The tracts of spinal cord

Ascending tracts:

- Dorsal column pathway
- Anterior & lateral spinothalamic tract
- Dorsal & ventral spinocerebellar tracts
- Spinotectal, spinoolivary, spinovestibular tracts

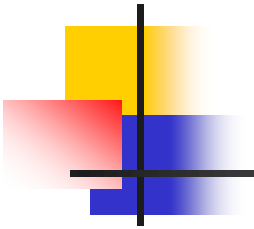
Descending tracts:

- Corticospinal tract /pyramidal tract
- Extrapyramidal tracts

Dorsal column pathway

Sensation subserved:

- Fine touch
- Tactile localisation
- Tactile discrimination
- Vibration sense
- Position sense
- stereognosis



- Anterior spinothalamic tract carries crude touch & pressure
- Lateral spinothalamic tract carries pain & temperature
- Dorsal & ventral spinocerebellar tract carries proprioception

Touch pathway

Fine touch :

- From body excluding head & face:
- **Dorsal column pathway**
- From head & face: **trigeminal pathway**

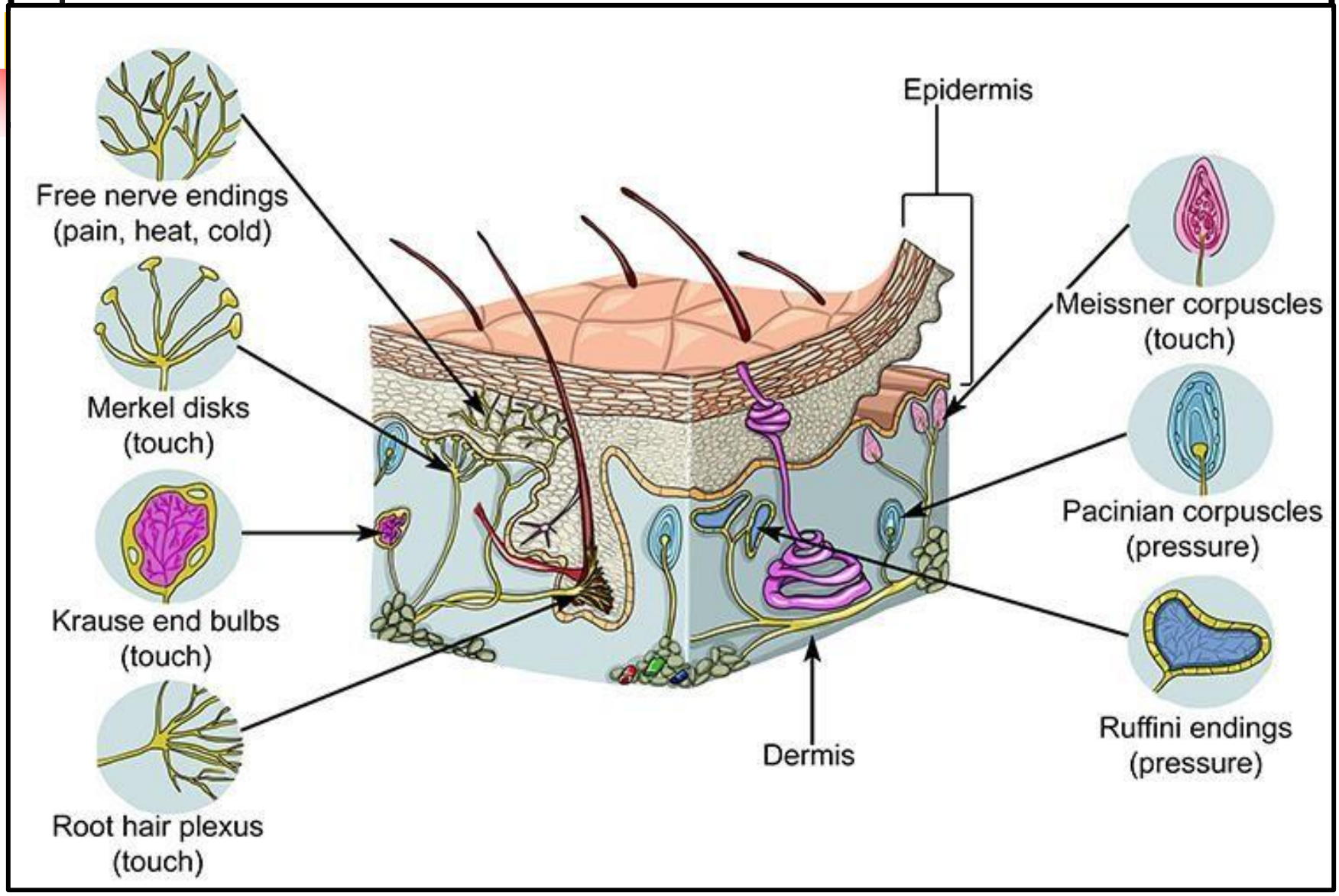
Crude touch:

- From body excluding head & face: **anterior spinothalamic tract**
- From head & face : **trigeminal pathway**

