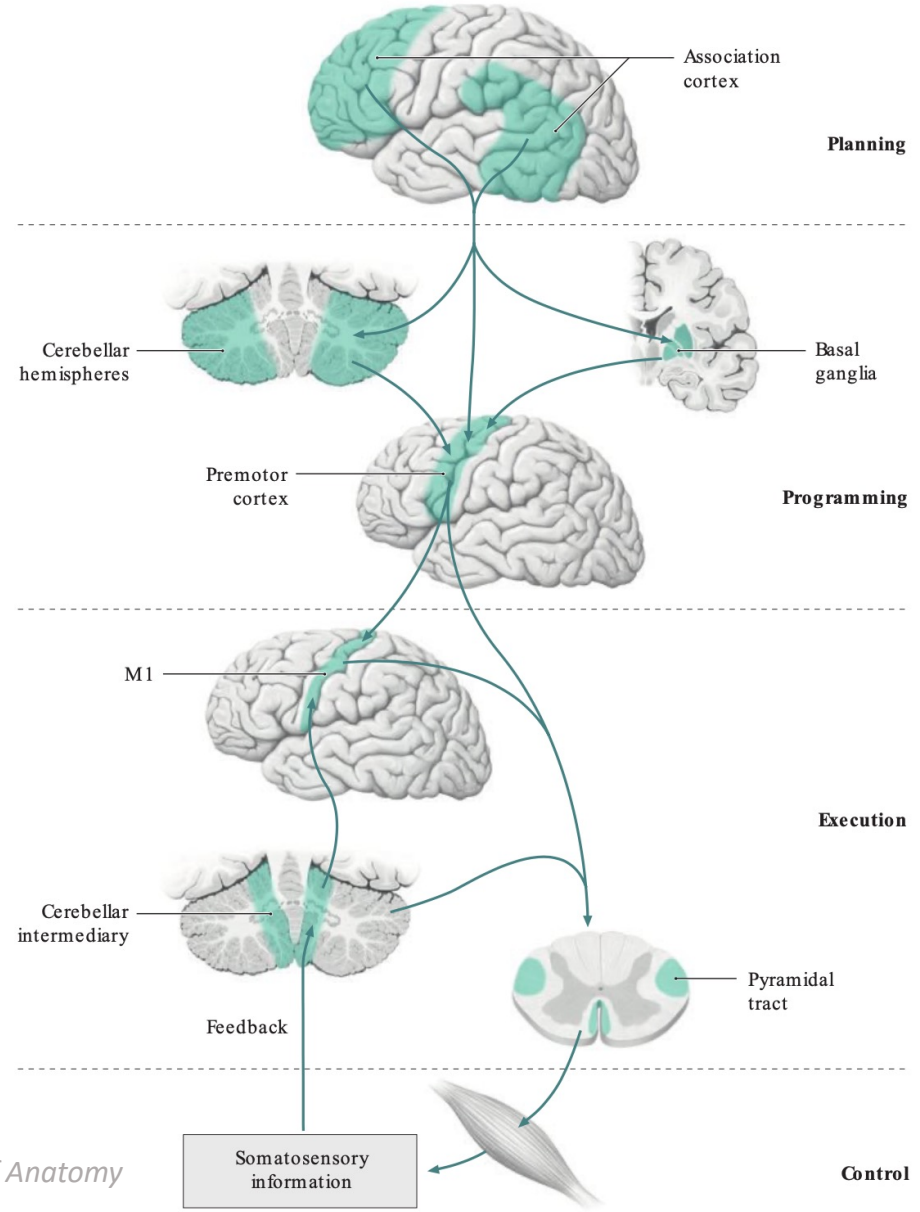
somatosensoric and motor system

Prof. MUDr. Jiří Ferda, Ph.D.

Motion

- Planning
- Programming
- Execution
- Control

- Motor system - work
- Somatosensory system - feedback



Motion

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  - Association cortex
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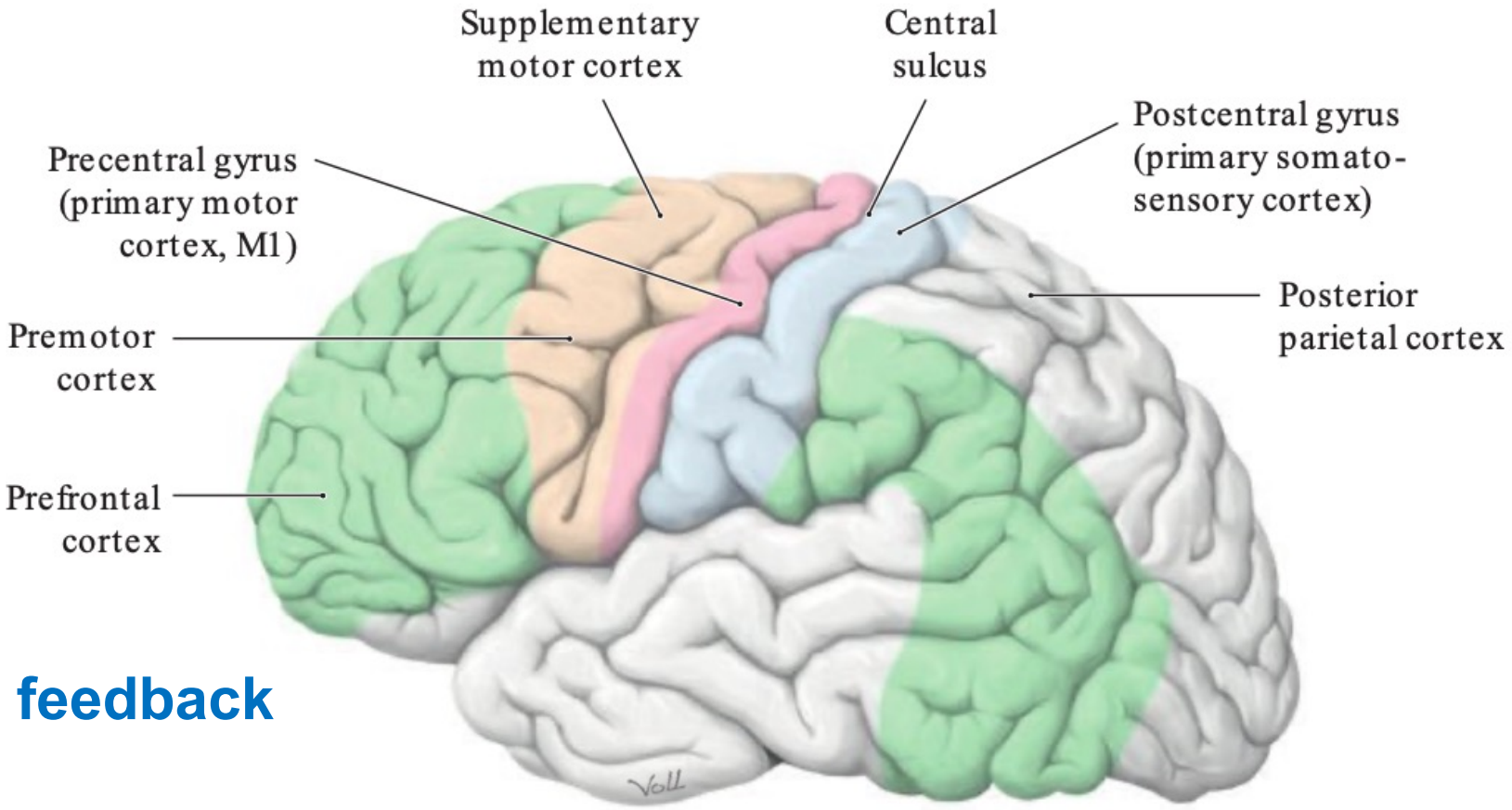

