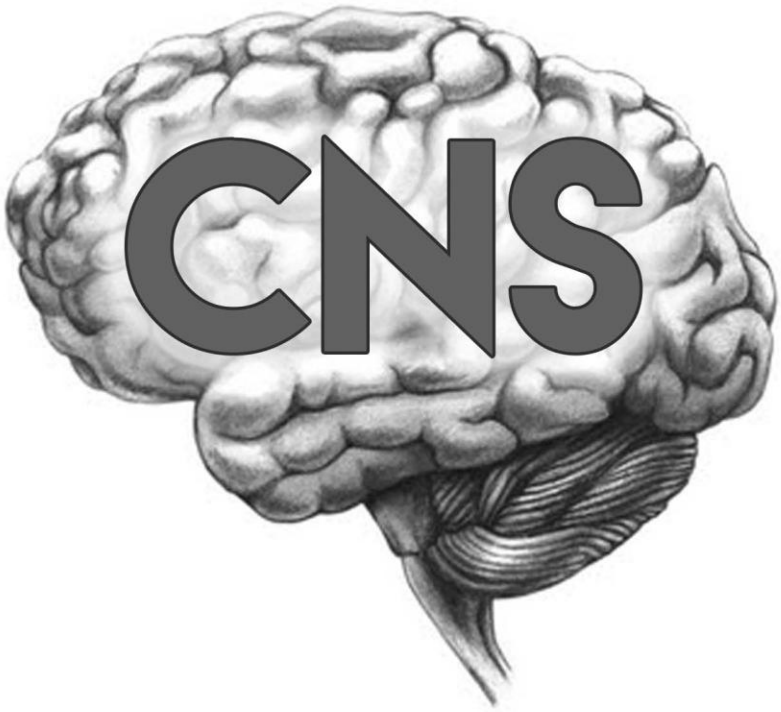


# ANATOMY

☑ Sheet ○ Slide ○ Handout

Number

12

Subject

Introduction to sensory tracts

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(sec-2)
In this lecture we will discuss the following :

- Disc prolapse
- Introduction to sensory tracts
- Spinothalamic sensory tract

## Disc prolapse -cont.

What is the disc prolapse?
Tear of annulus fibrosis and herniation of nucleus pulposus (most commonly it herniates posterolaterally).
Recall that:

- ✓ The body of the vertebrae is anterior while the arch is posterior.
- ✓ The disc is situated between two bodies.
- Complications:
  Compression of the spinal cord ( if herniated at the cervical or the thoracic region) OR compression of the lumbar and sacral nerve roots "=cauda equna" ( if herniated at the lumbar or sacral region).
  These roots can be sensory or motor and certain dermatomes and myotomes will be affected as discussed in lec-11.
  Most important dermatomes are those of the big toe (L5) , little toe (S1) , front of the thigh (L1, L2 , L3) , medial aspect of the leg (L4) , lateral aspect of the leg (L5) , perianal region "where u set " (S3, S4 ).
  Most important myotomes are those of femoral nerve (L2, L3, L4) which supply the muscles of the thigh (quadriceps, iliopsoas, adductor group -by obturate nerve-), L5 for the anterior compartment of the leg which induce dorsal flexion, S1 supply the muscles of the posterior compartment of the leg (gastrocnemius and soleus) which induce plantar flexion.
  →So , u can test L5 myotome by asking the patient to stand on his heels (dorsal flexion) and S1 myotome by asking the patient to stand on his

tiptoes (planter flexion).

Note: the femoral and the obturator nerve have the same root value.

Bear in mind that the disc prolapse occur most commonly around L5, above it or below it (between L4 and L5 OR between L5 and S1).

→If the disc between L4-L5 is herniated, which is it the nerve root of L4 or L5 most likely to get affected?

L5, the lateral aspect of the leg + the big toe sensation is affected and the anterior compartment muscles of the leg are affected (dorsal flexion is affected).

→If the disc prolapsed between L5 and S1?

S1 nerve is affected, the little toe sensation is affected and the muscles of the posterior compartment of the leg is affected.

→How to test for the myotome activity?

By observing how the muscle respond to JERK test, for example for posterior compartment of the leg ( gastrocnemius and soleus ) you do the ankle jerk by tapping on the Tendo calcaneus (Achilles tendon) , this is the common tendon of posterior compartment muscles, if S1 nerve root is affected this jerk will be significantly weaker.

Similarly, if the disk prolapse is at the level of L3-L4, L4 myotome (quadriceps muscle) will be affected and the patellar tendon reflex will be weak.

- **Major symptoms of disc prolapse:**

Here we are talking about typical disk prolapse ( around L5):

✓ Backache (low back pain )

- This pain is radiating to the gluteal region, the back of the thigh and back of the leg.
- The reason behind the backache:

1. Once the **spinal nerve** emerges from the intervertebral foramen it directly gives a **recurrent branch** back to the segment , this recurrent nerve bring sensation from **the dura** matter , the outer part of the disc

and from the posterior longitudinal ligament ( a ligament presented at the posterior aspect of the vertebral column)

2. The **dura matter is sensitive to stretch** , when the disc prolapse the dura is stretched and the recurrent branch of the emerged spinal nerve transmit the stretch signal.
3. We feel this recognizable (transmitted) stretch signals as backache (pain).

- When asking the patient where do u feel your lower back pain, he will put his entire palm on his lower back (he won't point by just his index), why?

  By using his palm to indicate where his pain is , he is really pointing to several dermatomes (not a single one) this reflects **the overlapping of dermatomes** of different nerve roots (see figure1) , when looking at the figure u can see the degree of overlapping; if we take the Dural dermatome of L5 a degree of overlapping occur with L4 dermatome (above) and S1 dermatome (below) as a result the patient will show up with "diffuse" lower backache.

  In another word if the dura supplied by L5 is affected this is reflected as pain felt at lowerL4, L5, upper S1 dermatomes.

  Note : the Dr did not use the term "dural dermatome " it's obviously wrong but I've used it to emphasis that the pain that is felt at the derma is caused by the dural stretch.

✓ Sciatica

- It is the pain that the patient feel at the back of his thigh and leg.
- Called so because the affected muscles are supplied by the sciatic n.
- Knowing that the root value of sciatic nerve is L4, L5, S1, S2, S3, if the disc prolapse -typically- between L4 and L5 OR between L5 and S1, then it will compresses L5 OR S1, respectively. (One of the roots of the sciatic nerve will be compressed, sciatica appears).
- Also the related myotomes and dermatomes will be affected.

يشتكي المريض من ألم في أسفل ظهره ينتشر إلى فخده وقدمه، هذا يؤشر أنّ المريض يعاني من "دسك"

**Leg raising test: a test for disc prolapse.**

Ask the patient to lie on his back, then ask him to rise his leg in a straight manner. If he felt lower back pain radiating down this highly suggests that he has a disc prolapse.

Explanation:

- When the spinal nerve emerge from the spinal cord , its beginning is surrounded by dura mater , the nerve dura is connected to the dura of the spinal cord , that if stretched will cause pain at the corresponding dermatome.
- When the patient rise his leg his sciatic nerve is stretched, the dura of the sciatic nerve is stretched, the dura of the spinal cord is stretched >> pain at the corresponding dermatome (with a degree of overlapping as mentioned above).