Dorsal column pathway

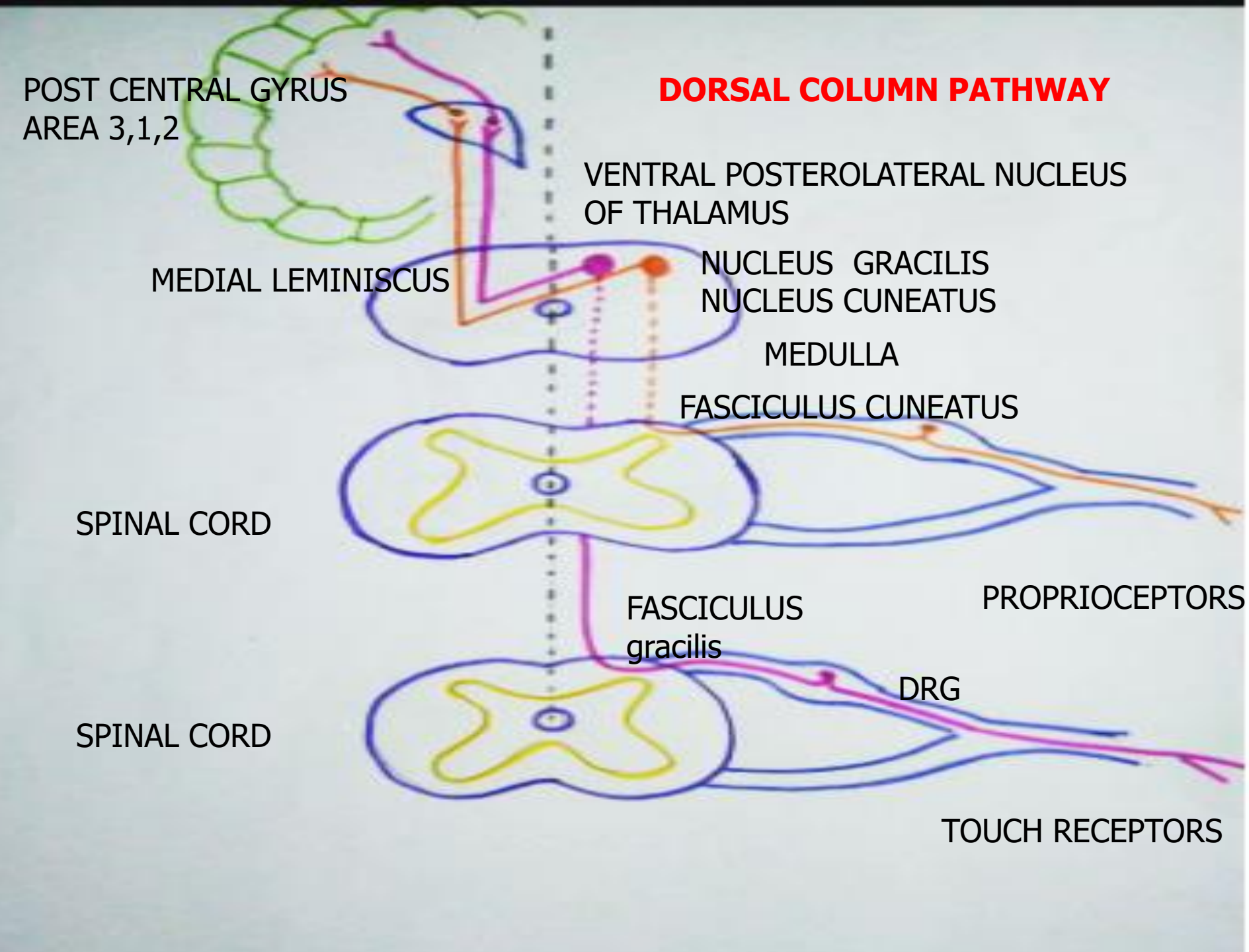
- Tract of Gall & Burdach
- Located in posterior column
- Tract of Gall medially & Burdach laterally

