

ANAT LEC 3 (FINAL)

* Ascending Sensory tracts:

Posterior column - medial lemniscal pathway

- purely **sensory**, high velocity & precise signals
- located in post. white column which is **divided into**:
 - ① fasciculus gracilis (medially)
 - ② fasciculus cuneatus (laterally)
- **Modality**:
ability to discriminate when touched in different points (precise) (senses: touch, vibration, pressure, conscious proprioception in muscles & joints to know its position)
- **conscious** proprioception → signals reach cortex / **unconscious** → signals reach cerebellum
- **receptor**: most types except free nerve endings (they're slower)

• 1st Order neuron (1° afferent neuron)

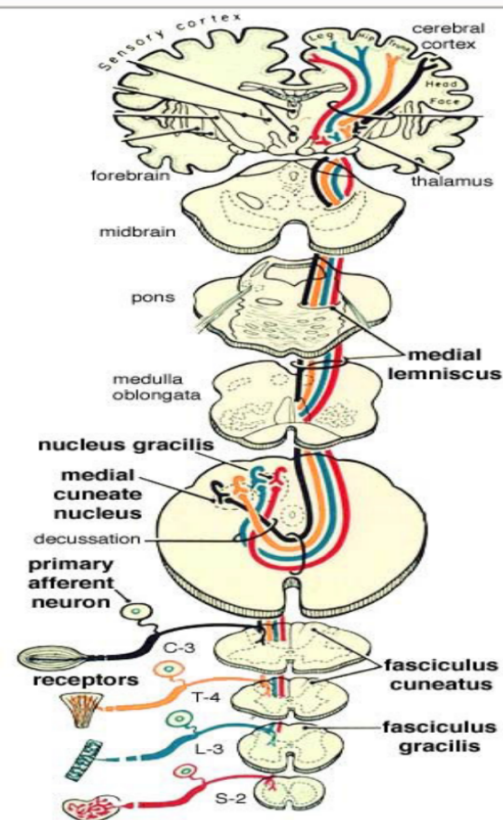
- Cell bodies → in dorsal root ganglion
- pseudounipolar → 2 processes:
 - ① peripheral (comes from skin)
 - ② central: enter spinal cord to post. white column (no synapse) → ascends ipsilat. to reach medulla oblongata → synapse with 2nd order neuron

• 2nd order neuron

- Cell bodies → in medulla oblongata (nucleus gracilis (med.) & cuneatus (lat.))
- internal accurate fiber - lemniscal decussation - medial lemniscus
- fibers of 2 nuclei cross midline (in the lower part of medulla oblongata) forming the internal accurate fibers (inj. sensory decussation, sensation is contralateral) → ascend to reach thalamus (3rd order neuron)

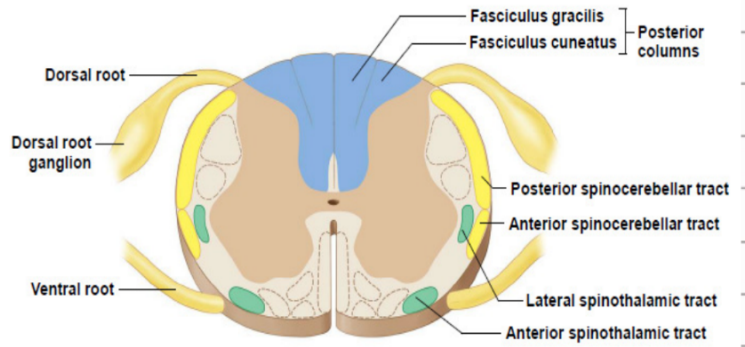
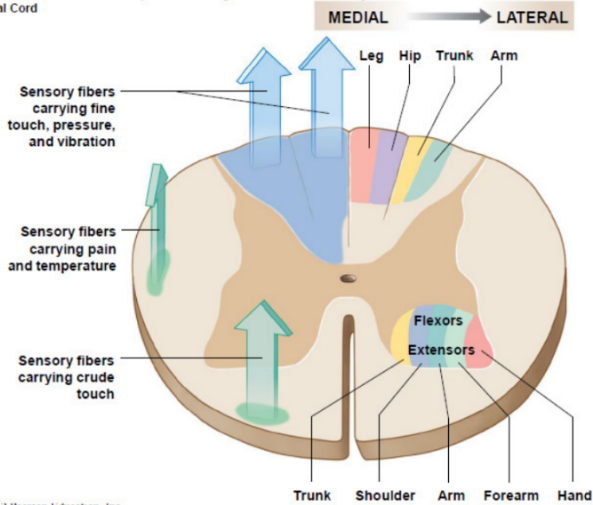
• 3rd order neuron

