كلية الطب البشري
Faculty of Medicine

CNS Module

Physiology Lectures

(Lecture 3)

Topic 2: Spinal cord & somatic sensations

Sensory System

Presented by:

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Somatic sensory Pathways

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Sens. carried by Spinothalamic Tract

Sensation	Receptor	Afferent fiber
Crude Touch	FNE & Hair F.	Aδ (VST)
Tickle & itch	FNE	C (VST)
Warm	FNE	C (LST)
Cold	FNE	C & Aδ (LST)
Pain	FNE	C & Aδ (LST)

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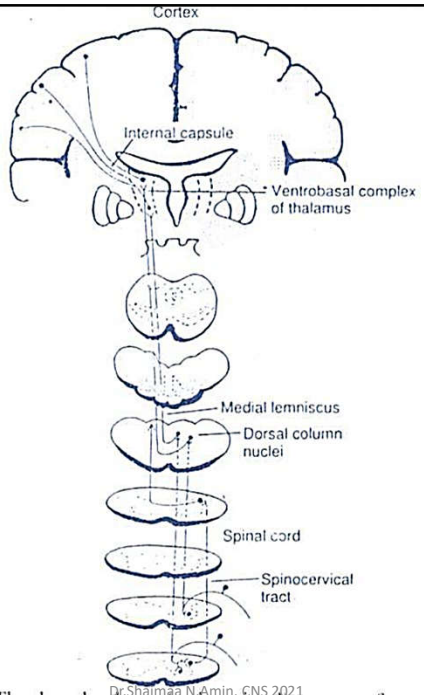

Figure 14 : The dorsal column (or lemniscal) system of ascending tracts.

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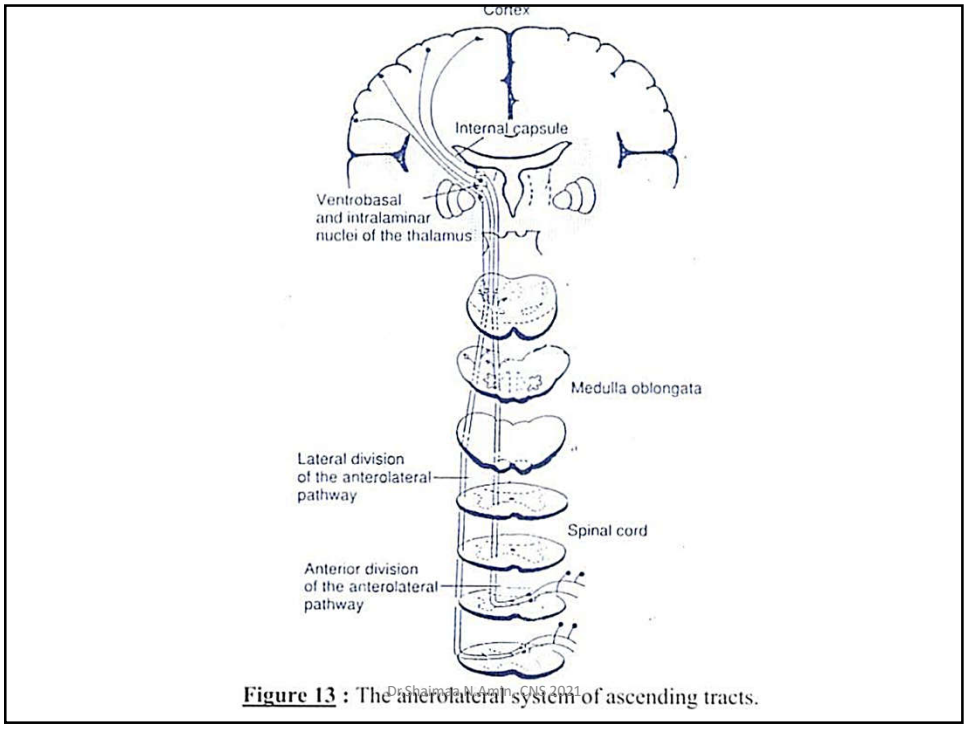

Figure 13 : The anterolateral system of ascending tracts.

