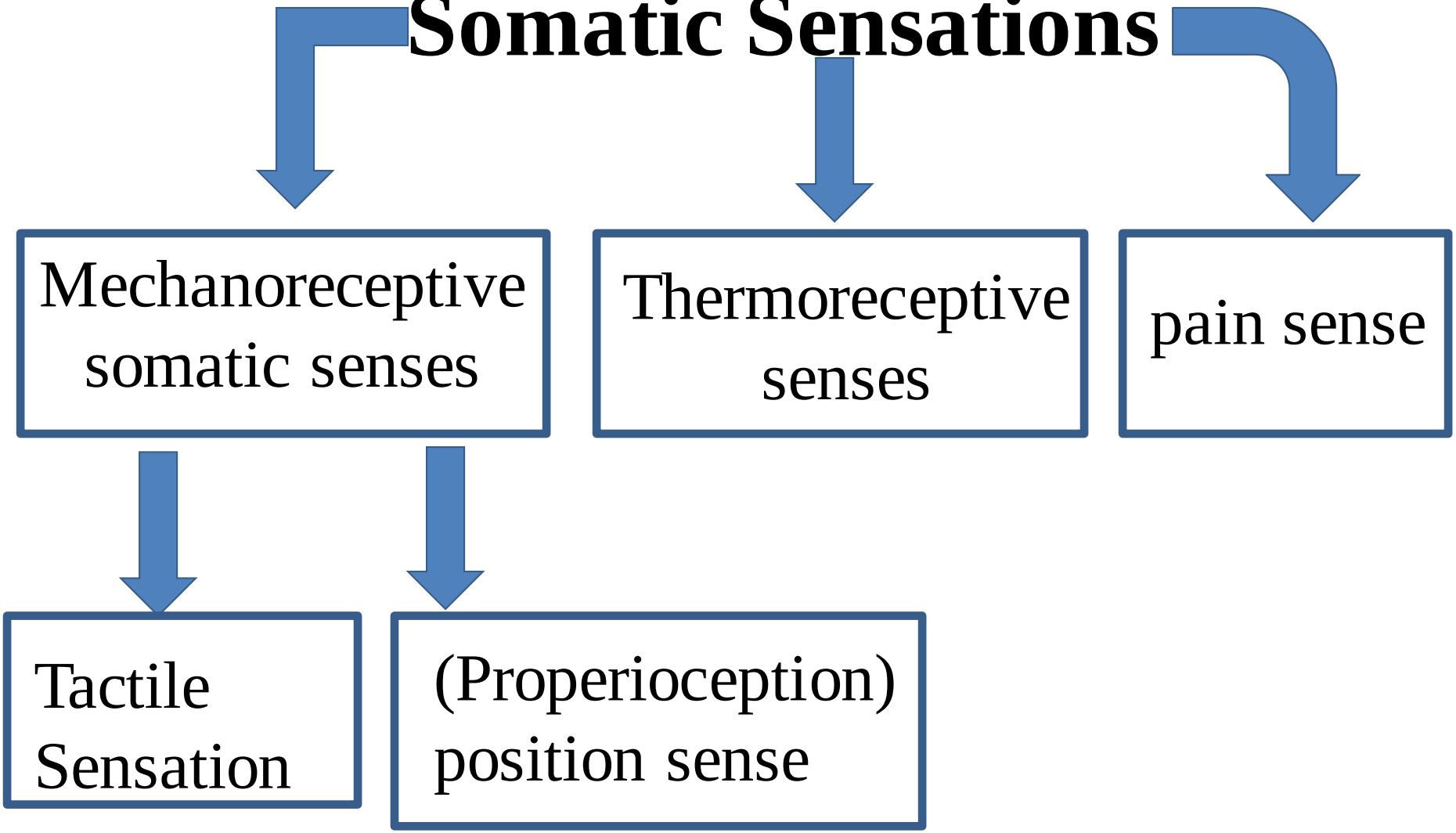
Type C fibers — small unmyelinated nerve fibers conduct impulses at low velocities.

The larger diameter the greater the conducting velocity

Numerical classification sometimes used for sensory neurons.

Number	Origin	Fiber Type
Ia	Muscle spindle, annulo-spiral ending	A α
Ib	Golgi tendon organ	A α
II	Muscle spindle, flower-spray ending; touch, pressure	A β
III	Pain and cold receptors; some touch receptors	A δ
IV	Pain, temperature, and other receptors	Dorsal root C

