Physiology

Modified no.1

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Neurophysiology

Somatic sensation

Color code

- Slides
- Doctor
- Additional info
- Important

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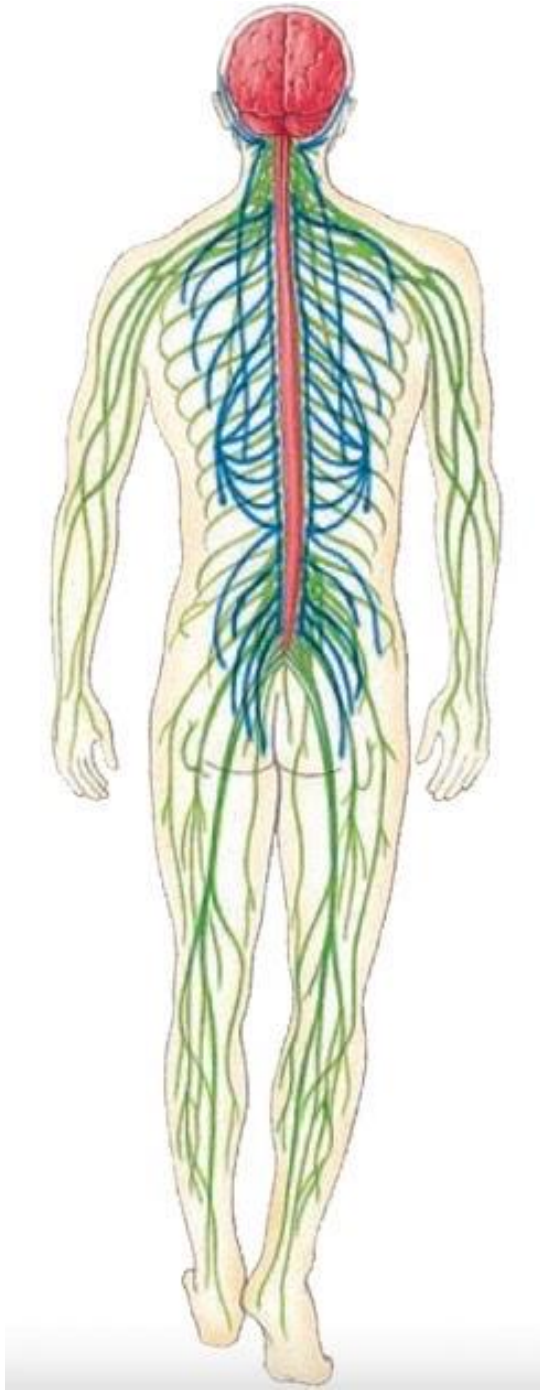
Let's start our first incredible physiology lecture in the CNS 🎉

The main function of the nervous system is control, and to perform control we need information about changes inside and outside the body, which can be detected by specialized sensory receptors "المستقبلات الحسيّة"
This function is called the sensory function of the nervous system.

Then we want to process these information in order to make decisions, processing means contrasting and comparing these new information to the previous information that we have, like thoughts and memory.
This function is called integrative function and happens in the CNS (brain and spinal cord), and the higher we go, the more the process advances, and unfortunately, the less we understand about these functions because the psychologic effect plays a role not only the biological effect.



Now the decision is:

1- to do an immediate action, by changing the activity of muscular cells [either contraction or relaxation] and gland secretion [either endocrine or exocrine]
This function is called motor function.