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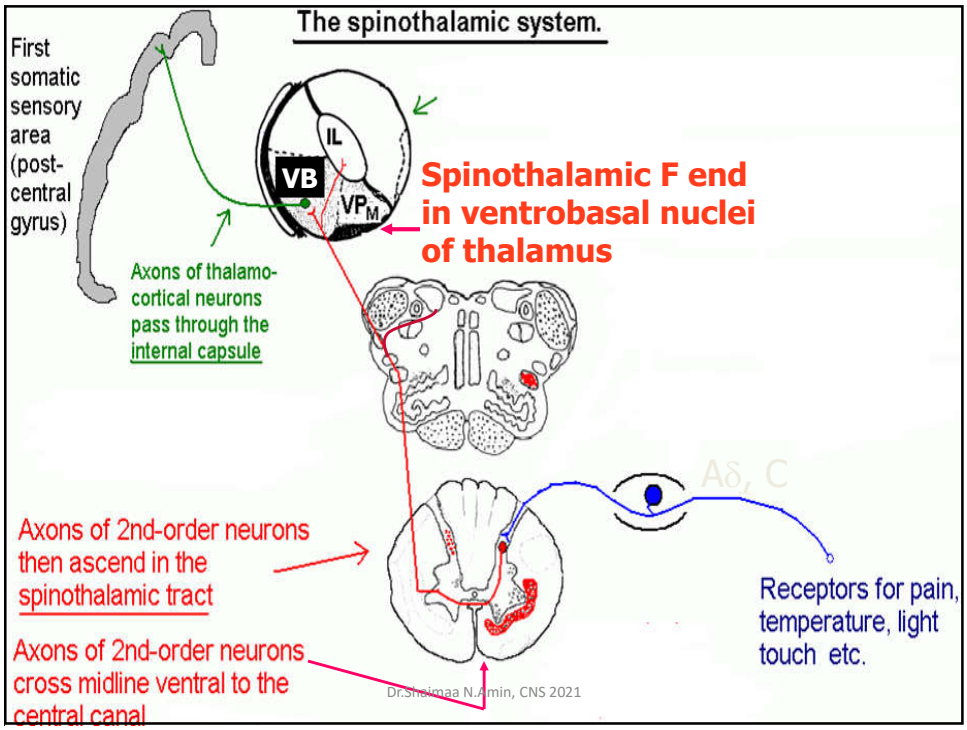

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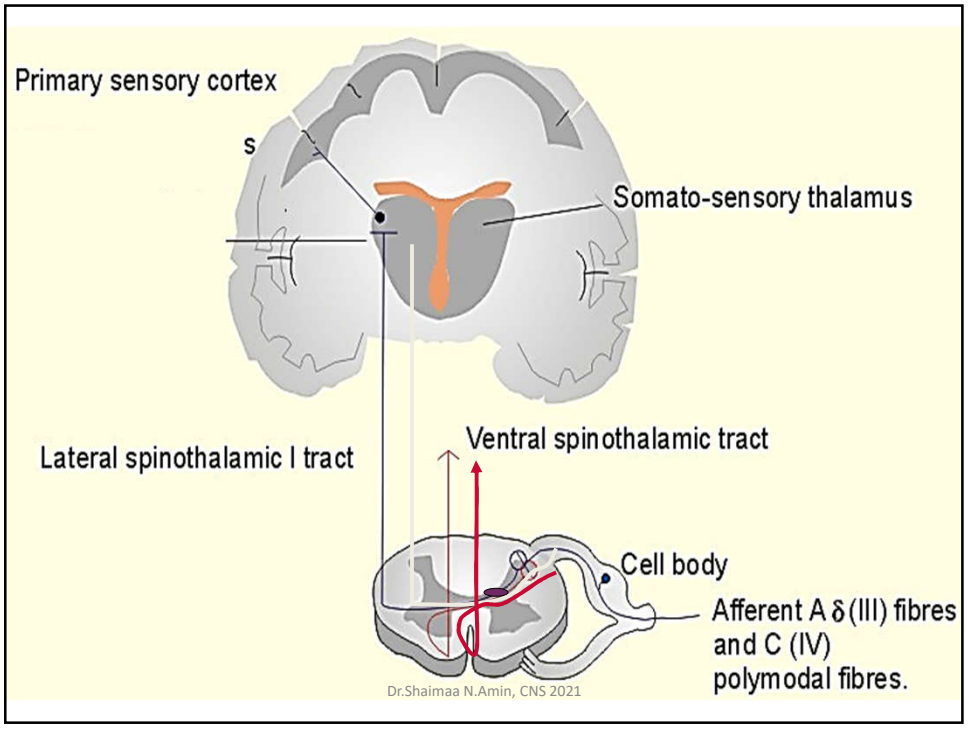
Primary sensory cortex
s
Somato-sensory thalamus
Lateral spinothalamic I tract
Ventral spinothalamic tract
Cell body
Afferent A δ (III) fibres
and C (IV)
polymodal fibres.
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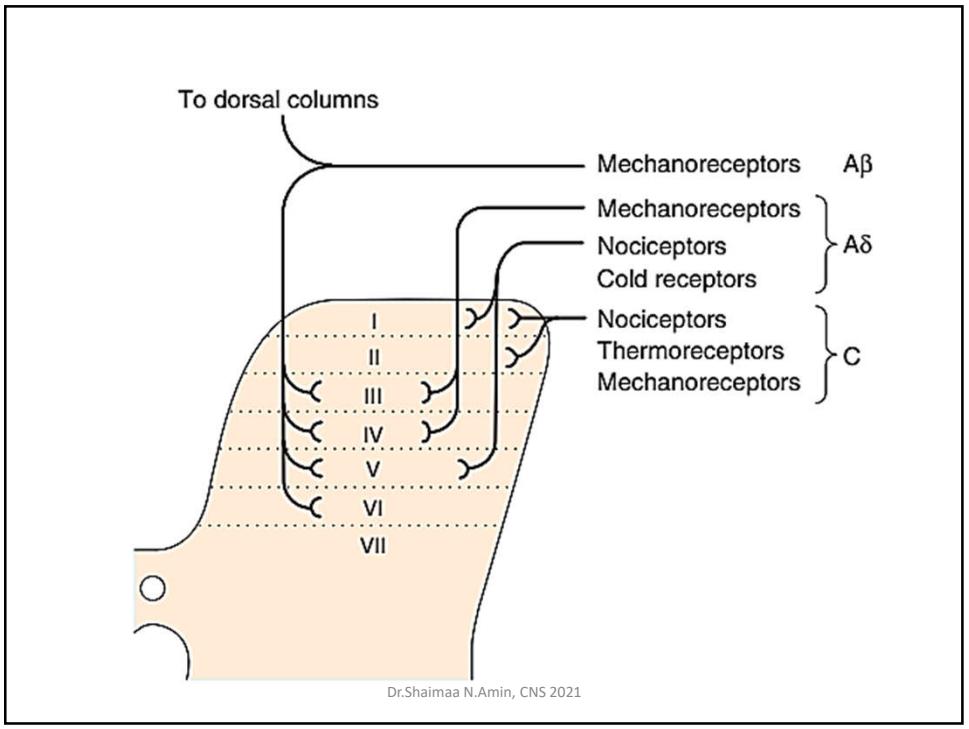
To dorsal columns
Mechanoreceptors Aβ
Mechanoreceptors
Nociceptors
Cold receptors
Aδ
Nociceptors
Thermoreceptors
Mechanoreceptors
C
I
II
III
IV
V
VI
VII
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Thermoceptive Sensation

