

# ASCENDING TRACTS

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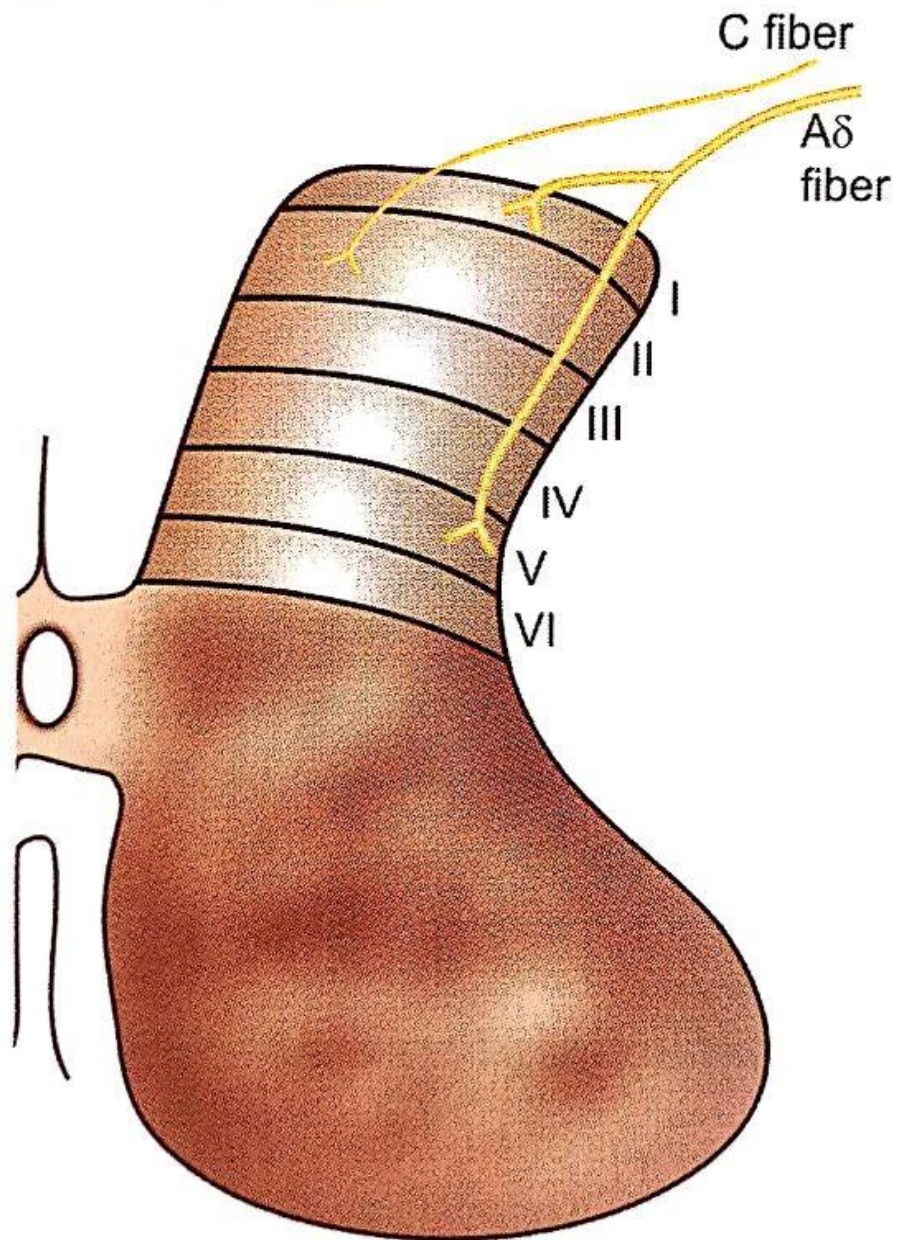
# DERMATOME

- ▶ AREA OF SKIN SUPPLIED BY SINGLE SPINAL NERVE

# REXED LAMINAE

Grey matter is divided into various laminae.

The **Rexed laminae** comprise a system of ten layers of grey matter (I-X), identified in the early 1950s by **Bror Rexed** to label portions of the spinal cord.



**Fig. 120.1:** Termination of pain fibers in dorsal horn of spinal cord.

## **GREY MATTER :**

contains cell bodies of neurons, dendrites and parts of axons.

### **\*\* POSTERIOR/DORSAL HORN: Lamina I–VI**

- ▶ Neurons present are: Nucleus proprius, Substantia gelatinosa of Rolando (SGR) cells (lamina III and IV), chief sensory cells.
- ▶ Lamina VII is called as intermediate zone where there are special type of cells called as Dorsal nucleus or Clarke's column.

