Somatic Pain
&
Thermal Sensation

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SENSATIONS

- **They are divided according to the site of origin into:**

1. Somatic sensations (comes from soma or body)

2. Visceral sensations (from viscera). As visceral pain and fullness of the bladder.

3. Special sensations (vision, hearing, smell, taste)

4. Hypothalamic or organic sensations (thirst-hunger-fear).

SOMATIC SENSATIONS

- further subdivided according to **site of receptors** into *:*

1. Cutaneous sensations (e.g. pain-touch-temperature)
2. Deep sensations : as sense of *position, movements, muscle tension, deep pressure, relation of the body parts to each other and relation of the body to the space.*
3. Mixed sensations (receptors in skin and deep structures):

A) STEREOGNOSIS

B) VIBRATION SENSE

PAIN SENSATION

characters:

- **unpleasant sensation** resulting from tissue damage and resulting in protective mechanisms as withdrawal reflex.
- **Pain is a specific type** of sensation and is not due to over stimulation of other sensations.
- **The threshold of excitation** of pain receptors is much higher than other sensations.
- **Pain is a "pre-potent stimulus"** during pain; any other sensations are inhibited as hunger sensation .

TYPES OF PAIN :

- According to the **site, pain** is classified to:

➢ Cutaneous pain

➢ Deep pain

➢ Visceral pain

pain receptors :

They are specific naked ***free nerve endings*** ***(slowly or even not adapt at all)*** called **nociceptors** **&** subdivided into **3 types** according to the **mode of stimulation**.

1. **Mechanosensitive** *pain receptors* stimulated by excessive mechanical stress as crushing or sever trauma.

2. **Thermosensitive** *pain receptors* stimulated by extremes of either cold or hot i.e., above 45c° or below 10 c°.

3. **Chemosensitive** *pain receptors* which respond to chemical injurious stimuli.

The first two types are connected to (**A delta**) myelinated fibers. (**5-15 meters/sec**) while the third type is attached to **C-fibers-non myelinated** a slowly conducting fibers (**0.2 - 2 meters/sec**.).

Mechanism of stimulation of pain receptors

- **Painful stimuli** ⇨ tissue damage ⇨ liberation of pain mediators ⇨ stimulation of nociceptors.

- **Pain mediators** like substance **P** & **P**rostaglandins & **P**otassium & **B**radykinin.

1- Cutaneous pain

- It arises from the skin.
- Usually described as pricking , stitching or burning pain.
- There are **2 types** of cutaneous pain: **fast & slow** pain
- **Cutaneous pain** is accompanied by ***sympathetic reactions*** as increase in heart rate and blood pressure, sweating and dilatation of the pupil. Also, ***protective withdrawal reflexes*** occur in this type of pain.

fast pain

- Bricking.
- Immediate and persist for short time.
- well localized.
- Conducted by fast myelinated group "**A delta** " fibers(neo- lat. spinothalamic tract)
- Moderate compression on nerve, blocks "**A**" fibers
- Relay in thalamus then to somatic sensory cortex

slow pain

- Burning .
- Delayed and persists for long time.
- Poorly localized.
- Conducted by "C" un-myelinated fibers(paleo- lat. spinothalamic tract)
- local anesthesia block "C" fibers
- Relay mainly in reticular-formation then to all areas of cerebral cortex.

2- Deep pain

- It arises from **deep structures** (muscle, ligaments, joints, capsules).
- It is described as dull aching pain and is not well localized.
- Transmitted by **"C" fibers**.
- Deep pain is accompanied by reflex muscle spasm, bradycardia ,drop of the blood pressure, miosis ,nausea and even vomiting.

- **Important type** of deep pain is (**intermittent claudication**) occurs in skeletal muscles due to ischemia or atherosclerosis.

Reactions to pain

➢ Somatic reflexes :

- protective withdrawal reflex
- Reflex spasm of skeletal muscle over diseased viscera.
- The mechanism is that the nerve fibers which carry pain sensations on entering the spinal cord will give collaterals to the anterior horn cells which innervate the surrounding muscles.

➢ Emotional reactions :

- As impulses carrying pain sensations to sensory cortex send collaterals to the hypothalamus which is one of the higher centers of emotions.
- This causes emotional reactions like **crying**, **anger** or **depression**. Very severe pain on the other hand may cause even complete loss of consciousness or fainting attacks.

