

# CNS

**SENSORY DIVISION**

**BY**

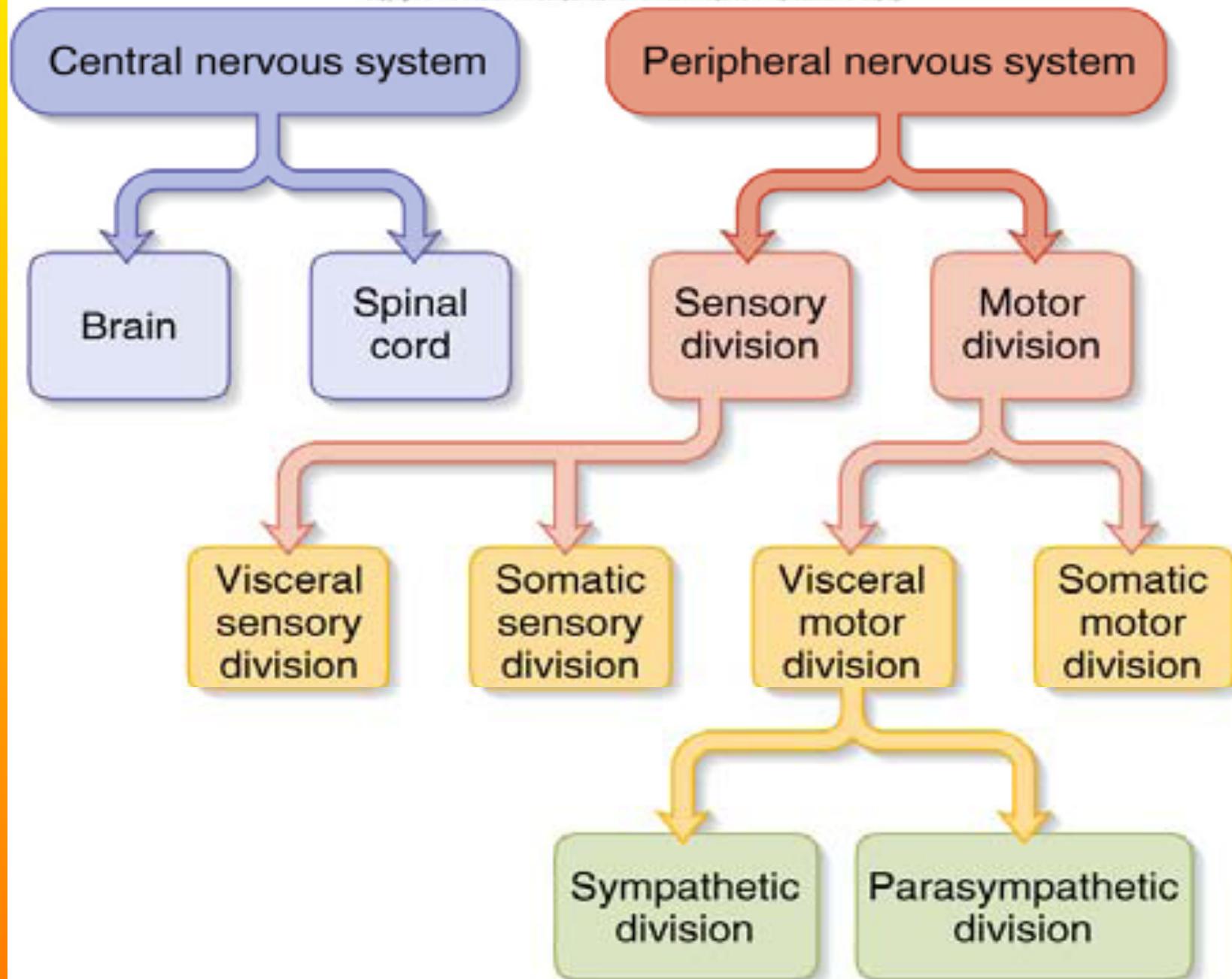
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**The functions of body systems and organs are controlled by two main regulatory systems:**

**A-Nervous regulation: which is mediated by the nervous system. This type of regulation is very rapid and of short duration.**

**B-Chemical regulation: which is mediated by hormones, enzymes and vitamins. This type of regulation is slow but persists for long period.**



# SENSORY RECEPTORS

- Receptors:
- *They* are structures which can transform the stimulus into action potential (**transducers**)
- They are situated at the termination of the afferent neurons which are found in the dorsal root ganglia along the whole spinal cord.
- They detect the stimulus. (Change in environment).