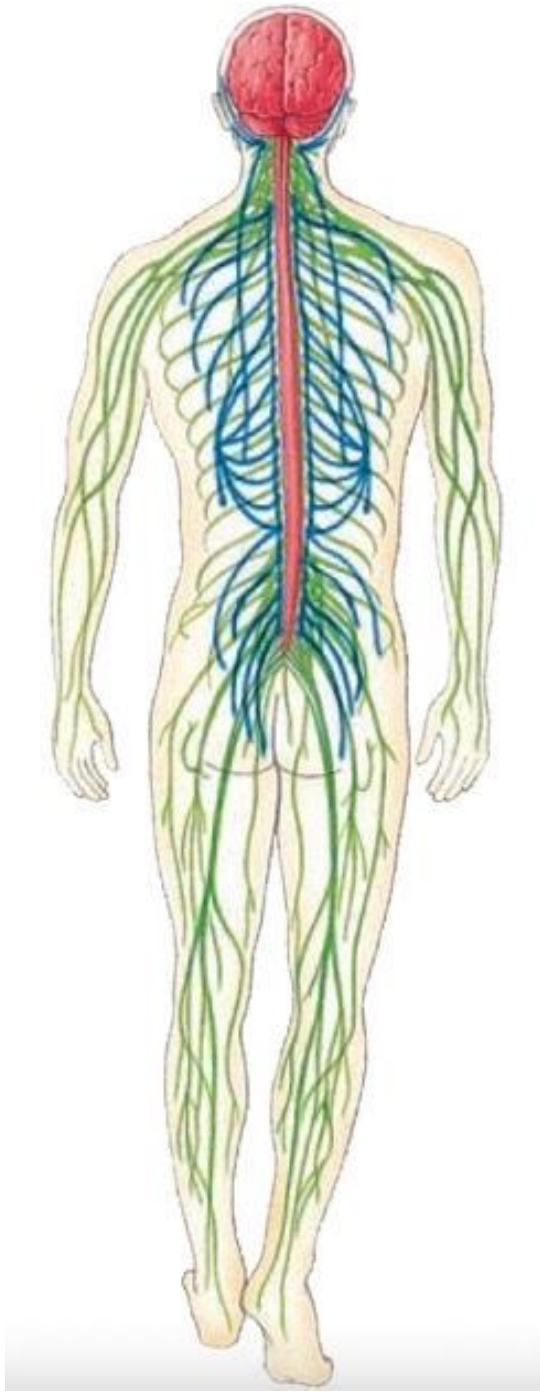
2- to store information

3- to discard information, this means that some information are not relevant to me now. For example, during a lecture, you are surrounded by various sensory stimuli, such as wearing a watch, the pressure of the chair you're sitting on, the temperature, and the scent of perfume. However, the most prominent thing you perceive is the professor's voice. In fact, 90% of the information will be discarded.

The choice between these three options depends on past experiences and thoughts.
This means that the same sensory information can lead to different individual decisions.

For example, two friends see a dog [both have the same visual stimulus] :

- The first one associates dogs with biting, so he runs away.
- The second one has a pet dog at home, so he starts playing with it.



Functions of the nervous system

- **Sensory function**: sensory receptors detect internal or external stimuli. The sensory information is carried to the CNS through cranial and spinal nerves.

- **Integrative function**: processes sensory information by analyzing it and making decision for appropriate responses.

- **Motor function**: changes the activity of the effectors (muscles and glands) through cranial and spinal nerves.

Divisions of nervous system

Central nervous system (CNS)

- Brain
- Spinal cord

- Responsible for integration.
- Note that the spinal cord can do decisions not only the brain.

Peripheral nervous system (PNS)

- Somatic system (SNS)
- Autonomic system (ANS)
- Enteric system (ENS)

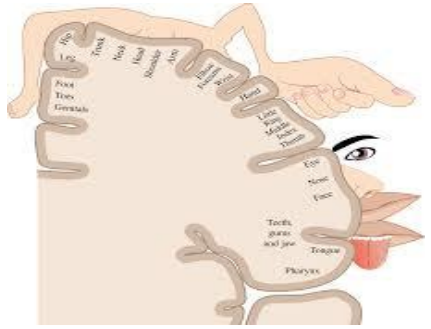
The sensory and motor parts of somatic nervous system works through cranial and spinal nerves that transit signals between CNS and PNS.