Motion

- Planning
  - Prefrontal cortex
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- Programming
  - Basal ganglia
  - Thalamus
  - Cerebellum
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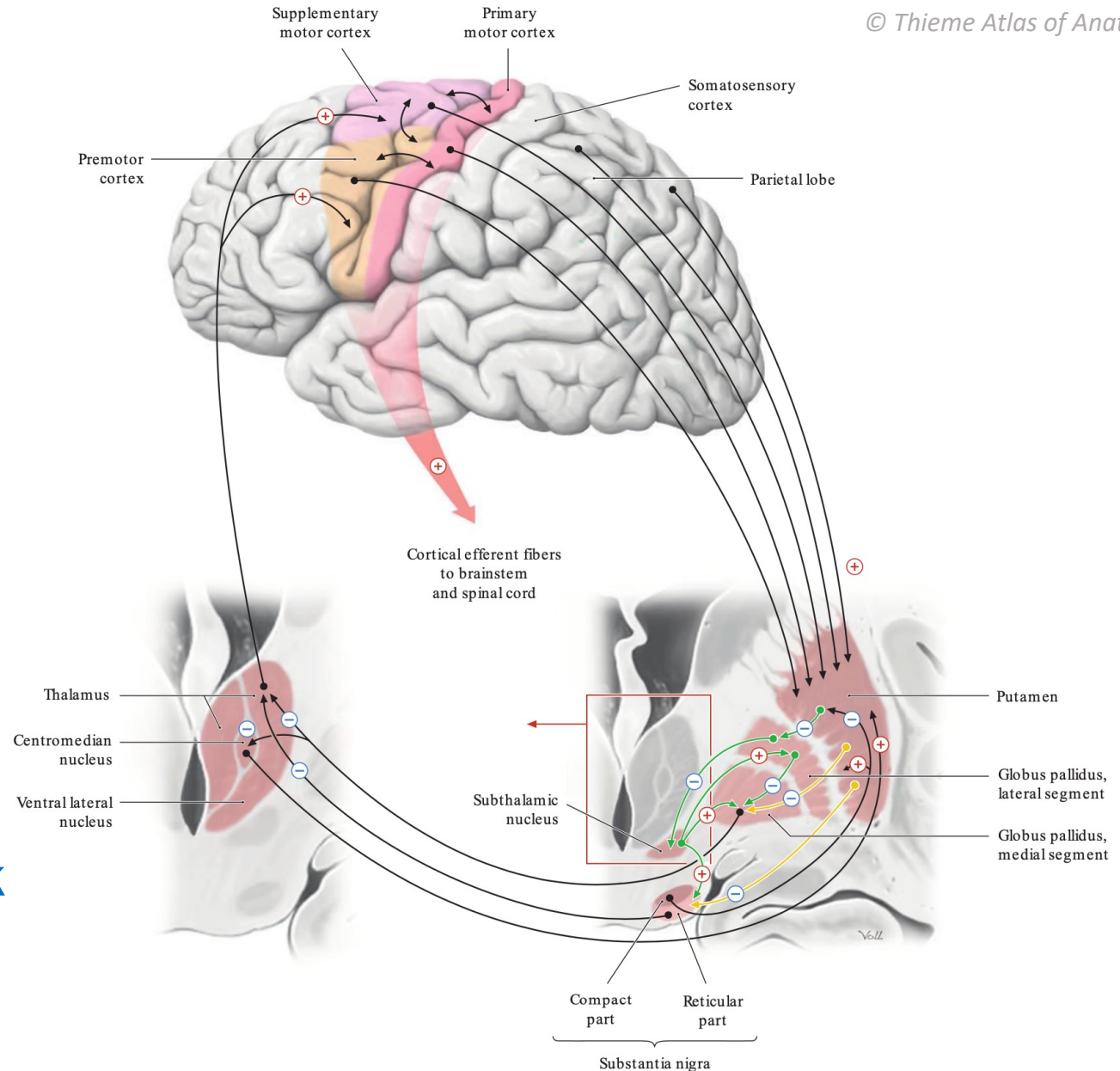
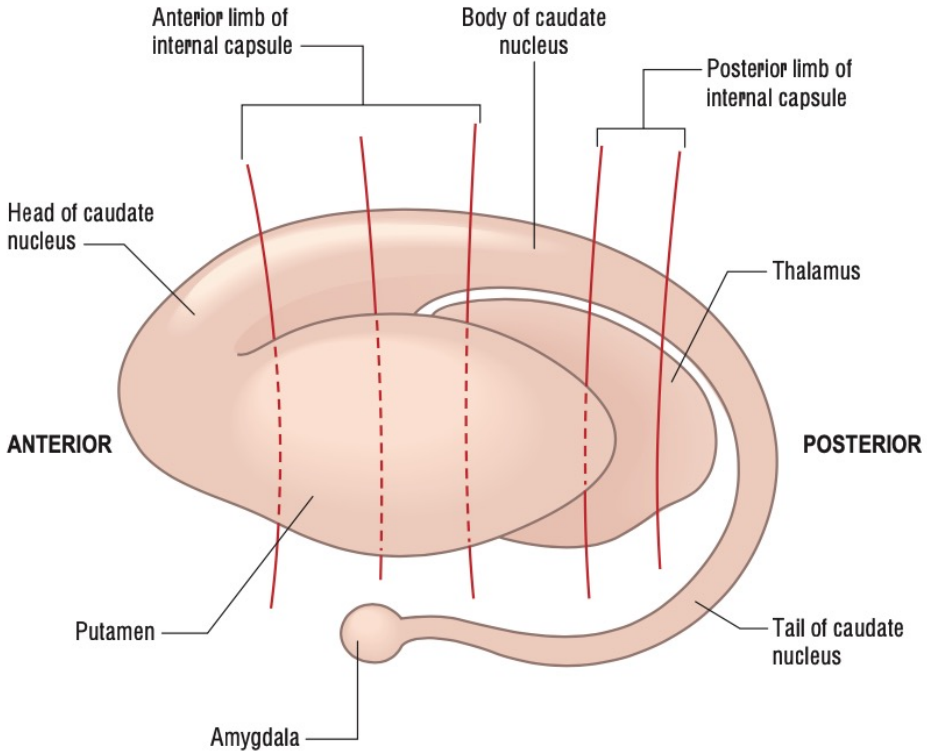
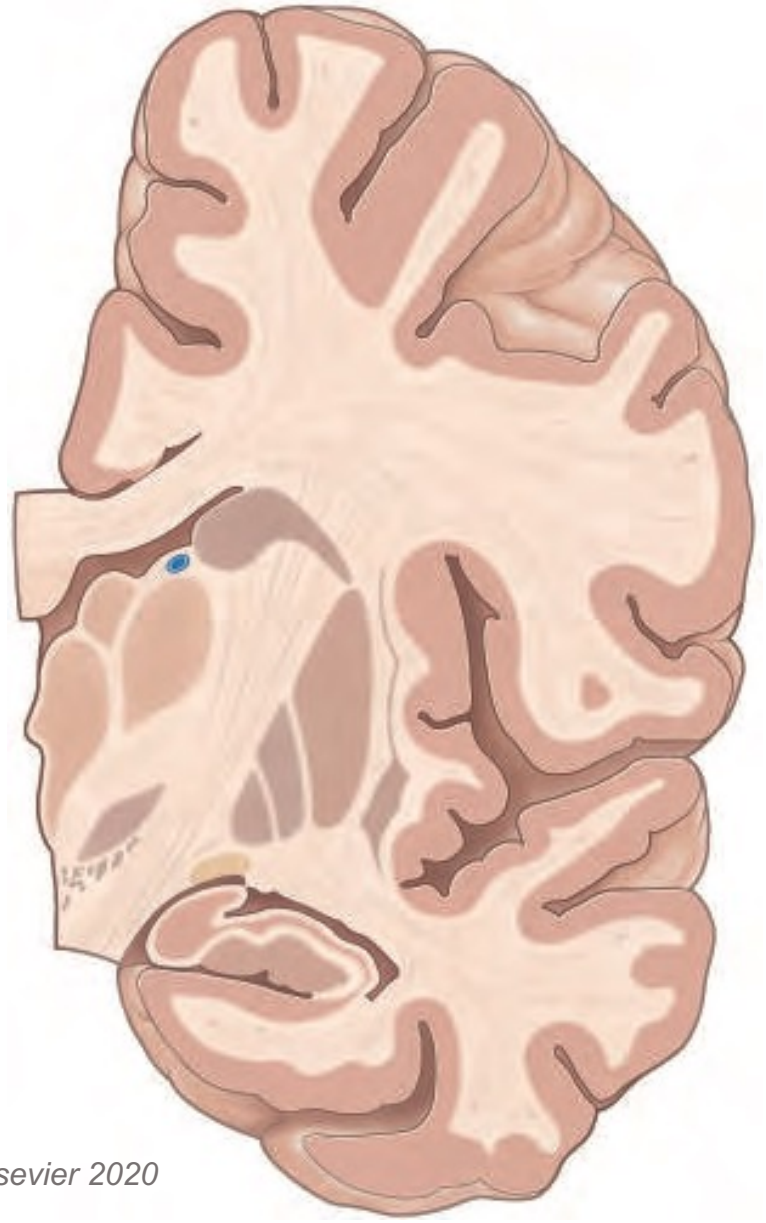


Basal ganglia

- Subcortical nuclei
- Corpus striatum
  - Nucleus caudatus
  - Putamen
  - Globus pallidus
- Claustrum
- Amygdaloid complex
- Associated centres
  - Diencephalon
  - Mezencephalon



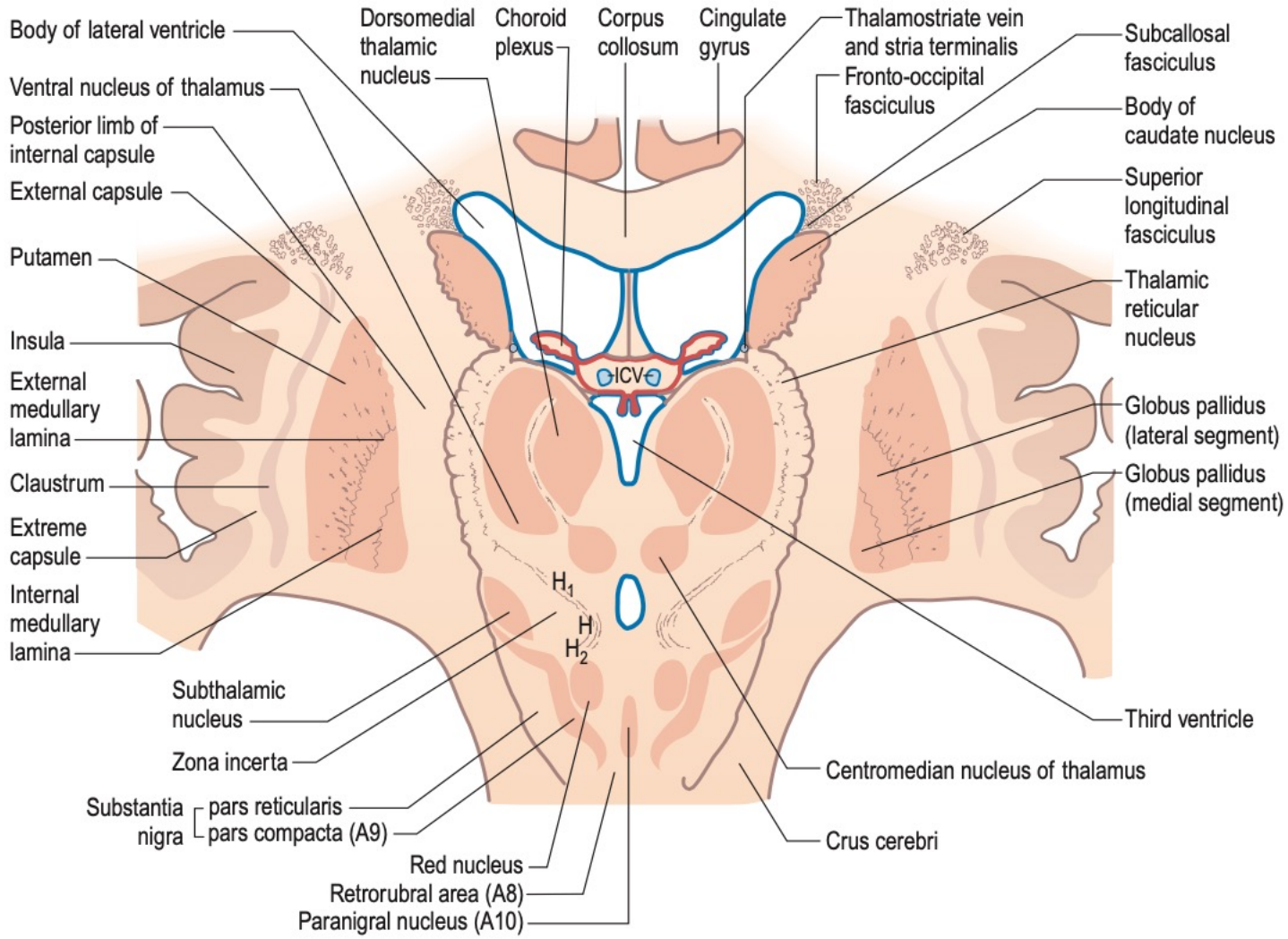


- Neostriatum = striatum = nucleus caudatus + putamen
- Paleostriatum = globus pallidus = pallidum