Characters of thermal receptors

- Have a small receptive field and widely separated.
- Cold R. are 10 times more numerous than warm R.
- Cold R. adapt more slowly than warm.

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Detection of thermal Sensation

1.Cold pain R	5-15^{0}C (5)
2.Cold R.	10-43^{0}C (25)
3.Warm R.	30-50^{0}C (45)
4.Warm pain R.	45^{0}C

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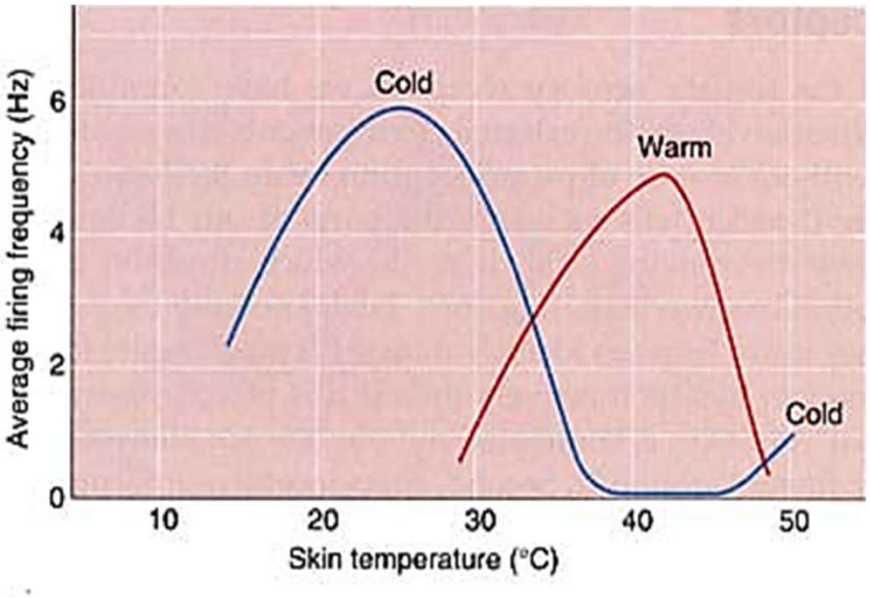

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Mechanism of stimulation of thermoreceptors

Thermoreceptors are stimulated <u>chemically by changing the metabolic rate</u>

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Pain

Nociceptors

- Free nerve endings, slowly (non) adapting to prolonged stimulation

- 4 types:
  a. Mechanical pain receptors.
  b. Thermal pain receptors.
  C. Chemical pain receptors.
  d. Polymodal pain receptors

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Distribution of pain receptors

Widely distributed	Less distributed	Absent
Sup. Layers of skin Periosteum Arterial walls Joint surface Flax & tentorium of cranial cavity	Deep tissues & Viscera	Liver Parenchyma Lung alveoli Brain tissue

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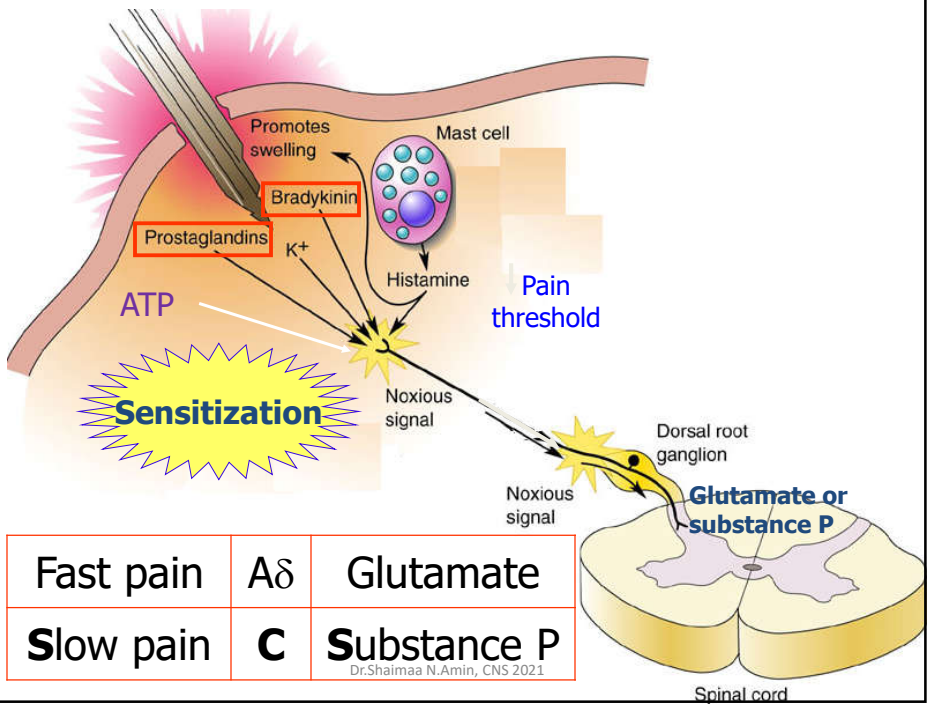