Sensation

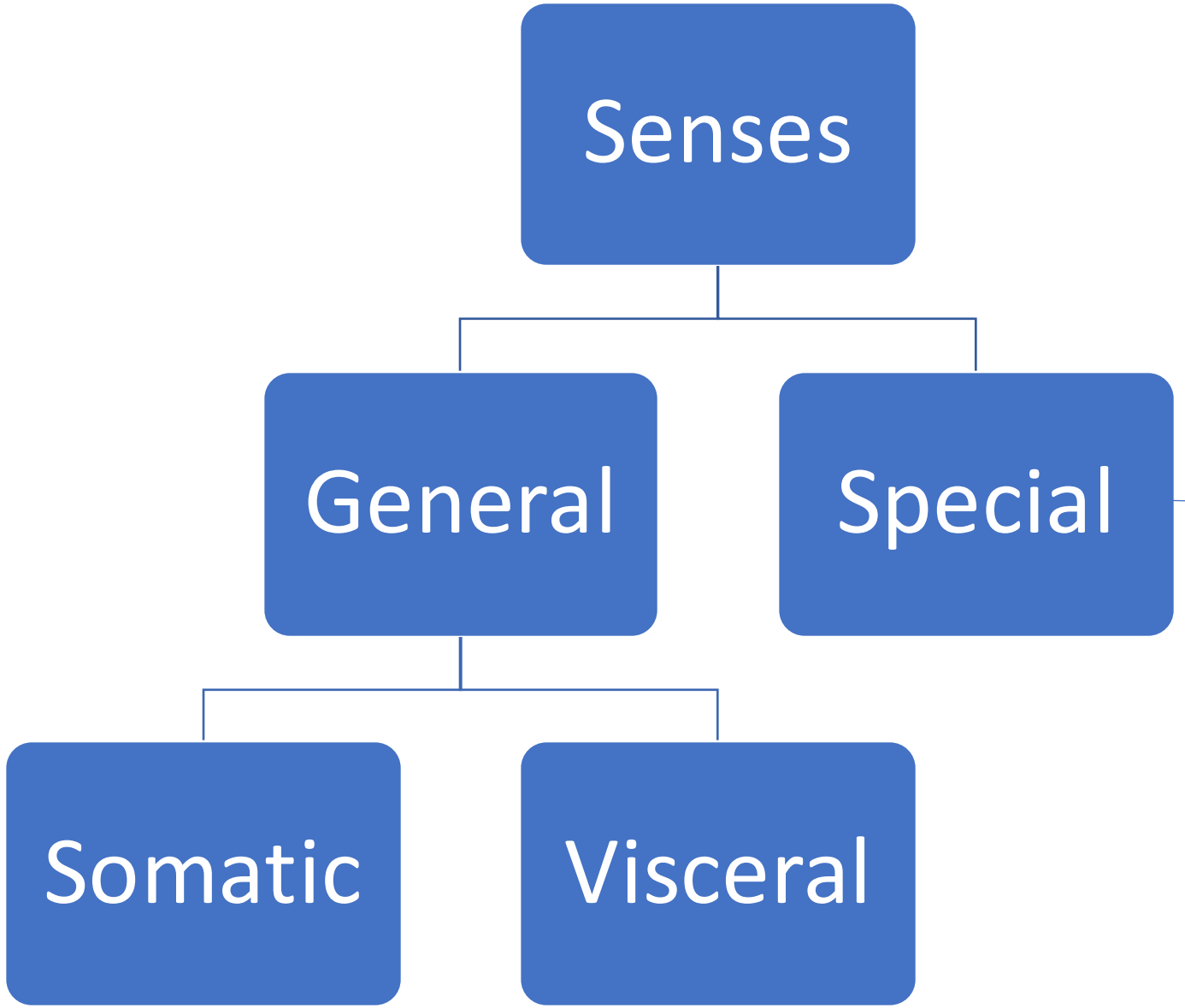
- **Sensation** is the conscious or subconscious awareness of changes in the external or internal environment.
  - Changes examples:
  - External/conscious ---> turning the light off will be detected by specific receptors.
  - Internal/subconscious ---> the fluctuation of blood pressure which can be detected by baroreceptors.

- **Perception** is the conscious interpretation of sensations and is primarily a function of the cerebral cortex. (the highest area of the brain)
  - if the signal reaches the brain stem, cerebellum, or other part than the cortex, we won't consciously be aware of it (for example: blood pressure integration is in the brain stem so we are subconsciously aware of it)

Sensation is input about the physical world obtained by our sensory receptors, and perception is the process by which the brain selects, organizes, and interprets these sensations.