➢ Autonomic reactions :

- By impulses that reaches the reticular formation from ascending pain fibers.
- Autonomic reactions include changes in heart rate, respiratory rate, dilation of pupil, sweating and even inhibition of gastrointestinal activity. **Mild pain** as a rule causes **sympathetic stimulation** ; while **very severe or visceral pain** stimulates **parasympathetic activity**

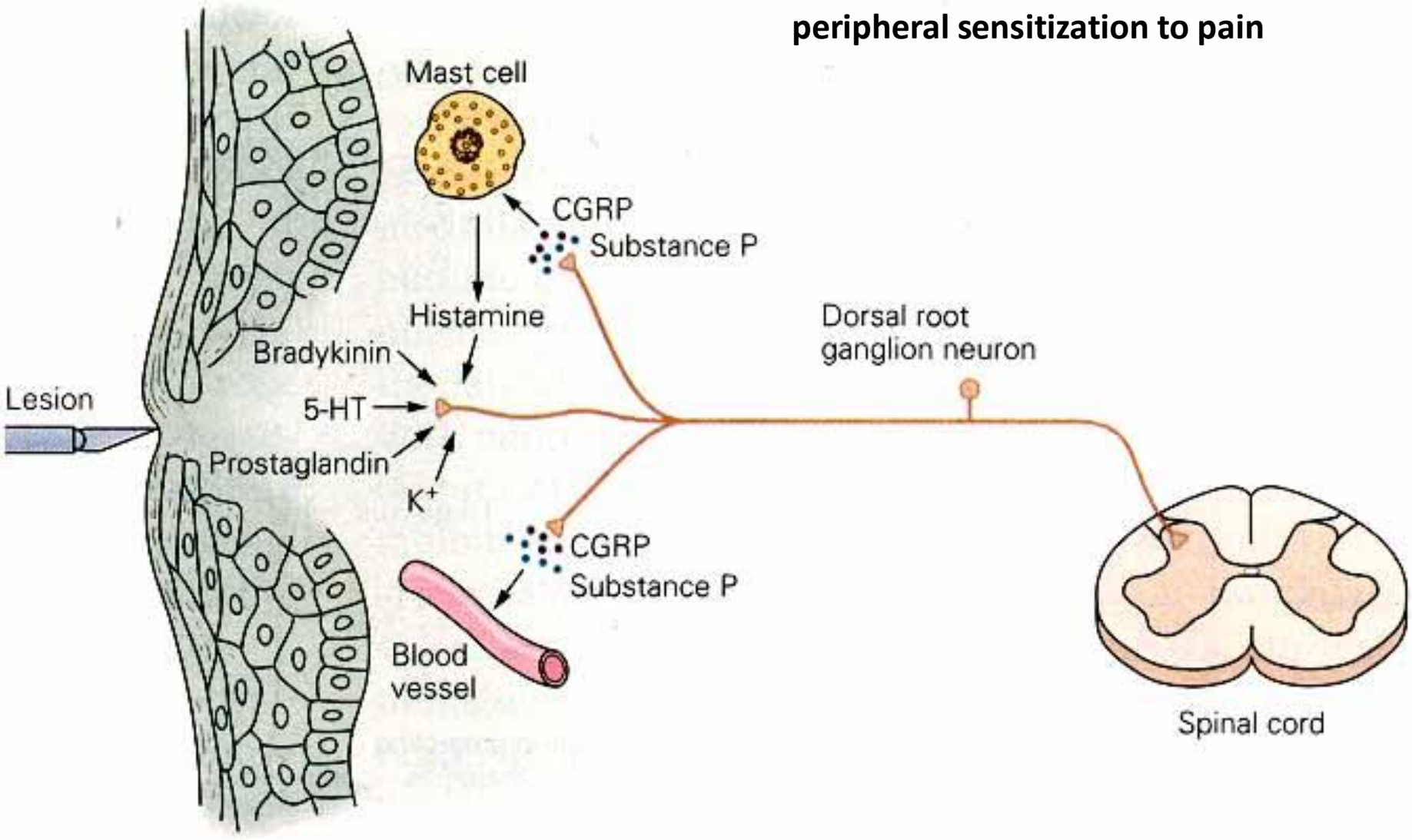
➢ Hyperalgesia: (Hyper = increase & Algesia = pain)

- it is state of pathological skin condition.

✓ Primary hyperalgesia: (At site of the lesion itself)

- It becomes **edematous**, **red**, **hot** and very painful
- The mechanism is by **local axon reflex**
- Destroyed tissues release mediators that **lower threshold of pain receptor** (**Non painful stimulus →painful)**and cause local vasodilatation Also, anti-dromic impulses that cause arteriolar dilation⟶ **edema** which causes continuous pressure on the hypersensitive nerve endings causing maintained pain.
- Mechanism is ***Facilitation of receptors***

Mechanisms associated with peripheral sensitization to pain



✓ Secondary hyperalgesia

- In the surrounding area of the lesion.
- It appears normal but painful stimulus to it induces severe pain.