Strandring S et al.: Gray's Anatomy, 42th ed. Elsevier 2020

Basal ganglia

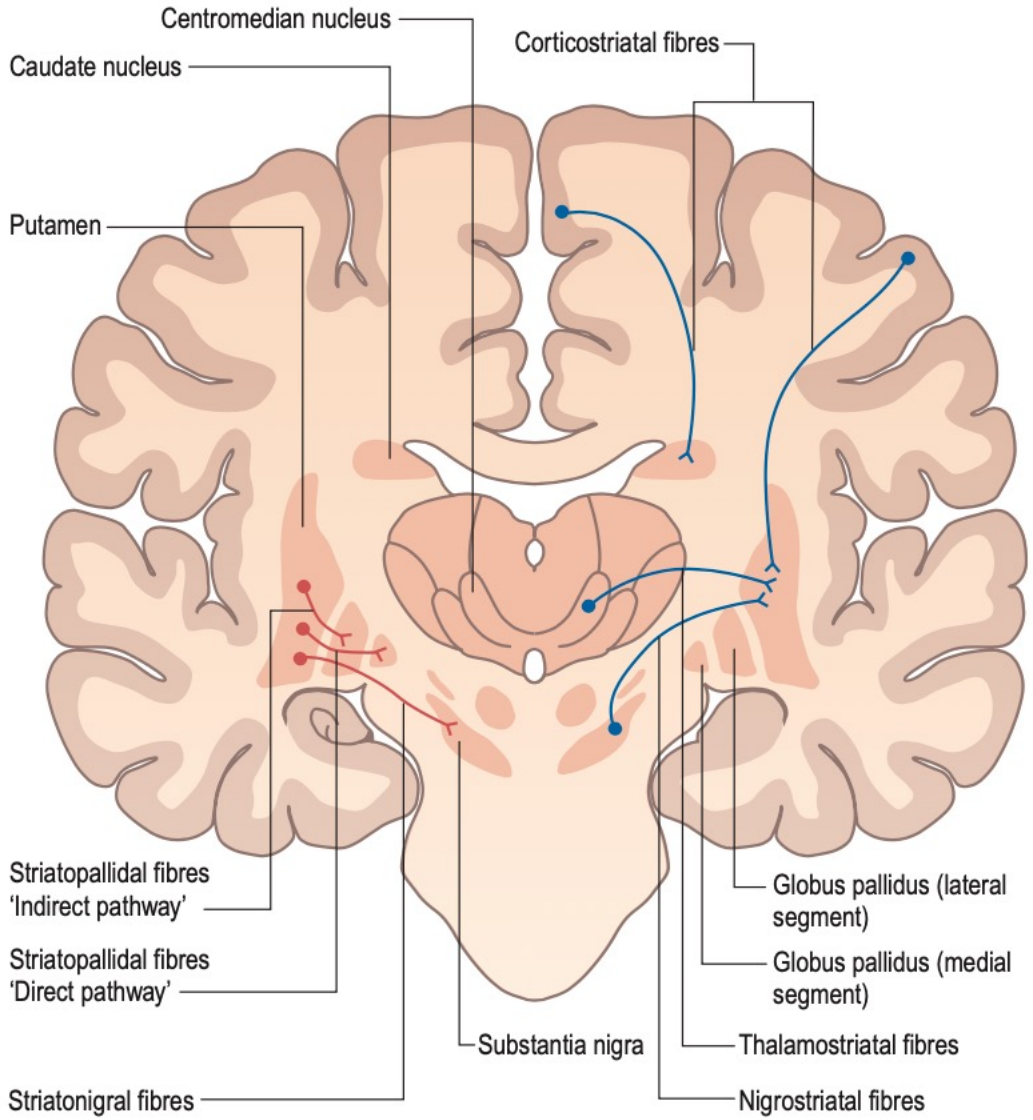
- principal input function
- Whole neocortex
- STRIATUM
- Efferent connections
  - globus pallidus
  - Substantia nigra
- principal output function
- GLOBUS PALLIDUM
- SUBSTANTIA NIGRA pars reticulata
- Efferent connection
  - Thalamus
- Basal gagnlia disordes
- Abnormal motions
- Hypertonia (Parkinson disease)
- Abnormal involuntary motions (chorea, Huntington disease)



Strandring S et al.: Gray's Anatomy, 42th ed. Elsevier 2020

Striatum

- High cellular density
- Bugh vascular density
- GABA
- Enkefalines
  - D2 receptors of dopamine
- Substance P (dynorphin)
  - D1 receptors of dopamine
- Somatostatine
- Acetylcholine
- **Afferent connections**
  - Cortex
  - Thalamus
  - Substantia nigra
- **Efferent connections**
  - Globus pallidus – medial – „direct pathway“
  - Globus pallidus – lateral - “indirect pathway“
  - Nc. subthalamicus



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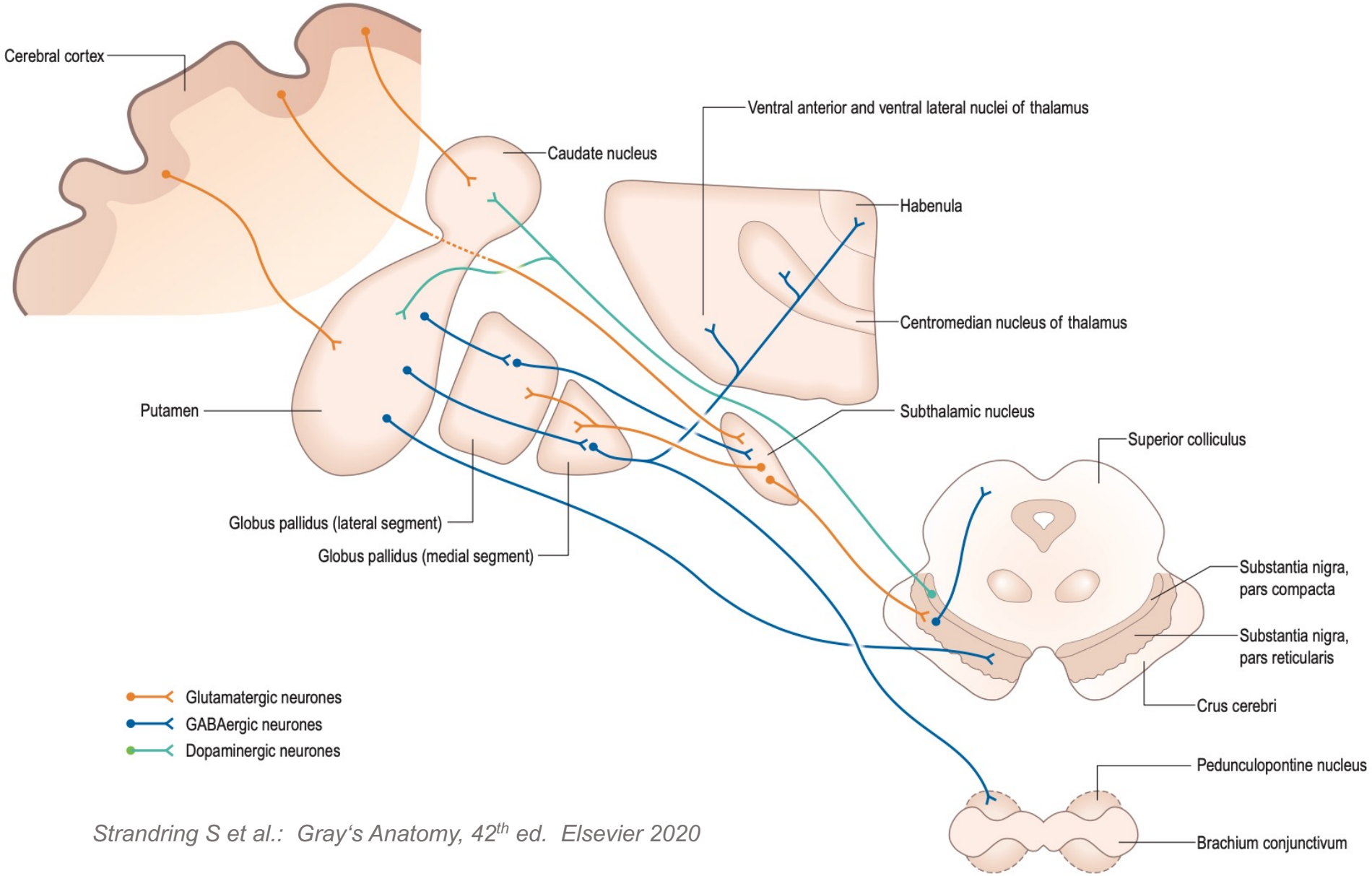
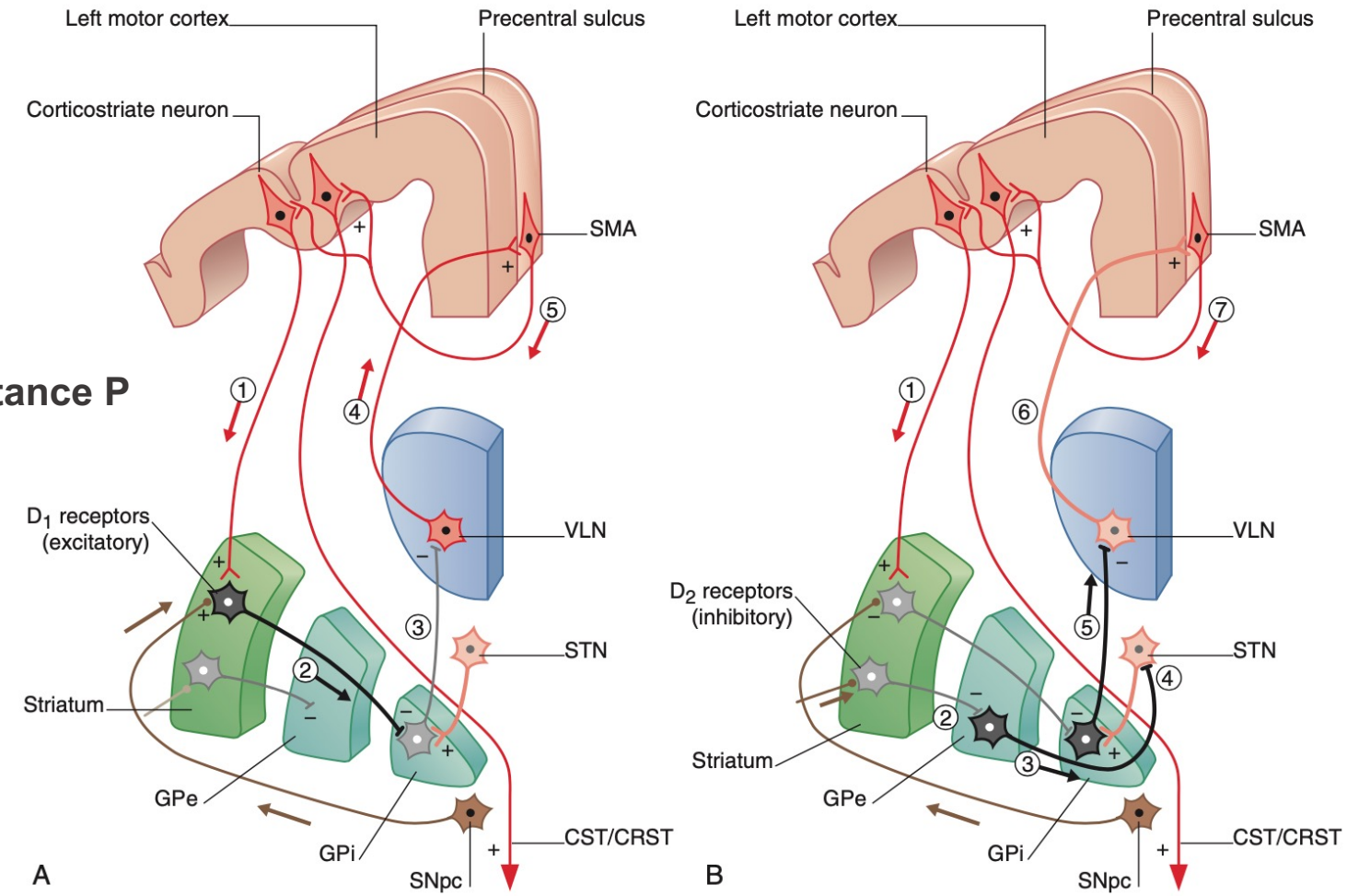
Connections of striatum