Extra pic

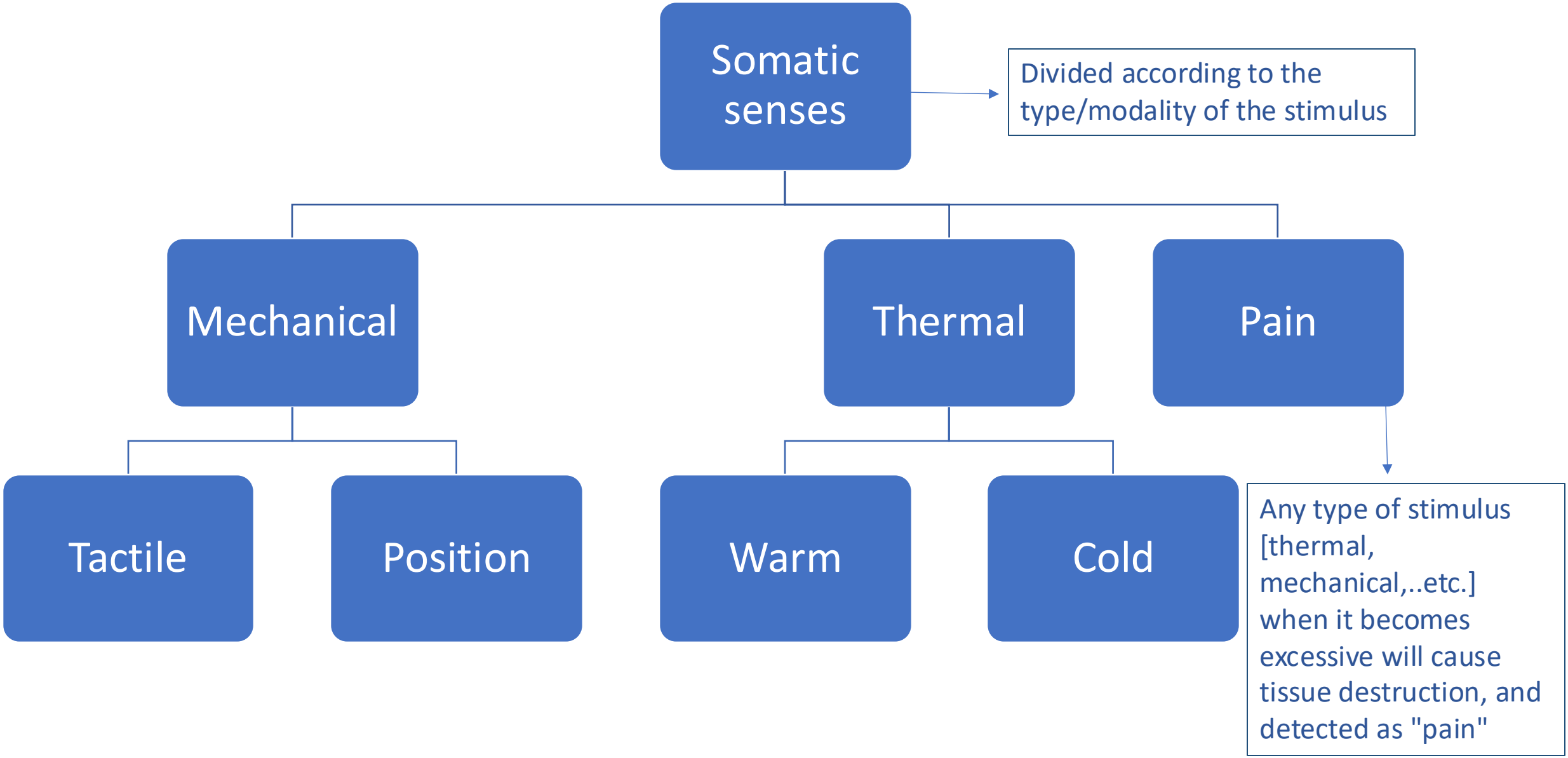


Include:
Taste
Vision
Hearing
Smell
Equilibrium

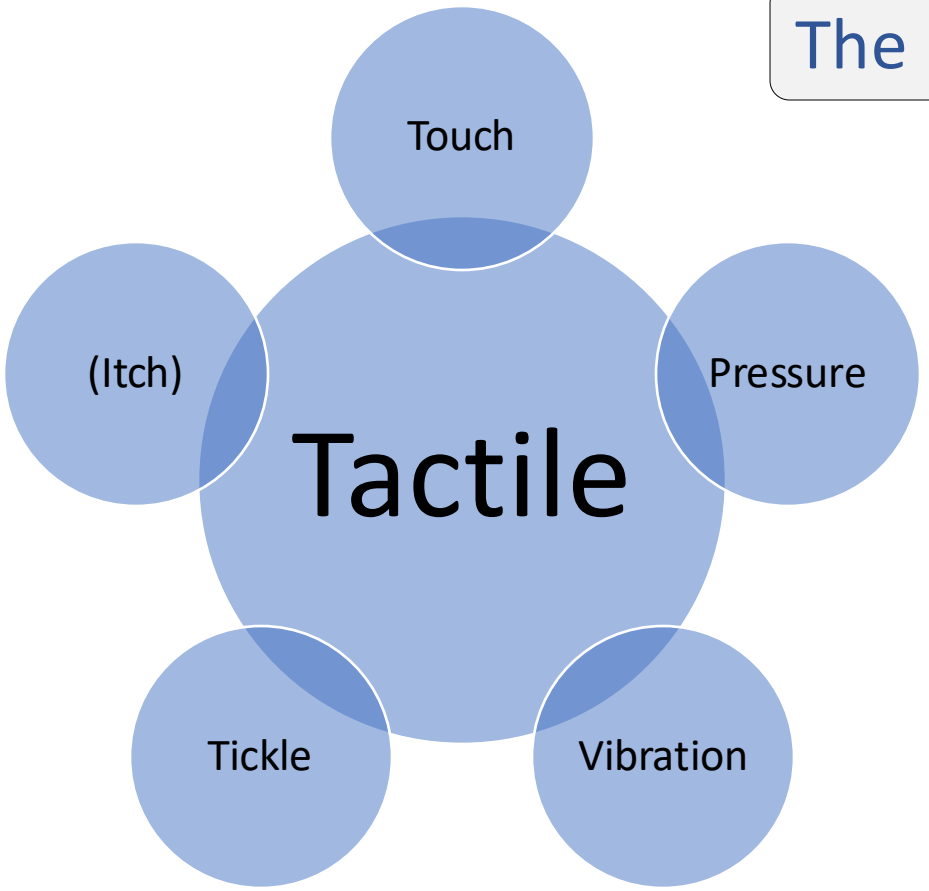
Some books include touch and some exclude it, however in our lec we consider it as a part of the somatic.