- Cell bodies → in thalamus (ventral posterolateral cell bodies)
- neuron goes to cortex through narrow space bet. caudate medially & lentiform laterally (internal capsule → has fibers, corona radiata)



• **termination** : 1° Somatosensory area (S1)
 most proprioception is subunconscious but here its conscious

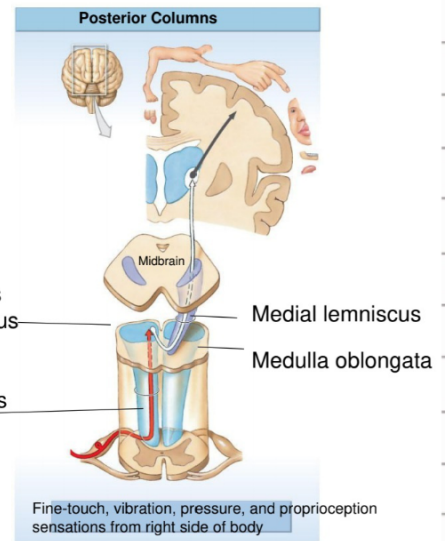
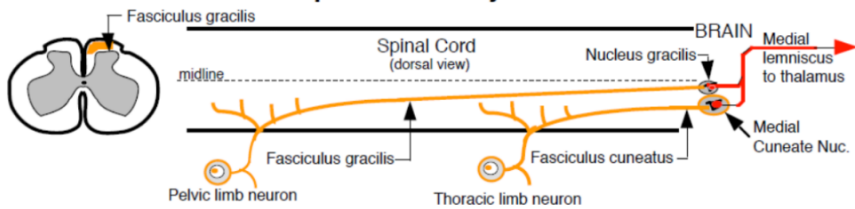
Figure 15.1 Anatomical Principles for the Organization of the Sensory Tracts and Lower-Motor Neurons in the Spinal Cord



• **Somatotopic principle** :
 fibers are arranged according to their location (lower organs → more medial)

• **fasciculus gracilis** (medially) transmits info from below T6
 • **fasciculus cuneatus** (laterally) transmits info from above T6

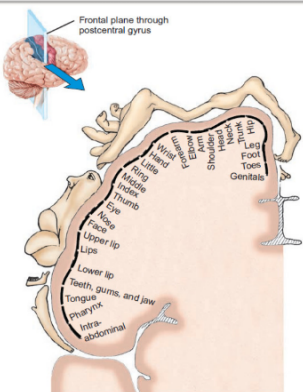
Discriminative Touch Spinal Pathway



clearer table from O19 sheets

ELECTROPHYSIOLOGIC CLASSIFICATION OF PERIPHERAL NERVES	CLASSIFICATION OF AFFERENT FIBERS ONLY (CLASS/GROUP)	FIBER DIAMETER (μm)	CONDUCTION VELOCITY (m/s)	RECEPTOR SUPPLIED
Sensory Fiber Type				
Aα	Ia and Ib	13-20	80-120	Primary muscle spindles, Golgi tendon organ
AB	II	6-12	35-75	Secondary muscle spindles, Skin mechanoreceptors
Aδ	III	1-5	5-30	Skin mechanoreceptors, thermal receptors, and nociceptors (fast pain)
C	IV	0.2-1.5	0.5-2	Skin mechanoreceptors, thermal receptors, and nociceptors (slow pain)
Motor Fiber Type				
Aα	N/A	12-20	72-120	Extrafusal skeletal muscle fibers
Aγ	N/A	2-8	12-48	Intrafusal muscle fibers
B	N/A	1-3	6-18	Preganglionic autonomic fibers
C	N/A	0.2-2	0.5-2	Postganglionic autonomic fibers