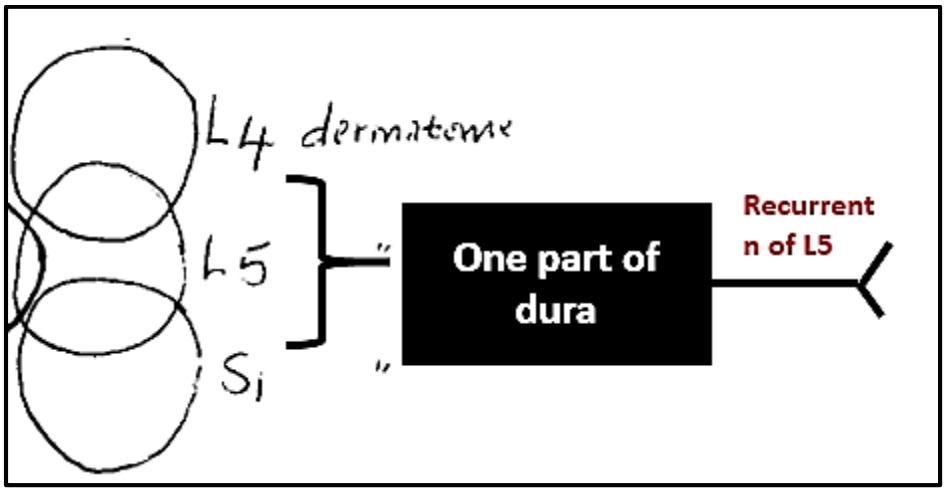


*Figure 1: overlapping btw several dermatomes when one part of the dura is stretched.*

## Introduction to sensory pathways

**Types of sensation**

There are two classifications of sensation, the first one is old and simple, the 2nd one is newer.

<u>The first classification:</u>

- ✓ **Exteroceptive** sensation = cutaneous sensation (sensation of pain, temperature, simple touch).
- ✓ **Proprioceptive** sensation (sensation from muscles, joints) this type of sensation can be **conscious** if it reach the cortex through the thalamus, or **unconscious** proprioception, if it reach the cerebellum.

<u>The newer classification:</u>

- ✓ **Mechanoreceptive** sensation , this type of sensation involve:
  - Tactile (touch).
  - Position sense = proprioception= sense from joints and muscles
    - Which means that the patient is aware where his joint is (**static position sense**) المفصل مثني ولّا مفرود and how it's moving and in what direction (**dynamic position sense**) المفصل بتحرّك ولّا ثابت.
    - U can test for the position sense by asking the patient to close his eyes then ask him about his big toe (after moving it).
  - Pressure.
  - Vibration.
  - Tickle and itch الدغدغة و الحكّة.
  - Sexual sensation.
- ✓ **Thermoreceptive** sensation:
  - Sense of heat and cold.
  - The test here is done by using tubes filled with cold or hot water.
- ✓ **Pain** sensation:
  - We feel pain after get exposed to **any stimulus** that induce **tissue damage.**
  - This implies that the stimulus can be of any type: mechanical, chemical, electrical.

## Flash back: The gray matter of the spinal cord

The gray matter of the spinal cord is arranged in columns of nuclei, in a cross section these columns appear as laminae. There are 10 columns at each side of the spinal segment (according to Redex classification, before redex classification they used "certain names" for each nucleus instead of columns numbers)
at each column the cells are similar in appearance and function.
The laminae concerned with sensory tract: (look at figure2):

- ✓ **Lamina 1** (at the tip of dorsal horn) receives afferent from the dorsal root and plays a major role in the spinothalamic tract or anterolateral system (major sensory tract).
- ✓ **Lamina 2** (previously called substancia gelatinous), this part contributes in modifying pain sensation, like blocking the pain from being transmitted upward after receiving an order from the upper parts.
- ✓ **Lamina 3 and lamina 4** receive afferent of pain sensation, temperature and touch; these laminae have many interneurons.
  Note: some AMRICAN BOOKS says that substancia gelatinous represent lamina 2 and 3 on redex classification.
- ✓ **Lamina 5** (a major lamina) contribute in spinothalamic tract.
  Collectively, **Laminae 5, 1 and 2** contribute in the **spinothalamic tract**.

**سطور في المعركة الفسيو-تشريحيّة :**

جميعنا لاحظ الاختلافات بين مادتي الفسيولوجي و الأناتومي؛ يرجع هذا الاختلاف إلى تعدد الأدلة عند كل مادة ، و اختلاف طرق التصنيف، و أنّ العصبونات شبكيّة الطبع غير محكومة بحدود الطبقات التي نضعها لها ، لذا من الطبيعي أن تجد أحد الفسيولوجيّين يخالف الرأي التشريحي القائل بأنّ الطبقات الخامسة و الأولى و الثانية هي التي تساهم في ال spinothalamic tract فبالفسيولوجيا يقولون :

in physiology they suggest that the spinothalamic tract pass through lamina 3 and 4, and this accepted anatomically as the cell bodies of lamina 5 have dendrites that can reach lamina 3 and 4. This means **that all laminae are connected and interactive (no solid demarcation).**

- ✓ **Lamina 6** presents only at the cervical and lumbar enlargements and receives proprioception (position sense).
- ✓ **Lamina 7** , has multiple nuclei :

- **Intermedio-lateral nucleus**, contains preganglionic fibers of sympathetic. ( this nucleus is btw T1 -L2 >> remember the sympathetic lateral horn).
- **Intermedio-medial nucleus** , presents all over the spinal cord , receive visceral pain.
- **Dorsal nucleus of Clark's (or thoracic nucleus or Clark's nucleus)** presents at (C8 – L2 or T1- L3) , the dorsal/ posterior spinocerebellar pass through here.

✓ **Lamina 8**, here there are a lot of interneurons in which the vestibulospinal tract, the pontine and medullary reticulospinal tracts "descend on" and synapse with them >> then the interneurons transmit the signals to alpha and gamma.

Do you remember when we said that the pontine reticullospinal tract become bilateral at the segments; it's time to know the exact HOW?
(say we are talking about the Rt pontine reticulospinal tract )

- The Rt pontine reticulospinal tract fibers descends on the Rt side and synapse with the interneurons at lamina 8 at the Rt side of the spinal segment.
- The Rt interneurons transmits signals to Rt and Lt alpha and gamma neurons ( at lamina 9 )
- Most of these interneurons projection is contralaterally. (on the Lt side in our example)
- By this the pontine has begun ipsilateral and ended bilateral ie. **The pontine reticulospinal tract cross segmentally.**
  Without admitting that this tract is bilateral, we cannot understand the spasticity that happen in UMN lesion.

✓ **Lamina 9** (motor/ where alpha and gamma neurons are present) ,

- Its medial group supplies axial and proximal muscles. (this group is present at the whole length of the spinal cord).
- Its lateral group supplies distal muscles. (present only at the cervical and lumbar enlargement).