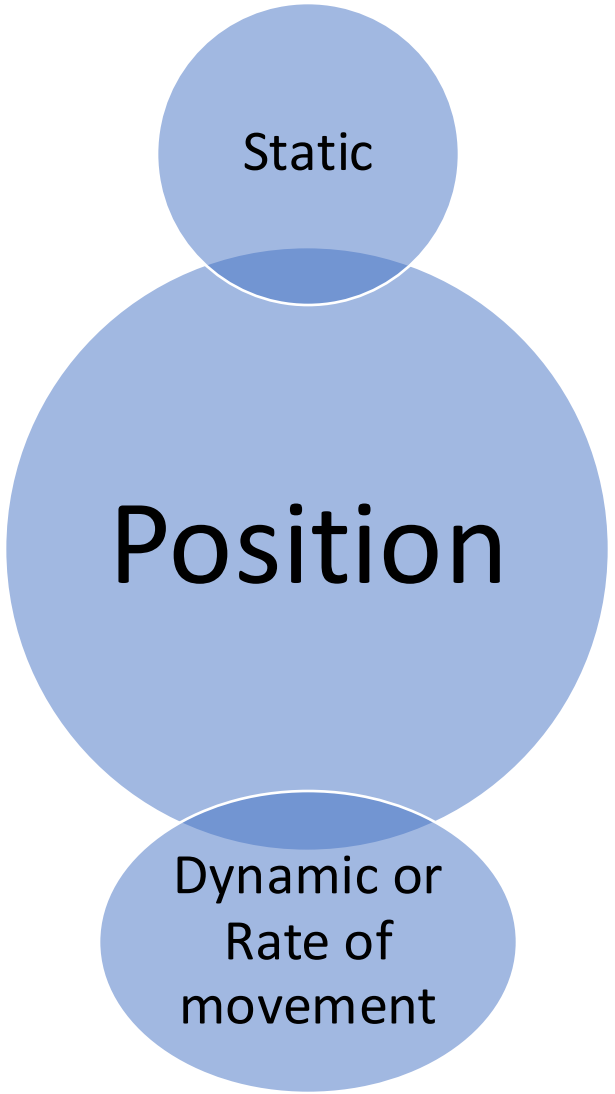
Somatic sensory receptors

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


Somatic senses
Divided according to the type/modality of the stimulus
Mechanical
Thermal
Pain
Tactile
Position
Warm
Cold
Any type of stimulus [thermal, mechanical,..etc.] when it becomes excessive will cause tissue destruction, and detected as "pain"

The mechanical stimulus





- Tactile related to touch.
- If the touch becomes deeper, we call it pressure.
- If the touch becomes repetitive, we call it vibration.
- If it becomes light movement over the skin, we call it either tickle or itch.

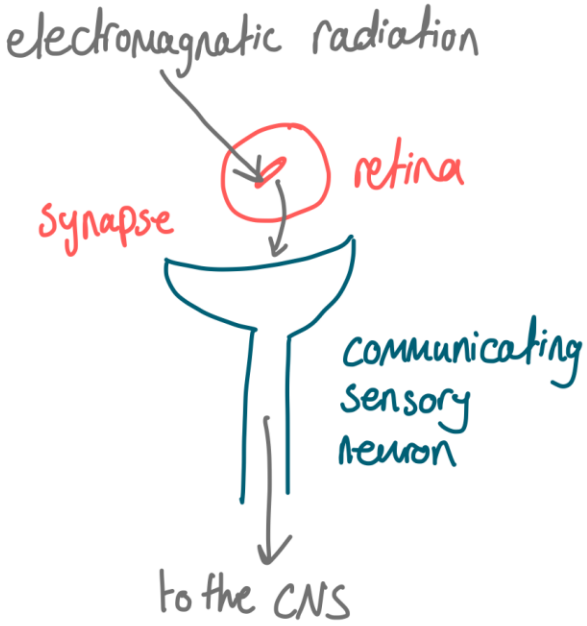
The process of sensation

So, we talked about different types of sensory modality that will be received or detected by different structures in the body, they are almost specific to the type of stimulus.
Now let's talk about receptors, what is a sensory receptor?
It is a specialized structure in the body that will detect these different changes in the environment either internal or external.
Sensory receptor can be part of sensory neuron (free or encapsulated nerve ending) or it can be a specialized cell that communicates with the sensory neuron (usually it is an epithelial cell but a specialized one)

1. **Stimulation of the sensory receptor**.

