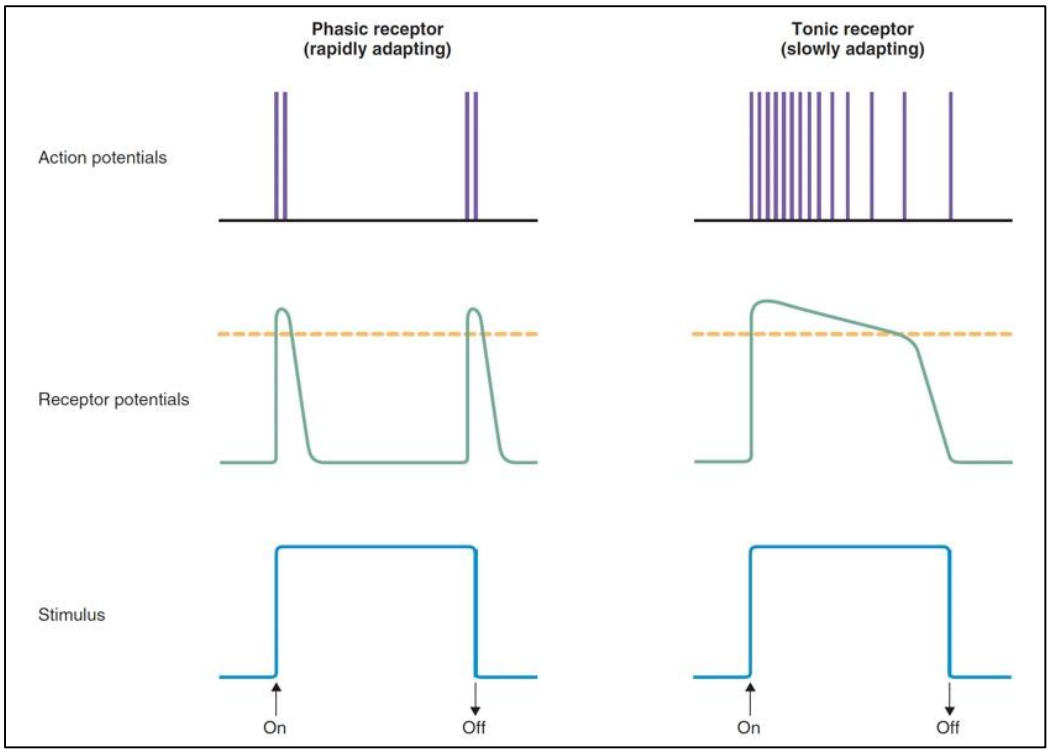
Somatic sensations-II

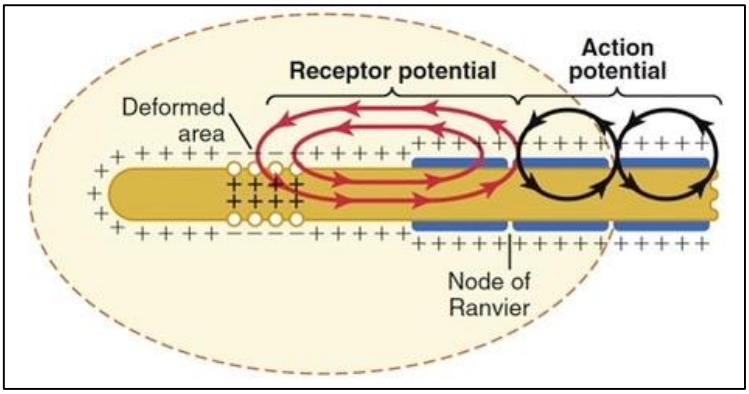
Tactile senses

- Although touch, pressure, and vibration are frequently classified as separate sensations, they are all detected by the same types of receptors.
- Almost all tactile receptors are involved in detection of vibration, although different receptors detect different frequencies of vibration (Pacinian and Meissner).



Pacinian corpuscle adaptation mechanism:

Readjustments in the structure of the receptor.
Inactivation of Na+ channels.
The mechanism of adaptation varies between receptors.