Strandring S et al.: Gray's Anatomy, 42th ed. Elsevier 2020

Globus pallidus = pallidum

- Paleostriatum = pallidum
  - 5% of cells in comparison to striatum
  - Striatopallidal connections
- Direct pathway
  - striatum
  - Globus pallidus pars medialis
    - (pallidum internum)
  - Substantia nigra pars reticulata
  - Dopamin (D1 receptor), dynorphin, substance P
- Indirect pathway
  - striatum - nc. subthalamicus
  - Globus pallidus pars lateralis
    - (pallidum externum)
  - Substantia nigra pars reticulata
  - Dopamin (D2 receptor), enkefalin
- Hyper-direct pathway
  - Frontal lobe
  - Nc. subthalamicus

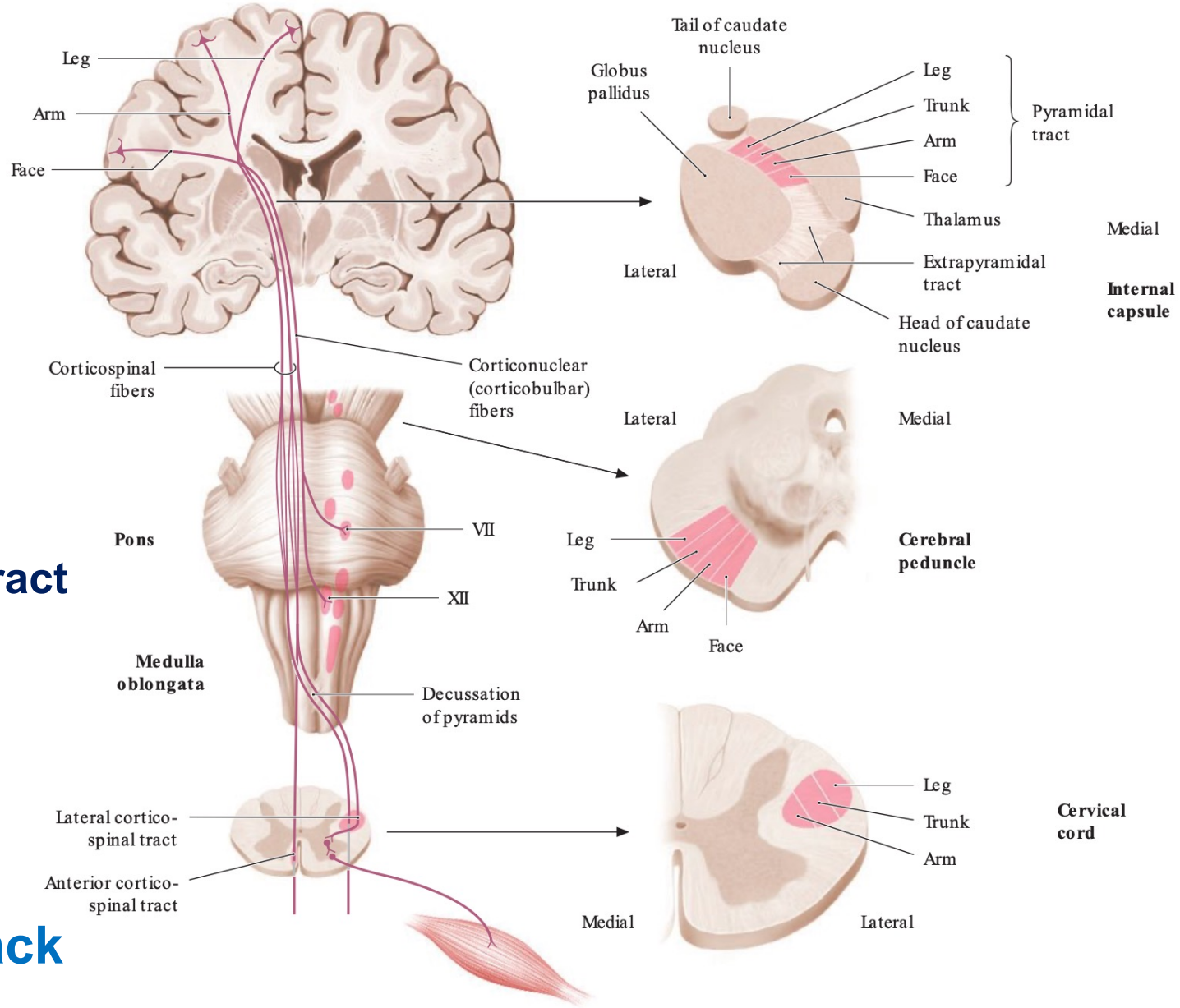


Strandring S et al.: Gray's Anatomy, 42th ed. Elsevier 2020

Motion

- **Planning**
  - **Prefrontal cortex**
  - **Association cortex**
- **Programming**
  - **Basal ganglia**
  - **Thalamus**
  - **Cerebellum**
- **Execution**
  - **Corticospinal and corticonuclear tract**
  - **Extrapyramidal tracts**
- **Control**

- **Motor system - work**
- **Somatosensory system - feedback**



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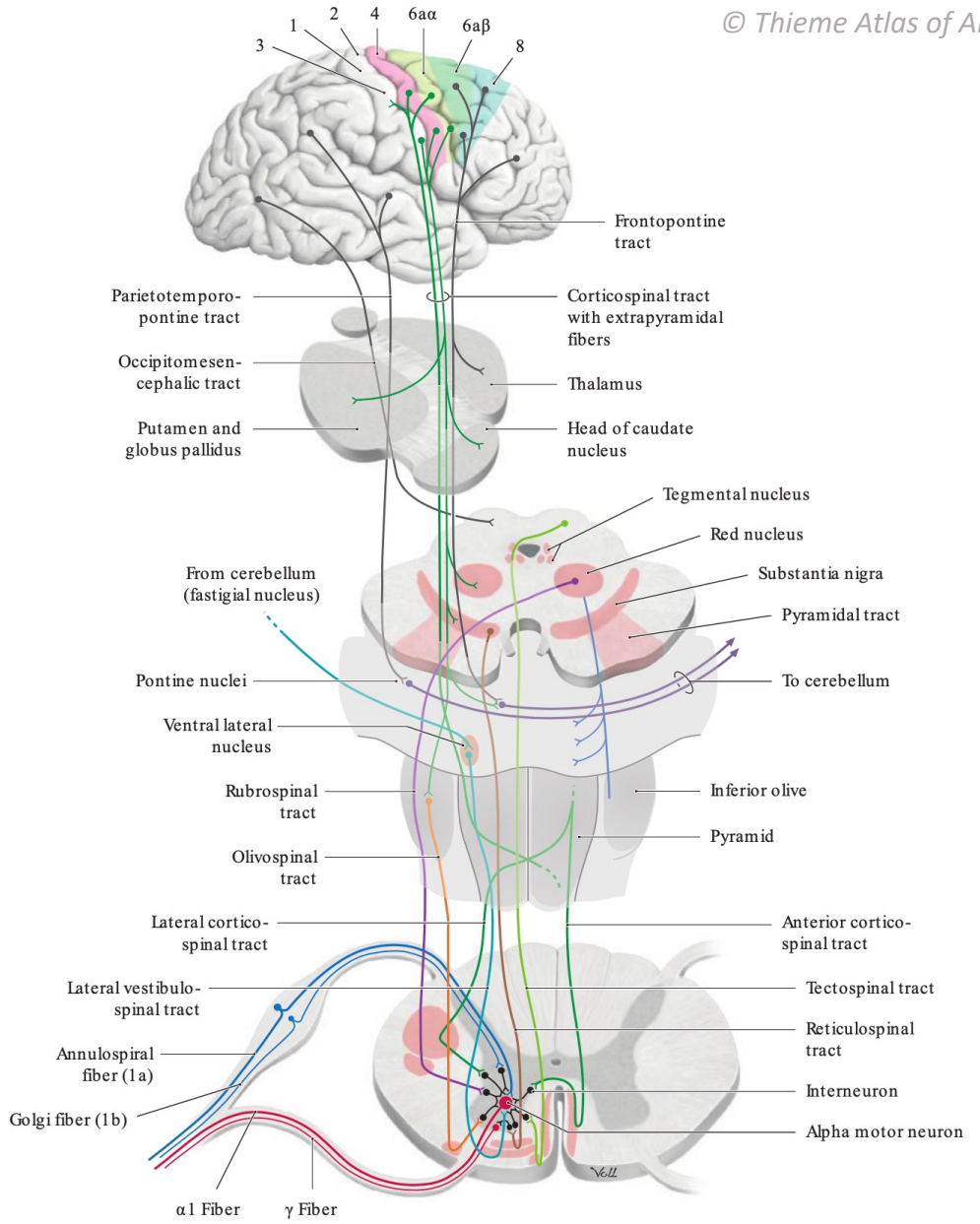
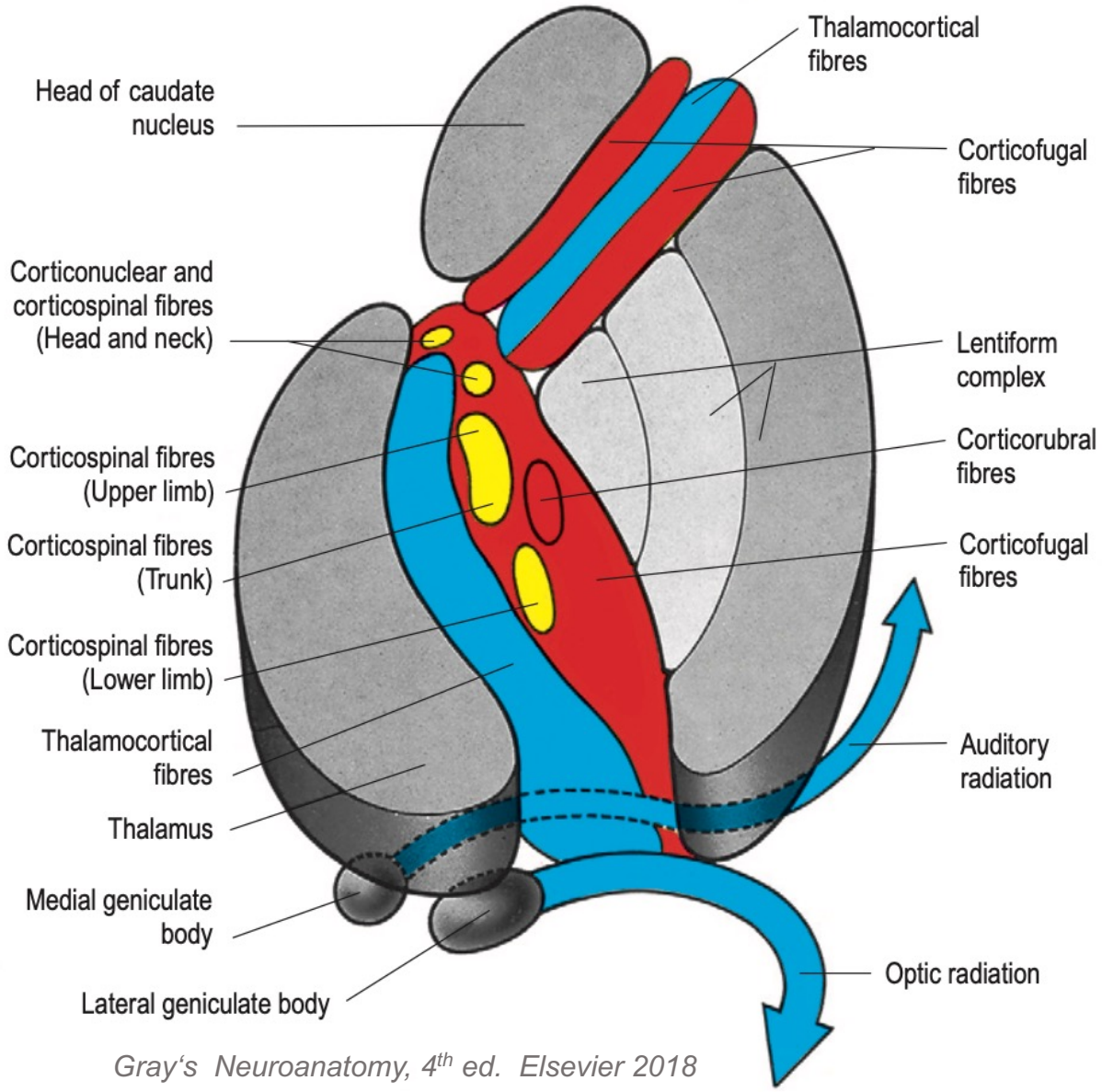