Touch receptors are mechanoreceptors



Dorsal column pathway

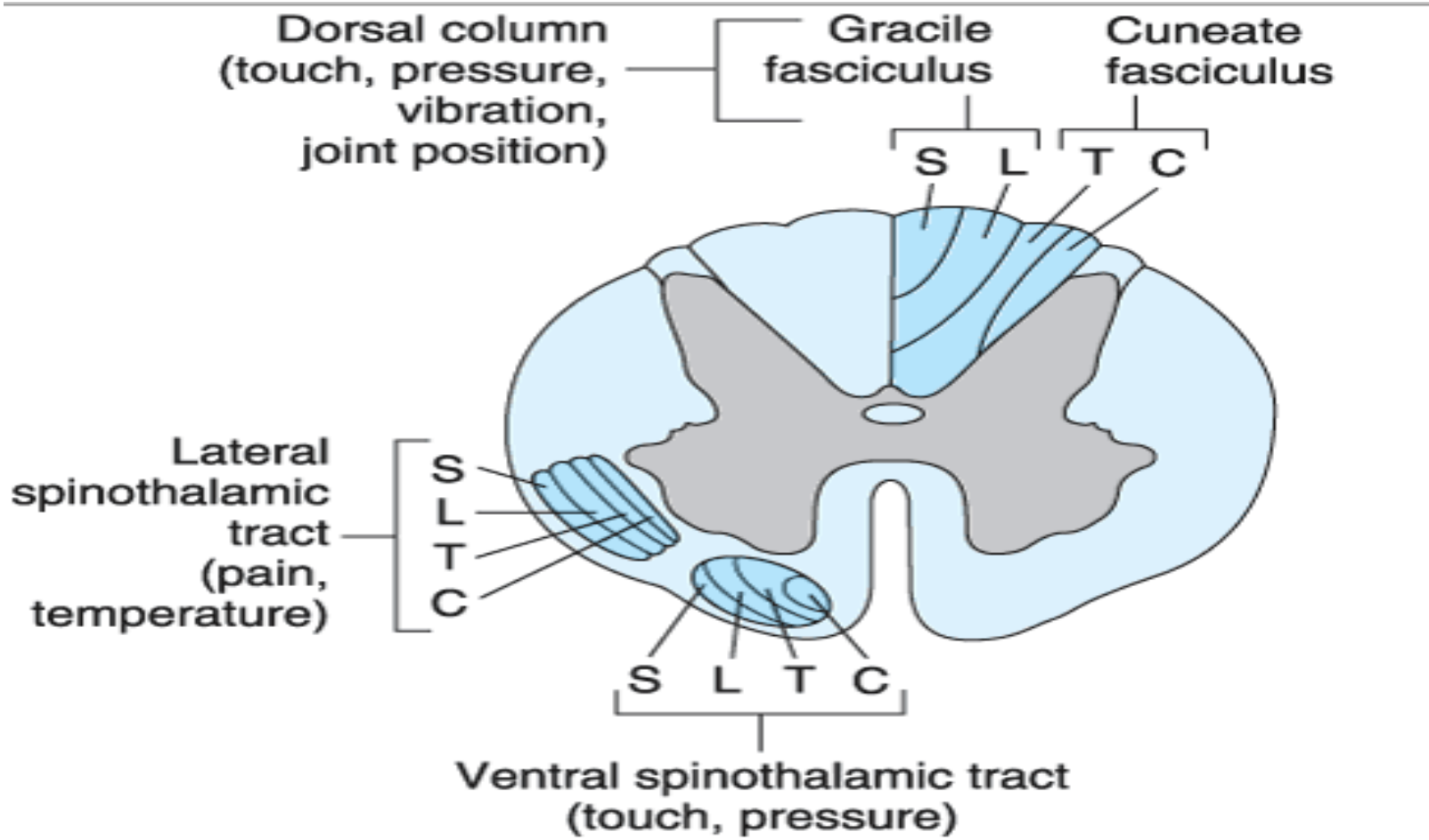
- **Receptor**: touch receptors: free nerve endings, meissner's corpuscle, merkel's disc, pacinian corpuscle
- **Afferent fibres**: Aβ mainly, C, Aδ, Aα for proprioception
- Cell body of 1st order neuron is in **DRG**
- The peripheral process supplies the receptor
- Central process enters the spinal cord through posterior nerve root

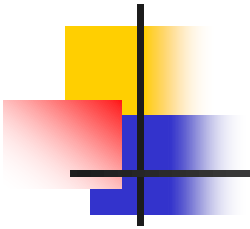

DORSAL COLUMN PATHWAY
POST CENTRAL GYRUS
AREA 3,1,2
VENTRAL POSTEROLATERAL NUCLEUS
OF THALAMUS
MEDIAL LEMINISCUS
NUCLEUS GRACILIS
NUCLEUS CUNEATUS
MEDULLA
FASCICULUS CUNEATUS
SPINAL CORD
PROPRIOCEPTORS
FASCICULUS
gracilis
DRG
SPINAL CORD
TOUCH RECEPTORS

- Fibres ascend in posterior column of same side
- They synapse in medulla with neurons of nucleus gracilis & nucleus cuneatus
- Tract of Gall begins from the lower level of spinal cord
- So carries fibres from coccygeal, sacral , lumbar & lower thoracic ganglia
- Tract of Burdach enters from mid thoracic level & contain fibres from upper thoracic & cervical segments
- Fibres entering from lower level gets pushed medially as they ascend in the cord

- So the fibre arrangement or lamination from medial to lateral side is sacral, lumbar, thoracic & cervical fibres in the cord
- The first order neurons are uncrossed
- Cell body of 2nd order neuron is in the nucleus gracilis & cuneatus
- The fibres of 2nd order neurons (internal arc uate fibres) cross the midline forming the chief sensory decussation
- They ascend in medial leminiscus to end in ventral posterolateral nucleus & related specific sensory relay nuclei in thalamus