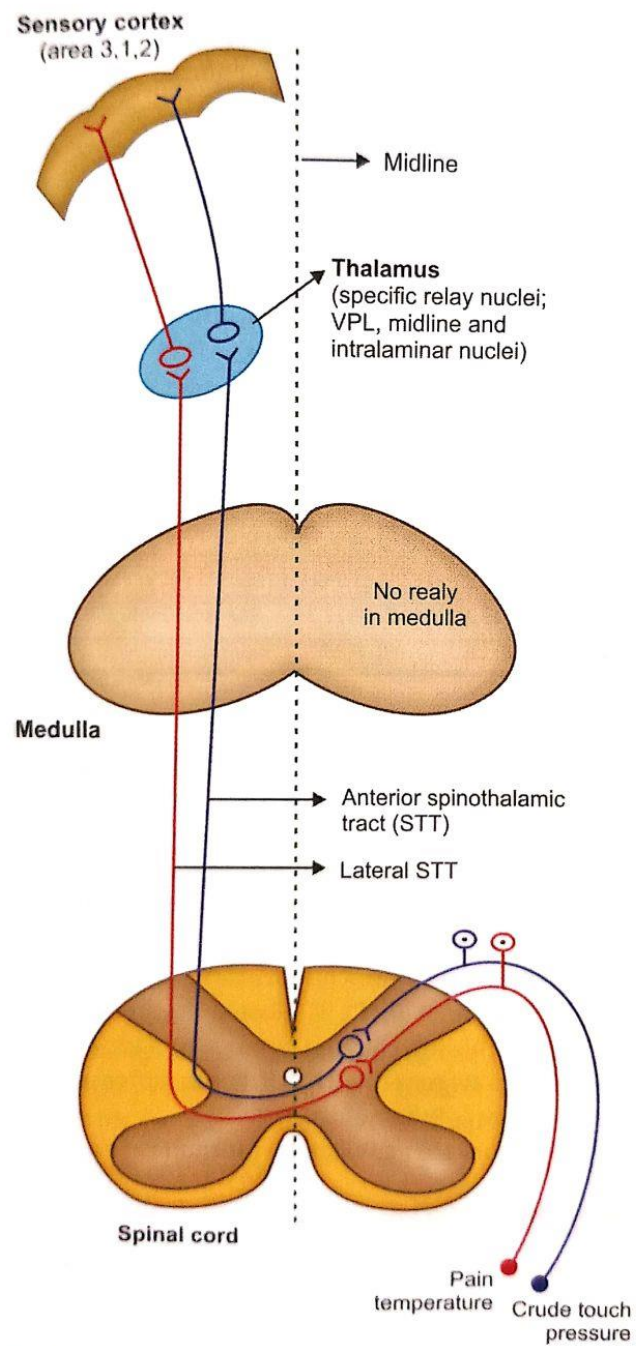
- \*\* ANTERIOR / VENTRAL HORN:** (Lamina VIII & IX): Alpha motor neurons, Beta motor neurons, Gamma motor neurons.
- ▶ Lamina X forms area of gray matter around spinal cord.

## **\*\*LATERAL HORN:**

Present only in the thoracic and upper lumbar segments. They give rise to pre ganglionic sympathetic fibres.

# WHITE MATTER

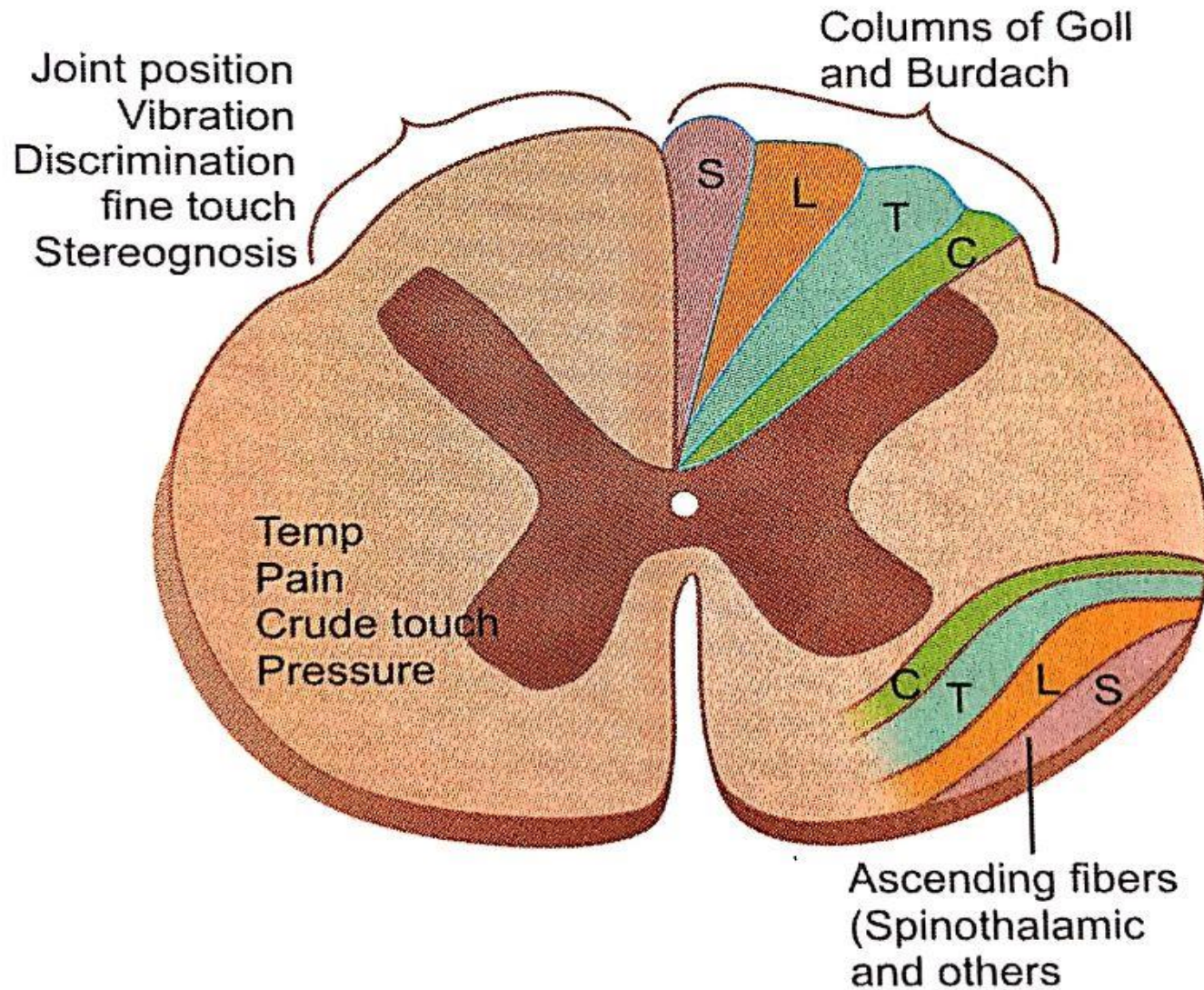
- ▶ Contains myelinated and unmyelinated nerve fibres.
- ▶ These fibres are arranged in groups, having similar functions and are called **tracts**.