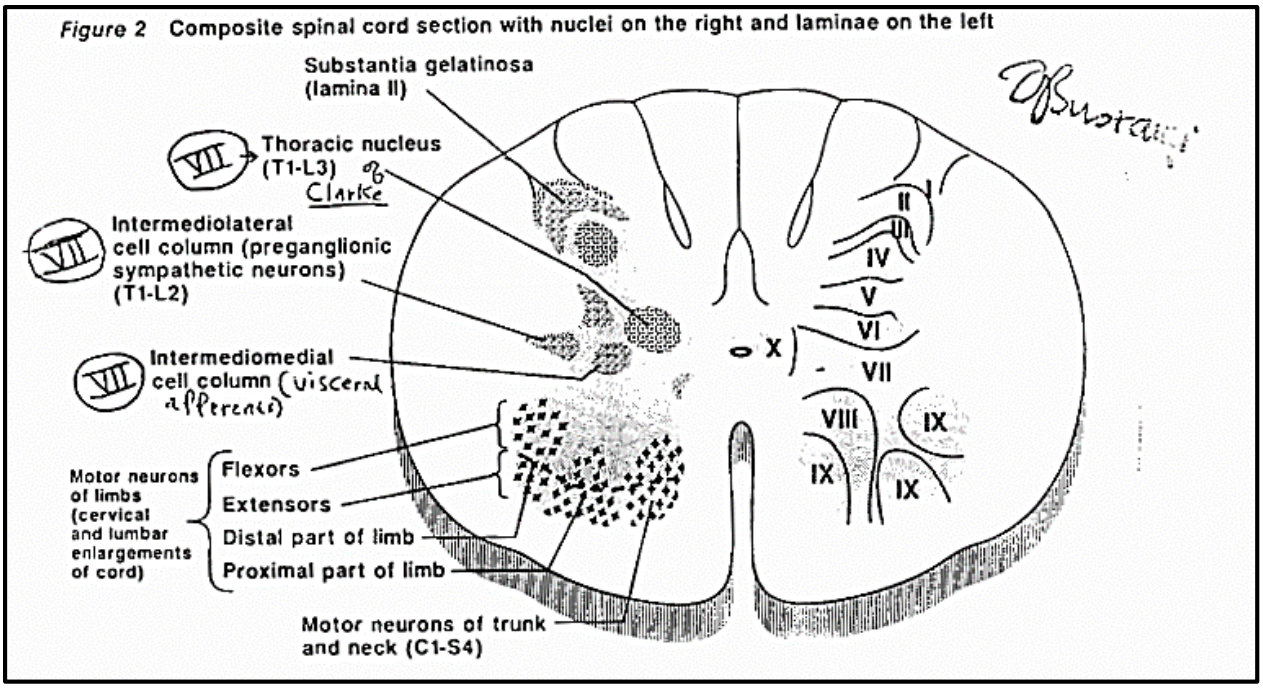


*Figure 2 :* ***Laminae of the gray mater.***

## Receptors of the sensory pathways

Any sensory pathway must start with a sensory receptor.
The sensory receptor could be simply **nerve endings** or **specialized organ** = in which the nerve endings are surrounded by connective tissue forming a ball-like-structure called "corpuscle".
The **function of any receptor** is to convert the energy that the stimuli carry into action potential, this action potential that is formed and get transmitted through the nerve fiber did not form directly but rather gradually , HOW?

**Stimulus → graded potential → receptor potential →** then **full action potential**.

<u>If sensory pathways transmit all kinds of stimulus signals as a single type of action potentials how can we differentiate different sensation type?</u>
→**First:** each type of sensation is felt and translated into AP by a certain type of sensory receptors.
→**Second:** each type of sensation is transmitted in a certain pathway.

→**Third:** when the cortex receive the AP it can understand what is the stimuli and the sensation type. (Further explanations later on).

To understand the sensory receptors, we must first recall the basic structure of **the dorsal (sensory/afferent) root**, the type of this nerve fiber is pseudo-unipolar neuron, it receives signals from the periphery and transmits it to the spinal cord.

The structure of the dorsal root (look at figures 3 and 4):

- It is a **pseudo-unipolar** neuron that has a single process that bifurcate into :
- A **peripheral process** that resemble **dendrites** in a typical neuron (this part is in touch with the peripheral receptor).
- A **central process** that resemble the **axon** of a typical neuron.
- The **cell body** of this neuron is at the **dorsal ganglion**, NO SYNAPSIS occur in this ganglion.

Now, we can talk about skin **sensory receptors** (figure5)

- ✓ Tactile sensations (mechanoreceptive) receptors (for touch, pressure, vibration ...)
  1. **Corpuscle of touch** (Meissner's corpuscle), this receptor is simply the peripheral process -or dendrites- of the dorsal root surrounded by connective tissue.
     This receptor respond to **touch, pressure and low frequency vibration.**

     Note: to test for vibration we use tuning fork الشوكة الرنّانة (  ) u put it on any bony prominence (like the superior anterior iliac spine ASIS, or the patella) and then observe the fork vibration – normally it must vibrate-.
     - This receptor is **rapidly adapting** (the transmission of signals fade away after stimulus exposure), it is beneficial that this receptor is **not slowly adapting** (in slow adaptation the AP is transmitted as long as the stimulus is present).
     - For touch receptors we want them to be rapidly adapting, think of it: when u put ur clothes on u initially feel them then u don't, u are not

aware of the stimulus despite it is there.

DO YOU WANT TO BE AWARE OF EVERYTHING THAT TOUCHES YOUR SKIN ALL THE TIME?

2. **Root hair plexus receptor**

   Here the peripheral process of dorsal root is present around the hair root بصلة الشعر, this receptor respond to hair movement.

   - Rapidly adapting receptor.

3. **Tactile Disc** ( or Merkel's disc or type I mechanoreceptor)
   - Here the peripheral processes are flattened.
   - Respond to discriminative touch اللمس الدقيق. [ explained later]
   - Slowly adapting.
4. **End organ of Ruffini** ( type 2 mechanoreceptor)
   - Slowly adapting.
   - Respond to heavy touch or stretch of the skin.
5. **Pacinian corpuscles**
   - The dendrites here are surrounded by several layers of connective tissue.
   - For **high frequency vibration and pressure**.
   - Slowly adapting.

✓ Thermo-receptors

- Free nerve endings (here the nerve fibers has reached the epidermis) – these endings are unmyelinated.
- **The warm receptors** respond to temperature above 45 C°, when the temperature is above 45 C° → these receptors are stimulated → burning sensation.
- The cold receptors respond to temperature between 10 and 20 C°, if temperature get below 10 C° → freezing sensation.

- ✓ Pain receptors
    - Also these are free nerve endings that can respond to any stimulus that can induce tissue damage.
    - The damaged tissue secrete histamine, substance P, bradykinin... and other factors that eventually stimulate the nerve endings and then we feel the pain.

      So, we can say that the pain is chemically induced.