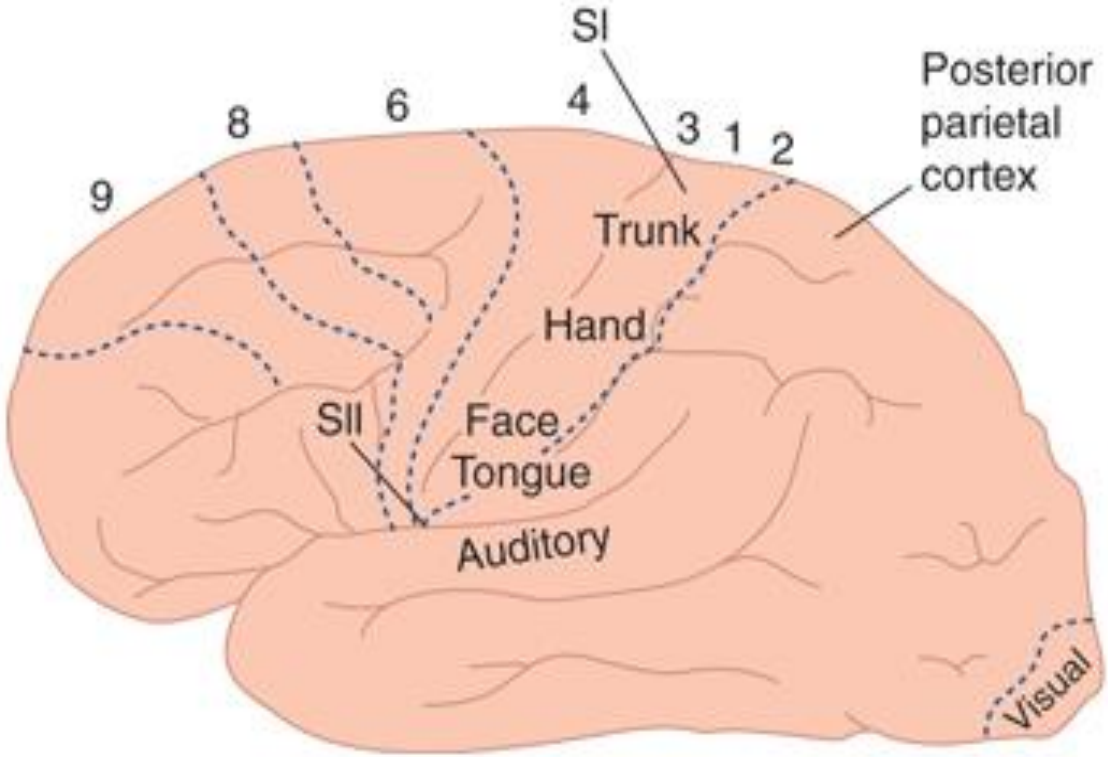
Lamination of fibres in spinal cord



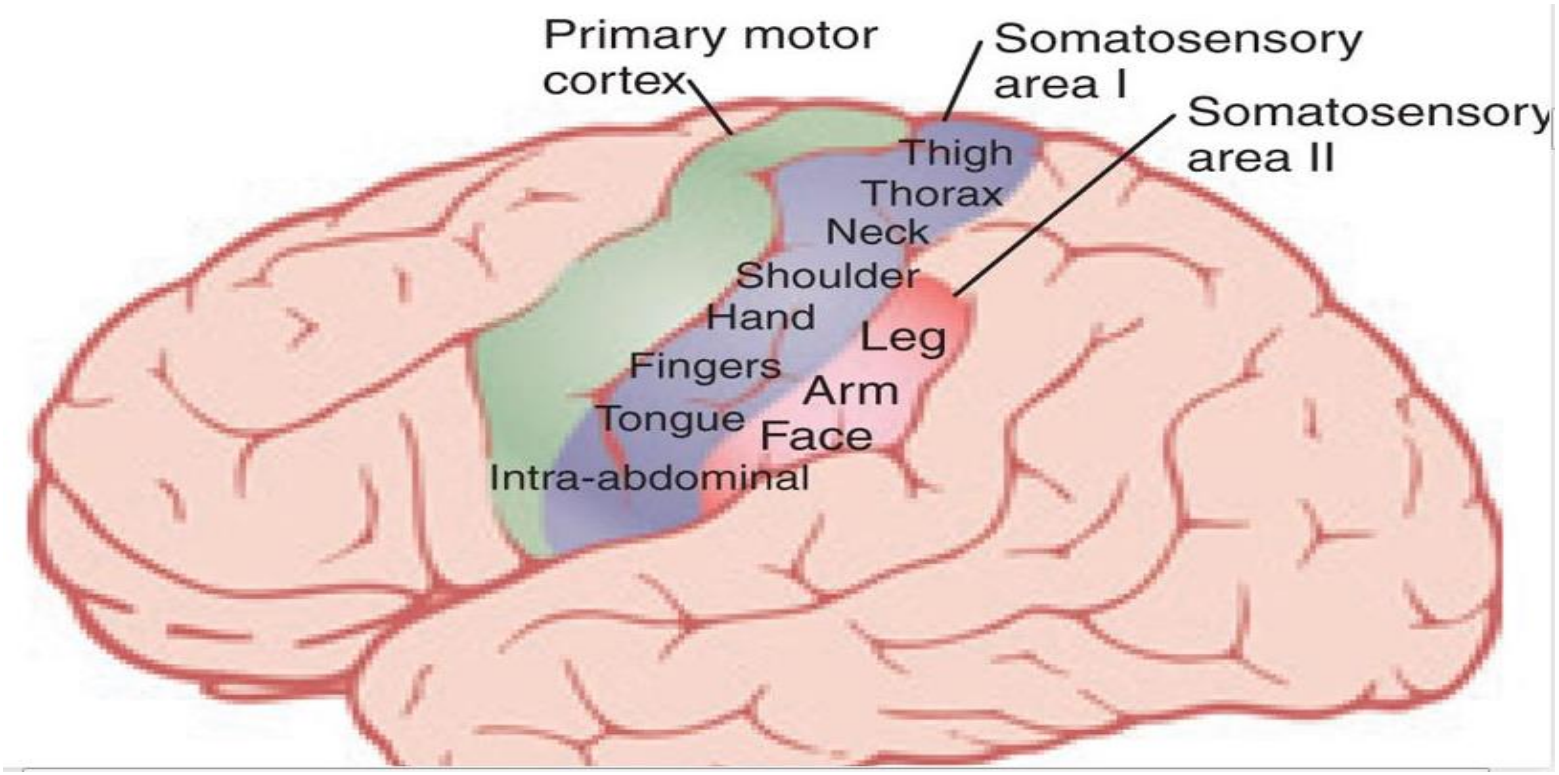


- 3rd order neuron arising from thalamus first pass in the posterior limb of internal capsule behind corticospinal fibres
- They form thalamic radiations that end in the post central gyrus of cerebral cortex Brodman's area 3,2,1 in parietal lobe (somatosensory area I or SI)
- Fibres also project to SII located in the wall of sylvian fissure