**Fig. 119.2:** Anterolateral system.

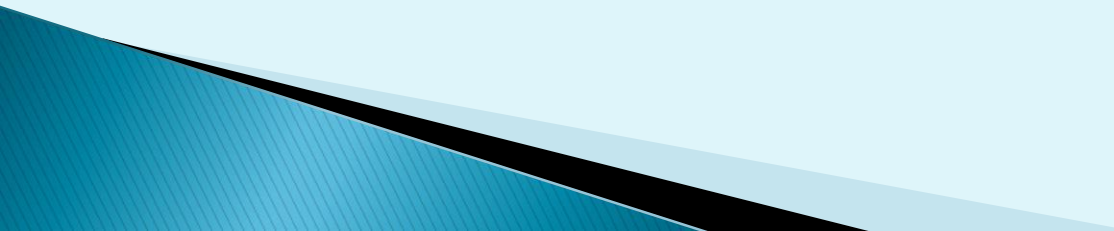
# ASCENDING (SENSORY)/ AFFERENT TRACTS

- ▶ DORSAL (POSTERIOR) WHITE COLUMN :  
TRACT OF GOLL AND BURDACH
- ▶ LATERAL WHITE COLUMN:
  - 1) LATERAL SPINOTHALAMIC TRACT
  - 2) VENTRAL AND DORSAL SPINOCEREBELLAR TRACT
- ▶ VENTRAL(ANTERIOR) WHITE COLUMN:  
VENTRAL SPINOTHALAMIC TRACT

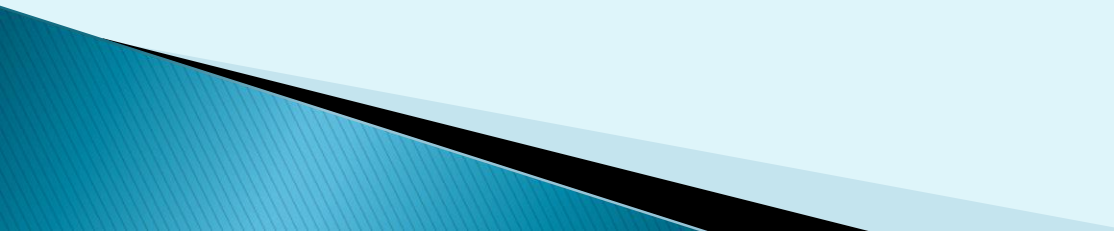


**Fig. 120.3:** Topographic organization of pain and other sensory fibers in spinal cord.

# OTHER ASCENDING TRACTS

- ▶ SPINO TECTAL TRACT
  - ▶ SPINO OLIVARY TRACT
  - ▶ SPINO RETICULAR TRACT
  - ▶ SPINO VESTIBULAR TRACT
  - ▶ SPINO PONTINE TRACT
  - ▶ SPINO CORTICAL TRACT
- 

# TRACT

- ▶ ORIGIN
  - ▶ SITUATION
  - ▶ COURSE
  - ▶ EXTENT
  - ▶ ORDER NEURONS
  - ▶ CROSSING
  - ▶ TERMINATION
  - ▶ FUNCTION
  - ▶ APPLIED
- 