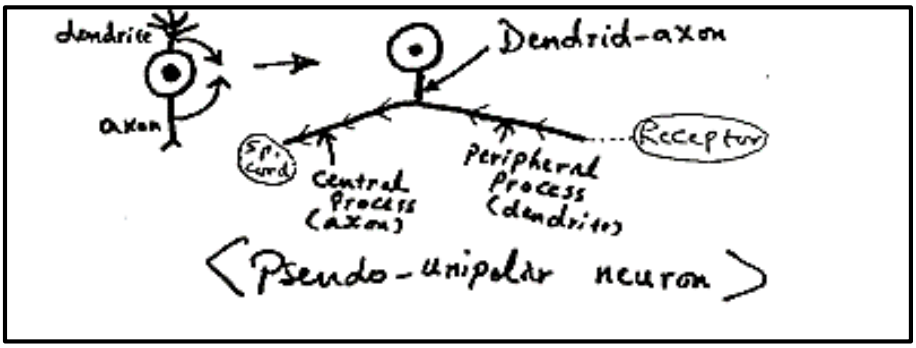


*Figure 3 :* ***Dorsal root structure.***

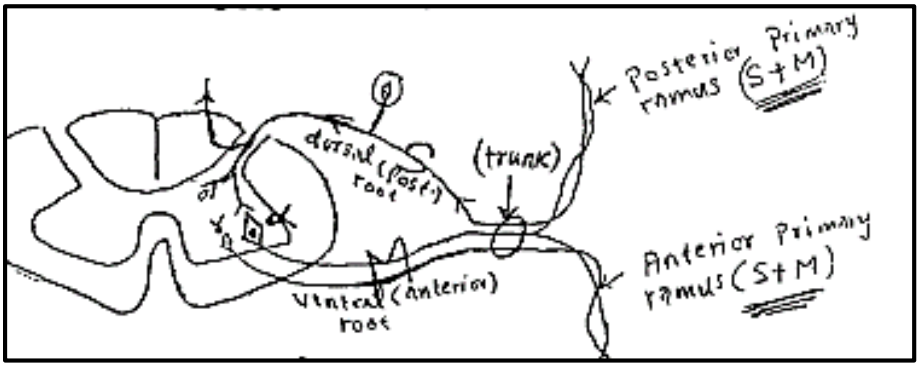


*Figure 4 :* ***ventral and dorsal roots alignment at the spinal segment.***

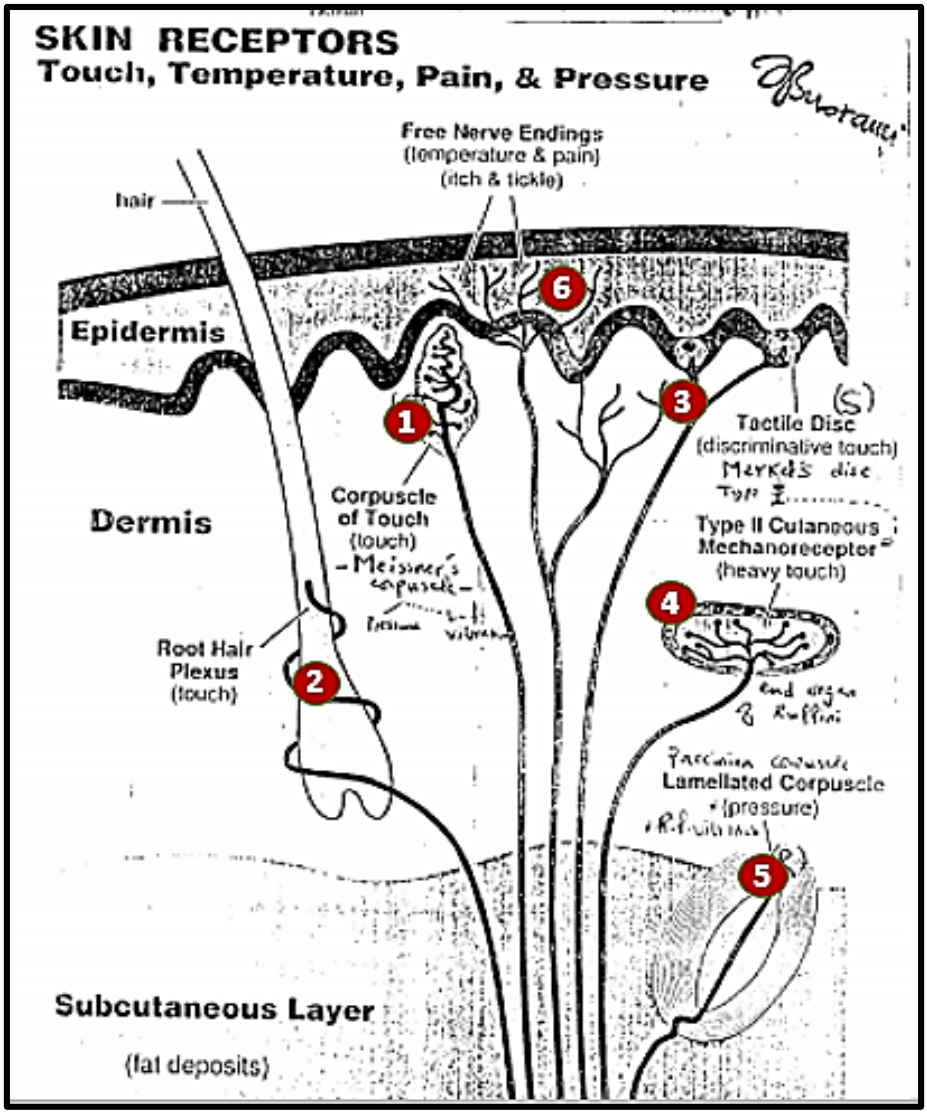


*Figure 5 : sensory receptors of the skin, numbered the same sequence as mentioned at the text. Note no. 6 the free nerve endings (dendrites/ peripheral processes) ends at the epidermis and transmit both temperature and pain.*

النص التالي هو فقط من باب تثبيت الحفظ لمستقبلات الحسّ، وهو غير دقيق علمياً ، و من نسج الخيال أيضاً

**(حالة للدراسة) : فتى في التاسعة من عمره ريثما هو جالسٌ بجانب والدته في حضرة بعض الضيوف صدرت منه بعض الحركات المستفزة و المحرجة للوالدة ( طبيعياً ، تبلغ حد الحركات المستفزة للأم بدون أن تُحدِث استجابة ٢ حركة في الدقيقة) فقامت والدته بقرصه على رجله ( وصف الفتى القرصة بأنها كانت دقيقة جداً ولكن مؤلمة إلى حدٍّ التلوي) ، ما هي المستقبلات التي تفعّلت أثناء انقراص فتانا هذا من قِبَل والدته:**

مستقبلات الألم بالتأكيد ، لكن ليس مستقبلات الحرارة إذ أنها تحتاج إلى دراجات عالية جداً أو منخفضة جداً لتُفعّل. ثانياً علينا أن نُوّجه تفكيرنا باتجاه ال slow adapting receptors إذ أنّ الفتى سيشعر بوجود القرصة طول فترة "القرص" يمكننا التفكير إذن بال End organ of Ruffini الذي يستجيب للّمس "العنيف و شدّ البشرة .لا يمكننا التفكير بال Corpuscle of touch بالطبع لأنّها تتكيف بسرعة مع القرصة وهذا يخالف الواقع ، بالطبع من هول المصيبة الواقعة على الفتى فإنّ شعرَ جسده سيقف من الخوف عندها ال Root hair plexus receptor سيتفعّل أيضاً ، مستقبلات الضغط و الاهتزاز قد لا تكون مفيدة في هذا السياق إذ أن العملية تحدث "على السكيتة".
وصف الفتى قرصة الأم بأنها كانت دقيقة جداً ؛ أي أنها استخدمت إصبعيها على مسافة قريبة جداً على رِجل الولد وهذا القدر لم يكن كافي لتفعيل الTactile Disc لنقل الإحساس الدقيق من منطقتين متقاربتين لكن مستقلتين بالمستقبلات الحسيّة. ( هذا الجزء سيُفهَم لاحقاً)

**Receptive field and its role in Discriminative touch**

Every receptor (i.e. Sensory neuron) receives sensation from a certain area of the skin, this area is called **receptive field**. حقل الإحساس

The receptive fields varies in their area المساحة التي تغطيها, at the tip of the fingers (most sensitive areas) the receptive fields are small, while at the elbow the receptive fields are large. (Look at figure 6)

Two general role here:

- ✓ <u>The size of the receptive field varies inversely with numbers of receptors at the region</u>**.** Which means that the smaller the receptive field the greater the number of the receptors and the larger the sensory presentation at the cortex.
- ✓ <u>The smaller the receptive field the greater is the acuity or the discriminative ability.</u> As the cortical presentation is also greater ( the cortex is responsible for understanding the sensation).