# **CLASSIFICATION OF RECEPTORS :**

## **A. ACCORDING TO THE MODE OF STIMULATION:**

### **1. Mechanoreceptors**

- stimulated by mechanical stimulation
- e.g., touch, auditory and all proprioceptors, which are found in muscles, ligaments and joints(detect: position and movements, muscle tension )

### **2. Chemoreceptors**

- stimulated by chemical stimulation
- e.g., taste, olfactory, O<sub>2</sub> lack, CO<sub>2</sub> excess receptors and osmoreceptors.

### 3. Electromagnetic

- stimulated by light
- they are found only in the retina .

### 4. Thermoreceptors

- stimulated by temperature
- they are found in the skin and in the hypothalamus.

### 5. Nociceptors

- stimulated by tissue damage
- free nerve endings, they are the receptors for **pain** sensation.

## B . ACCORDING TO THE SITE:

### 1. Exteroceptors :

- are found on the surface of the body in the skin
- (pain - touch - temperature ..)

### 2. Teleceptors :

- detect stimuli that occur away from the body as olfactory, visual and auditory receptors.
- They are called also distant receptors or *special sense* receptors.

# Interoceptors

found inside the body , deep from the skin

## a) Visceroceptors :

- found in viscera as stretch receptors in bladder and O<sub>2</sub> lack receptors in carotid body, also baroreceptors in the heart and vascular system.

## b) Hypothalamic receptors:

- glucoreceptors, thermoreceptors and osmoreceptors.

## c) Proprio-ceptors :

Found in muscle, ligaments, joints...

# PROPERTIES OF THE RECEPTORS :

- EXCITABILITY
- SPECIFICITY
- EFFECT OF INTENSITY OF STIMULUS
- ADAPTATION

# PHYSIOLOGICAL PROPERTIES OF THE RECEPTORS : **EXCITABILITY**

- Receptors are living structures
- They can respond to stimuli by changing the stimulus (one form of energy) into  
**"receptor or generator potential"**
- then this receptor potential is carried by the connected nerve as "action potential" to reach the C.N.S informing it about the nature of this stimulus.

# MECHANISM OF RECEPTOR OR GENERATOR POTENTIAL:

- *With the exception* of the free nerve endings all the sensory receptors are associated with non neural cells that surround it, forming "**a sense organ**".
- *In this sense organ* the final termination of the sensory nerve that is connected to the receptors losses its myelin sheath and enter the capsule of the receptors with first node of Ranvier.

# PACINIAN CORPUSCLES ARE TOUCH RECEPTORS,

- **In resting condition**, the receptor is in the polarized state i.e there is more positivity outside "about - 70 mV than inside.
- When the receptor is stimulated by an **adequate stimulus** there will be a **local depolarization** at the stimulated part due to an increase in the sodium permeability. This is called the **"generator potential"**.

- When the stimulation is continuous, this local depolarization increases in magnitude until a certain threshold level (10 millivolt).
- It will cause depolarization in the first node of Ranvier inside the receptor structure then this depolarization when sufficient it will be transmitted along the sensory nerve **Action potential**
- continuous stimulation of the receptor will be transformed into a train of impulses along the **sensory nerve**.

# PROPERTIES OF RECEPTOR POTENTIAL

- It is local non propagated.
- Its duration is more than 5 milliseconds (longer than the action potential).
- It has no absolute refractory period.
- It does not obey the all or none law.
- It can be summated.

## II. SPECIFICITY OR MODALITY

### Muller's law

- states that "each receptor is very sensitive to one specific type of stimuli called the "adequate stimulus" which can stimulate the receptor with least amount of energy".
- Also, the sensory nerve connected to the receptor can transmit only one type of sensation.

- optic nerve transmits **only light** sensation and the adequate stimulus for the photoreceptors is the electromagnetic waves.
- Photoreceptors can be stimulated also by inadequate stimulus e.g., **by pressure** but in this case the optic nerve still gives light sensations appears as flashes of light.
- The receptors need much larger amount of energy when they are stimulated by an inadequate stimulus.

# III. EFFECT OF INTENSITY OF STIMULUS ON RECEPTORS

## Weber-Fechner law

- states that "The frequency of the action potentials conducted along the afferent nerve fiber is **directly proportional to logarithm of the intensity** of the stimulus applied to the receptor".
- This means that an increase in the intensity of the stimulus leads to an increase in the amplitude of generator potential, that increase the frequency of the action potential conducted along the afferent fiber connected to the receptor.

# Compression function of receptors

- ↑ Intensity of stimulus (**100 folds**) ⇒  
↑ Number of AP (**2 folds**).
- ↑ Intensity of stimulus (**1000 folds**) ⇒  
↑ Number of AP (**3 folds**).
- This enables CNS to detect wide range of intensities with less energy.