Fast pain	Aδ	Glutamate
Slow pain	**C**	**S**ubstance P

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Types of pain

Pain can be classified according to Quality :

1. Fast pain (sharp, acute, pricking, immediate)
2. Slow pain (burning, chronic, dull aching, throbbing)

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Fast pain	Slow pain
Felt within 0.1 sec	Felt within 1 sec or more
Short duration	May be prolonged
Well localized	Poorly localized
Mechanical or thermal	All types of receptors
Usually in skin, rare in deep tissues	Skin, deep tissues & viscera

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Fast pain	Slow pain
Carried by Aδ, blocked by pressure	Carried by C, blocked by local anaesthetics
Aδ release Glutamate	C release Substance P
Transmitted by Neo-spinothalamic T	Transmitted by Paleospinothalamic T
Its fibers end in sensory cortex	End in RF ~~—N~~on-specific thalamic nuclei ~~—wh~~ole cortex

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Pain pathways

Two separate pathways:

I. Neospinothalamic pathway:

Conducting quick, localized pain (Fast sharp pain)

II. Paleospinothalamic pathway:

For slow pain

Lateral spinothalamic tract

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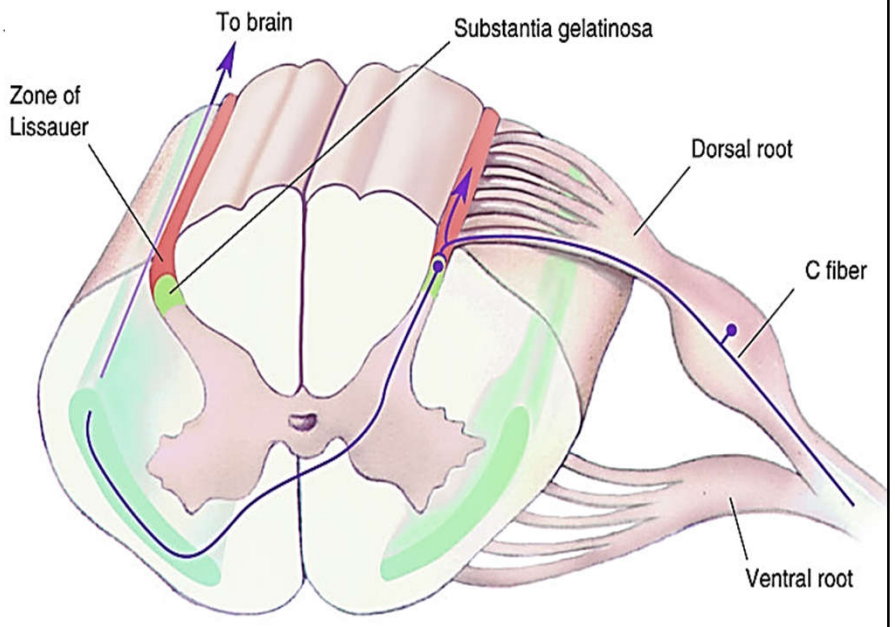

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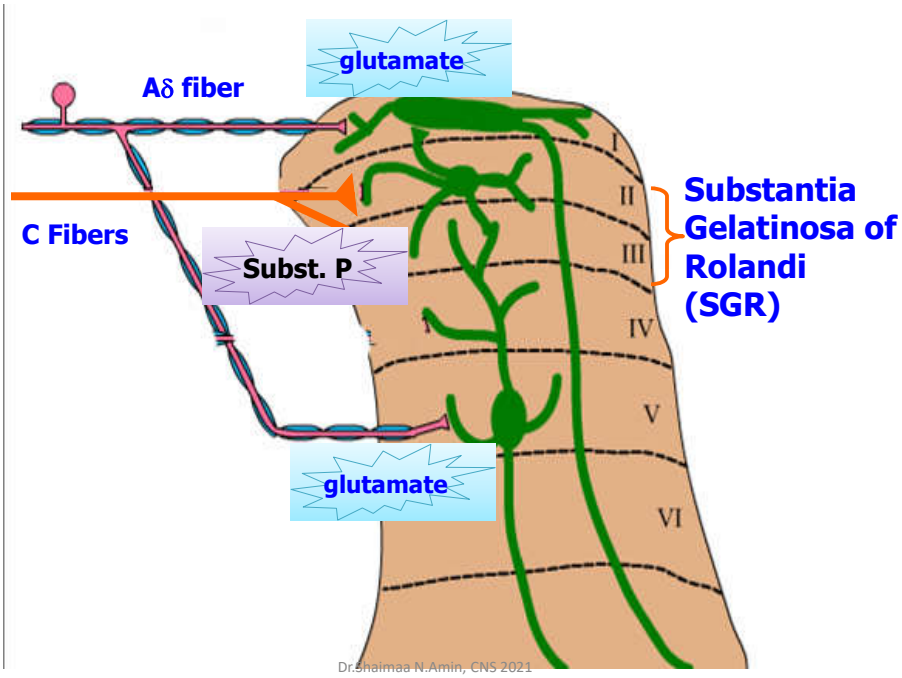