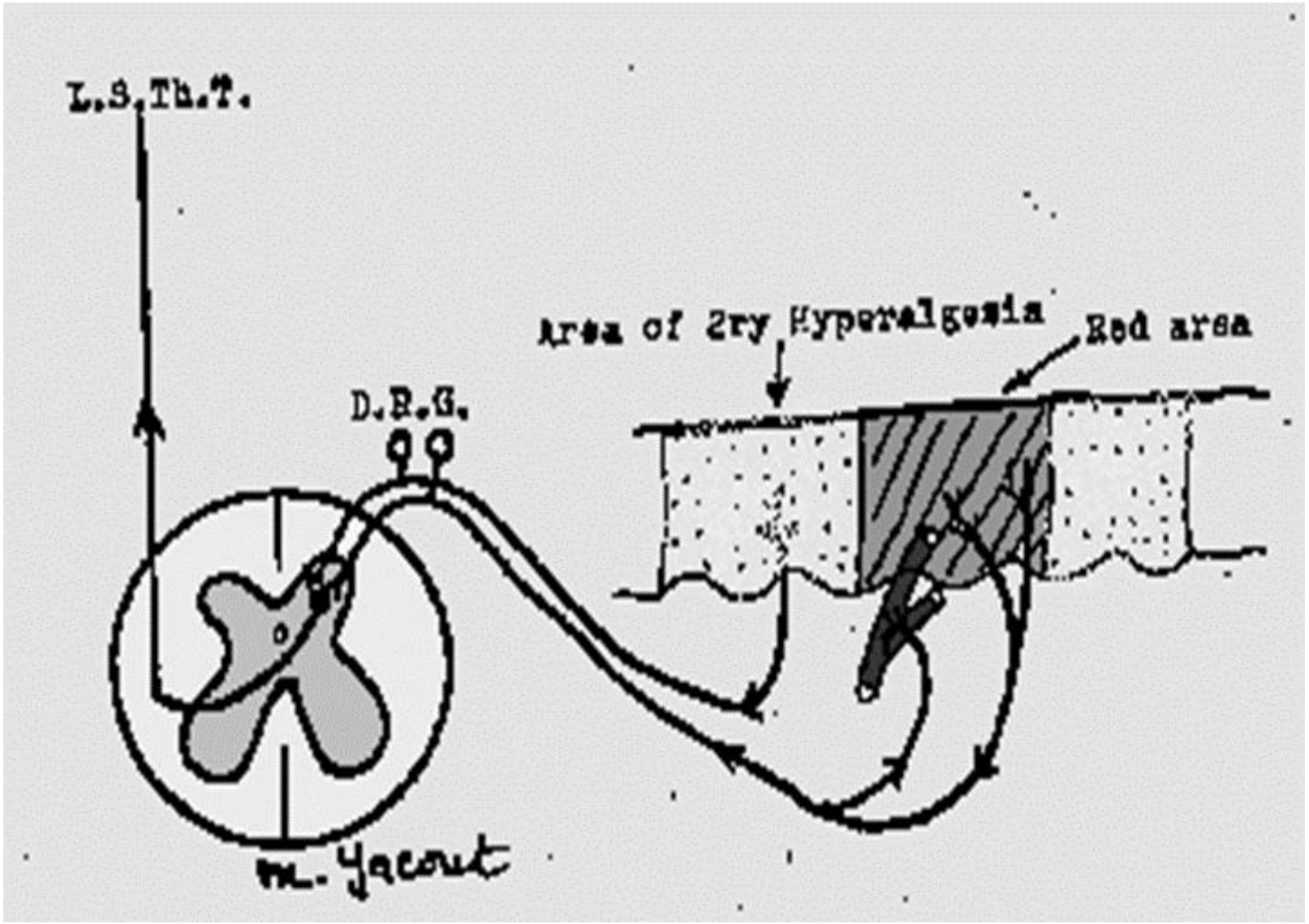
(Increase Reactions to pain)

- It is explained by **convergence- facilitation theory**

As pain from primary area is carried by sensory nerve that **converge** on a certain neuron in the spinal cord.