## IV. ADAPTATION

- **Adaptation means** the decrease in the intensity of the sensation due to **continuous constant** stimulation.
- **Adaptation is due to:**
  - 1) decrease generation of receptor potential in receptor.
  - 2) decrease generation of action potential in first node of Ranvier.

# Mechanism of adaptation

## *1) Readjustment of receptor structure:*

- As in the **Pacinian** corpuscles (receptors of touch).
- During rest, equal pressure on both sides  $\Rightarrow$  no receptor potential (RP).
- When a force is suddenly applied  $\Rightarrow$  unequal pressure on both sides  $\Rightarrow$  RP.
- Then, by continuous constant stimulation  $\Rightarrow$  readjustment of the receptor structure due to **redistribution of fluid** within the corpuscle  $\Rightarrow$  equal pressure on both sides  $\Rightarrow$  no RP.

## ***2) Chemical changes: •***

- As in the **photoreceptor** of the eye (rods & cones).
- Continuous constant stimulation  $\Rightarrow$   $\Downarrow$   
concentration of photo-pigments.

## ***3) Electrical changes:***

- By **accommodation** that occurs in the **nerve fiber** itself due to:
  - a) Inactivation of the Na<sup>+</sup> channels.
  - b)  $\Uparrow$  Activity of Na<sup>+</sup> K<sup>+</sup> pump.

# Differences between adaptation & fatigue

	Adaptation	Fatigue
Cause	<u>C</u> ontinuous <u>C</u> onstant stimulation.	<u>R</u> apid <u>R</u> epeated stimulation.
Site	Receptors.	<u>S</u> ynapses & <u>S</u> keletal Ms.
Mechanism	See above.	↓ Transmitter or ↑ Metabolites.
Effect of O <sub>2</sub> lack & Previous activity	No effect.	Make fatigue more rapid.

# ACCORDING TO THE RATE OF ADAPTATION THE RECEPTORS ARE CLASSIFIED INTO

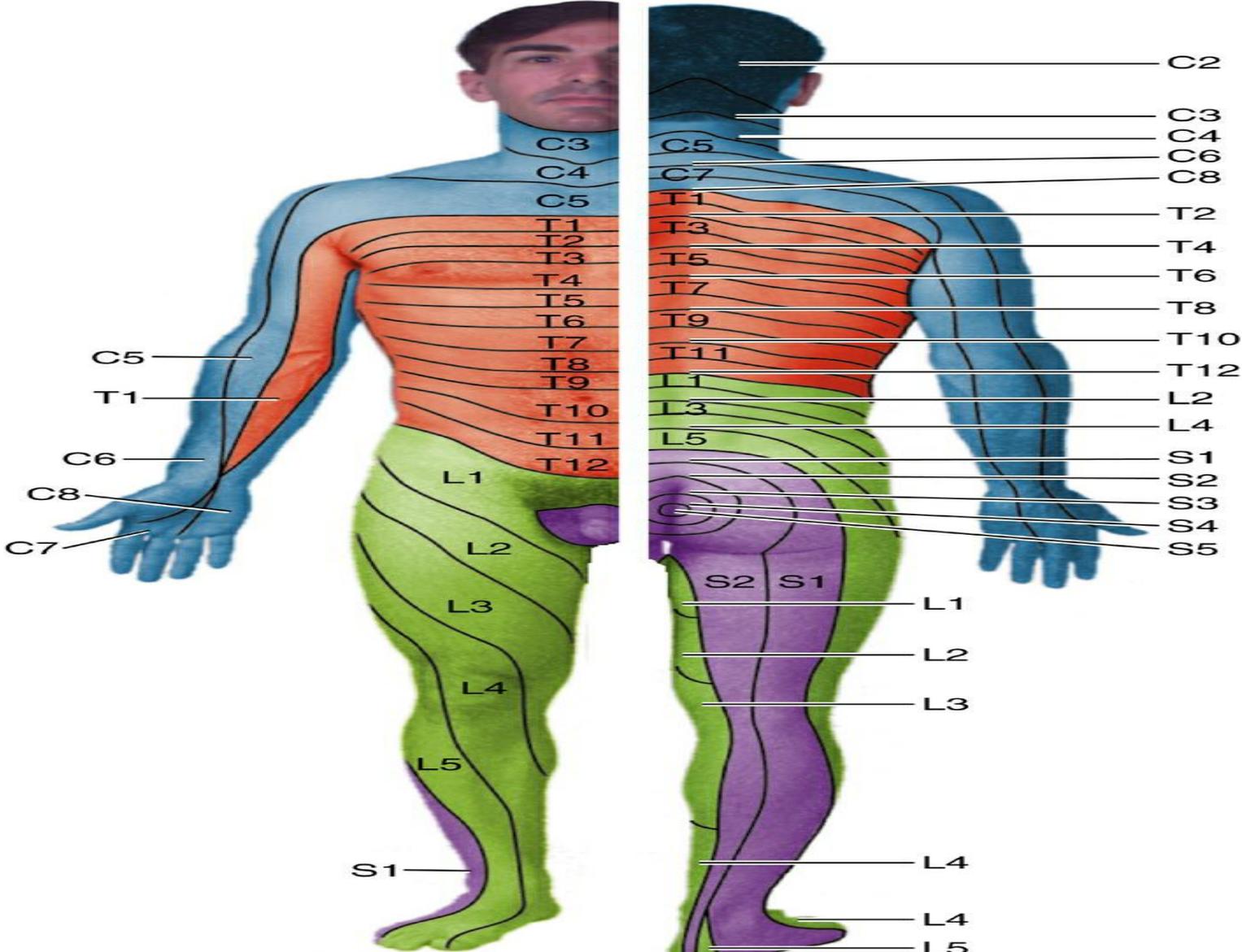
- **1. rapidly adapting receptors** : e.g. touch & pressure receptors.
- **2. moderately adapting receptors** e.g., temperature, smell and taste receptors,
- **3. slowly adapting receptors** ; vision, hearing, pain receptors.