Capsula interna

- **Motor (descending) fibers**
- **Corticonuclear tract**
- **Corticospinal tract**
  - ***Cervical***
  - ***Upper limb***
  - ***Trunk***
  - ***Lower limb***
- **Corticorubral tract**

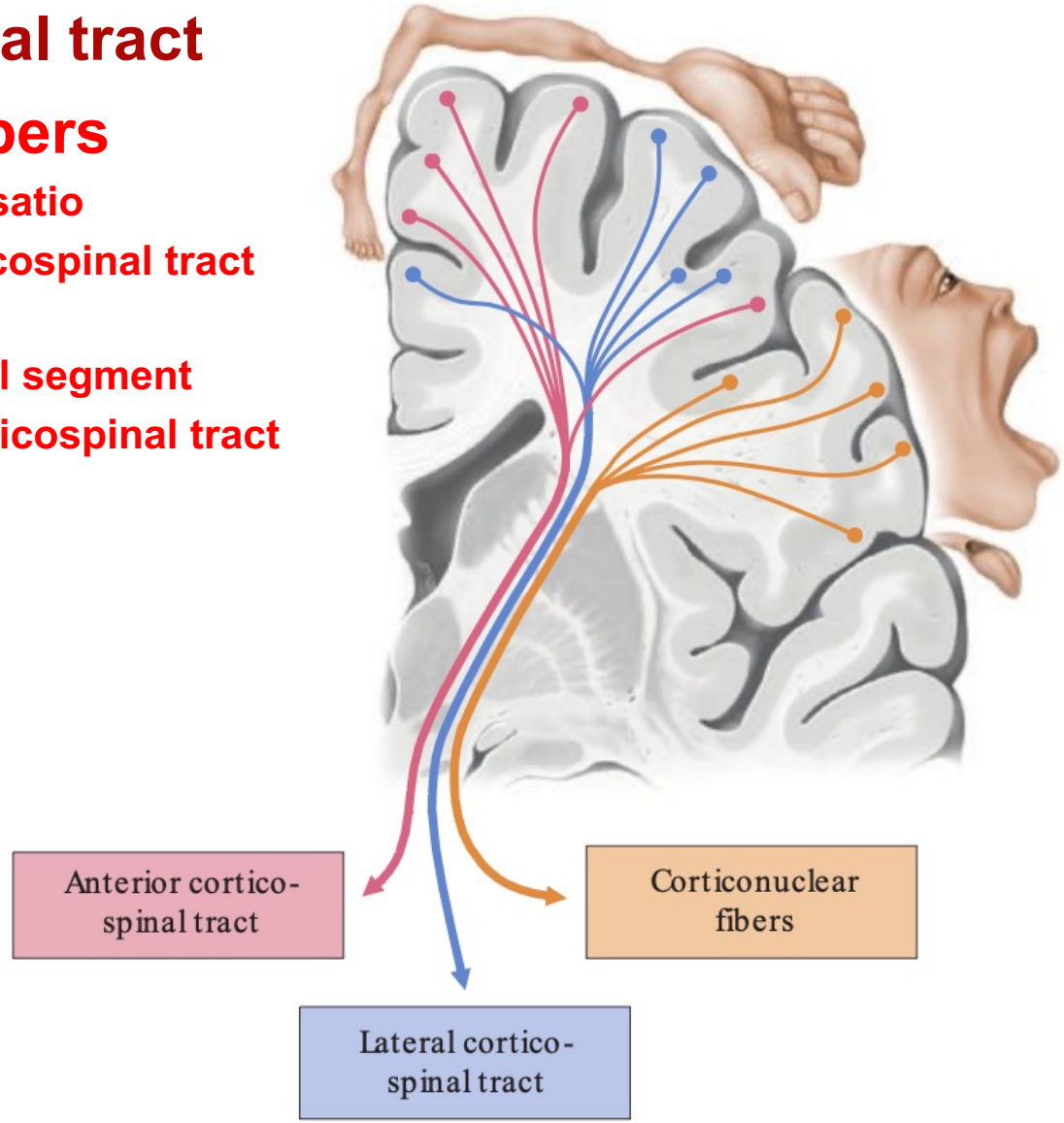
- **Somatosensory (ascending) fibers**
- **Thalamocortical tracts**