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	Dorsal column	Spinothalamic
n. Fiber type	Large myelin. Aα & Aβ	Smaller myelin. Aδ and non. C fibers
Origin in relation to the body	➢Carrying S. from the same side. ➢Ascend as 1st order n. non crossed f.	➢Carrying S. from the opposite side . ➢ Ascend as 2nd order n. crossed f.
Types of S.	Mechanoreceptive **(Unimodality)**	Crude touch, tickle & itch , temp., pain. **(Polymodality)**

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	Dorsal column	Spinothalamic
1st order n.	Long axons ascend in D.C. to end in gracile & cuneate n. in medulla	Short axons end in dorsal horn of spinal grey matter.
2nd order n.	➢Axons decussate in medulla ➢Ascend as medial lemniscus	➢Axons decussate in spinal cord ➢Ascend as contralateral spinothalamic T

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Roles of the cortex in pain perception are

1. **Localization of pain.**
2. **Discrimination of pain.**
3. **Modulation of pain.**

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Reaction to pain

- Arousal reaction
- Motor reflexes
  - Withdrawal reflex in fast pain
  - Increased m. tone in slow pain
- Autonomic reactions
- Emotional reactions

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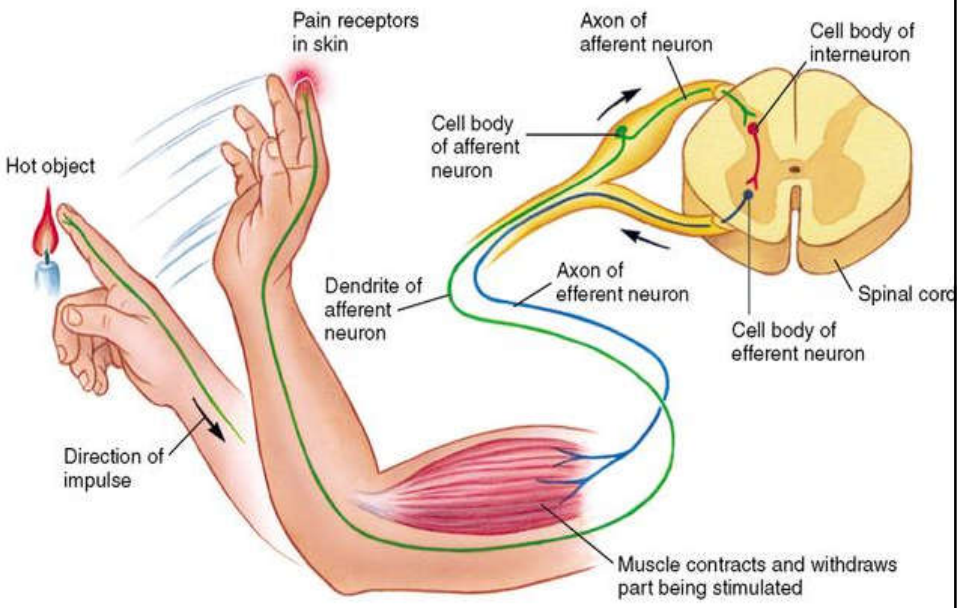

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Referred pain

- **Definition**

pain felt in somatic structure away from its site of origin & has the same dermatomal supply i.e. supplied by the same dorsal root.

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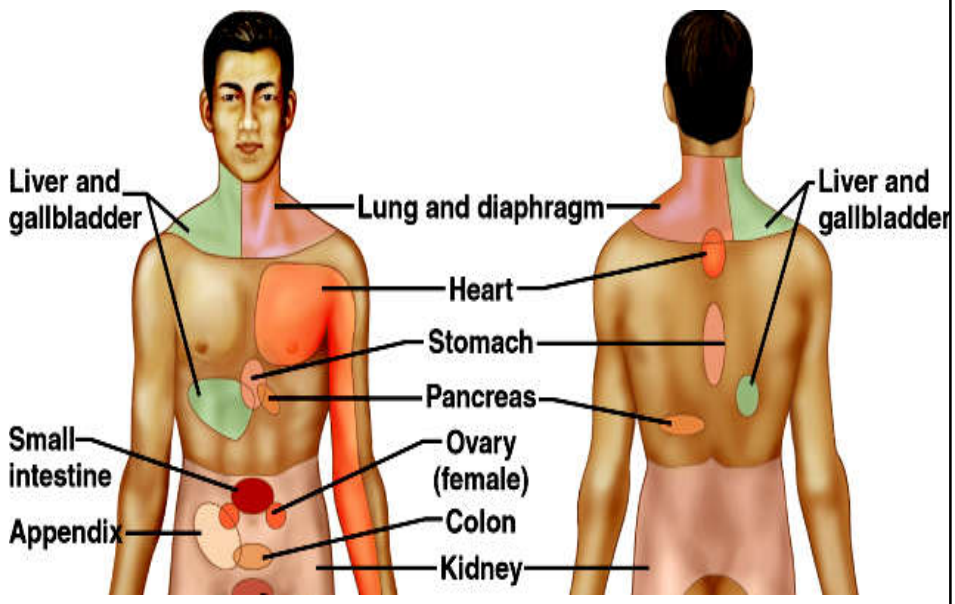