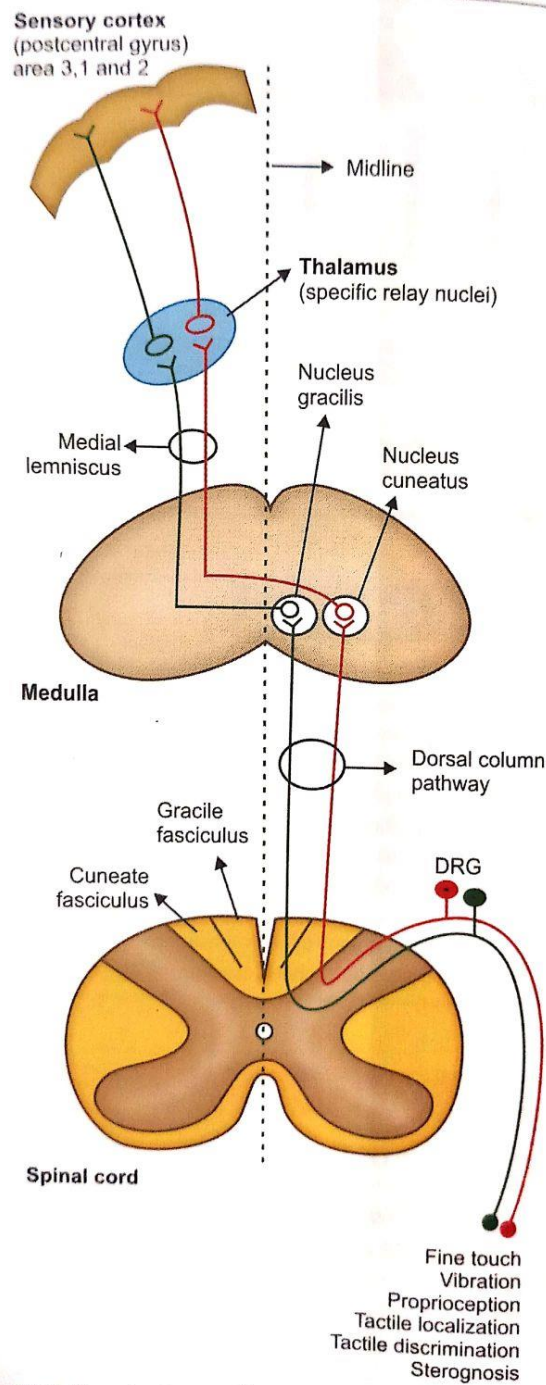
# TRACT OF GOLL AND BURDACH

- ▶ POSTERIOR COLUMN
- ▶ DORSAL COLUMN
- ▶ FASCICULUS GRACILIS, FASCICULUS CUNEATUS

# FUNCTIONS

- ▶ FINE TOUCH
  - ▶ TACTILE LOCALISATION
  - ▶ TACTILE DISCRIMINATION
  - ▶ KINESTHETIC SENSATIONS – SENSE OF POSTURE AND PASSIVE MOVEMENTS (CONCIOUS PROPRIOCEPTIVE SENSATIONS)
  - ▶ VIBRATION, STEREOGNOSIS
  - ▶ SOME UNCONCIOUS SENSATIONS
- 
- ▶ \* TRACT OF GOLL: LOWER HALF OF BODY
  - ▶ \* TRACT OF BURDACH: UPPER HALF OF BODY

- ▶ ORIGIN: AXONS OF BIPOLAR CELLS OF POSTERIOR ROOT GANGLION
- ▶ 1<sup>ST</sup> ORDER NEURONS: DO NOT CROSS, END IN N. GRACILIS AND N. CUNEATUS IN MEDULLA
- ▶ 2<sup>ND</sup> ORDER NEURONS:
  - a) EXTERNAL ARCUATE FIBERS
  - b) INTERNAL ARCUATE FIBERS



**Fig. 119.1:** Dorsal column pathways.

# ETERNAL ARCUATE FIBERS

## ▶ DORSAL

- INFERIOR CEREBELLAR PEDUNCLE
- SAME SIDED CEREBELLUM
- CARRY UNCONCIOUS SENSATIONS

## ▶ VENTRAL

- CROSS
- INFERIOR CEREBELLAR PEDUNCLE
- CEREBELLUM OF OPPOSITE SIDE
- CARRY UNCONCIOUS SENSATIONS

# INTERNAL ARCUATE FIBERS

- ▶ CROSS AND FORM MEDIAL LEMNISCUS
- ▶ MIDBRAIN
- ▶ VENTRO POSTRO LATERAL NUCLEUS OF THALAMUS
- ▶ FORM 3<sup>RD</sup> ORDER NEURONS  
POSTERIOR 1 / 3<sup>RD</sup> OF POST. LIMB OF  
INTERNAL CAPSULE  
POST CENTRAL GYRUS OF CEREBRAL CORTEX

# APPLIED

- ▶ TABES DORSALIS: SENSORY FIBERS IN DORSAL ROOT AND DORSAL TRACT ARE DEGENERATED DUE TO NEUROSYPHILIS
- ▶ SENSORY ATAXIA: DUE TO LACK OF INFORMATION FROM PROPRIOCEPTORS DUE TO DAMAGE TO DORSAL TRACT.  
SUBJECT CANNOT STAND OR WALK STRAIGHT WITH EYES CLOSED.
- \* ASTEREOGNOSIS: INABILITY TO RECOGNISE SIZE, SHAPE, FORM OF FAMILIAR OBJECTS WITH EYES CLOSED

Most of the incoming information results from stimulation of

General sensory receptors

Touch / pressure / temperature / pain

Stimulation of proprioceptors

Muscle stretch / tendon / joint

3 major somatic sensory pathways:

1. The posterior column pathway
2. The spinothalamic pathway
3. The spinocerebellar pathway

These pathways involve a chain of neurons:

First-order neuron – from sensory ganglion to the CNS

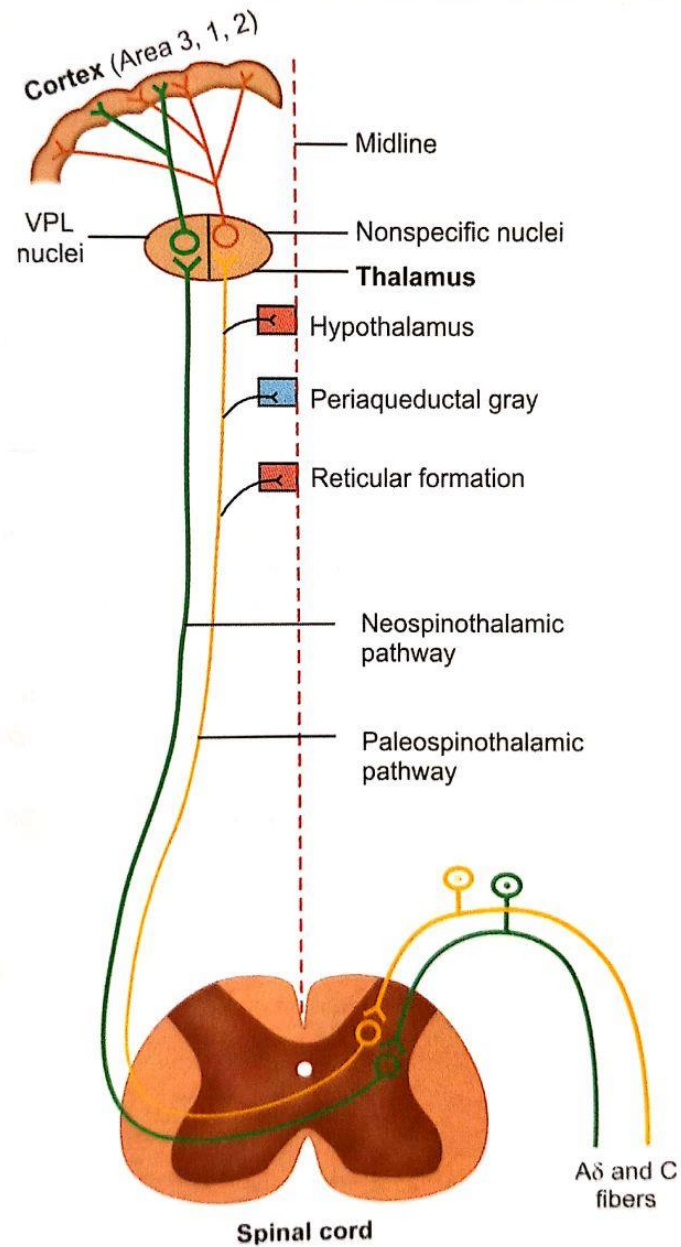
Second-order neuron – an interneuron located in either the spinal cord or the brain stem

Third-order neuron – carries information from the thalamus to the cerebral cortex



# SPINOTHALAMIC TRACT

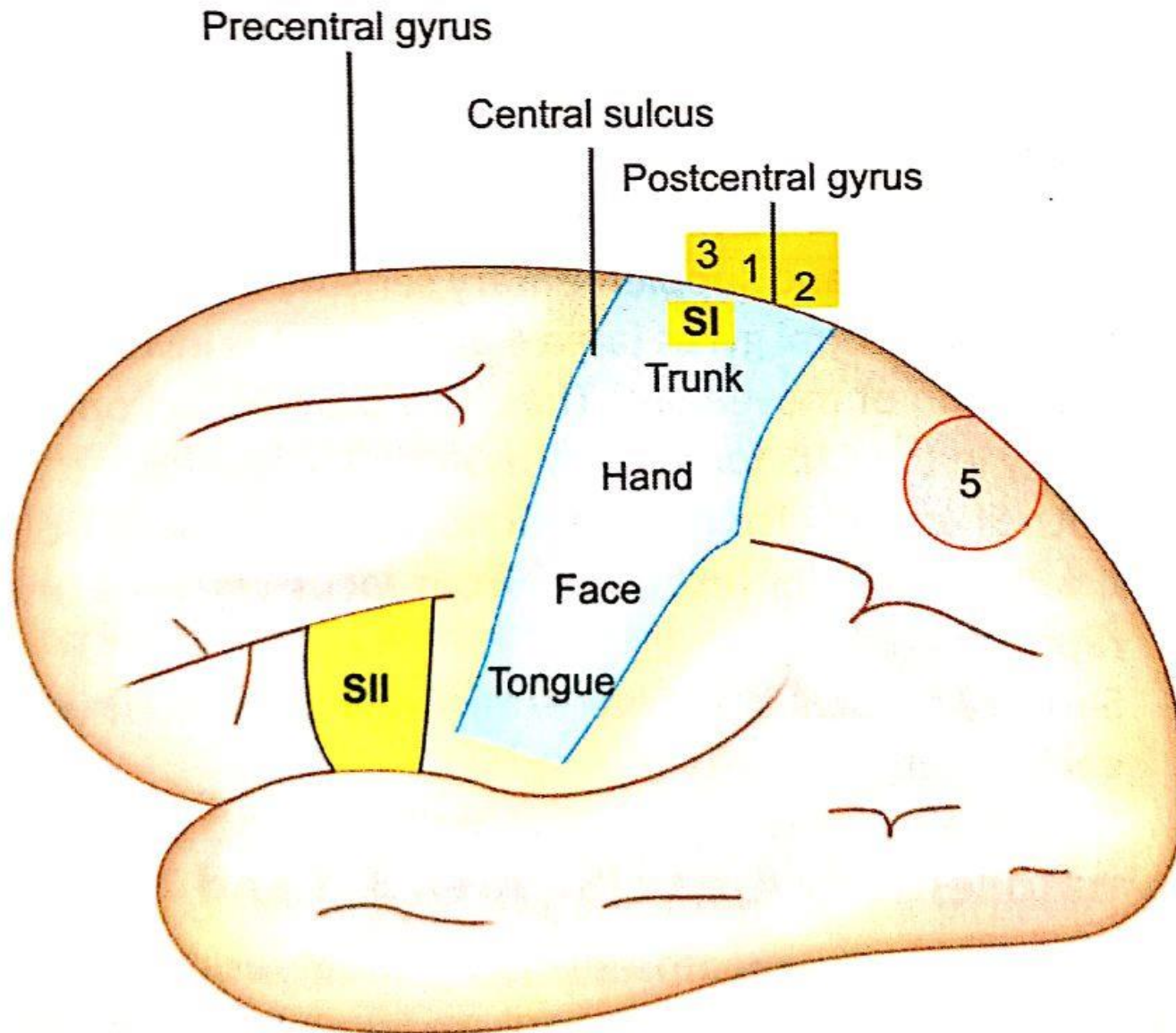
- ▶ ANTERIOR STT– LIES IN ANT. WHITE FUNICULUS
- ▶ LATERAL STT– LIES IN LATERAL WHITE FUNICULUS
- ▶ ORIGIN:
  - FIRST ORDER NEURONS– POST. NERVE ROOT GANGLIA
  - 2<sup>ND</sup> ORDER NERONS–
  - ANT. STT –CHIEF SENSORY CELLS OF POSTERIOR GRAY HORN
  - LATERAL STT– SUBSTANTIA GELATINOSA OF ROLANDO.