This neuron becomes **"facilitated"** have a lot of chemical transmitter, now if painful sensation reach this neuron from the surrounding **secondary area**, it will transmit it to **sensory cortex** as if it is **very painful sensation.**

Mechanism is **Facilitation of neuron.**



Secondary hyperalgesia

Temperature Sensation

- **"Cold" sensation** between 10° and 30c°.
- **"warm" sensation** between 30° and 45c°.
- **Below 10° and above 45°** tissue damage begins to occur, and this is described as **pain** sensation.
- **At 0 °C** No action potential is recorded from nerves.
- **Thermo receptors adapt** between 20c° and 40c°

Types of thermo-receptors:

A. **Superficial** receptors in skin ,they are **divided into:**

1) **Warm spots**: transmitted by "**C** " fibers.*(Free nerve ending receptor)*

2) **Cold spots:** transmitted by **" A delta** " fibers. *(Krause's end bulb receptors !)*

B. **Deep** receptors in hypothalamus: detect body temperature from blood.

- **Mode of stimulation of thermo-receptors.**

Chemically by change in their metabolic activity.

- Stimulation of receptors depends on **rate of heat conduction** from stimulant.

So, a piece of metal at 12 °C appears colder than apiece of wool at 12 °C.

- **Four groups of fibers carry temperature:**

***Cold fibers*, *warm fibers*, *pain cold fibers* and *pain hot fibers*.**

- **Paradoxical cold sensation:**

On taking hot shower at 45 °C, we 1st feel cold (shivering) followed by warm sensation. Because **cold receptors** are:

a) 10 Times **M**ore numerous & **M**ore superficial than warm receptors.

b) **M**omentary Brisk discharge at 45°C.

- **Temperature pathway**: Through **Lateral spinothalamic tract**

Pathway of Sensations

The ascending tracts can be classified into **three major systems**:

1) **The anterolateral spinothalamic system**. (Ventral & Lateral).

a) Lateral spinothalamic tract: carries **pain & temperature.**

b) Ventral spinothalamic tract: carries **crude touch .**

2) **The posterior (dorsal) column system**.

3) **Tracts which carry unconscious proprioceptive sensations**.

Characters of somatic sensory pathways:

1) All of them are formed of **3 order neurons** .

2) **The 1st order neuron**: the **dorsal root ganglion cells** (DRG).

3) **The 2nd order neuron**: the **crossing** neuron either:

a) At spinal cord: spinothalamic tracts.

b) At brain stem: Gracile & Cuneate tracts.

- *So, Most of the conscious sensations from the left side of the body reach the right sensory cortex and vice versa*

4) The 3rd order neuron: **PLVNT.**

- *With the exception of smell and unconscious proprioceptive sensations*

5) The pathway of sensory the tracts in brain stem are called "**lemnisci**".

Neo lateral Spinothalamic

- **Carry Fast pain& Cold temperature.**
- **1st Order Neuron**

Dorsal root ganglion cells (DRG) with peripheral branches carry sensation from receptors and central branches enter spinal cord via dorsal root → **Lissauer's tract** ascend or descend a few segments → dorsal horn

(A delta myelinated)

Paleo lateral Spinothalamic

- **Carry Slow pain& Warm temperature.**
- **1st Order Neuron**

Dorsal root ganglion cells (DRG) with peripheral branches carry sensation from receptors and central branches enter spinal cord via dorsal root →**Lissauer's tract** ascend or descend a few segments → dorsal horn

(C unmyelinated)

Neo lateral Spinothalamic

- **2nd Order Neuron**
- In Laminae **I & V** of dorsal horn of spinal cord.

(**lamina marginalis**)

- Then its axons **cross** to the opposite side in front of central canal.
- Ascend in spinal cord as the

Neo-lateral spinothalamic tract. Then, in brain stem it forms the **spinal leminiscus.**

Paleo lateral Spinothalamic

- **2nd Order Neuron**
- In Laminae **II & III** of dorsal horn of spinal cord.

Substantia Gelatinosa of Rolandi (SGR)

- Then its axons **cross** to the opposite side in front of central canal.
- Ascend in spinal cord as the

Paleo-lateral spinothalamic tract Then, in brain stem it forms

the **spinal leminiscus**.

Neo lateral Spinothalamic

- **3rd Order Neuron**
- **P**ostero- lateral ventral nucleus of thalamus (**PVLNT**)⇨
- **P**osterior half of **P**osterior limb of **internal capsule** sensory radiation **to area (3,1,2)**
- Somatic **sensory area** in **P**ostcentral gyrus.