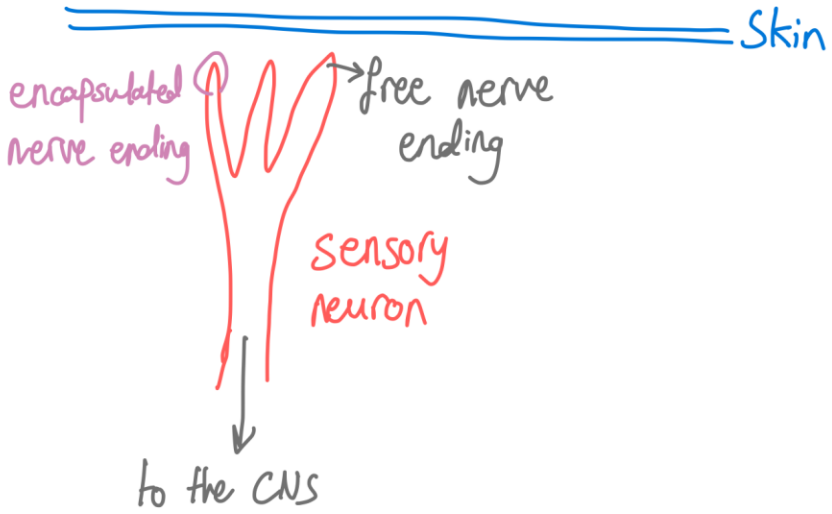
A receptor may be either (1) a specialized ending of the afferent neuron or (2) a separate receptor cell closely associated with the peripheral ending of the neuron.

Specialized



For example, photoreceptors in the retina are specialized cells so they are not part of sensory neurons, and they have specialized structures within them (photo pigments) which will respond to light (electromagnetic radiation). This response will cause certain changes in this pigment in this cell that will release certain transmitters to the communicating sensory neuron(first order neuron) and now, this sensory neuron will transmit this information to the CNS to be processed.

Part of a sensory neuron



If the sensory receptor is a part of a sensory neuron it could have 2 forms: 1-free nerve ending which has certain receptors with certain structure and function that detect mechanical changes on the skin for example, then receptors will be activated, signal delivered to the sensory neuron and finally to CNS to be processed.
Or 2-encapsulated nerve ending (Pacinian corpuscle) which also detect mechanical changes (pressure for example) all the way to CNS too.

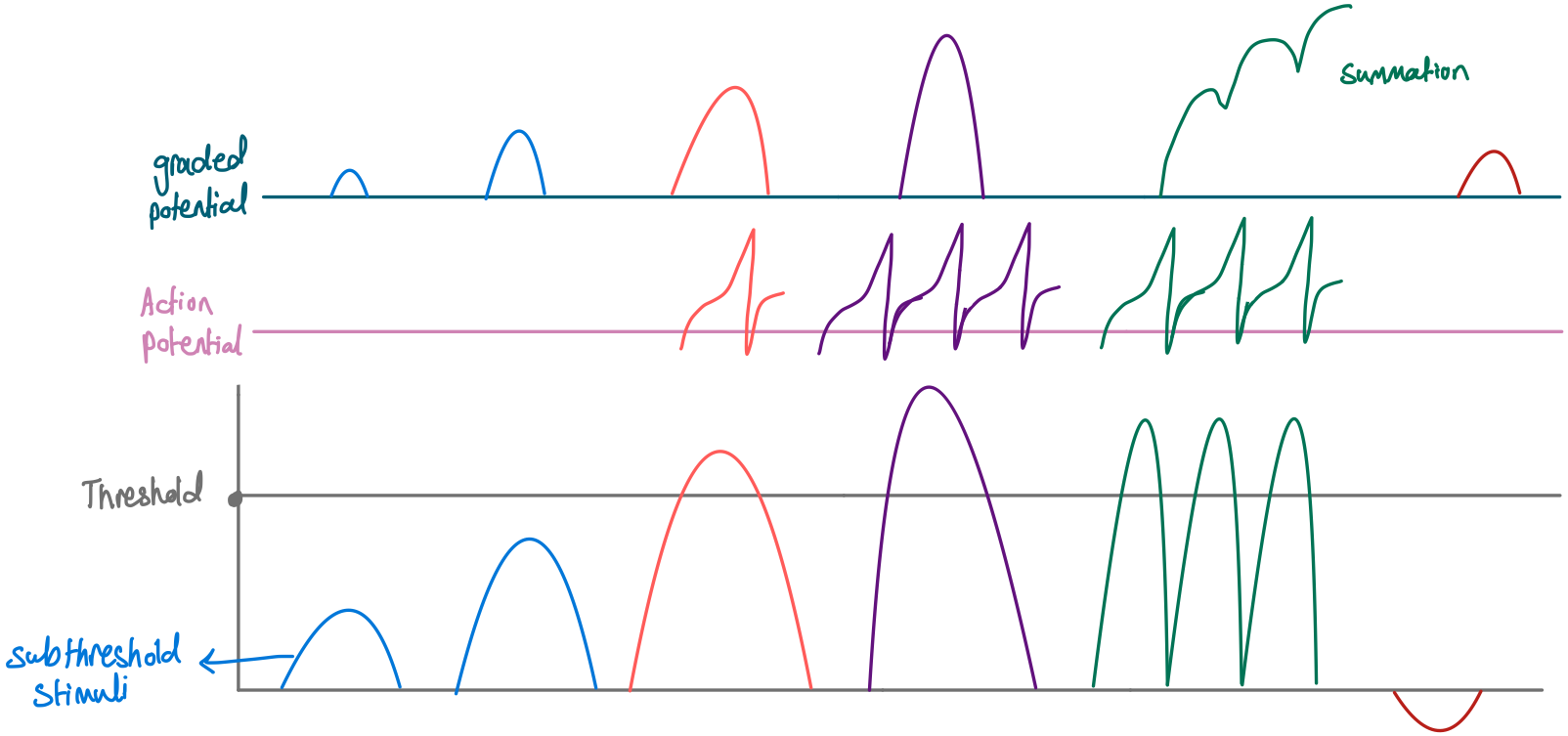
The process of sensation

- 1. **Stimulation of the sensory receptor**.