→**Discriminative touch test / two point discrimination** (figure7)
Procedure: by using two Pins, we stimulate the skin at two different but adjacent points.
If we stimulate two receptive fields >> the patient must feel two different stimuli.
If we stimulate one receptive field >> the patient will feel the two pins as a single stimuli.
This test depends on:

- The size of the receptive field >> which itself depend on where is the stimuli (the leg, finger...).

  →The distance between the pins is different from one are to another (look at figure 7) for example, at the anterior aspect of the leg it should be around 3 cm, while on the fingertips the distance shouldn't be more than 3-4 mm.
  →Remember that tactile disc is the receptor responsible for transmission of discriminative touch.

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Other Important principles with regard to sensory receptors:

- Adequate stimulus

  You have to know that every receptor have an **Adequate stimulus** , it is the weakest stimulus that can stimulate the receptor and induce AP.
  عتبة التنبيه : الحدّ الأدنى من التنبيه القادر على تفعيل المستقبل الحسي.
  Pain receptors are specific but their adequate stimulus are not specific. HOW? When u stimulate the pain receptor by **any stimulus** that induced tissue damage (mechanical, chemical , electrical stimulus..) and if this stimulus is able to reach the threshold it will induce AP → regardless what is the type of the stimulus, this make the pain adequate stimulus unspecific.
  The rest of the receptors' adequate stimulus are specific.

- Each receptor in the skin interacts with the CNS by an independent pathway. (labeled line).

  Generally, the pathway is from the receptor → to the spinal cord → to the brain stem → to the thalamus → to the cortex. (Each pathway has a certain area of the cortex that receive its signals).

  This implies that → activating the sensory receptors produce the same sensation independent of the stimulus which activate the receptor.

  This means that I don't recognize the type of sensation because of different stimuli types but rather because how the receptor had recognized the stimuli and how it get transmitted ( through which pathway).

  In another word if could stimulate the receptor -however how/ even without its specific stimuli that it usually correspond to it normally – the pathway can transmit the signal.

  أي أنني أستطيع تميز نوع الإحساس من خلال نوع الإشارات التي ينقلها المستقبل ، و من خلال الطريق المتميز الذي تُنقل خلاله الإشارات ولا يكون تميزي لنوع الإحساس بسبب المحفز نفسه.

  This does not contradict with the adequate stimuli concept , if the amount of stimuli is enough to stimulate the receptor → firing occur.

  example : say I've put in an experimental (hot) test tube on cold receptors with all its upstream pathway intact >> then I stimulate them with (hot) water in an adequate manner>> there will be an AP firing in the receptors that will produce cold sensation. - المثال تخيليّ من نسج الأسطورة د.فرج - أمدّه الله بالصحة والعافية

**طالما طريق الإحساس مُحدّد، أيّاً كانت طريقة تنبيه المُستقبل، سيشعر المرء بنفس إحساس هذا الطريق **

To sum up,

**the labeled line theory**: every receptor transmits the signals to certain parts of the cortex in a certain pathway and if I managed to stimulate the receptor adequately -however how/ regardless of the stimuli type- AP will be transmitted throughout the pathway and the same type of sensation will occur.

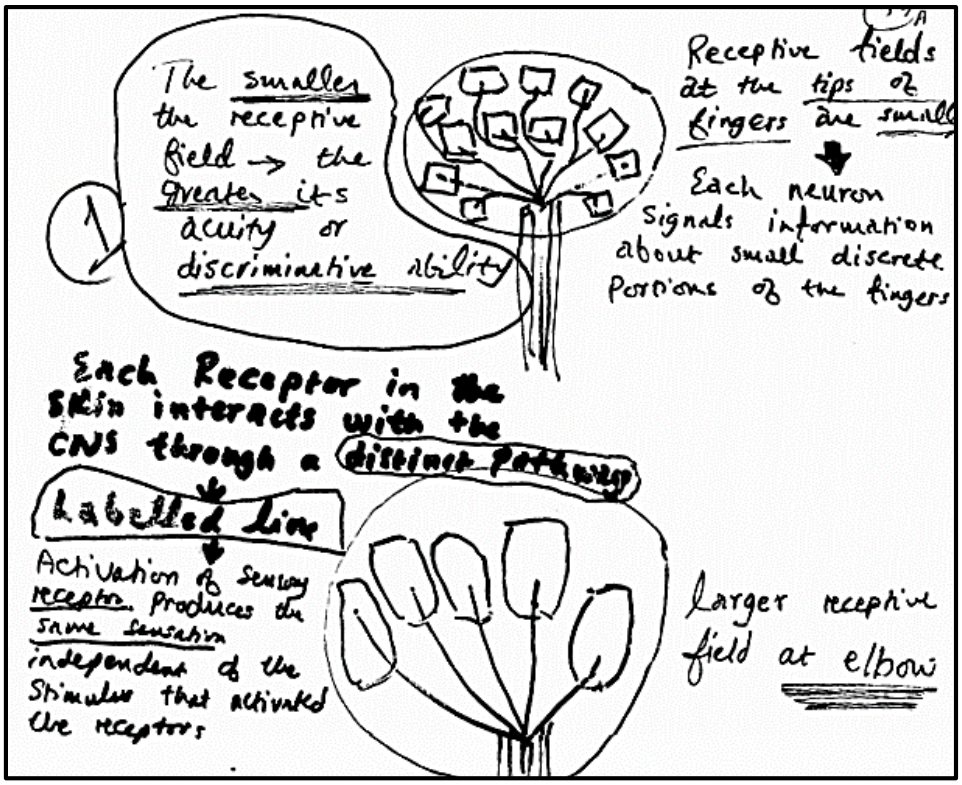


*Figure 6 :* ***receptive field concept, up : smaller receptive fields at the fingers providing high accuracy , down: large receptive fields at the elbow provide low accuracy.***