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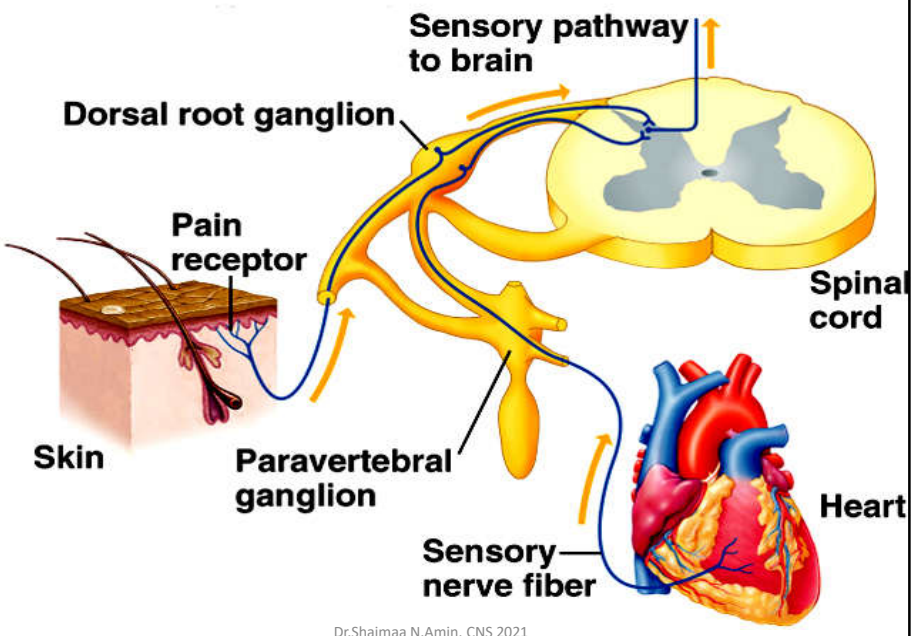
1. Convergence Projection theory



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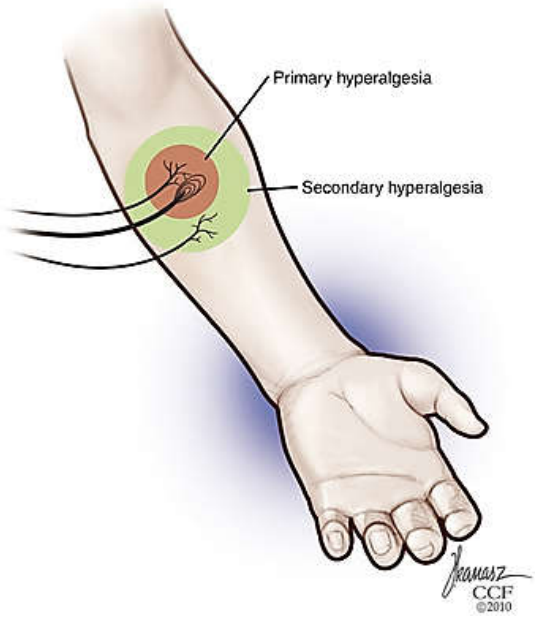

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Examples of referred pain

- Cardiac pain
- Gastric pain
- Gall bladder pain
- Renal Pain
- Appendicitis pain

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Headache

Pain referred to the surface of the head from deep structures.

I. Headache of intracranial origin

- **The brain is insensitive to pain**
- **Pain receptors are found only in :**
  - Venous sinuses
  - Dural arteries
  - Dura
  - Tentorium

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I. Causes of intracranial H.

Meningeal causes

1. Meningitis
2. Brain tumour
3. Alcohol
4. Trauma
5. Constipation

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Non Meningeal intracranial causes

1. Hypertension
2. Drop of intracranial pressure
3. Migraine

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II. Causes of extracranial H.