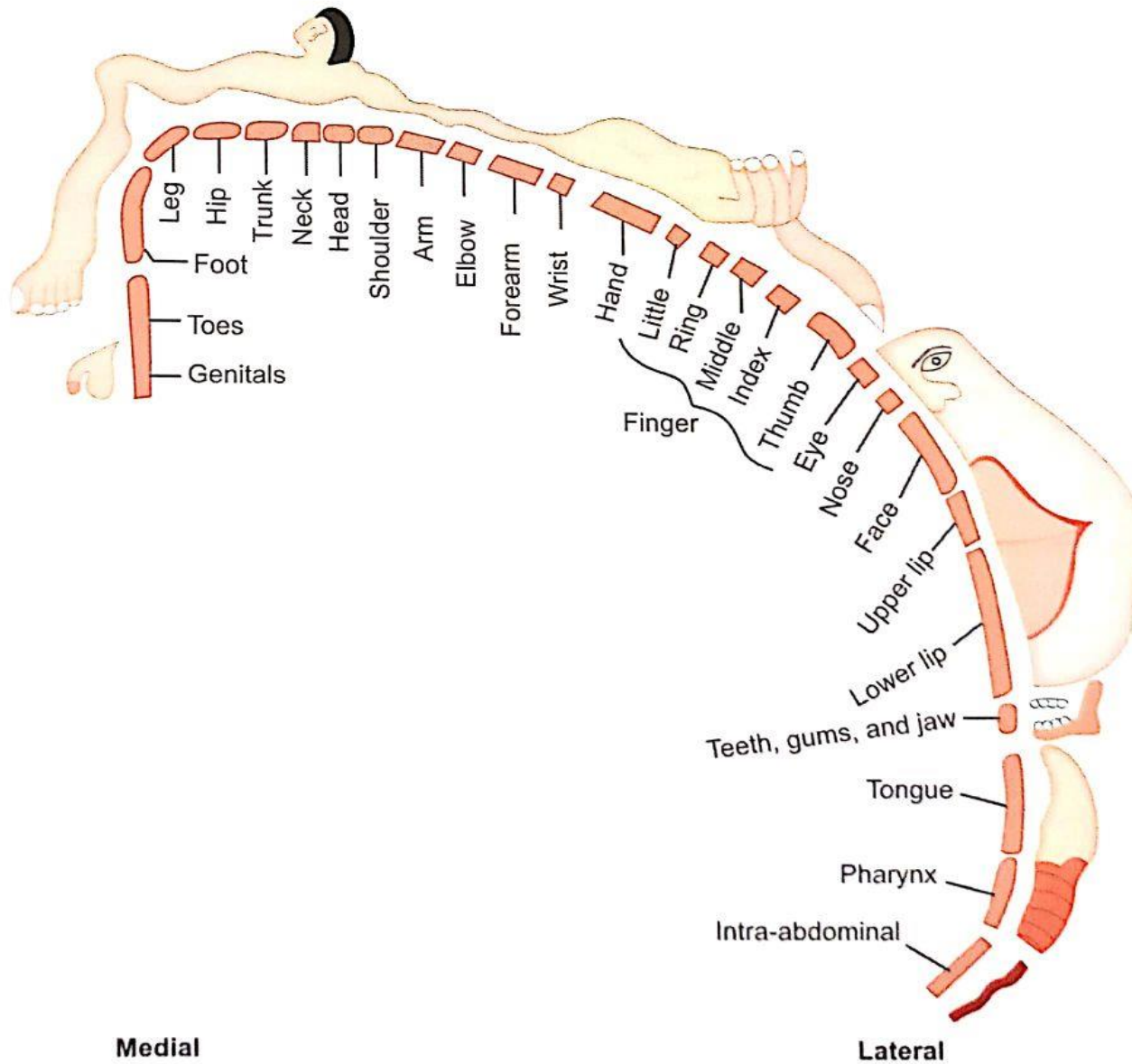
**Fig. 120.2:** Paleospinothalamic and neospinothalamic pain pathways. Note the collaterals in the brainstem from paleospinothalamic pathway terminating in different brainstem nuclei.

# COURSE

- ▶ SPINAL CORD– cross to opp. side and enter ant. or lat. white funiculus.  
crossed fibers then ascend up through other segments of sc.
- ▶ BRAINSTEM– fibers ascend through bs (called spinal lemniscus) and reach thalamus .some fibers of lat. stt end in reticular formation of brainstem.
- ▶ THALAMUS: 2<sup>nd</sup> order neuron fibers end in thalamic nucleus and give rise to 3<sup>rd</sup> order neuron fibers.
- ▶ CEREBRAL CORTEX: 3<sup>rd</sup> order neuron fibers terminate in sensory area of cortex.