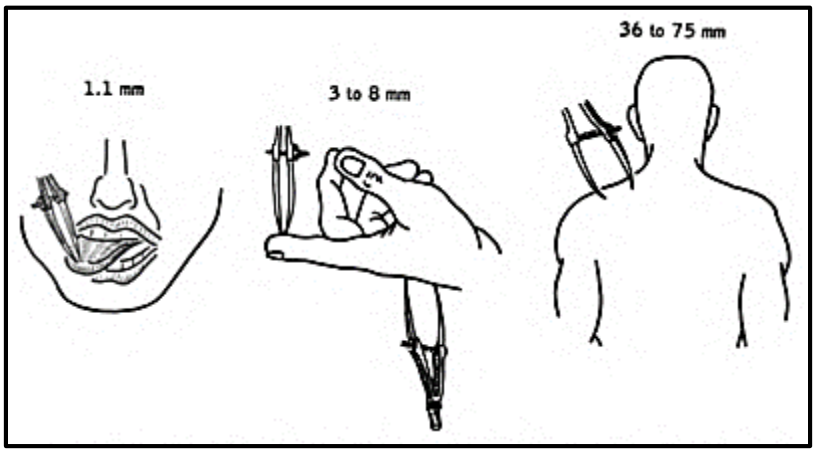


*Figure 7 :* ***two point discrimination test , notice how it differs from one area to another >> the greater the area between the two pins the greater the size of the receptive fields.***

**Basic structure of any sensory pathway**

From the receptor to the cortex: (figure8)

- The **dendrites** (or peripheral processes of dorsal root) reach the sensory **receptor** then the sensory fiber transmit the signal to at least 3 sensory neurons (including the dorsal root neuron) we care about where is the cell body of each one of these sensory neurons.
- The **first order sensory** neuron is the neuron of the dorsal root that is in touch with the receptor ( or its dendrites are the receptor) its cell body is present at the dorsal ganglion ( or the cranial n. ganglia like the trigeminal ganglion, if we are talking about a pathway for the face sensation for example ).
- The central process of the first order neuron enter the spinal cord to synapse with the **2nd order neuron** , the cell body of this 2nd order neuron is present at the dorsal horn of the spinal cord (or at the medulla if we are talking about a pathway for the face sensation for example )
  - The 2nd order neurons form **gracile and cuneate nuclei**
  - The axons of the 2nd order neurons **cross the midline** ( at the level of the spinal cord or the medulla , it depends ) and continue upward to reach the 3rd order neurons (at the thalamus).
  - The crossing of the 2nd order neurons implies that the sensation is transmitted to the **contralateral** cortex.
- **3rd order neurons** there cell bodies are at the **thalamus** , at the **ventrobasal complex**, which is composed from two parts **VPL and VPM** (ventral posterolateral , ventral posteromedial nuclei )
  - The VPL receives somatic sensation from the BODY.
  - The VPM receives somatic sensation from the face.
- From the thalamus to the sensory cortex ( area 3,1,2 and the association sensory cortex=area 5 and 7 )
  - At area 3,1,2 we do not recognize the type of the sensation.
  - At area 5 and 7 "association sensory cortex" we can understand the type and nature of sensation (is it temperature , pressure , ..).

- The thalamocortical pathway (the sensory radiation) pass from the **posterior limb of the internal capsule.**
  Note: also from the posterior limb of the internal capsule pass descending motor fibers. (between the thalamus and the lentiform).

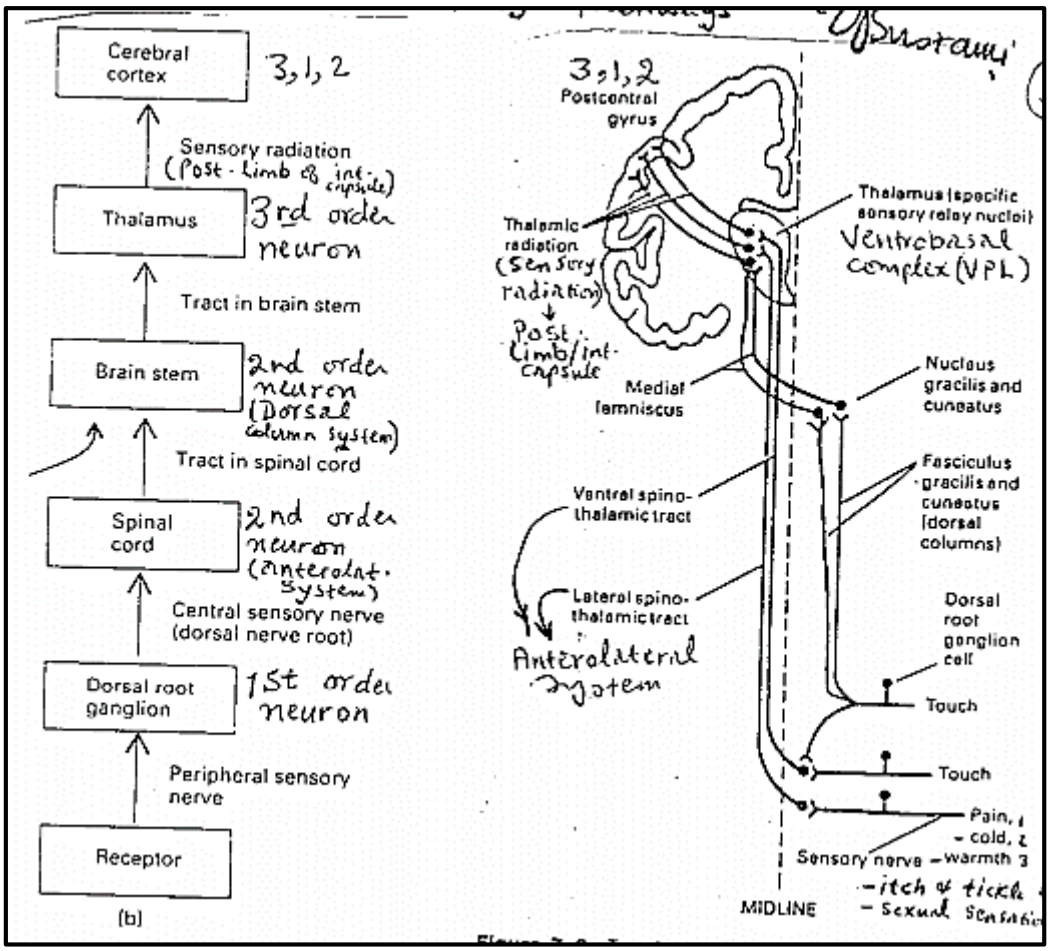


*Figure 8 :* ***basic structure of sensory pathway.***

Back to the **1st order neuron (the dorsal root)** -look at figure9

- ✓ The central process of the dorsal root divides into medial and lateral divisions.
- ✓ The medial division :
  - Has thick ,large and fast transmitting myelinated fibers ( type **1**/ A-alpha + type **2** or A-beta).
  - These fibers ( type 1 and 2 ) ascend at the dorsal column (white mater) of the spinal cord and form two pathways :**gracile and cuneate**

pathways.( the American books called them fasciculus gracilis and fasciculus cuneatus).

- The gracile pathway bring sensation from the lower limb.
- The cuneate pathway bring sensation from the upper half of the body.
- This whole medial division (G + C pathways) that ascend at the dorsal column transmits accurate sensation (discriminative touch and point discrimination), vibration, pressure proprioception & the stereognosis.
  **Collectively, we can say that the dorsal column transmit mechanoreceptive stumli.**
  →Stereognosis: it is the ability to identify the object without the help of vision.احط بإيد المريض شلن، ولازم يعرف إنو شلن بدون ما ينظر

✓ The lateral division :

- Has unmyelinated fibers (type 4 or C) and small myelinated (type 3 or A-delta).
- The fibers enter the dorsal horn (gray matter).
  we said previously that from the dorsal horn many important sensory tracts ascend
  - From lamina 1+ 5 → the spinothalamic tract ascend which transmit pain, tempreture and touch.
  - from lamina 1+ 2 → the spinoreticular tract ascend (special tract that transmit slow pain sensation – next lecture).