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

After stimulating the sensory receptors by different types of energy (chemical, electromagnetic changes…) it will be converted into electrical energy (which is the type of energy CNS understand) this function is called transduction.

Electricity in our body is simply the action potential or graded potential (flow of ions across membranes)



Difference between action potential and graded potential:

1-Action potential is always called action potential. However, graded potential can be named after the structure whose membrane's potential is changed, for example if we are talking about a receptor, we will call the graded potential “receptor potential”

2- Action potential is propagative once it reaches the threshold, which will make it travel for long distance. However, graded potential has short duration and travels for short distance (it dies out)

3- Action potential is all or non

4- Amplitude of action potential doesn't change by increasing the intensity of the stimulus. However, its frequency will increase. On the other hand, graded potential increases when the intensity of the stimulus increases

5-Action potential has an absolute refractory period and it can’t be stimulated during it. However, graded potential has summation activity

6-If stimulus is hyper-polarizing, action potential won’t be generated. However, graded potential will

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 (now its called action potential), which then propagate toward the CNS.

Nerve impulse=action potential

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

Characteristics of sensory receptors

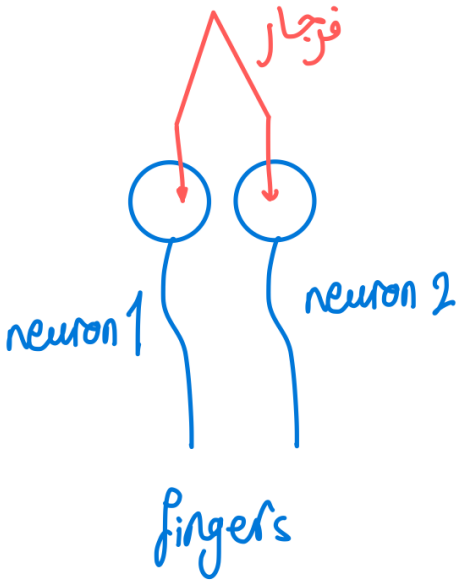
- **Differential sensitivity**

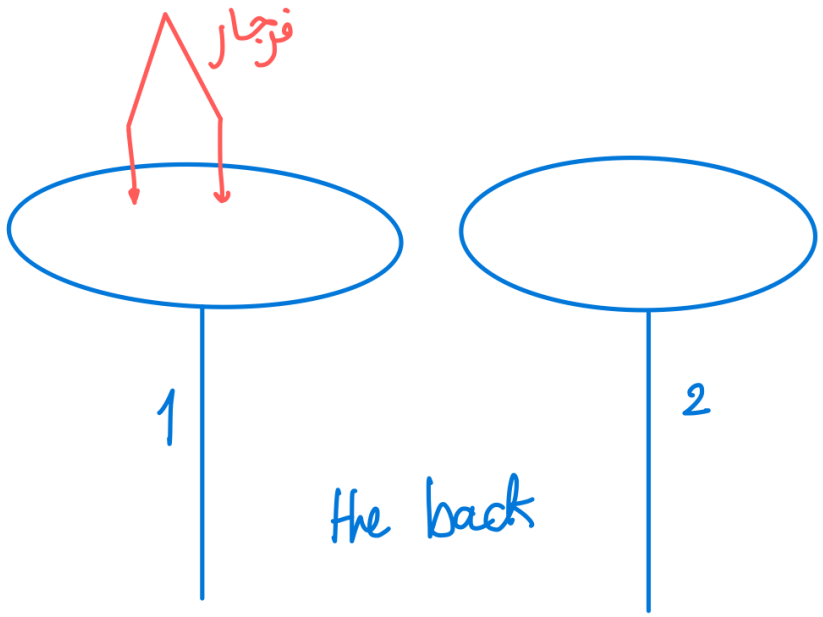
Each type of receptor is specialized to respond to one type of stimulus**.(specific)**

Photoreceptors can't be activated by sound waves for example. Structure serves function, photoreceptor's structure suits only electromagnetic radiation, Pacinian corpuscle also can't be activated by light, it can be activated by tactile sensation only.