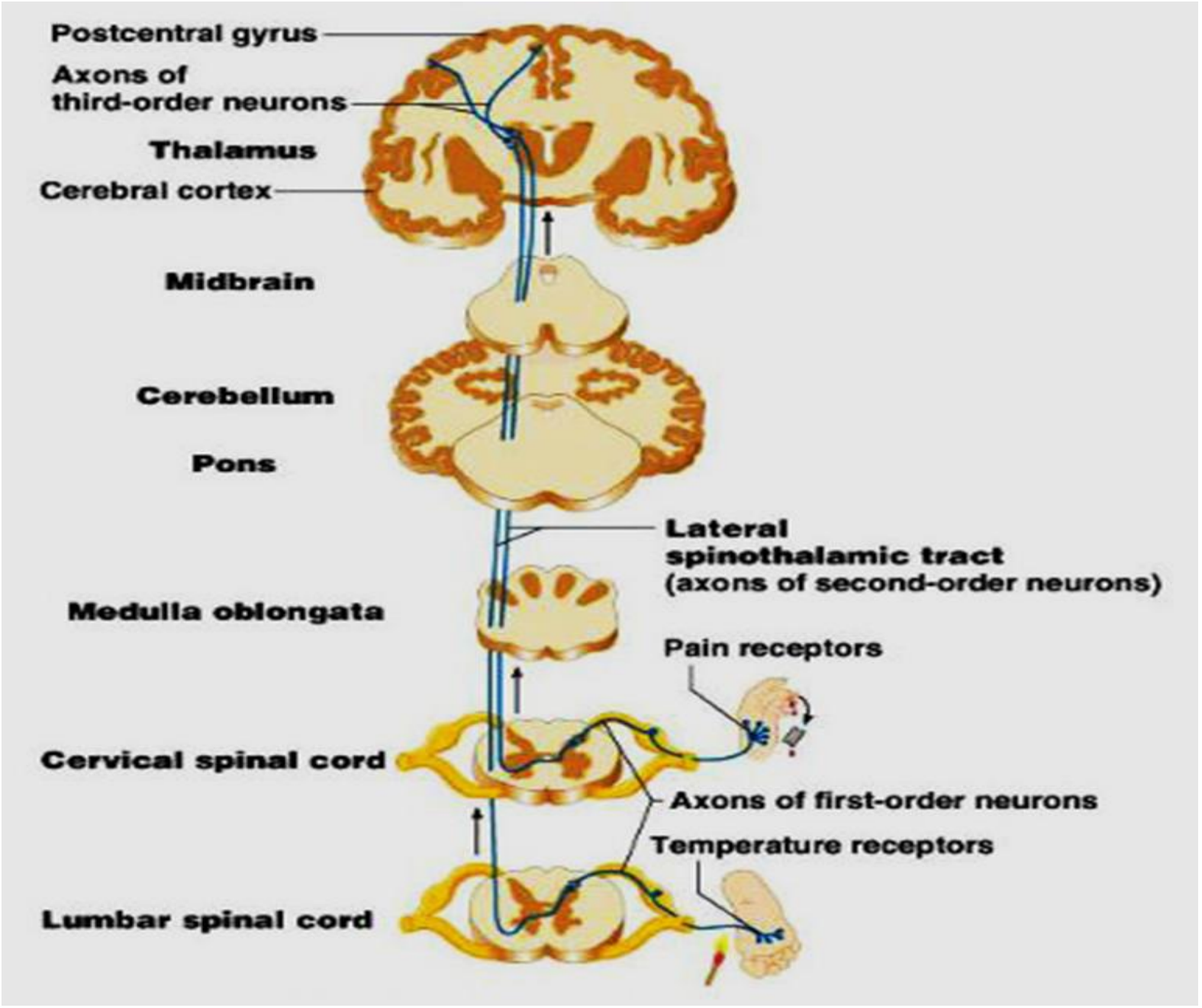
Paleo lateral Spinothalamic

- **3rd Order Neuron**
- **10%** of fiber reach **thalamus** (**intra-laminar and midline) nuclei**, then cerebral cortex.
- **90%** of fibers terminate in **3** sites:

1) **Reticular formation** ⇨ autonomic reactions.

2) **Tectal** area in mid brain

3) **PAG** in mid brain ⇨ pain control.


Postcentral gyrus
Axons of third-order neurons
Thalamus
Cerebral cortex
Midbrain
Cerebellum
Pons
Lateral spinothalamic tract (axons of second-order neurons)
Medulla oblongata
Pain receptors
Cervical spinal cord
Axons of first-order neurons
Temperature receptors
Lumbar spinal cord

Thank You