<u>More details about 1st order neurons →</u>

If we observe the 3 types of afferent fibers that come from the skin,( follow figure10) we can see the following :

- Fibers type 2 ( or A-beta) transmit mechanoreceptive signals , go mainly to the dorsal column of the spinal cord but there are also some lateral divisions that go to lamina ( 3, 4, 5,6).
- Fibers type 3 ( A-delta) transmit mechanoreceptive , Nociceptive (related to tissue damage , i.e. Pain sensation) and cold sensation signals.
  These fibers go to the dorsal horn of the spinal cord to lamina 3 and 4. With exception to nociceptive fibers that go to lamina 1.

- Fibers type 4 (C =nonmyelinated = slow) also transmit mechanoreceptive (minor), Nociceptive (mainly) and thermoreceptive (minor) signals.
  The nociceptive fibers go to lamina 1 and 2.

**Note**: a lot of overlapping is present, as lamina 3 and 4 receive interneurons from other laminae and lamina 5 dendrites reach lamina 3 and 4. But we can say that the tracts which ascend from lamina 1+5 and lamina 1+2 are precisely demarcated, can u name these tracts?

**Another note:** The neurons that are presented in the lamina can be either projecting (at lamina 1+2+ 5) or interneurons (at the rest of the laminae). Projecting = send ascending fibers that will synapse with other neurons to continue the sensory tract.

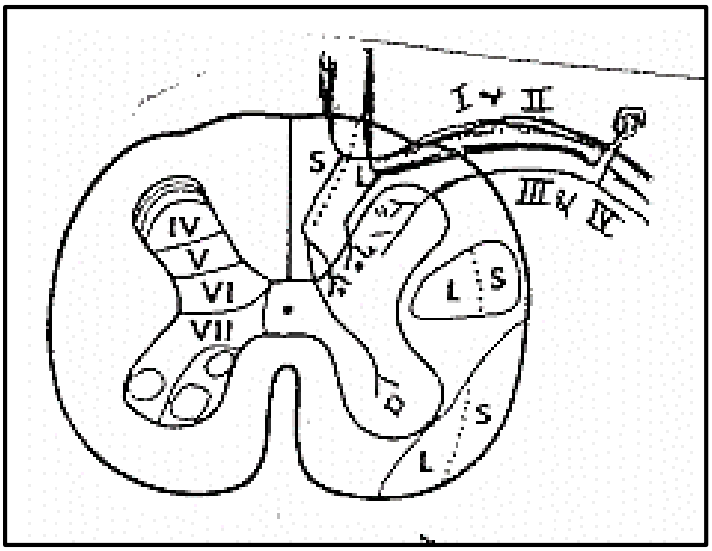


*Figure 9 :* ***medial and lateral divisions of the dorsal root.***

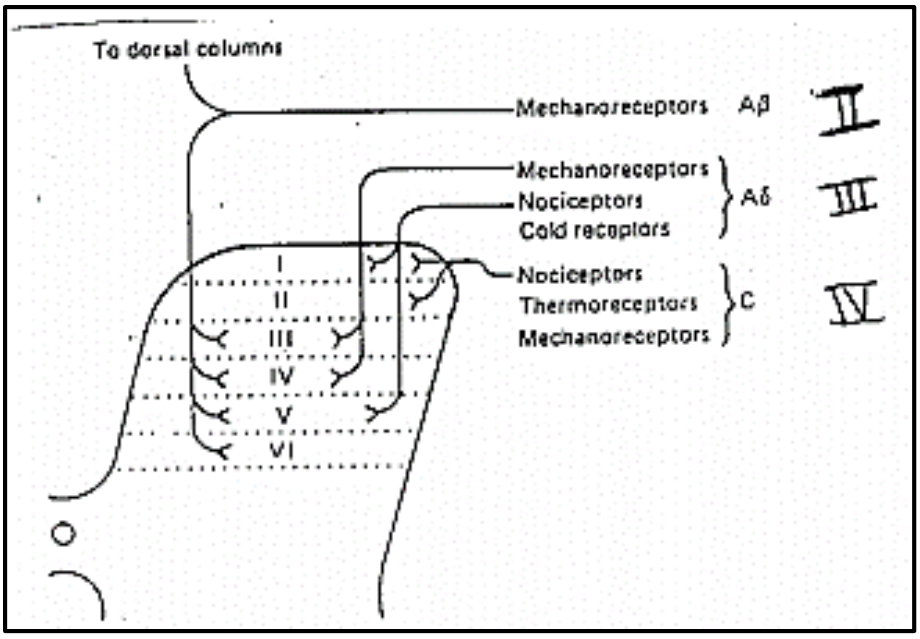


*Figure 10 :* ***3 types of 1ry afferent fibers that mediate cutaneous sensation ( to where they go exactly).***

## Spinothalamic sensory tract

- ✓ Also called antero-lateral system.
- ✓ It carries fast pain, temperature (cold+ hot) and simple touch (like when u touch the skin with a cotton pad).
- ✓ The tract :
  - From the **receptor** , The **1st order neuron** ( dorsal root) carry the-above-mentioned stimuli >> to the **lateral division** of the dorsal root ( fibers type 3 or A-delta) >> these fibers must enter the gray mater to synapse with the 2nd order neurons, but first they ascend or descend 1 or 2 spinal segments at the **dorsal column** (white mater) but near the tip of the dorsal horn then after **ascending/descending** it enters **the dorsal horn and synapse there with the 2nd order neuron**. (Mostly the fibers descend, say that the fibers enter the spinal cord at T8 segment it will descend to T10 through the dorsal column , then enter the dorsal horn and synapse there. here the main synapse occur at **lamina 1 and 5**).
  - We call neurons at lamina 1+5 transmission cells (T-cells).
    يمكننا أن نقول أن هذه العصبونات هي أمهات المسار

- The axons of lamina 1 and 5 are the 2nd order neuron axons which cross the mid line, the crossing occur at the white commissure >> then from the spinal cord to the thalamus to the 3rd order neurons at the ventrobasal complex → and by this the spinothalamic tract is formed.
- From the 3rd order neuron to area 3,1,2 at the cortex.

✓ In the past they used to say that there are lateral and ventral spinothalamic tract
- The lateral for fast pain transmission.
- The ventral for the touch transmission.

But this classification is not present now, as the two division have a lot of overlapping →so it's called now **anterolateral system**. (Or spinothalamic tract).

The anterolateral system fibers are present between the junction of the lateral and the ventral column of the spinal cord at its periphery.

The fibers run in a tract (or a bundle) and are aligned in the bundle in a special manner, generally : (look at figure 11- important to look at)

✓ The fibers of the upper limb are most medial.
✓ The fibers of the trunk are at the center of the bundle.
✓ The fibers of the lower limb are most lateral.