Receptive Field

- Each sensory neuron responds to a stimulus only within a specific region surrounding it, this region is called its **receptive field**.
- The size of a receptive field varies inversely with the density of receptors in the region.
- The smaller the receptive field is in a region, the greater its acuity or discriminative ability: **2 point discrimination**

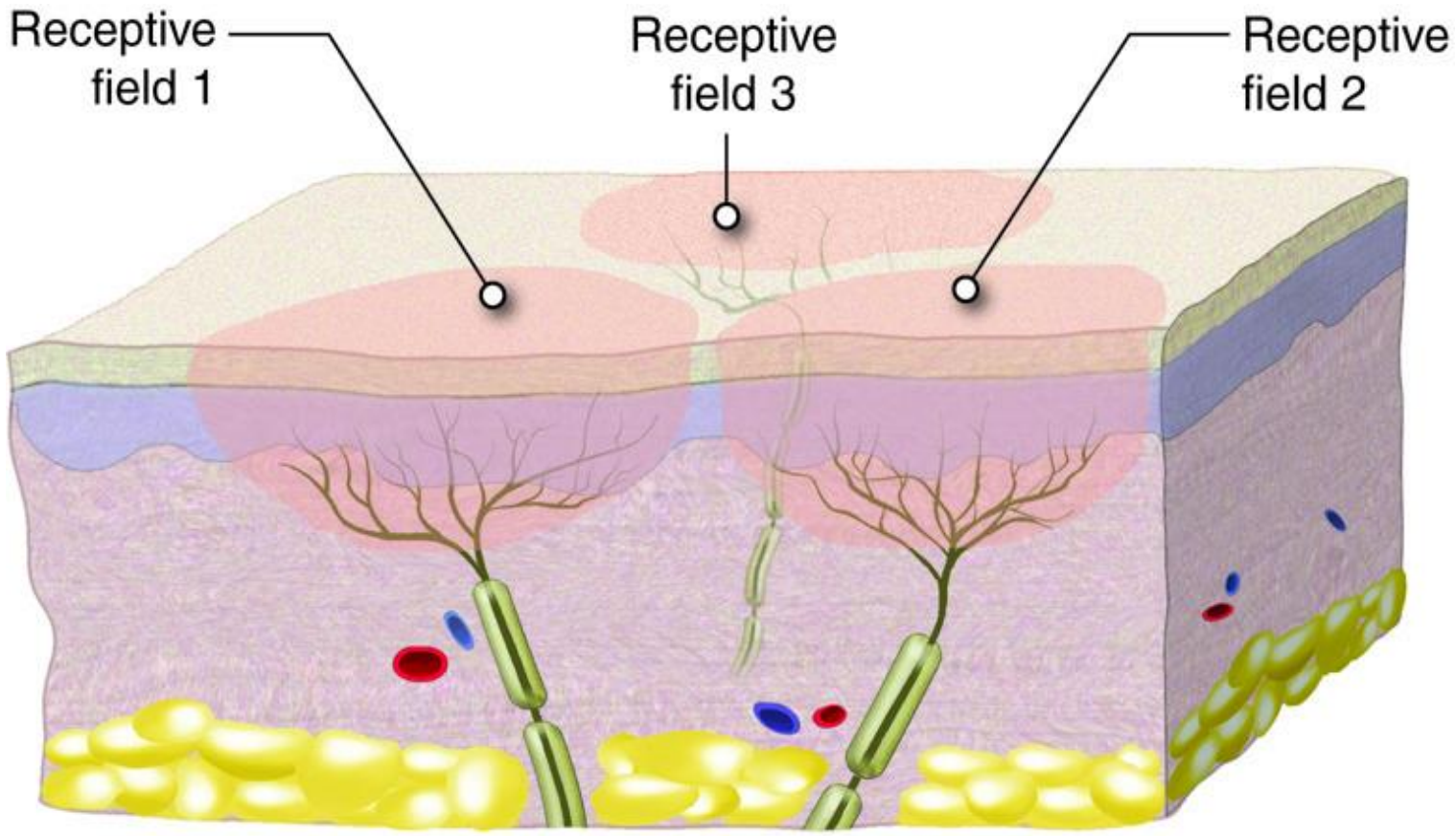




Patient will feel it as 2 points

Patient will feel it as 1 point

Discrimination ability increases with decreased receptive field area.
Receptive field area increases when the density of sensory receptors decrease.



If the stimulus was outside the receptive fields, there will be no response

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

Somatic sensory receptors distribution

- Receptors are **distributed unevenly**. (for example touch and pressure)

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

Additional sources

1. https://youtu.be/JETSP09Snq4?si=mzVH5BJ9WYiG1IuC
2. https://youtu.be/vX35WDJohFo?si=Y7ejCKkKNC3waQSh

لنُتقن لزوم ثغورنا علّ
النّصر يقترب

VERSIONS	SLIDE #	BEFORE CORRECTION	AFTER CORRECTION
V1→ V2			
V2→V3			

امسح الرمز و شاركنا بأفكارك لتحسين أدائنا !!