Somatic Sensations



Tactile Sensations

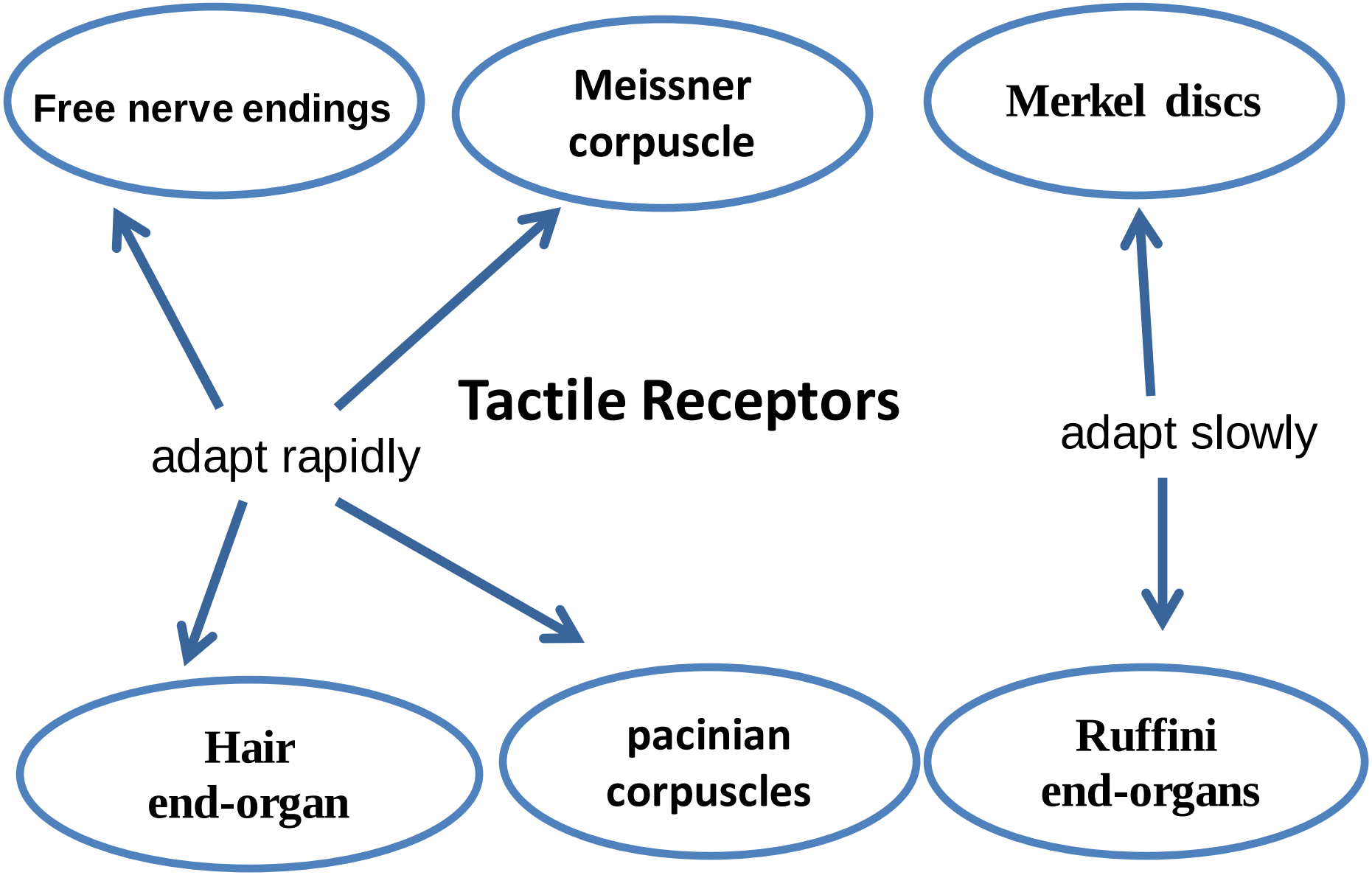
Although touch, pressure, and vibration are frequently classified as separate sensations, they are all detected by **the same types of receptors**

differences among them

(1) touch sensation → stimulation of tactile receptors in the skin or in tissues immediately beneath the skin.

(2) pressure sensation → deformation of deeper tissues.

(3) vibration sensation → rapidly repetitive sensory signals, but the same types of receptors as those for touch and pressure are used.


Free nerve endings
Meissner corpuscle
Merkel discs
Tactile Receptors
adapt rapidly
adapt slowly
Hair end-organ
pacinian corpuscles
Ruffini end-organs

Transmission:

All tactile receptor transmit through type Aβ nerve fibers except

- The free nerve endings which transmit impulses through type Aδ nerve fibers
- some tactile free nerve ending transmit impulses by type C unmyelinated nerve fibers mainly for tickle sense.

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Pacinian corpuscles are

A) a type of thermoreceptor.

B) usually innervated by Aδ nerve fibers.

C) rapidly adapting touch receptors.

D) nociceptors.

Tickle and itch

Receptors: very sensitive, rapidly adapting mechanoreceptive free nerve endings found almost exclusively in superficial layers of the skin.

transmission:

by very small type C, unmyelinated fibers.

The purpose of the itch sensation

is presumably to call attention to mild surface stimuli such as a flea crawling on the skin, the elicited signals then activate the scratch reflex or other maneuvers that rid the host of the irritant.

Position Senses

Receptors:

1. skin tactile receptors like the pacinian corpuscles, Ruffini's endings
2. deep receptors (like muscle spindles and Golgi tendon receptors found in muscle tendons).

Recap

1. Sensory Transduction is the process by which an environmental stimulus activates a receptor and is converted into electrical energy
2. change the membrane electrical potential, after excitation of the receptors by a stimulus receptor potential
3. Mechanism of adaptation
4. Classification of Nerve fibers
5. Touch, tickle and position sense.

Thank You