# SENSORY CODING

- Converting receptor stimulus to recognizable sensation.
- This depends on:
  - Modality
  - Locality
  - Intensity

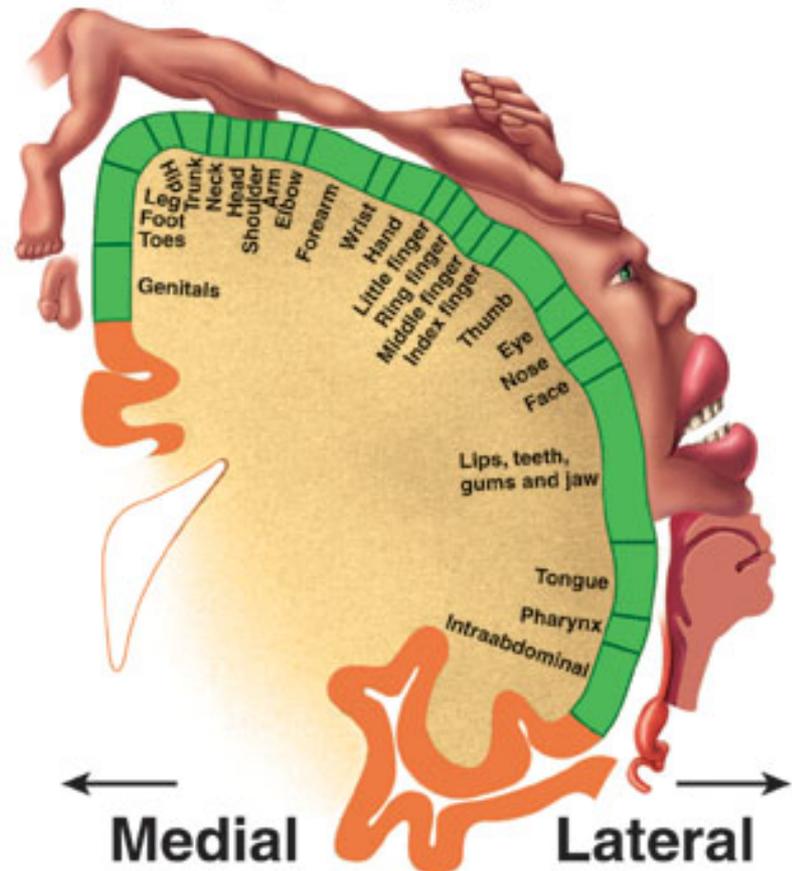
- **a- C.N.S can know type** of stimulus according to **Muller's law**, a cold object when is put on the leg it will stimulate only cold receptors
- **b- C.N.S can determine the site** of the stimulus because every part in the body is represented in a certain points in the sensory cortex, thus a stimulus on the leg will reach the leg area, according to the dermatomal distribution.**(Law of projection)**.
- **c- C.N.S can know intensity** of the stimulus by "**Weber Fechner's law**"

# Dermatomes

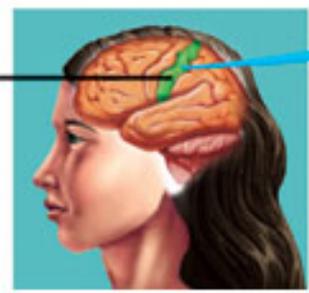


**Anterior view**

**Posterior view**



**Primary somatic sensory cortex (postcentral gyrus)**





**THank you**