Somatic Pain
&
Thermal Sensation

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*Sensation receptors have 2 functions: detecting stimulus, converting the stimulus to AP (تتحول الطاقة / stimulus إلى اللغة اللي بتفهمها AP ← CNS الـ)

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) → found in the superficial layers of the skin
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 → the ability to sense by a closed eye person (recognition) مجسم 3D dimension — depends on touch and Pressure of 3D objects not on vision

B) VIBRATION SENSE

Vibration of Phone

* الدكتورة ذكرت مثال عن مكعب الثلج لو انحط بإيد الشخص وهو مغمض رح يحكي إنه في شيء بارد بإيده حسب الـ Sensation لكن لو الواحد فتح عيونه رح يكون فارق إنه في ثلجة بإيده حتى لو لسا أجاه الـ Sensation لذلك بنغيب الـ vision حتى نختبر الـ Sensation

* To examine sensation, the person should have his eyes closed ليش؟ حتى ما يحكي الحاجة اللي حاسسه حسب الـ vision حتى الـ Sensation

رح يعملنا بالباطنة

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 :

according to character:- according to adaptation:-

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**.

Tissue damage can happen by 3 different ways:-

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°. → this will activate the thermosensitive/Pain receptors not the cold receptors (not cold/hot stimulus)

hot Pain — cold Pain

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

Pouring of acid on skin in the lab

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**.).

Chemosensitive

Mechanism of stimulation of pain receptors

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

Pain receptors نفسها

- **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.

* in the 1st year we took a lecture about sensory coding (how the brain knows the place of sensation, the intensity of stimulus and type of stimulus. if you hold an ice cube in your right hand, cold receptors in the right hand will be activated how? the stimulation will go to a specific area (Chanel area) in the sensory somatic cortex

fast pain

- Bricking. ألم نخز الدبوس
- Immediate and persist for short time.
- well localized. → this means it reaches specific areas in the somatic sensory cortex

- Conducted by fast myelinated group "**A delta** " fibers(neo- lat. spinothalamic tract) → Thalamus → Somatic sensory cortex

- Moderate compression on nerve, blocks "**A**" fibers
  - Relay in thalamus then to somatic sensory cortex

slow pain

هو نوع الألم اللي رح يزايق الشخص لأنه بطول (persists for long time) + اللي بخلينا ما نقدر ننام من الوجع

- Burning pain in the area that was injured
- Delayed (after fast pain) and persists for long time.
- Poorly localized. → doesn't reach the specific area in the somatic sensory cortex الواحد ما بقدر يحدد مكان الألم بالزبط
- Conducted by "C" un-myelinated fibers(paleo- lat. spinothalamic tract) (type of fibers in the tract)
- local anesthesia block "C" fibers
- Relay mainly in (Subcortical) reticular-formation then to all areas of cerebral cortex.(diffused fibers) → the person stays alert and can't sleep

* reticular formation → responsible of alert system
the impulses that come from these fibers are sent to the cortex to stay alert and awake
once these impulses stop → no alert so the person sleeps
we can give sedatives so the person can sleep

2- Deep pain → Para sympathetic

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

example :- if there is pain from the knee joint the muscle that covers the knee joint will have somatic reflex muscle spasm

- **Important type** of deep pain is (**intermittent claudication**) occurs in skeletal muscles due to ischemia or atherosclerosis. this happens to a person who has a problem in his blood flow

الألم ج يخليو تمشي ج

* intermediate claudication → after exercising a lot or playing football after a long break there will be a squeezing pain in your legs deep pain

why does this type of pain happen? due to bad blood flow and accumulation of metabolites so it will cause a pain similar to atherosclerosis

Reactions to pain

➢ Somatic reflexes :

- protective withdrawal reflex
- Reflex spasm of skeletal muscle over diseased viscera. in acute appendicitis, the abdominal muscles over the inflamed viscera will be rigid and there will be reflex spasms even though it's a skeletal muscle (collaterals will be given to ANS at the same level of the same segment where there's pain
- 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. in the site of pain stimulation