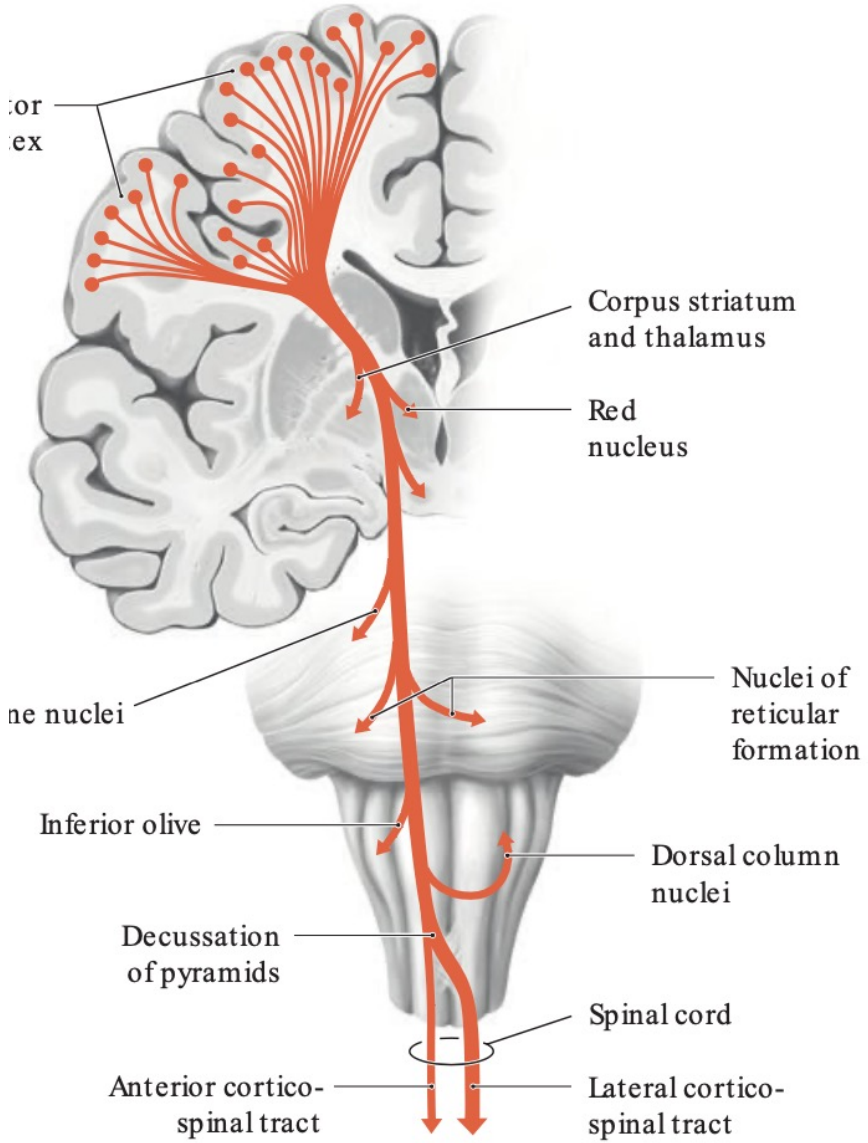


Gray's Neuroanatomy, 4th ed. Elsevier 2018

Motor cortex

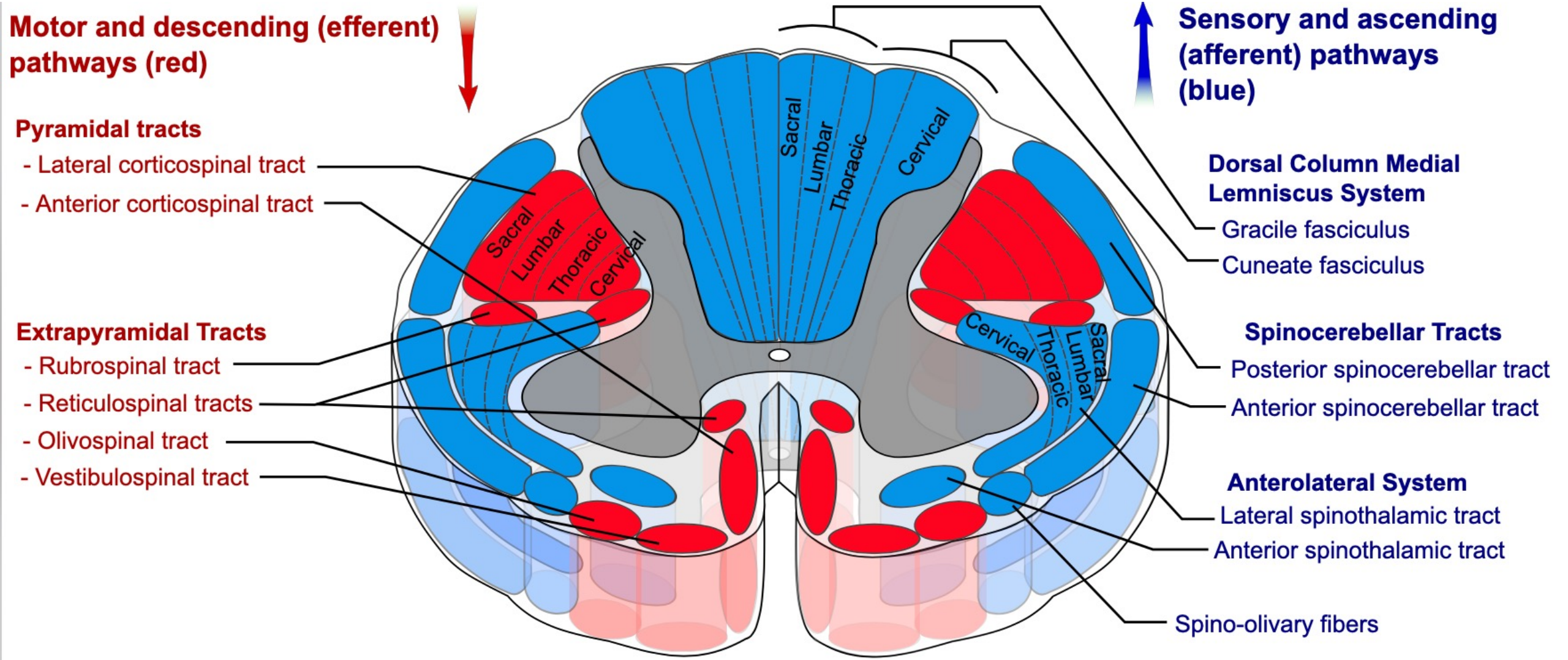
- **Corticospinal tract**
- **Crossing fibers**
  - 80% at decusatio
  - Lateral corticospinal tract
  - 20% at spinal segment
  - Anterior corticospinal tract