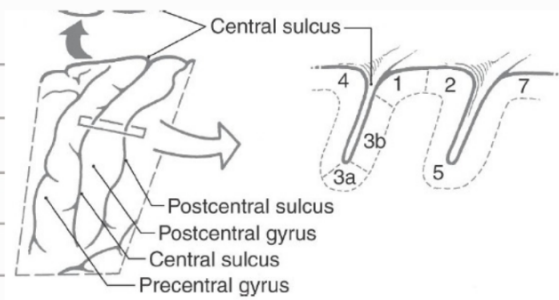
→ diameter & velocity



• Cortex is divided into 4 lobes :
 ① frontal → motor ② temporal → auditory
 ③ occipital → visual
 ④ parietal → sensory (post central gyrus, 1° sensory cortex (S1/2)) → sensory homunculus according to no. of receptors (somatotopic principle)

1° Somatosensory Cortex is sub divided :

- Area 3a → mainly muscle spindle afferents
- Area 2 → mainly golgi tendon organs & joint afferents
- Area 3b & 1 → Cutaneous afferents from receptors (pain, temp, meissner cells, merkel cells)

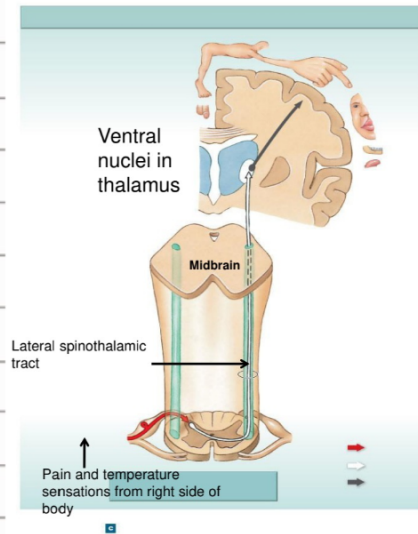


Anterolateral System (ALS)

- Sub divided into : ant. & lat. Spinothalamic pathways
- Modality : pain, temp, Crude touch, pressure

Lateral Spinothalamic pathway

- modality : pain & temp
- receptors : free nerve endings
- purely sensory



1st order neuron

- cell bodies → in dorsal root ganglion
- brings sensation from skin into spinal cord through dorsal root → synapses in dorsal horn (grey matter) with 2nd order neuron (ipsilaterally)

2nd order neuron

- cell bodies → in post. grey column (Substantia gelatinosa formed by laminae 1 & 2)
- axons cross midline (to opposite side of grey & white commissures) → ascend in contralateral white column (lat. spinothalamic tract) → reach thalamus (3rd order neuron)

3rd order neuron

- cell bodies → in ventral posterolateral nucleus VPL (thalamus)
- projects to cortex via internal capsule, corona radiata

- termination : 1° Somatosensory area & widespread cortical region (more than 1 location to influence how we perceive pain)

rexed laminae

- lamina 1,2,5 → info related to pain & temp (related to spinothalamic tract)
- lamina 3,4 → Nucleus proprius (have many interneurons)
- lamina 6 → presents Cervical & lumbar enlargements, recieve proprioception
- lamina 7

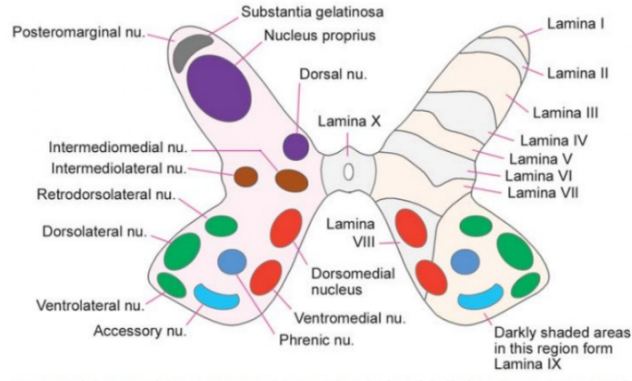
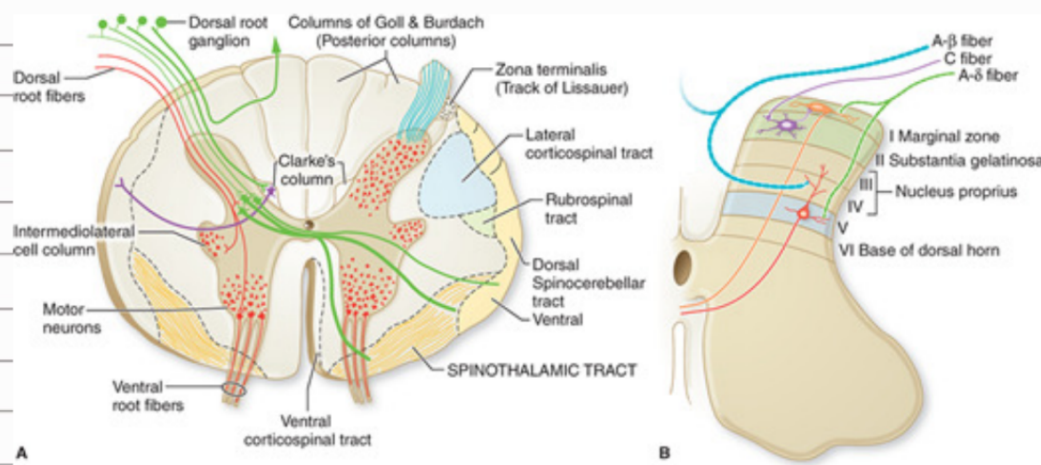