➢ Emotional reactions : We all share the same threshold for pain receptor (the same in females and males), the difference is the reaction * القدرة على تحمل نفس الوجع يختلف من شخص لشخص

- 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 (higher center for autonomic) 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**) depending on collateral fibers (Pain pathway ascending fibers) sends collaterals to reticular formations which will activate the symp or parasym depending on the type of pain (mild / severe)

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

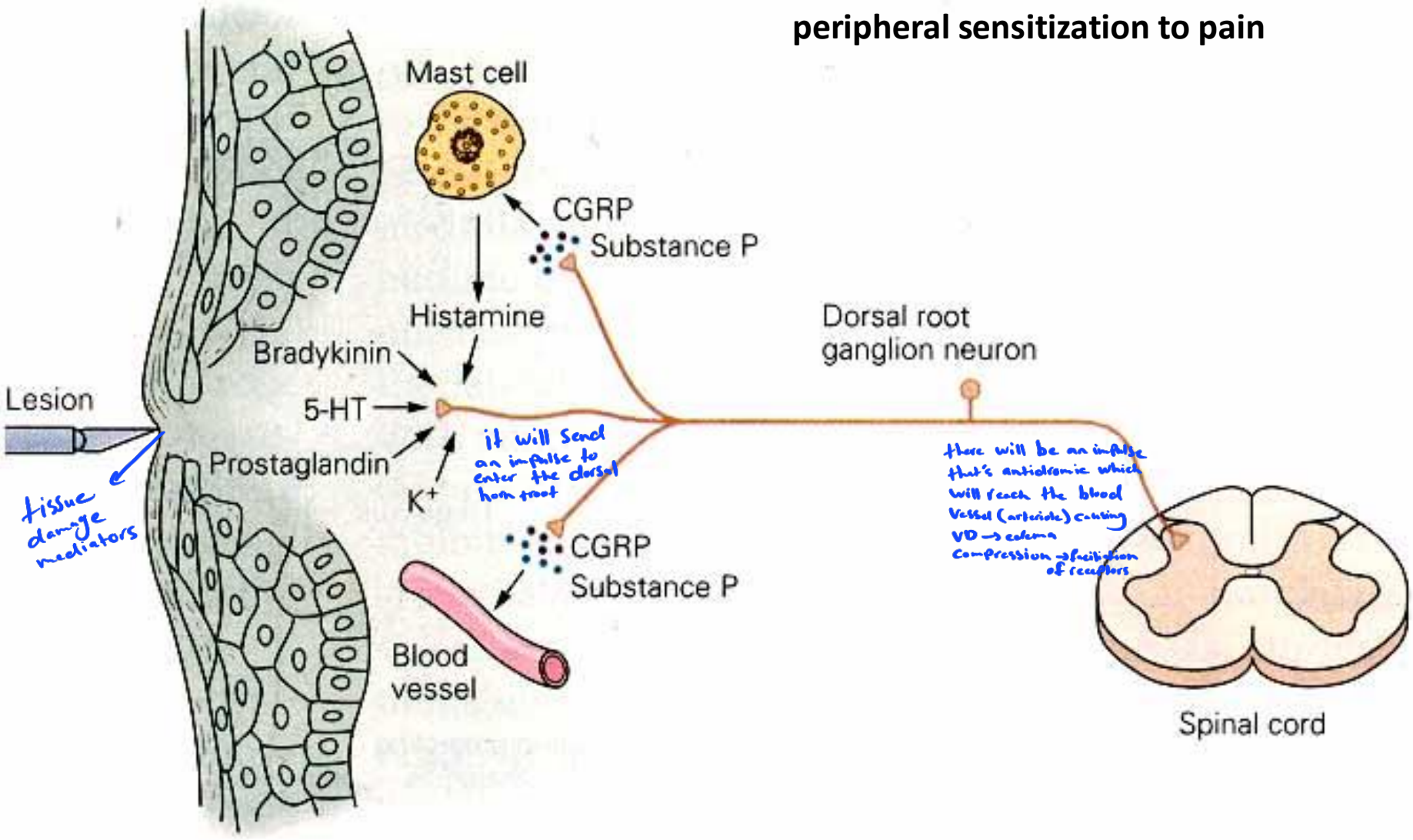
- it is state of pathological skin condition.