Tickle and Itch senses

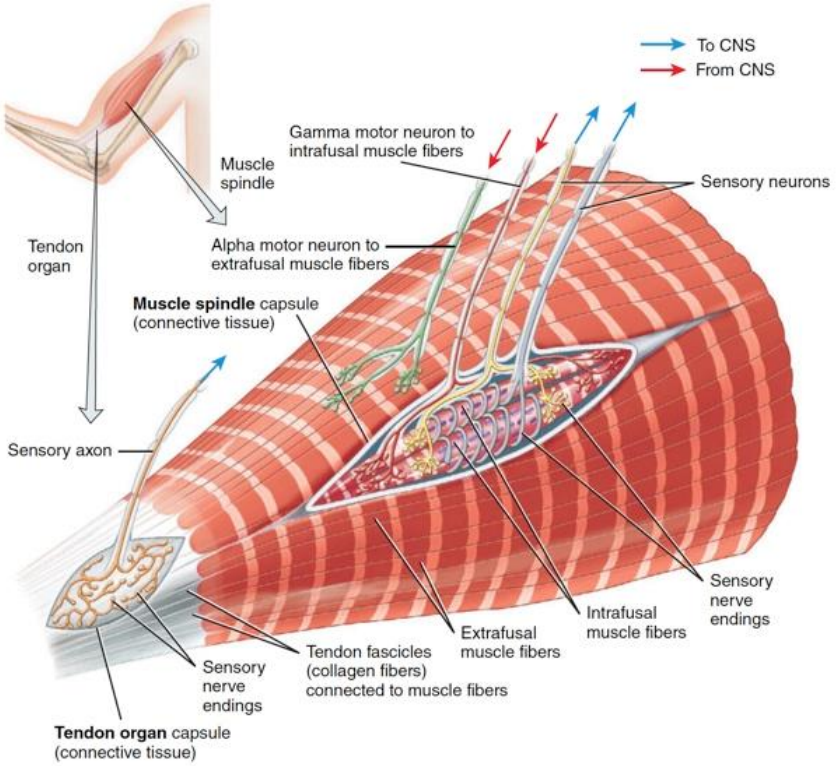
- Itch and tickle receptors are free nerve endings found almost exclusively in superficial layers of the skin, which is also the only tissue from which the tickle and itch sensations usually can be elicited.
- These sensations are transmitted by very small type C, unmyelinated fibers.
- Central cancellation of self produced tickle sensation.

Itch

- The purpose of the itch sensation is presumably to call attention to mild surface stimuli such as a flea crawling on the skin.
- The signals elicited then activate the scratch reflex or other maneuvers that rid the host of the irritant.
- Itch can be relieved by scratching if this action removes the irritant or if the scratch is strong enough to elicit pain.
- The pain signals are believed to suppress the itch signals in the cord by lateral inhibition.

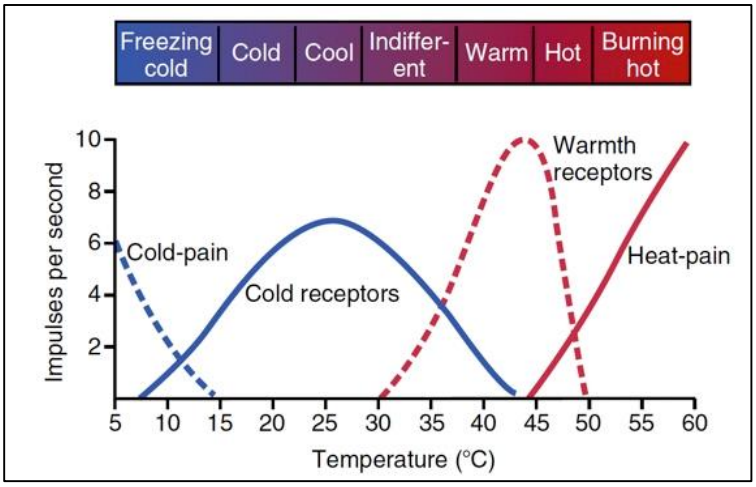
Position receptors (proprioceptors)

- Slowly adapting
- They can be 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.
- allow us to know where our body parts are located and how they are moving even if we are not looking at them, so that we can walk, type, or dress without using our eyes.
- Proprioceptors also allow weight discrimination, the ability to assess the weight of an object. This type of information helps to determine the muscular effort necessary to perform a task.
- 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. Both skin tactile receptors and deep receptors near the joints are used.



Thermoreceptors

- Thermal gradations are discriminated by at least three types of sensory receptors—cold receptors, warmth receptors, and pain receptors.
- The pain receptors are stimulated only by extreme degrees of heat or cold.
- The cold and warmth receptors are located immediately under the skin at discrete separated spots.
- Most areas of the body have 3 to 10 times as many cold spots as warmth spots.
- The number in different areas of the body varies.
- Thermoreceptors are believed to be free nerve endings because warmth signals are transmitted mainly over unmyelinated type C nerve fibers (warmth receptors) and mainly type Aδ myelinated nerve ending (cold receptors).
- Each type of receptor functions over a broad range of temperatures, with some overlap in the moderate temperature range.