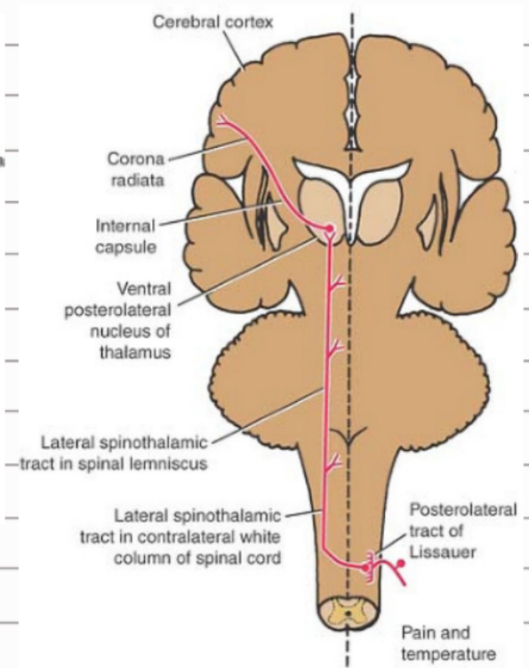
Fig. 5.2. Subdivisions of the grey matter of the spinal cord. The left half of the figure shows the cell groups usually described. The right half shows the newer concept of laminae.

- ↳ intermedio lateral nucleus → preganglionic Symp. (T₁-L₂)
- ↳ intermedio medial nucleus → visceral pain (all spinal cord)
- ↳ dorsal nucleus of Clark's → unconscious proprioception (C₈-L₂ or T₁-L₄)

pain	description	fibers	laminae	example
fast	Sharp, initial injury	Aδ	1,5	needle stick injury
slow	poorly localized, dull	C	1,2 (Substantia gelatinosa)	infection pain

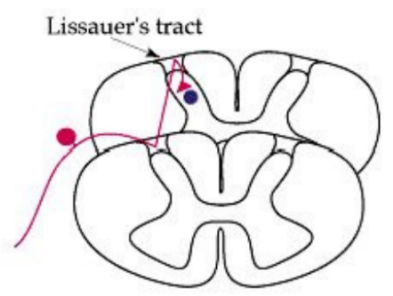


Source: Ropper AH, Samuels MA, Klein JP: Adams and Victor's Principles of Neurology, Tenth Edition. www.accessmedicine.com. Copyright © The McGraw-Hill Companies, Inc. All rights reserved.



Posterolateral tract of Lissauer

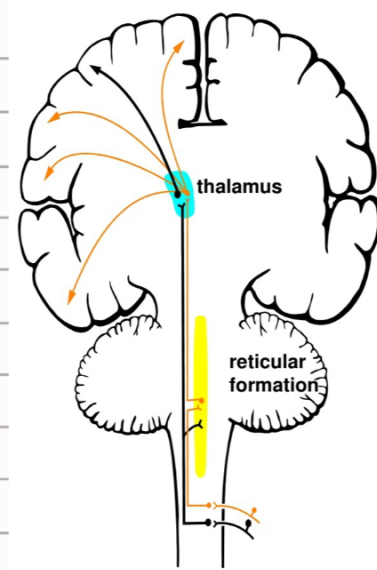
- bet. posterior & lateral white columns
- fibers enter spinal cord but don't necessarily synapse within the same segment, they can go up or down to another segment forming Lissauer's tract (made of 1st order neuron)



• other terminations of lat. Spinothalamic tract:

① reticular formation

- mainly in brain stem (pons, medulla, midbrain)
- majority of slow pain fibers
- aware of pain
- the conscious mind responsible for consciousness & works like switch of cortex.
eg: fibers of slow pain activate reticular formation to keep us aware of pain / loud sound activate reticular formation to switch cortex on so we wake up.