✓ 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***

* the non Painful Stimuli reaches the cortex Painful
* touching the area of lesion (touching is a non Painful stimulus ↓ So normally no tissue damage) the person who has hyperalgesia will find it to be a very Painful Stimulus because the threshold of Pain is low + compression of nerve endings (Pain receptors)

Mechanisms associated with peripheral sensitization to pain



✓ Secondary hyperalgesia

1ry hyperalgesia :. non-touch Painful stimulus is painful at site of lesion

2ry " :. Painful stimulus causes severe pain in the surrounding area

- 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**

Both dorsal root of the same cell → 1ry area secretes a lot of chemical neurotransmitters

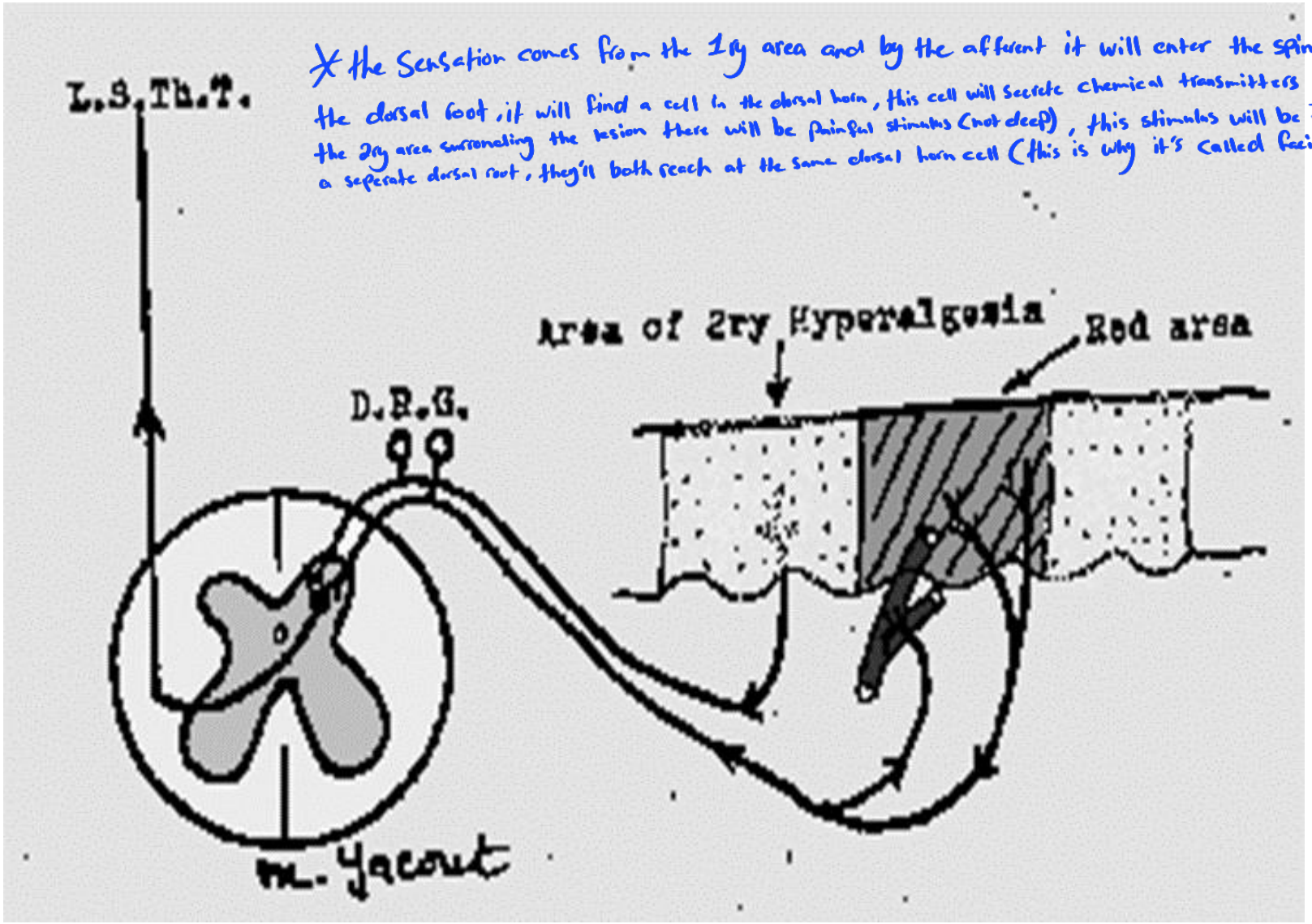
As pain from primary area is carried by sensory nerve that **converge** on a certain neuron in the spinal cord.