Somatosensory area I



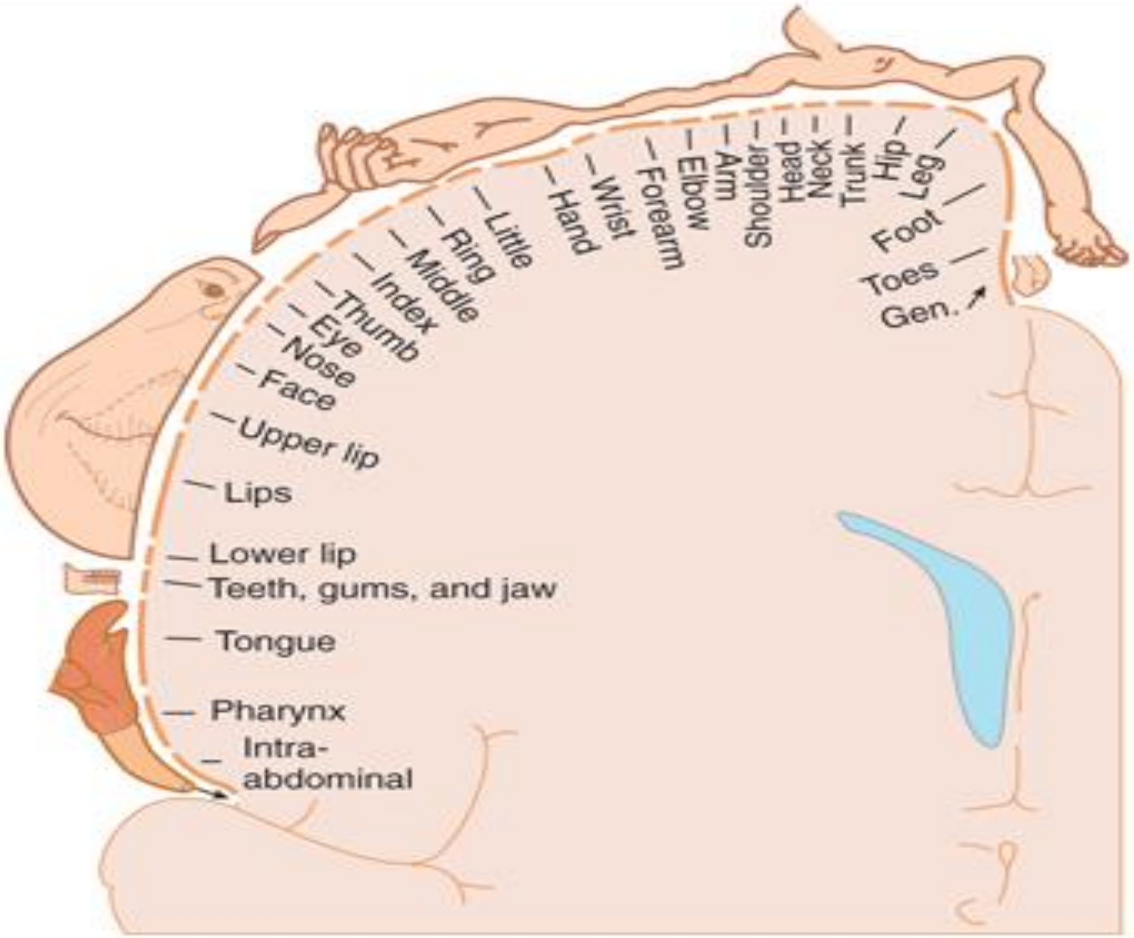
Somatosensory areas I & II



Arrangement of fibres in SI

- Parts of the body are arranged in order along post central gyrus with legs on top & head at foot of gyrus
- Point to point representation of sensory receiving areas is there in the cortex
- Size of cortical area for a sensory impulse from a particular part of the body is proportional to the use of the part
- Large area for hand & parts of mouth concerned with speech

Sensory homunculus



- Incoming sensory signals excite layer 4
- Then spreads towards superficial & deep layers
- Cells in cerebral cortex are organised in vertical columns
- Each column serve as receiving area for single specific sensory modality
- Columns of different sensory modalities are interspersed among each other
- So cells in given column are all activated by afferents from a given part of the body
- And all respond to same sensory modality

Lesion of SSI

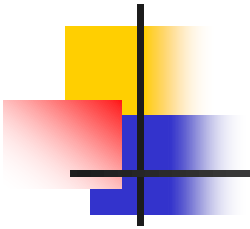
- Unable to localise sensations
- **Astereognosis** : unable to judge shapes & forms of objects
- Pain & temperature sensations are preserved in intensity & quality but poorly localised

Somatosensory area II

- Located in superior wall of sylvian fissure
- There is no detailed representation of body parts as in SI
- Head in inferior end of post central gyrus
- Foot at bottom of sylvian fissure

Somatosensory association areas:

- Area 5 & 7
- Located behind SSI in parietal lobe & above SSII
- Role in deciphering deeper meaning of sensory information
- Receives signals from SSI, thalamus, visual & auditory cortex



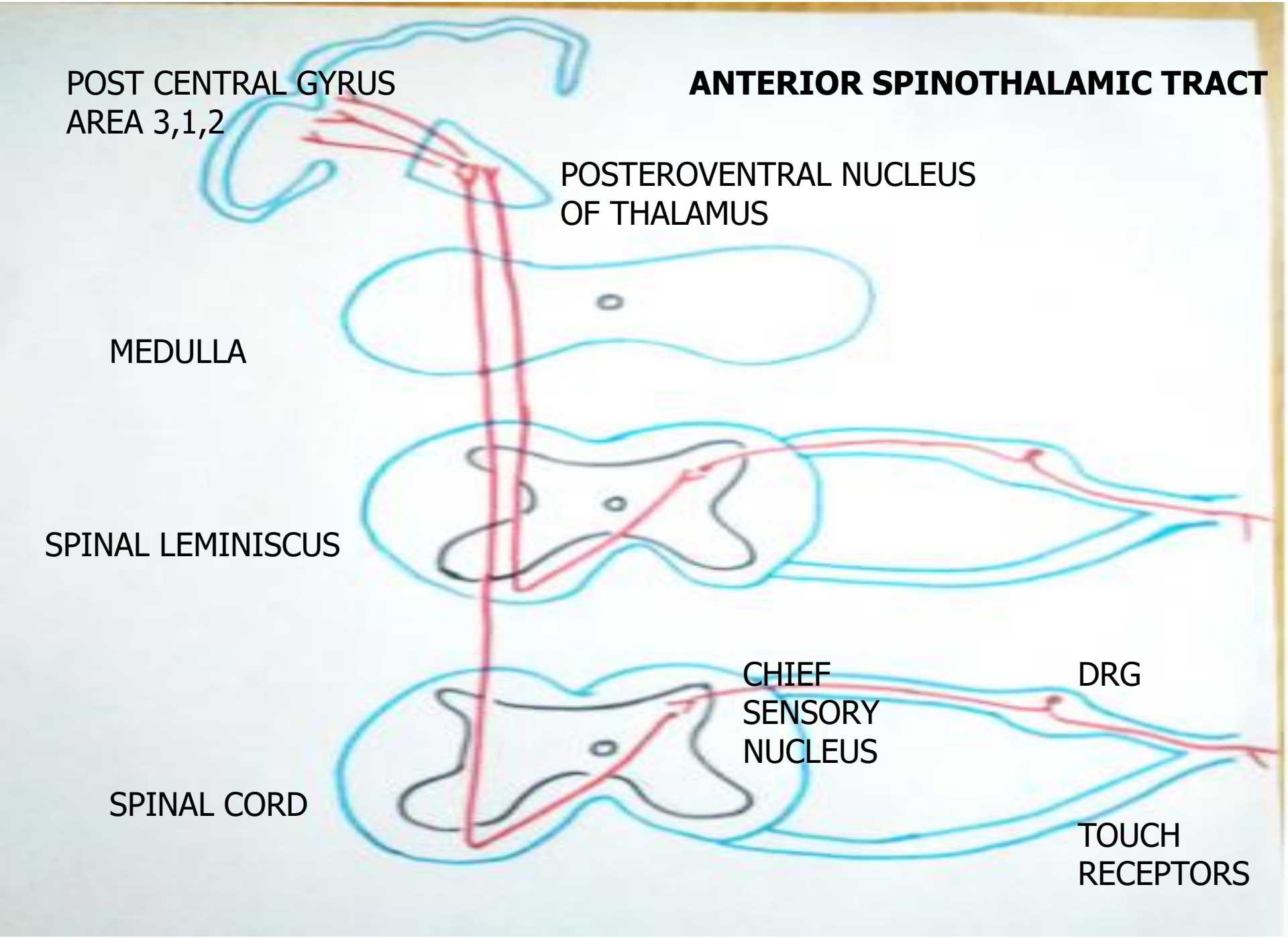
- Lesion of association area causes **amorphosynthesis**
- Inability to recognize complex objects & forms felt on opposite side of body
- Even forgets presence of body parts on opposite side of body

Cortical plasticity

- Neuronal connections can be changed rapidly depending on activity of represented area
- If a digit is amputated in a monkey the cortical areas of neighbouring digits spread to that area which was formerly occupied by amputated digit
- If cortical area for a digit is removed somatosensory map of the digit moves to the surrounding cortex

Anterior spinothalamic tract

- Receptor: touch receptors
- 1st order neuron : DRG
- Peripheral process innervate the receptor
- Central process reaches spinal cord through posterior nerve root
- Synapse occurs at chief sensory nucleus in same spinal level


POST CENTRAL GYRUS
AREA 3,1,2
ANTERIOR SPINOTHALAMIC TRACT
POSTEROVENTRAL NUCLEUS
OF THALAMUS
MEDULLA
SPINAL LEMINISCUS
CHIEF
SENSORY
NUCLEUS
DRG
SPINAL CORD
TOUCH
RECEPTORS