1. Muscular spasm
2. Inflammation of nasal sinuses
3. Errors of refraction
4. Otitis media
5. Toothache
6. Systemic disorders
7. Trigeminal neuralgia

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Pain control

The gate theory

The dorsal horn cells of the spinal cord, in particular the cells of the SGR, act as a gate for the transmission of pain sensation to the brain

Opening of the gate	Closure of the gate
Impulses in C fibers	Analgesia system
	Opioid peptides
	Impulses in Aβ or Aδ

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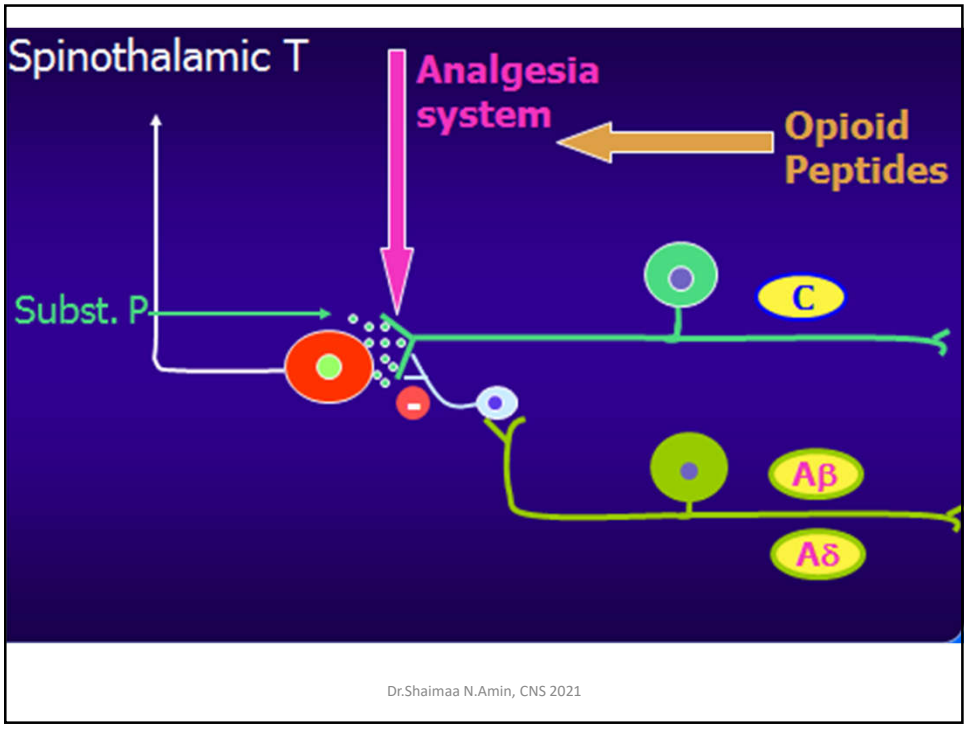
Spinothalamic T
Analgesia system
Opioid Peptides
Subst. P
C
Aβ
Aδ
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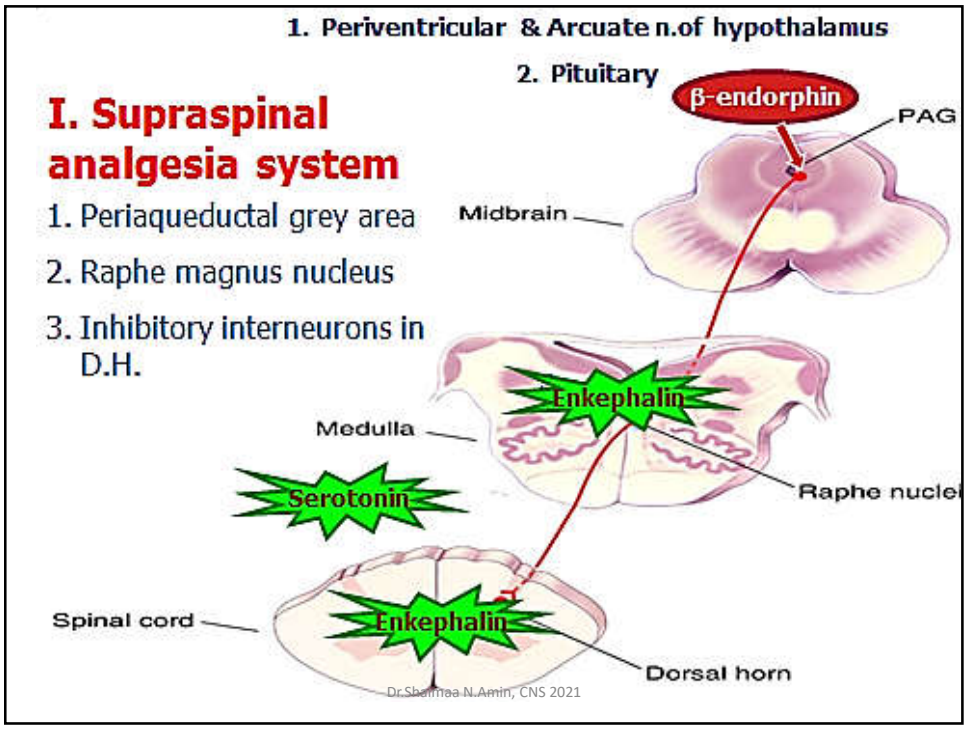
1. Periventricular & Arcuate n.of hypothalamus
2. Pituitary
β-endorphin
PAG
I. Supraspinal analgesia system
1. Periaqueductal grey area
2. Raphe magnus nucleus
3. Inhibitory interneurons in D.H.
Midbrain
Enkephalin
Medulla
Raphe nuclei
Serotonin
Spinal cord
Enkephalin
Dorsal horn
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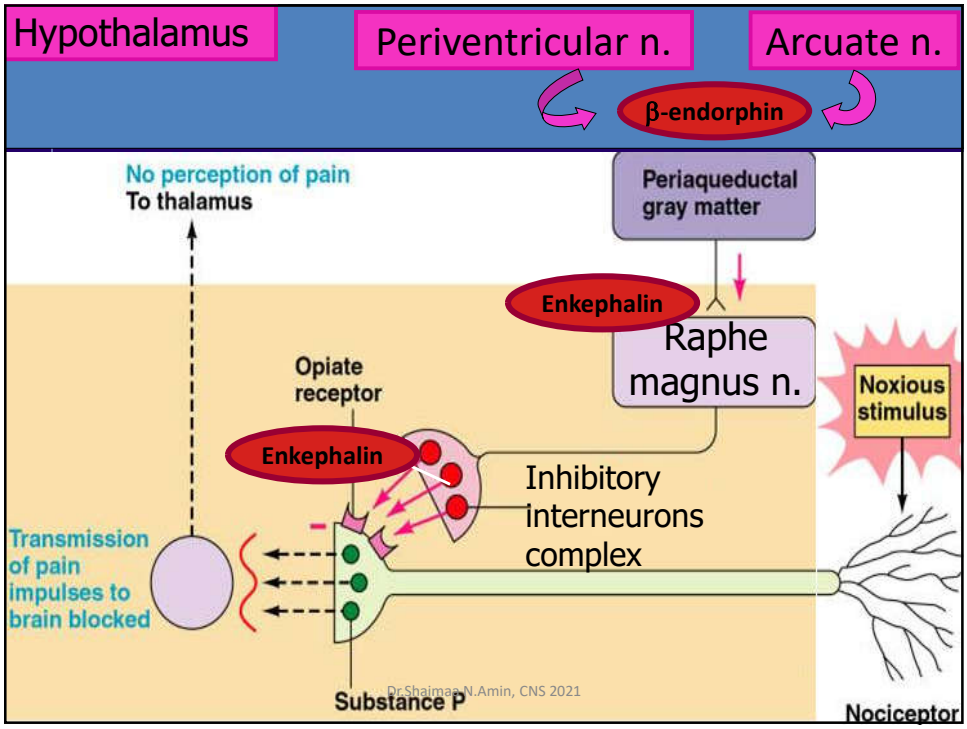