This neuron becomes **"facilitated"** from the 1ry area 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.**

1ry → facilitation of receptors

2ry → facilitation of neurons



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**:

* why is it called antero lateral ? grey matter are cells (cell body), axons are found in white matter, these tracts are white matter they will be found anteriorly and laterally (ant-lat ascending tract / ant-lat compartment)

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

from the spinal cord → main relay from thalamus → cortex

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

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

2) **The posterior (dorsal) column system**. fastest tract in our body

it will carry impulses for deep sensations, deep pressure, muscle tension, vibrations, mixed sensations, sense of position and movement, stereognosis
*this system has 2 tracts (gracile and cuneate) gracile → lower limbs, cuneate → upper limbs } they carry fine touch

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

the dorsal system needs second to second information for the brain (to maintain the equilibrium)
it's fibers are formed mainly by A-α, A-β which are the fastest conducting/ascending fibers

has a small single tract called spinocerebral tract

* Classification of neurons based on the shape → unipolar → dorsal root ganglion cells (cell body, small stem, 2 processes → peripheral → connects to receptor; central → sends sensation and reaches the tract); bipolar; multipolar

* peripheral process → receptors sense stimulation → generator potential, AP → afferent → reaches the cell body → central process

Characters of somatic sensory pathways: the message will be carried by 3 order neurons until it reaches the higher center

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

2) **The 1st order neuron**: the **dorsal root ganglion cells** (DRG). collection of nerve fibers outside the CNS

3) **The 2nd order neuron**: the **crossing** neuron either: nucleus → collection of fibers inside the CNS

a) At spinal cord: spinothalamic tracts. Ventral / Lateral → the axon of the 2nd order neuron causes the crossing → crossing at spinal cord

b) At brain stem: Gracile & Cuneate tracts. → crossing at brain stem

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

4) The 3rd order neuron: **PLVNT**. (the nucleus found in the thalamus) → postero - lateral - ventral nucleus of thalamus

- *With the exception of smell and unconscious proprioceptive sensations* → spinocerebellum not PLVNT

5) The pathway of sensory the tracts in brain stem are called "**lemnisci**". Once the tracts enter the brain stem they're called lemnisci (Lateral spinothalamic tract when it enters the brain stem → lateral spinothalamic lemniscus)

* If cutting happens in the 2nd order neuron → neuro signs; sensory disturbance

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)

* lissauer tract → before the fibers converge at the dorsal horn cell it will give 2 segments upwards and 2 segments downwards

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)

the only difference between these 2 types are the type of fibers of the afferent

Neo lateral Spinothalamic

crossing

- **2nd Order Neuron**

the dorsal horn is divided to layers (laminae)

- 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. found in upper regions of the brain
  Suki → lower regions
  توضيح بس