**Fig. 123.1:** Cortical sensory areas.



Medial

Lateral

**Fig. 123.3:** Sensory homunculus. Note, larger cortical representations are from face and hands.

# FUNCTION:

- ▶ ANTERIOR STT. CARRIES– CRUDE TOUCH.
- ▶ LATERAL STT CARRIES – FINE TOUCH, PAIN, TEMPERATURE SENSATIONS.

## EFFECT OF LESION:

UNILATERAL LESION CAUSE LOSS OF PAIN, TEMP, AND TOUCH ON OPPOSITE SIDE OF LESION.

# Trigeminal Pathway for Fine-Touch Sensation from the Face

Primary afferent fibers that supply the **face, teeth, oral and nasal cavities, and cranial meninges** synapse in several brainstem nuclei, including the **main sensory nucleus** and the **spinal nucleus of the trigeminal nerve**.

This sensory nucleus relays tactile information to the contralateral **ventral posterior medial (VPM) thalamic nucleus** by way of the **trigeminothalamic tract**.

Third-order neurons in the **VPM nucleus** project to the facial area of the somatosensory cortex.

# SPINOCEREBELLAR TRACT

- ▶ VENTRAL (CROSSED/GOWER'S)  
SPINOCEREBELLAR TRACT
- ▶ DORSAL (UNCROSSED/FLECHSIG'S)  
SPINOCEREBELLAR TRACT

\* LOCATION: SITUATED IN LATERAL WHITE  
FUNICULUS

▶ ORIGIN:

1<sup>ST</sup> ORDER NEURONS– POSTERIOR ROOT  
GANGLIA

2<sup>ND</sup> ORDER NEURONS–  
CLARKE'S COLUMN (VENTRAL SC T.) L3–L5  
CLARKE'S COLUMN (DORSAL SC T.) C7–T6

# COURSE

- \* SPINAL CORD: fibers of ventral sc t. immediately cross to opposite side and ascend up in spinal cord.
- fibers of dorsal sct. ascend through sc without crossing.
- ▶ spinocerebellar fibers ascend from sc to medulla, pons and midbrain to reach cerebellum.
- ▶ CEREBELLUM– fibers reach cerebellum through cerebellar peduncles and end in vermis of cerebellum, 3<sup>rd</sup> neurons arise and reach cortex of cerebellum

# FUNCTION

- ▶ CARRY SUBCONCIOUS KINESTHETIC SENSATIONS (PROPRIOCEPTIVE IMPULSES FROM MUSCLES, TENDONS AND JOINTS).
- ▶ EFFECT OF LESION:  
VENTRAL SC T.– LOSS OF SUBCONCIOUS SENSATIONS ON OPPOSITE SIDE OF BODY.  
DORSAL SC T.– LOSS OF SUBCONCIOUS SENSATIONS ON SAME SIDE OF BODY.

- ▶ CEREBRAL CORTEX HAS CONTRALATERAL (OPPOSITE SIDED) CONTROL.
- ▶ CEREBELLUM HAS IPSILATERAL (SAME SIDED) CONTROL.

# PATHWAY OF TOUCH

- ▶ TRACT OF GOLL AND BURDACH: FINE TOUCH
- ▶ ANTERIOR SPINOTHALAMIC TRACT: CRUDE TOUCH
- ▶ TRIGEMINAL LEMNISCUS: TOUCH FROM FACE REGION

# SPINOTECTAL TRACT

- ▶ SPINAL CORD TO SUPERIOR COLLICULUS ( MID BRAIN).
- ▶ FUNCTION: SPINOVISUAL REFLEXES

# SPINORETICULAR TRACT

- ▶ SPINAL CORD TO RETICULAR NUCLEI IN RETICULAR FORMATION OF BRAINSTEM
- ▶ FUNCTION: MAINTENANCE OF CONSCIOUSNESS AND AWARENESS.

# SPINOVESTIBULAR TRACT

- ▶ SPINAL CORD TO LATERAL VESTIBULAR NUCLEUS
- ▶ FUNCTION: CONCERNED WITH POSTURAL REFLEXES.

# SPINO OLIVARY TRACT

- ▶ SPINAL CORD TO INFERIOR OLIVARY NUCLEUS

# INJURIES OF SPINAL CORD

- ▶ HEMISECTION– BROWN SEQUARD SYNDROME.
- ▶ COMPLETE TRANSECTION
- ▶ INCOMPLETE TRANSECTION

# HEMISECTION OF SPINAL CORD– (BROWN SEQUARD SYNDROME)

- ▶ Partial transaction and damage caused only to half of the spinal cord.
- ▶ Typical motor and sensory changes develop after recovery from the spinal shock.
  - \* At the level of section,
  - \* Below the level of section and
  - \* Above the level of section.

# BELOW THE LEVEL OF LESION

## SENSORY CHANGE

- ▶ Same side– All fine sensations (fine touch & vibration) & position sense lost (due to damage to tract of Goll and Burdach's) but crude sensations persist.
- ▶ Opposite side– All crude sensations (crude touch, pain & temp.) lost due to damage to anterior and lateral spinothalamic tracts but fine sensations persist.

## MOTOR CHANGES

- ▶ Same side– There is upper motor neuron type of paralysis (increased muscle tone, exaggerated reflexes, Babinski's sign)
- ▶ Opposite side– No motor loss

# AT THE LEVEL OF SECTION

## SENSORY CHANGE

- ▶ Same side– All sensations (fine and crude) are lost due to damage to posterior root.
- ▶ Opposite side– Only some crude sensations specially pain are lost as many spinothalamic fibers do cross at the same level of spinal cord.