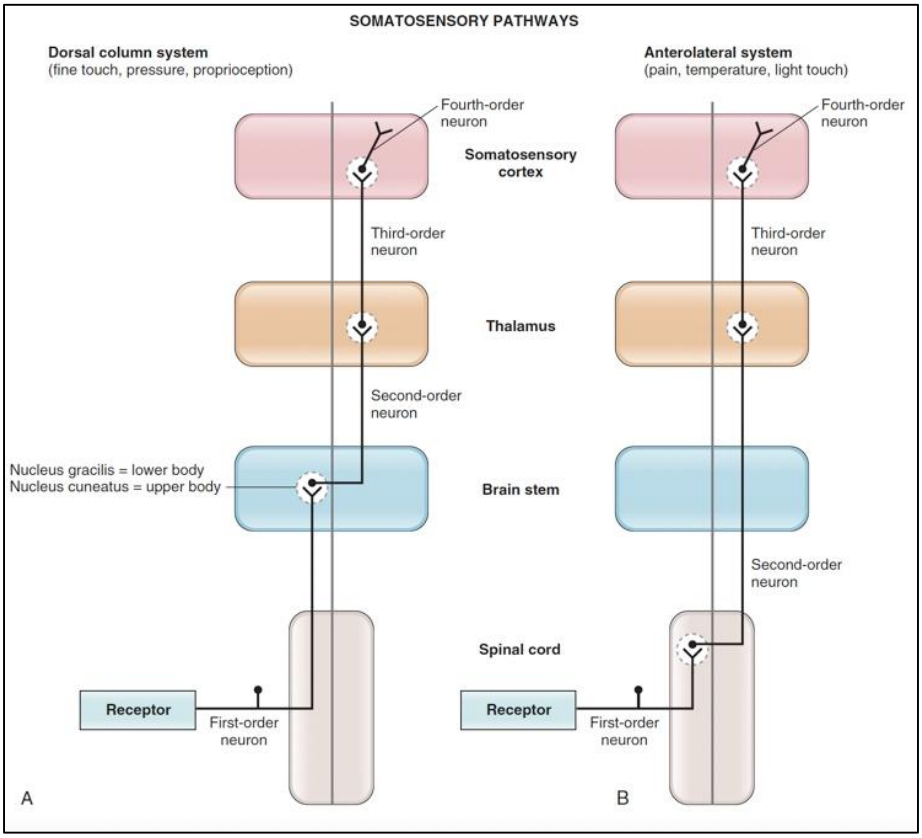
- Transduction of warm temperatures involves transient receptor potential (TRP) channels in the family of vanilloid receptors (i.e., TRPV).
- These channels are activated by compounds in the vanilloid class, which includes capsaicin, an ingredient in spicy foods.
- Transduction of cold temperatures involves a different TRP channel, TRPM8, which is also opened by compounds like menthol.
- It is believed that the cold and warmth receptors are stimulated by changes in their metabolic rates, and that these changes result from the fact that temperature alters the rate of intracellular chemical reactions more than twofold for each 10°C change.

- When a cold receptor is suddenly subjected to an abrupt fall in temperature, it becomes strongly stimulated at first, but this stimulation fades rapidly during the first few seconds and progressively more slowly during the next 30 minutes or more.
- Thus, it is evident that the thermal senses respond markedly to changes in temperature in addition to being able to respond 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.
- Spatial Summation of Thermal Sensations:
- Because the number of cold or warmth endings in any one surface area of the body is slight, 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.

Nociceptors

- The pain receptors in the skin and other tissues are all free nerve. endings.
- They are widespread in the superficial layers of the skin, as well as in certain internal tissues.
- Pain can be elicited by multiple types of stimuli, classified as mechanical, thermal, and chemical pain stimuli.
- Some of the chemicals that excite the chemical type of pain are bradykinin, serotonin, histamine, potassium ions, acids, acetylcholine, and proteolytic enzymes. In addition, prostaglandins and substance P enhance the sensitivity of pain endings but do not directly excite them.
- The chemical substances are especially important in stimulating the slow suffering type of pain that occurs after tissue injury.
- In contrast to most other sensory receptors of the body, pain receptors adapt very little and sometimes not at all.
- It allows the pain to keep the person apprised of a tissue-damaging stimulus as long as it persists.

- The intensity of pain is also closely correlated with the rate of tissue damage.
- Tissue Ischemia as a Cause of Pain.
- When blood flow to a tissue is blocked, the tissue often becomes very painful within a few minutes.
- The greater the rate of metabolism of the tissue, the more rapidly the pain appears.
- One of the suggested causes of pain during ischemia is accumulation of large amounts of lactic acid and other chemical agents, such as bradykinin and proteolytic enzymes, are formed in the tissues because of cell damage.
- Nociceptors respond to noxious stimuli that can produce tissue damage.
- There are two major classes of nociceptors: thermal or mechanical nociceptors and polymodal nociceptors.
- Thermal or mechanical nociceptors (TRPV or TRPM8 channels) are supplied by finely myelinated A-delta afferent nerve fibers.
- Polymodal nociceptors are supplied by unmyelinated C fibers and respond to high-intensity mechanical or chemical stimuli and thermal stimuli.



Sensory neurons

- The first-order neuron in the somatosensory pathway is the primary afferent neuron.
- Primary afferent neurons have their cell bodies in dorsal root or cranial ganglia, and their axons synapse on somatosensory receptor cells.
- The signal is transduced by the receptor and transmitted to the CNS by the primary afferent neuron.
- The second-order neuron is located in the spinal cord (anterolateral system) or in the brain stem (dorsal column system).
- The second-order neurons receive information from first-order neurons and transmit that information to the thalamus.
- Axons of the second-order neurons cross the midline, either in the spinal cord or in the brain stem, and ascend to the thalamus.
- This decussation means that somatosensory information from one side of the body is received in the contralateral thalamus.
- The third-order neuron is located in one of the somatosensory nuclei of the thalamus.
- The thalamus has a somatotopic arrangement of somatosensory information.