② cingulate gyrus

- emotional aspect of pain (memories of pain & conditioning)
- very important part of limbic system (bet. telencephalon & diencephalon of cortex)

③ insular gyrus

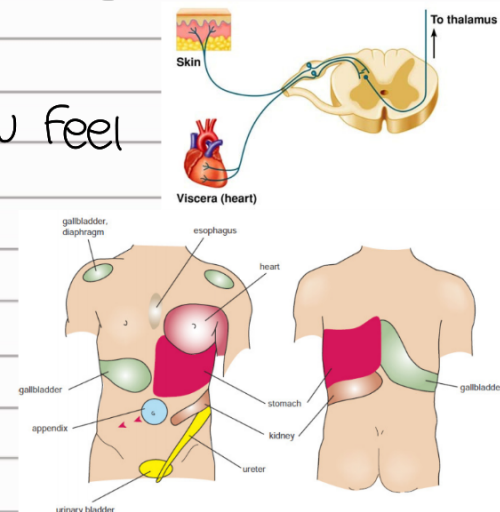
- deep in lateral sulcus
- autonomic response to pain stimuli (sweating, vomiting, ↑HR)

• referred pain:

- When the source of pain is visceral but you feel it somewhere else

- info from multiple nociceptor afferents converges onto individual spinothalamic tract neurons → brain interprets info coming from visceral receptors as having arisen from surface receptors (usually nociceptors are on body surface) → brain can't decide pain origin so it assumes it came from the usual place (skin) → referred pain

- eg: a) Rt shoulder pain → gallbladder origin
- b) Lt shoulder, arm, lower jaw pain → heart origin
- c) Umbilicus region pain → appendicitis



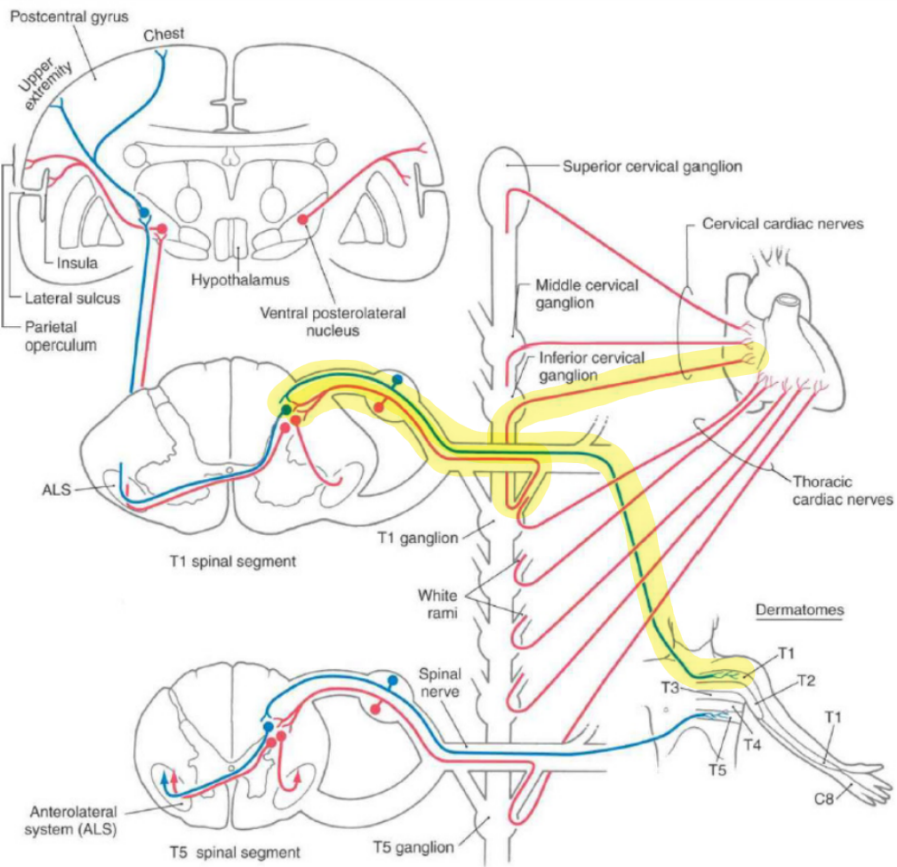
• heart receives innervation from:

① Autonomic

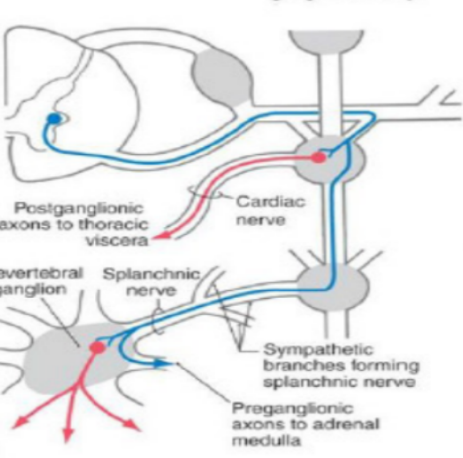
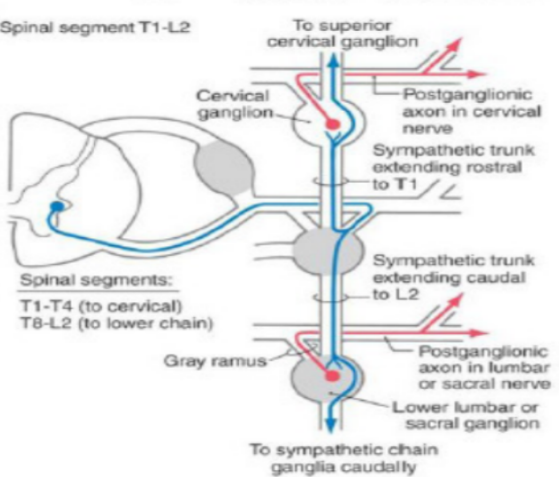
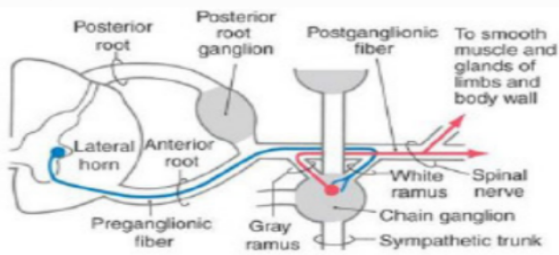
(motor, synapse in Symp. Chain)

② C fibers

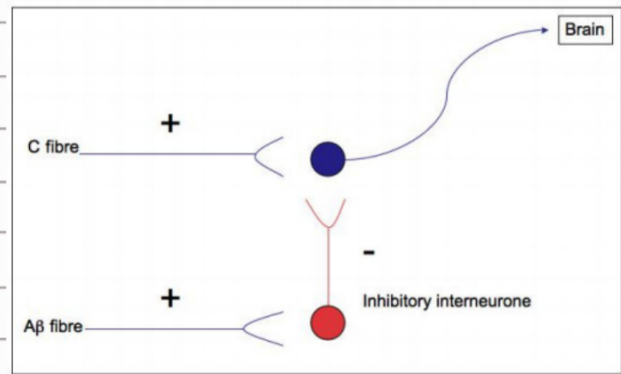
(thoracic & cervical cardiac nerves, sensory, synapse with the same 2nd order neuron as skin)



• Sympathetic Chain ↓



• the gating theory (pain control in CNS)