## MOTOR CHANGES

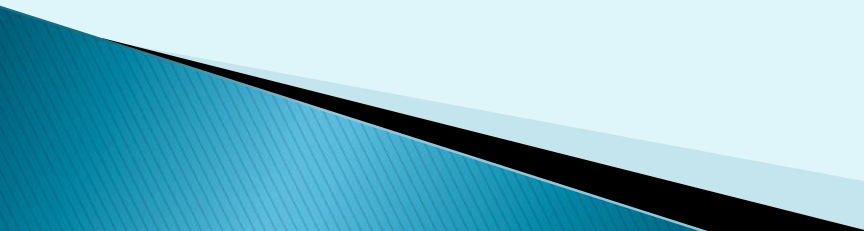
- ▶ Same side– Lower motor neuron type of paralysis (loss of muscle tone, reflexes, and muscle power) because of damage to the anterior nerve roots.
- ▶ Opposite side– No motor loss or little lower motor neuron type of paresis

# ABOVE THE LEVEL OF LESION

## SENSORY CHANGE

- ▶ Same side– Sensory irritation (hyper aesthesia, i.e. increased cutaneous sensations)
- ▶ for one or two segments above the level of section.
- ▶ Opposite side– little sensory irritation

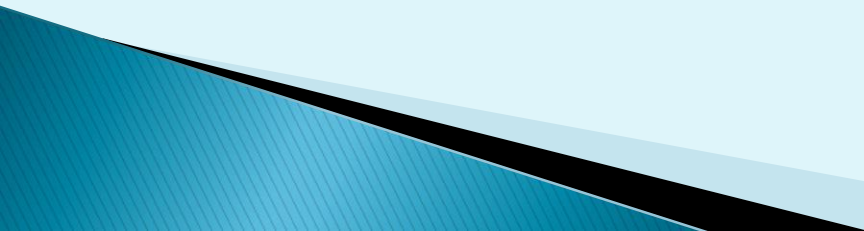
## MOTOR CHANGES

- ▶ Same side– Motor irritation
  - ▶ Opposite side– Little motor irritation
- 

# HEMISECTION OF SPINAL CORD– (BROWN SEQUARD SYNDROME)

- ▶ EFFECTS BELOW, AT, ABOVE THE LEVEL OF LESION.
- ▶ BELOW LEVEL OF LESION:  
SAME SIDE: LOSS OF FINE TOUCH, TACTILE LOCALISATION AND DISCRIMINATION, VIBRATION ETC.  
OPPOSITE SIDE: LOSS OF CRUDE TOUCH, PAIN, TEMPERATURE

# COMPLETE TRANSECTION OF SPINAL CORD

- ▶ STAGE OF SPINAL SHOCK
  - ▶ STAGE OF REFLEX ACTIVITY
  - ▶ STAGE OF REFLEX FAILURE
- 

# COMPLETE TRANSECTION OF SC

## CAUSES

- ▶ Complete division of spinal cord: Automobile accidents, gunshot injury, dislocation of spine.

## 1) Stage of spinal shock or flaccidity–

- Loss of all spinal cord functions– motor, sensory as well as partial autonomic loss.
- Flaccid paralysis
- If lesion above C5, fatal.
- Loss of all reflexes (areflexia)
- loss of all sensation
- low BP, low venous return & weak pulse. (ANS)
- paralysis of bladder & rectum
- Duration– for a minimum of 2 weeks.
- Cause– loss of excitatory discharges from higher centers to spinal neurons.

## 2) STAGE OF REFLEX ACTIVITY

- ▶ first smooth muscle tone returns: leads partial control of bladder & rectum,
- ▶ VMC tone returns so BP is restored to normal,
- ▶ skeletal tone returns & first in flexor groups of muscles this leads PARAPLEGIA IN FLEXION
- ▶ Hyperactive spinal reflexes return, first withdrawal (+ Babinski's sign) then stretch (usually knee jerks)
- ▶ other spinal reflexes like postural autonomic, sexual reflexes, mass reflex etc are elicited,
- ▶ Still limbs don't support body & walking not possible.

### 3) STAGE OF REFLEX FAILURE

- ▶ If complications like infection develop there may be reflex failure, coma and death (septicemia, uremia ).

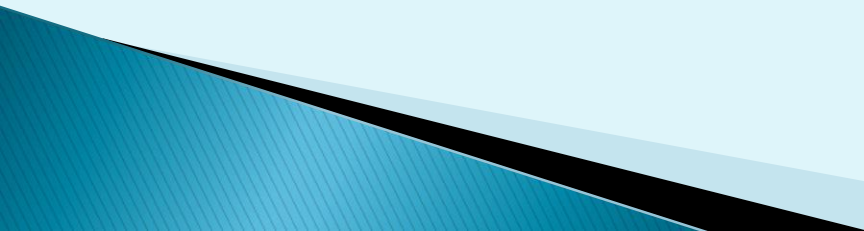
### COMPLICATIONS:

- ▶ Decubitus ulcers, stones, UTI etc

### TREATMENT

- ▶ Glucocorticoids, antibiotics, nutrition, fluid balance, skin care, bladder function & general nursing, stem cell.

# INCOMPLETE TRANSECTION OF SPINAL CORD

- ▶ STAGE OF SPINAL SHOCK
  - ▶ STAGE OF REFLEX ACTIVITY
  - \* STAGE OF REFLEX FAILURE
- 

# STAGE OF REFLEX ACTIVITY

- ▶ Tone first appears in extensor muscles.  
'paraplegia in extension'.
- Extensor reflexes return first.
- Phillipson reflex
- Extensor thrust reflex
- Crossed extensor reflex
- Mass reflex absent.

**THANK  
YOU**