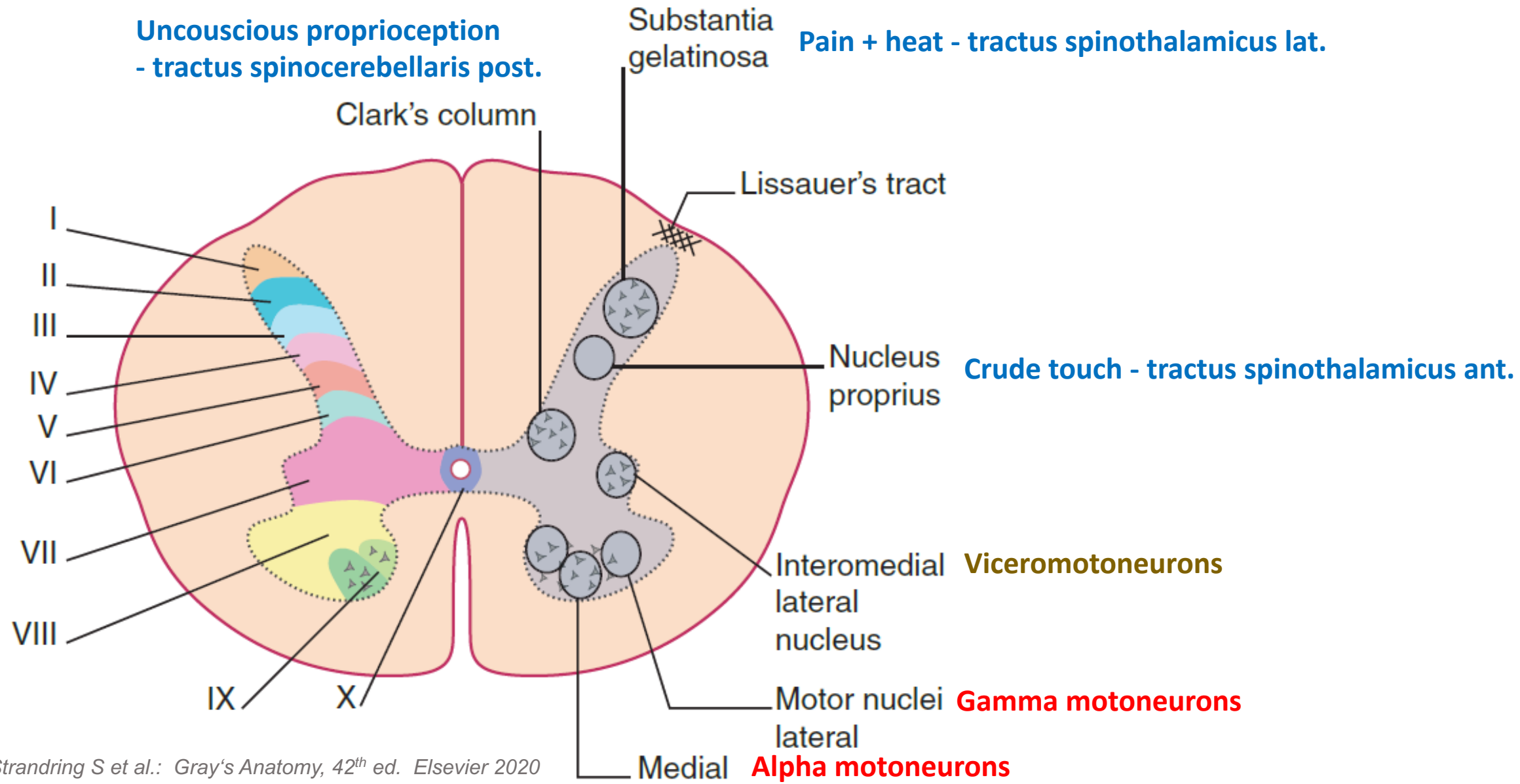


Tractus medullae spinalis

Wikipedia



Nuclei medullae spinalis

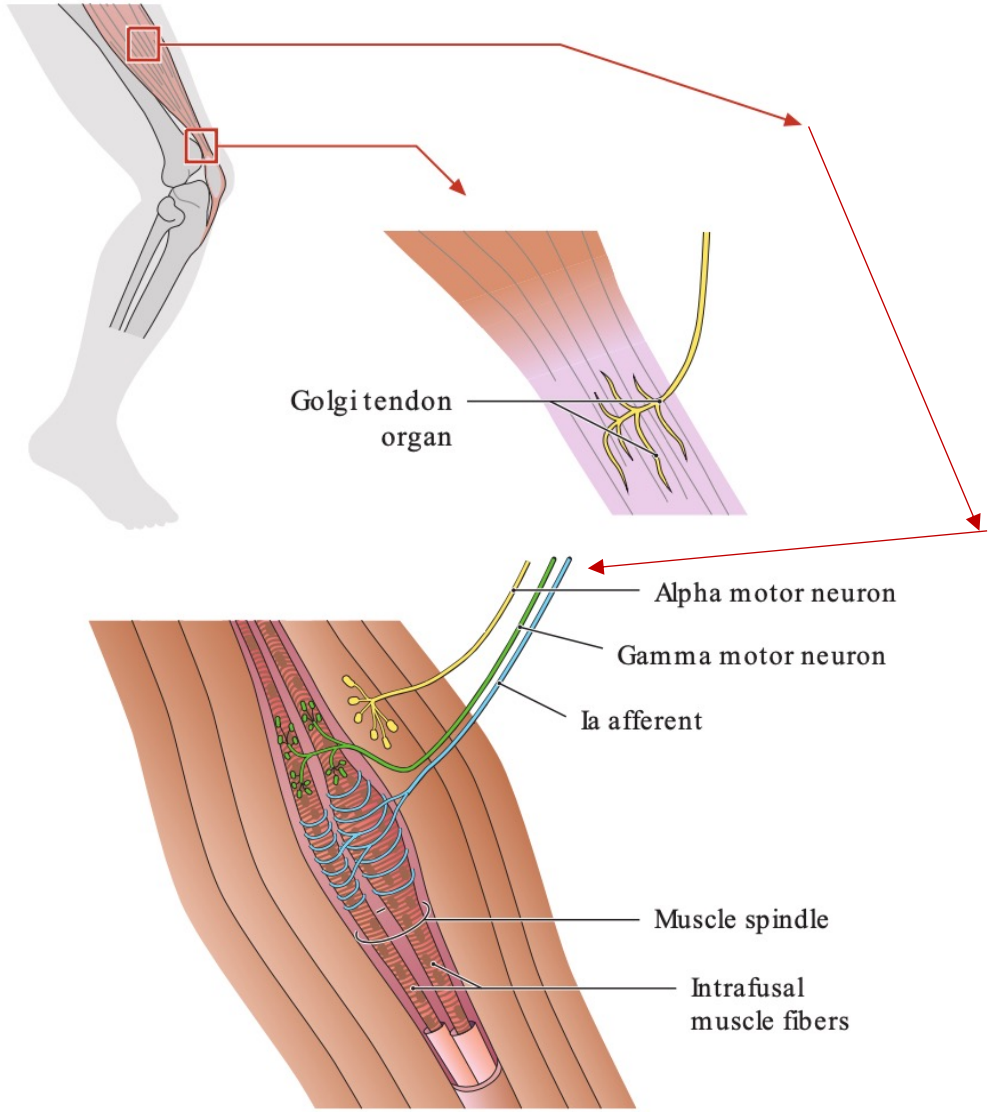


Strandring S et al.: Gray's Anatomy, 42th ed. Elsevier 2020

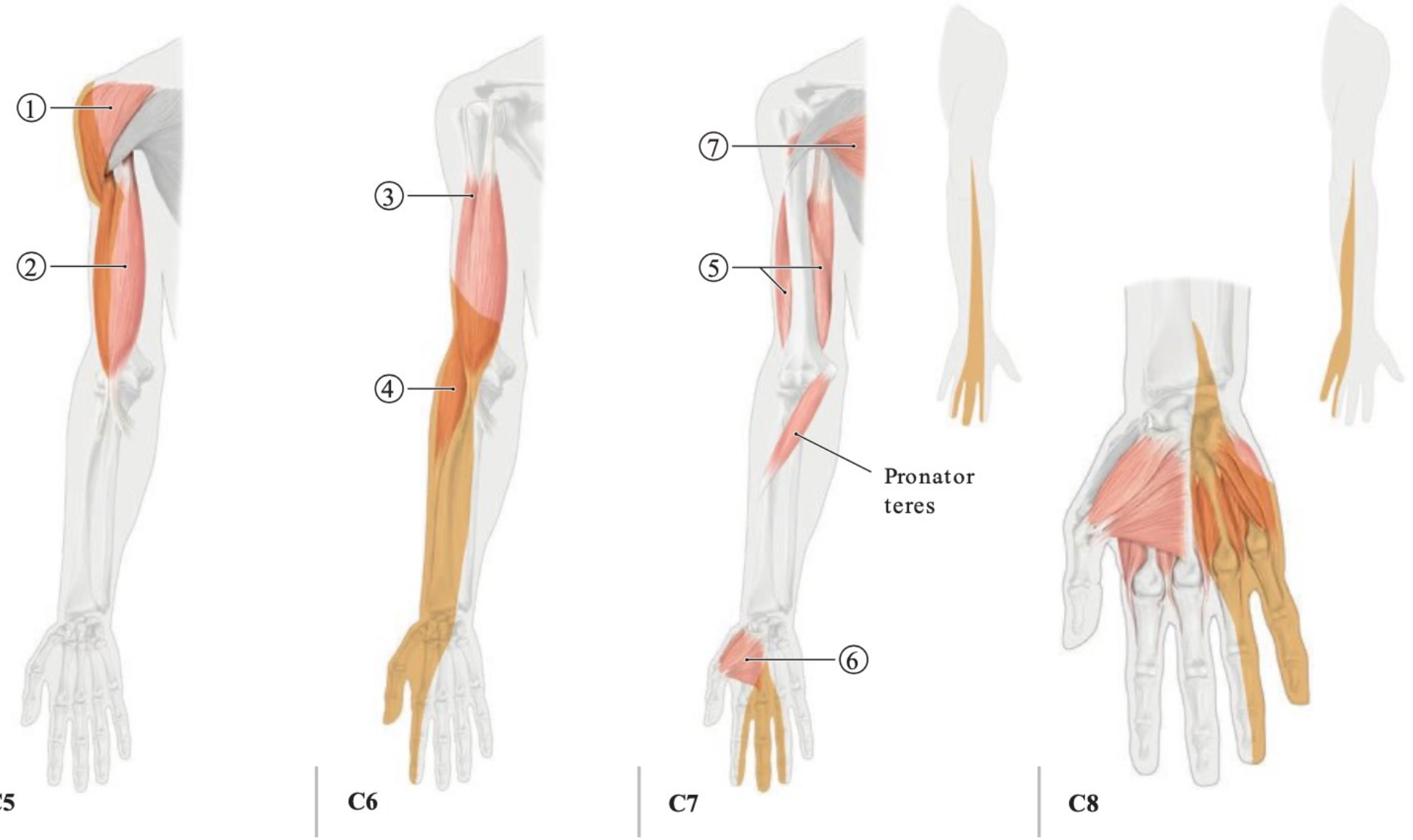
Motion sensation

- **Proprioception conscious**
  - ***Funniculus posterior – fasciculus gracilis, cuneatus***
  - ***Relayed through nc. gracilis et cuneatus***
  - ***And by the way by cuneo/gracillo cerebellar tract***
  - ***(from nc. cuneatus/gracilis accesorius)***
  - *Space and position information*
  - *Tension information*
  - *How the motion was executed*

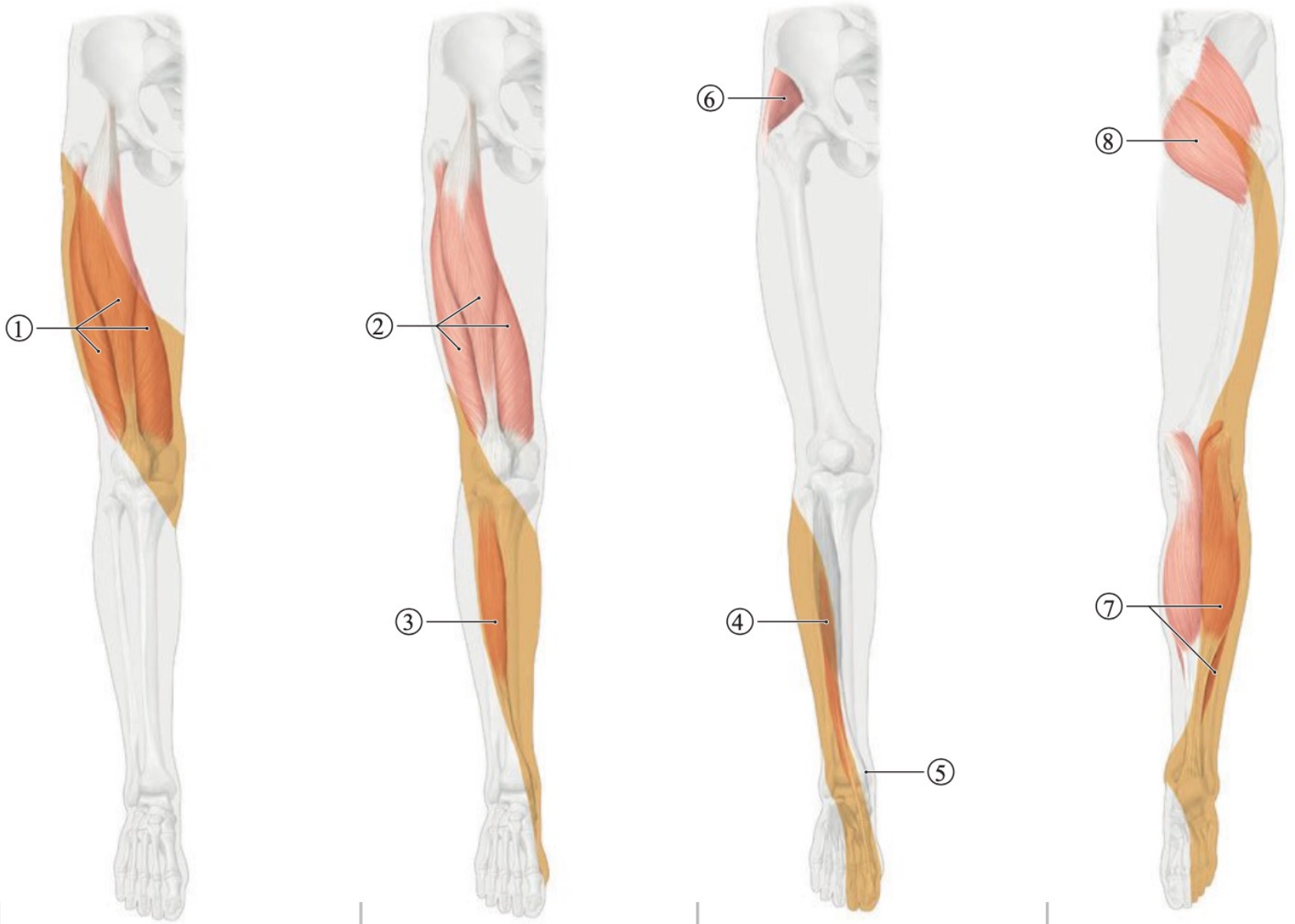
- **Proprioception uncousnious**
  - *Spinocerebellar tract*
  - *(head – n. trigeminus)*
  - *Used for an information of cyclic motions*
  - *Clim stairs*
  - *Ride a bicycle*