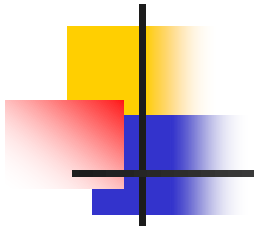
- The second order neurons from spinal cord cross to opposite side in anterior white commissure
- Ascend in anterior funiculus as anterior spinothalamic tract
- Fibre arrangement in the tract from medial to lateral side is cervical, thoracic, lumbar & sacral fibres
- Fibres ascend up in brain stem along with lateral spinothalamic tract to form spinal leminiscus or spinal fillet
- Synapse with posteroventral nucleus of thalamus

- Third order neurons from thalamus pass through internal capsule & corona radiata
- End in post central gyrus (area 3, 1, 2) of parietal lobe

- Sensation of touch has a dual pathway
- So lesions of anterior spinothalamic tract causes only slight loss of touch mainly crude touch

Sensations from face

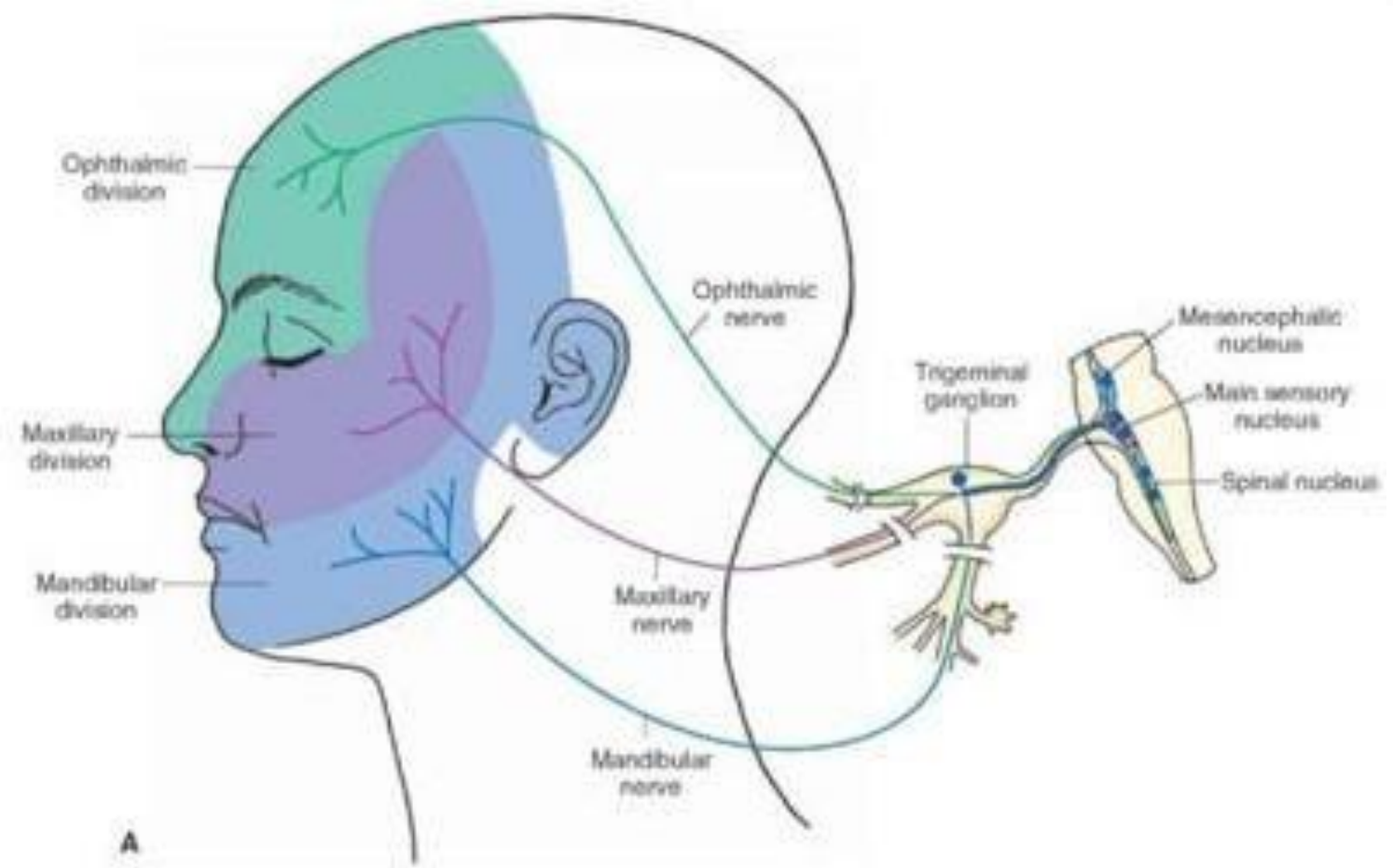
- Carried by sensory root of trigeminal nerve
- 1st order neuron: cell body is in **trigeminal ganglion or gasserian ganglion**
- All sensations touch, pain, temperature & proprioception are carried by 3 main branches of trigeminal nerve-ophthalmic , maxillary & mandibular
- Peripheral process from ganglion innervate the receptor