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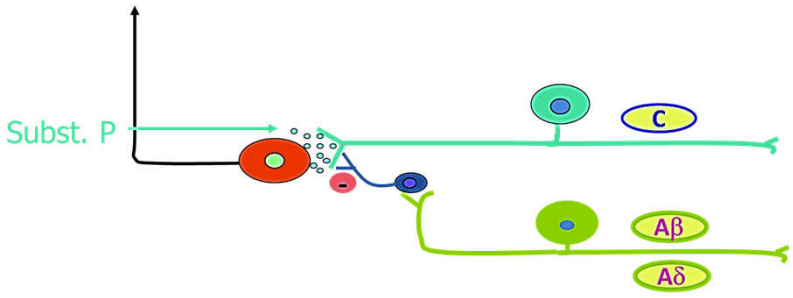
Spinal impulses

a. Collaterals from Aβ Fibers (rubbing of skin)

b. Collaterals from Aδ (counter irritation and acupuncture)



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What are the differences between the ascending and descending pain pathways?

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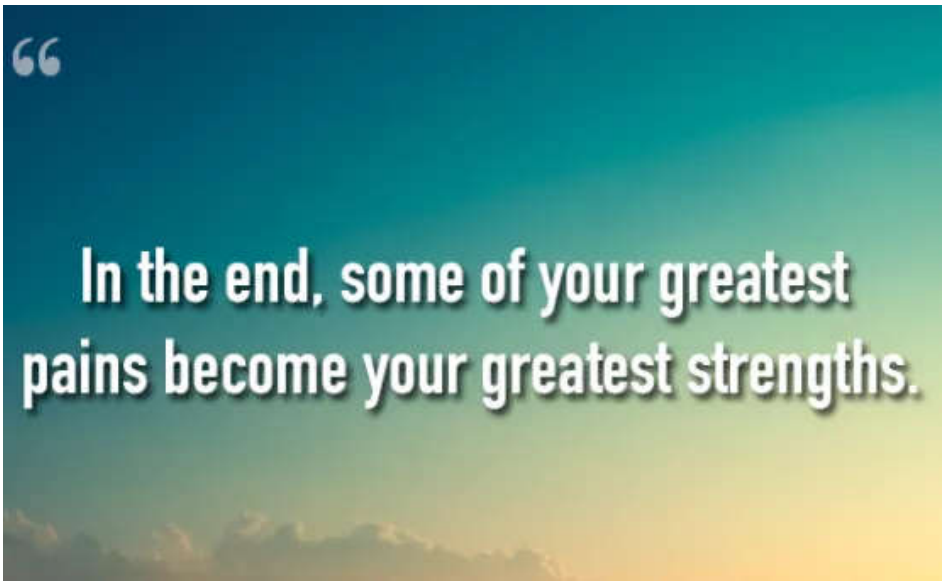

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