Clinical correlation: **Intramedullary tumor VS extramedullary tumor**

If a tumor arise from the spinal cord it's called intramedullary , otherwise it is extramedullary (might arise from the meninges , i.e. Meningioma).

✓ Intramedullary tumor would affect the cervical fibers (most medial fibers those of the upper limb).
✓ Extramedullary tumor would affect lower limb fibers (most lateral).

Remember when the fiber is affected there will be loss of sensation at the corresponding dermatome (the touch , temperature , pressure sensation .. all gone).

**Sacral sparing**

- ✓ Occur at intramedullary tumor.
- ✓ The patient loss sensation of his legs , but not his perianal region “where u set” as the legs are innervated by sacrolumbar fibers (more medially at the bundle) while the perianal region is supplied by lower sacral fibers (more laterally at the bundle.
- ✓ In the intramedullary tumor medial fibers are damaged but the lateral fibers are intact >> sacral sparing.

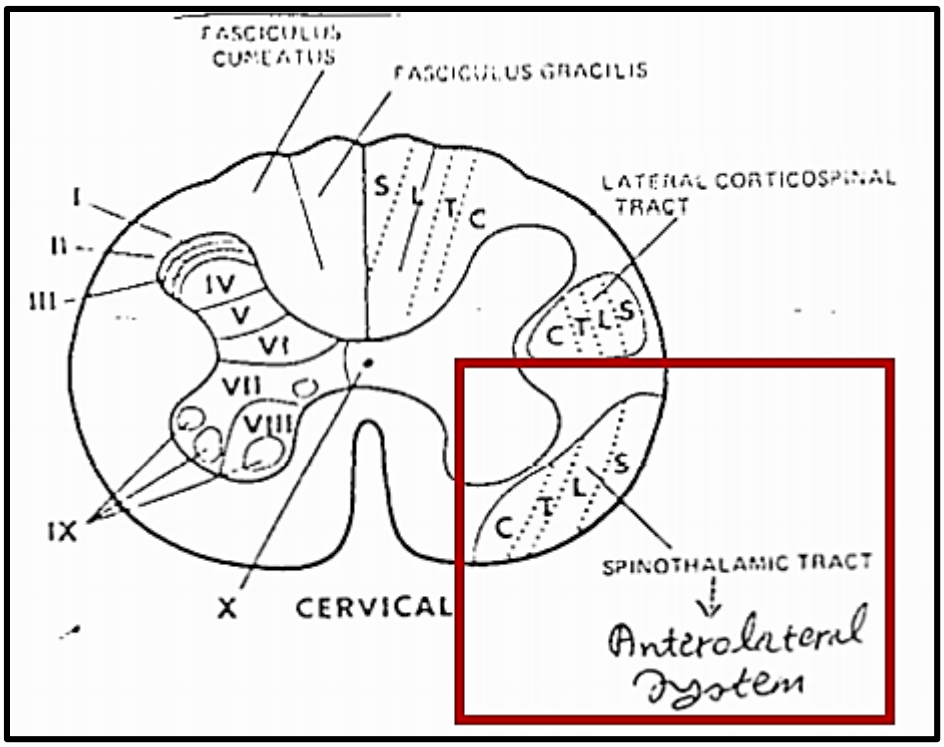


*Figure 11 :* ***the location of the spinothalamic tract, notice where it's located at the junction between the lateral column and the ventral column , also notice how the fibers are aligned from medial to lateral (cervical fibers , thoracic , lumbar then sacral).***

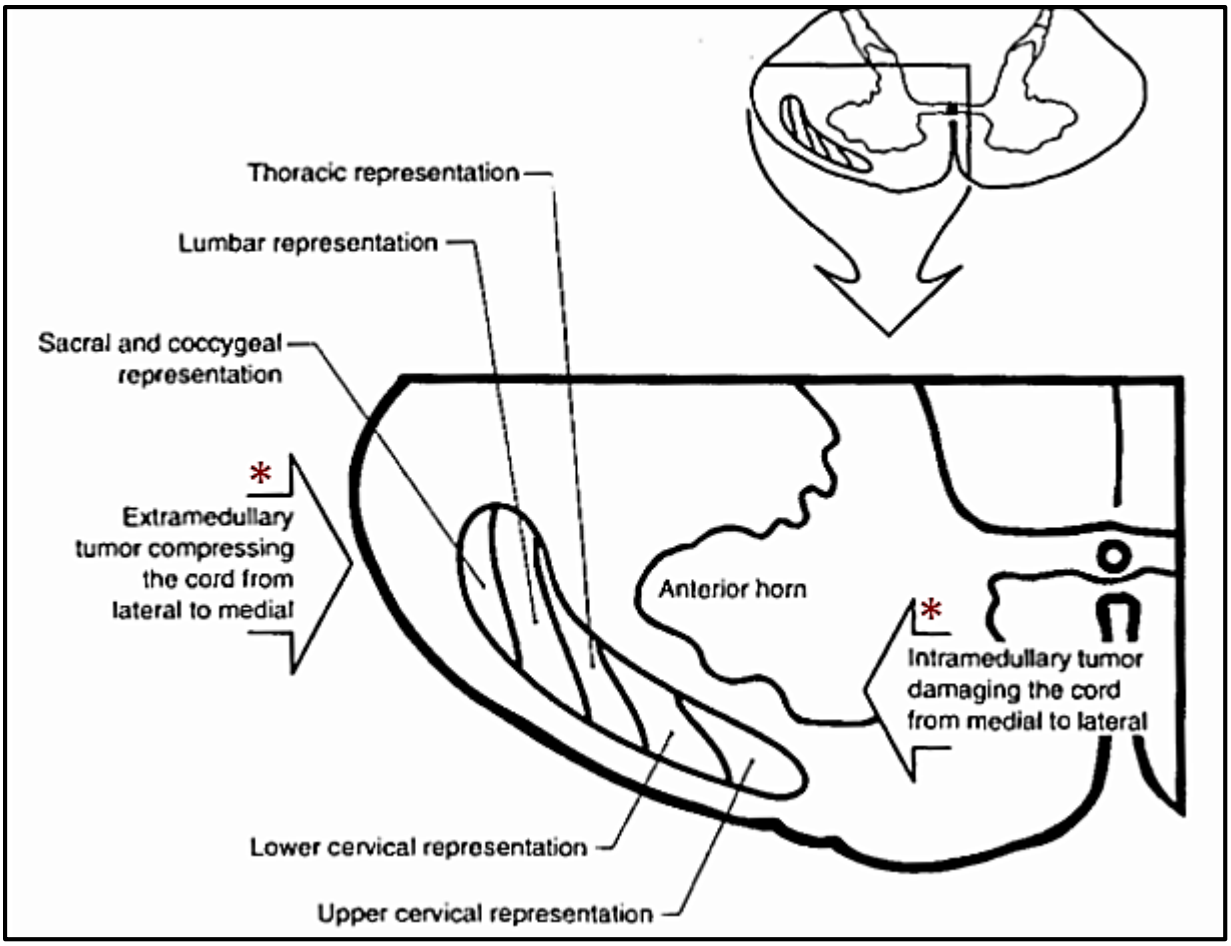


*Figure 12 :* ***Intra VS extramedullary tumor effect. notice how the fibers are aligned from medial to lateral (cervical fibers , thoracic , lumbar then sacral).***

**END OF TEXT**