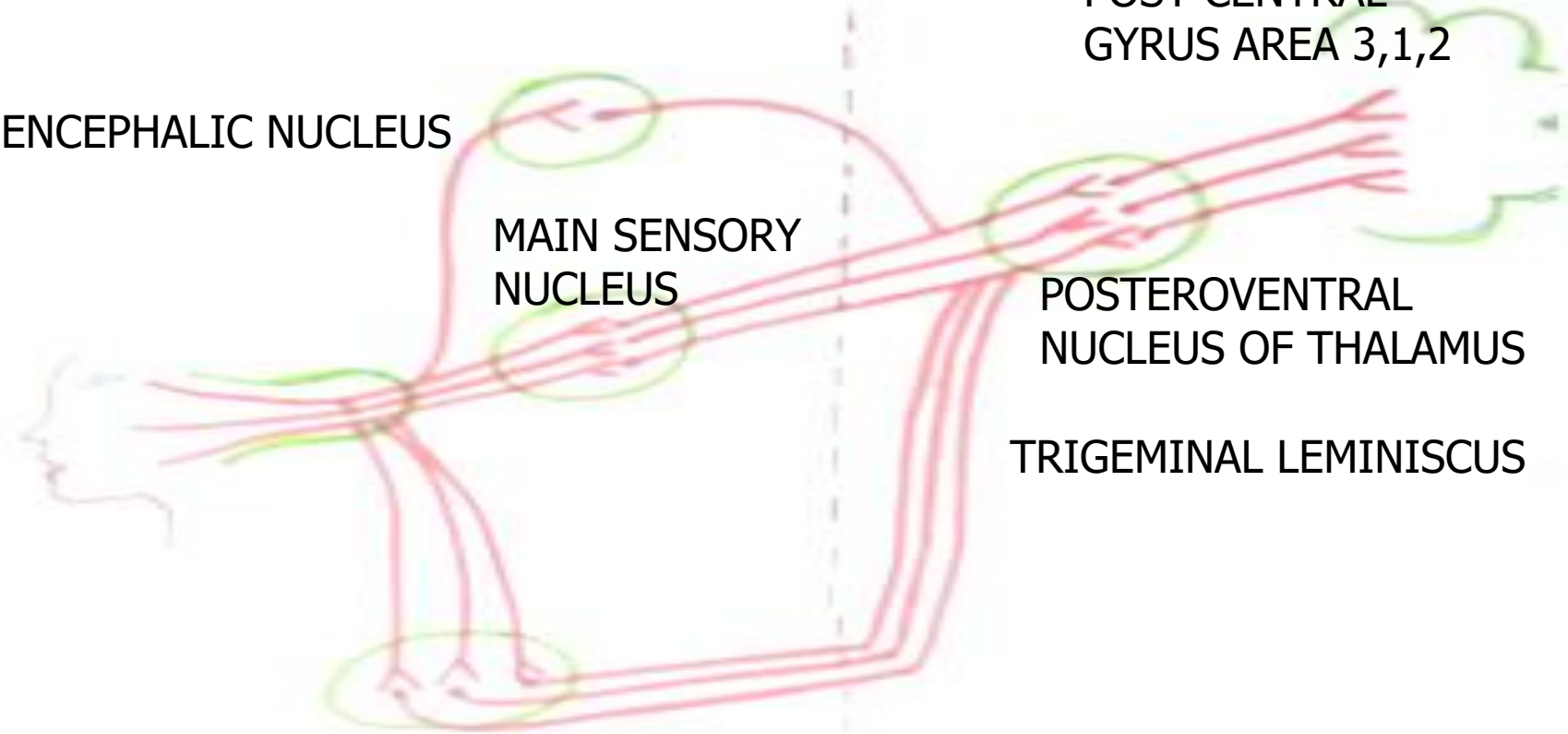
- Central process enters pons through the sensory root of fifth nerve
- Fibres end in 3 sensory nuclei of trigeminal nerve

1. Mesencephalic nucleus
2. Main sensory nucleus
3. Spinal nucleus

Sensory dermatomes of trigeminal nerve



TRIGEMINAL PATHWAY



- Fibres carrying **touch sensation**, **tactile localisation, discrimination, sense of position, movement & vibration** reach **main sensory nucleus** & synapse there
- Cross to opposite side pass along trigeminal leminiscus to posteroventral nucleus of thalamus
- 3rd order neurons pass through posterior limb of internal capsule & corona radiata & reach post central gyrus

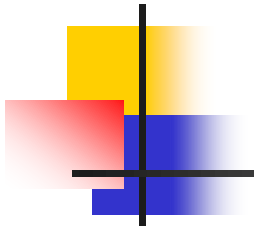
- 1st order neurons carrying **pain & temperature** from face descend from pons through medulla & spinal cord
- Synapse with **spinal nucleus of trigeminal nerve**
- Fibres cross to opposite side & ascend up to reach trigeminal leminiscus → posteroventral nucleus of thalamus→ sensory cortex

- Fibres carrying **proprioceptive sensation** from muscles of mastication & ocular muscles enters pons
- Ascend to **mesencephalic nucleus**→ cross to opposite side→ ascend in trigeminal leminiscus → reach thalamus→ sensory cortex

Abnormalities of touch sensation

- Anaesthesia- complete loss of all sensations
- Seen in peripheral nerve lesions
- Complete transection of spinal cord
- Dissociated anaesthesia:loss of pain and temperature with preservation of touch
- E.g.in syringomyelia, intramedullary tumours

- **Hyperesthesia**- exaggerated response to sensory stimulation
- Seen in thalamic lesions
- **Paraesthesia**: altered sensations
- Pricking ,numbness
- Seen in nerve compression, thalamic lesions ,sub acute combined degeneration of spinal cord



- **Agraphesthesia**: inability to recognise numbers or letters written on skin with blunt point like pen or key
- Seen in lesions of sensory cortex