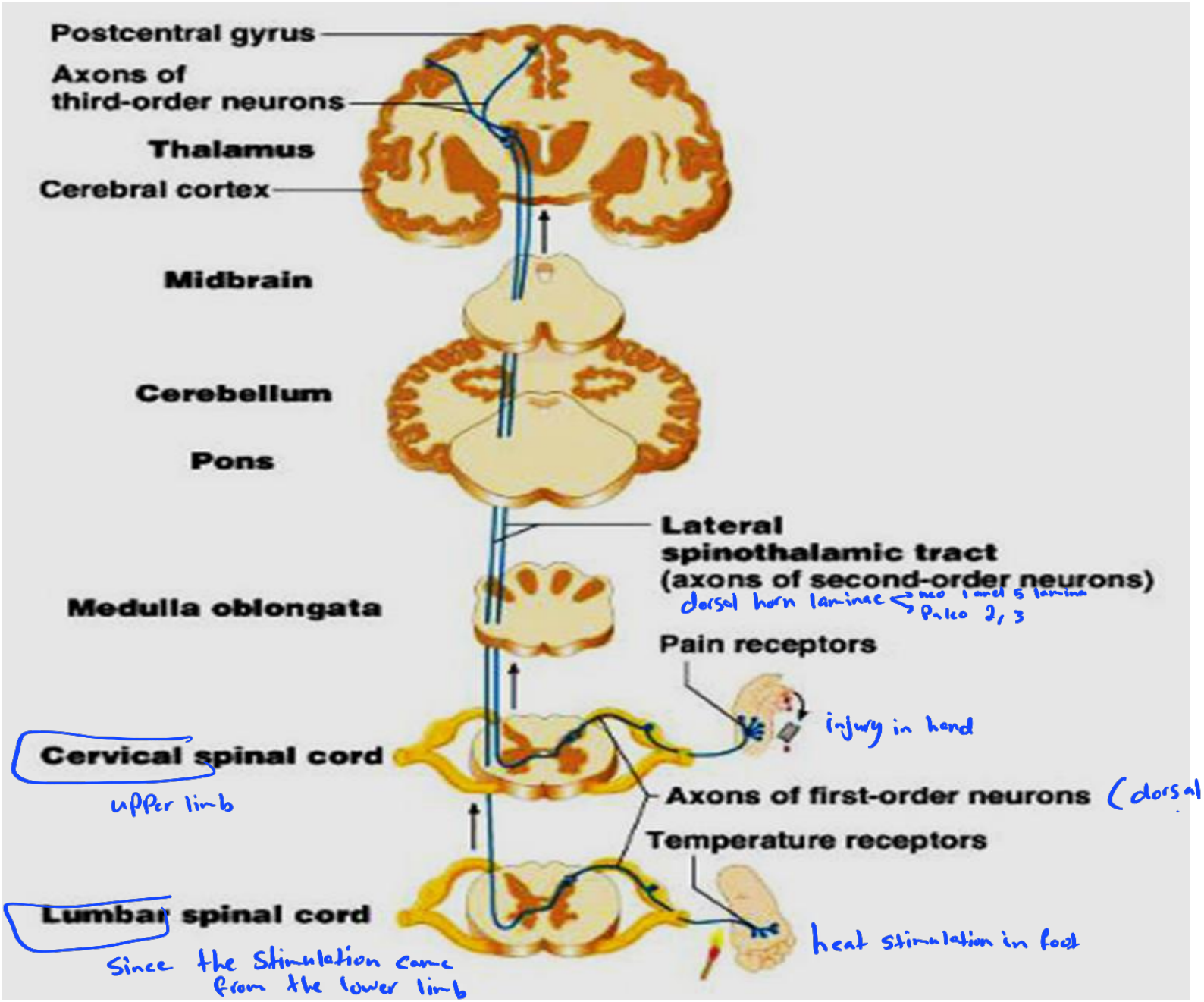
Paleo lateral Spinothalamic

- **3rd Order Neuron** not all fibers reach the thalamus → not all fibers will reach the cerebral cortex
- **10%** of fiber reach **thalamus** (**intra-laminar and midline**) **nuclei**, then cerebral cortex. ↓ not well localized
- **90%** of fibers terminate in **3** sites:

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

2) **Tectal** area in mid brain → important area for vision

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)
dorsal horn laminae
neo 1 and 5 lamina
Paleo 2, 3
Medulla oblongata
Pain receptors
injury in hand
Cervical spinal cord
upper limb
Axons of first-order neurons (dorsal root)
Temperature receptors
Lumbar spinal cord
Since the Stimulation came from the lower limb
heat stimulation in foot

ومن طلب العلا من غير كد، أضاع العمر في طلب المحال..

الزم ثغرك وأحسن دراستك، لتكون سببًا في نهوض الأمة..