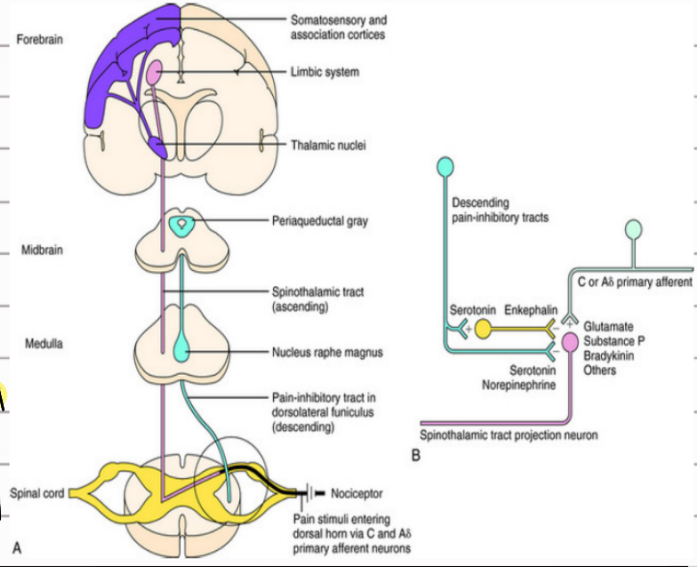
- gating theory: you can inhibit pain sensation via mechanical stimulus (pressure, touch)

- C, A δ \rightarrow nociceptor fibers (activate 2nd order neuron going to cortex)

- A β \rightarrow mechanoreceptors (connected with interneuron that synapses with 2nd order neuron of pain pathway to inhibit pain sensation (\oplus A β \rightarrow gate closed, \ominus A β \rightarrow gate open))

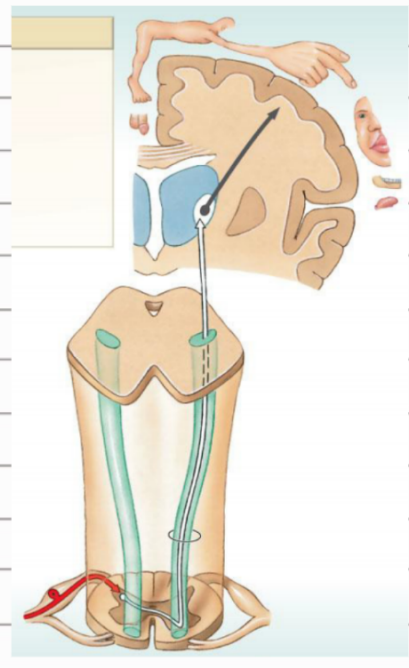
• descending control of pain (pain control in CNS)

- **Spinoreticular fibers** (pain fibers)
 - Stimulate Periaqueductal gray (PAG) → PAG fibers project to nucleus raphe magnus (NRM) → NRM produces **Serotonin** → Activates inhibitory neurons → Secrete **enkephalins & endorphins** (morphine like actions) in **Substantia gelatinosa**
- **locus coeruleus** in pons directly inhibits Substantia gelatinosa



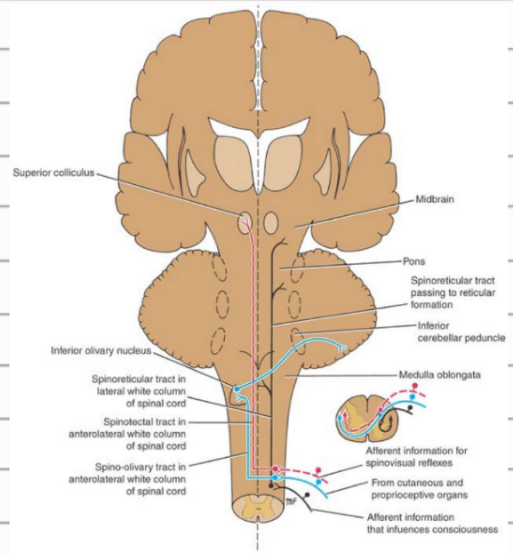
2] Anterior spinothalamic tract

- **modality**: crude touch & pressure
- **receptors**: free nerve endings
- **1st order neuron**
 - Cell bodies → in dorsal root ganglia
- **2nd order neuron**
 - Cell bodies → nucleus proprius (posterior grey column)
 - axons cross midline in Ant. gray & white Commissures → ascends contralaterally
- **3rd order neurons**
 - Cell bodies → VPL (thalamus)
 - projects to Cortex via int. capsule - Corona radiata
- **termination**: 1° somatosensory pathway



Spinotectal tract

- **tectum** = post. aspect of mid brain
- ascend in anterolateral white column close to subthalamic
- **termination**: Sup. Colliculus
- **modality**: afferents for spinovisual reflexes (eg: move head & eyes to injury site)
- Anterolateral Spinothalamic + Spinotectal = **Spinal Lemniscus**



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