radicular terrirories

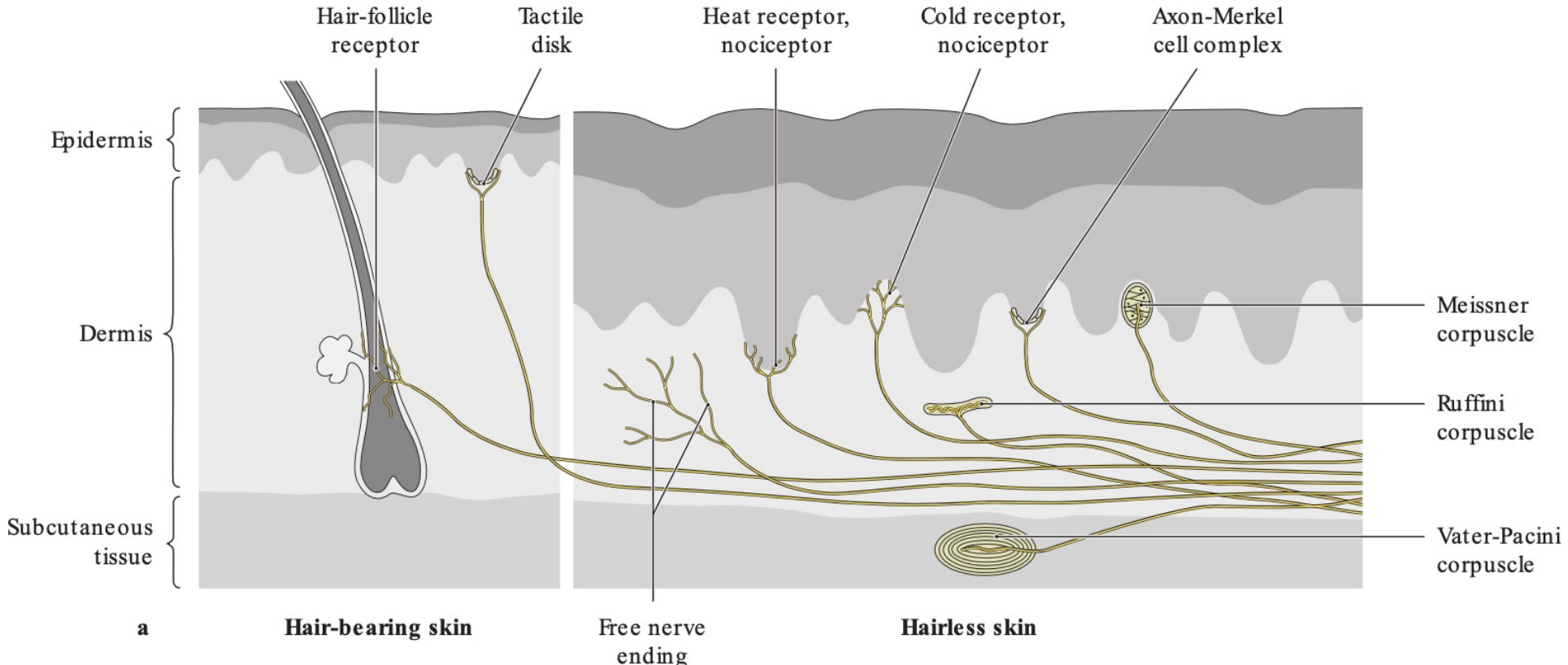


radicular terrirories



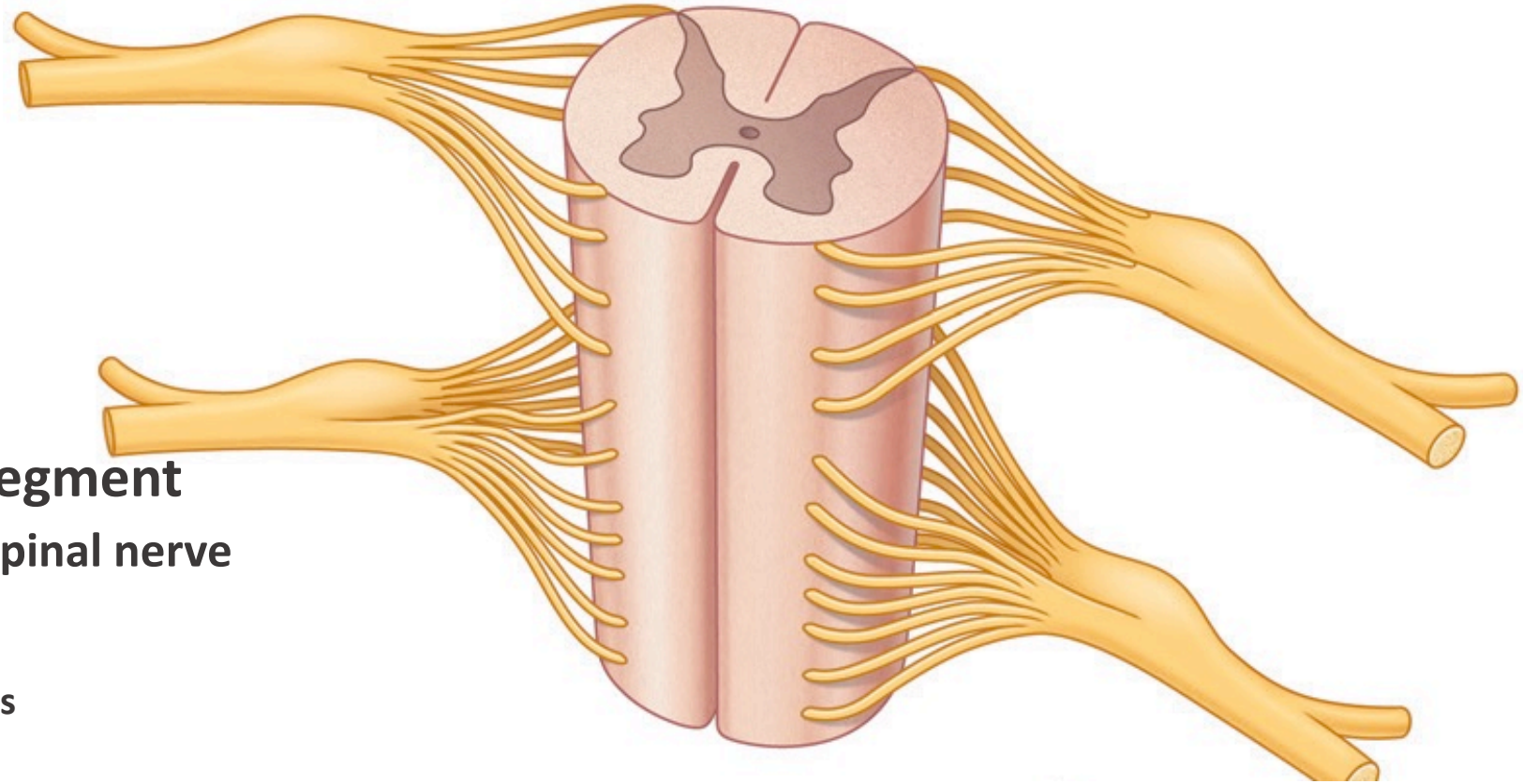
Skin sensation

- **Fine tactile perception**
  - *Funniculus posterior – fasciculus gracilis, cuneatus - detailed skin perception*
- **Crude perception**
  - *Spinothalamic lateral tract - wide projection in spinal cord*
- **Pain and heat perception - nociception**
  - *Unmyelinzed free endings - one segment spinal cord projection*



Nervi spinales

- radix posterior - posterior root
  - Soma in ganglion spinale (neural crest cell)
  - Senzitive filaments
  - centripetal
- radix anterior - anterior root
  - Soma in anterior horn
  - Motoric filaments
  - centifugal
- segmentum spinalis - spinal segment
  - rootlets - roots - forming one spinal nerve
- Rami nervi spinalis
  - Ramus posterior - intrinsic mm, et cutis
  - Ramus anterior other mm, and skin
  - Rami meningeales - recurrent small branches



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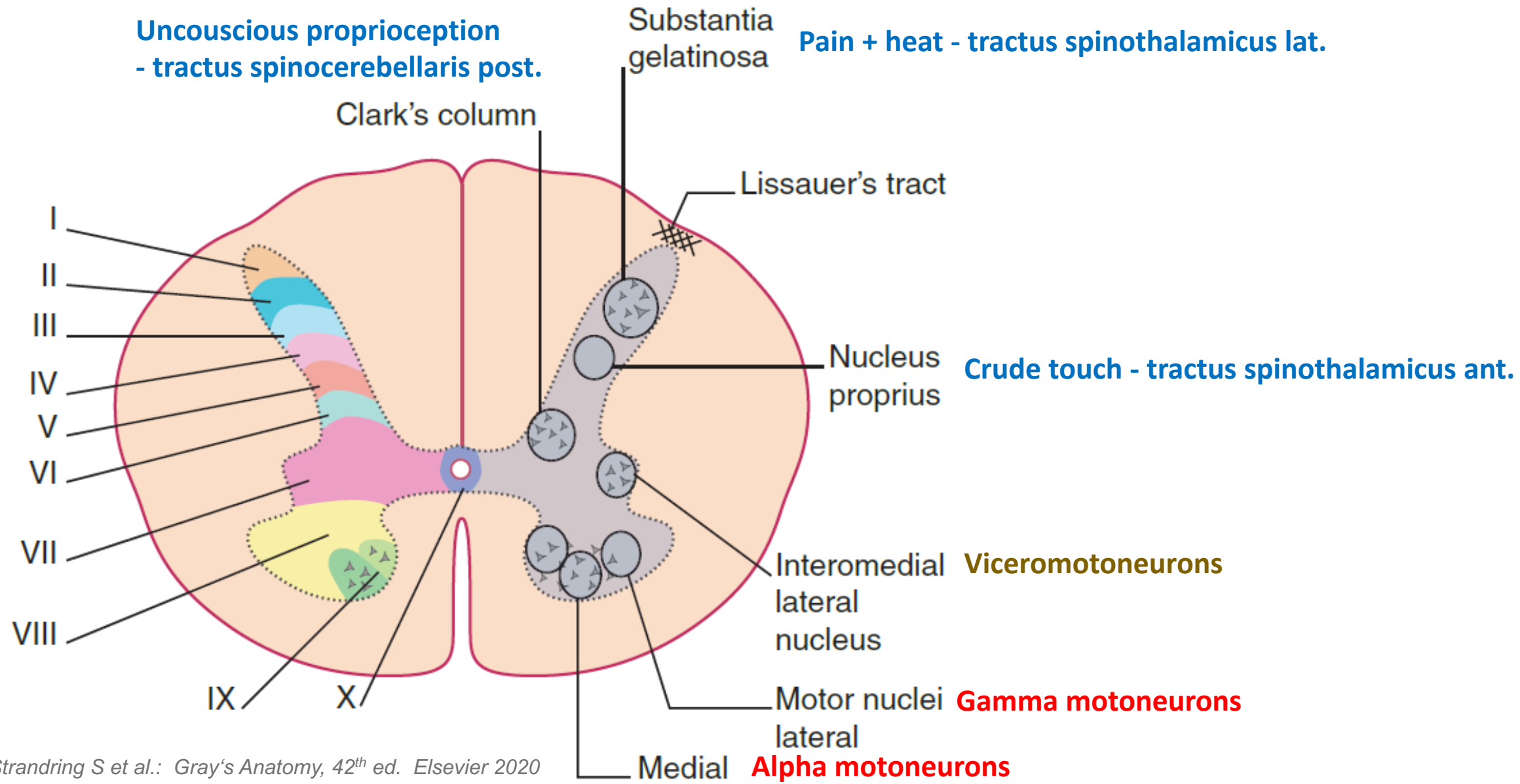
Nuclei medullae spinalis



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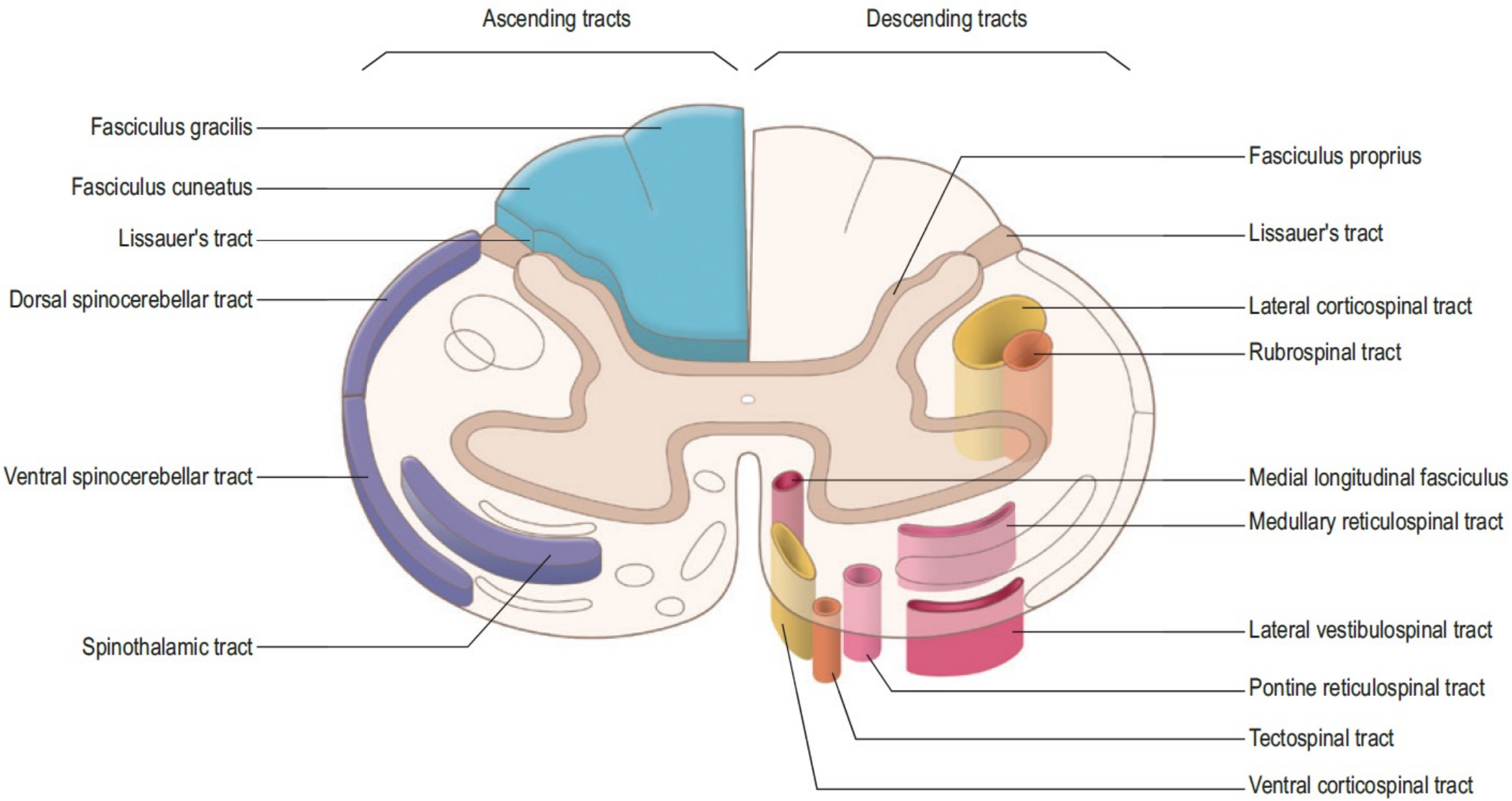
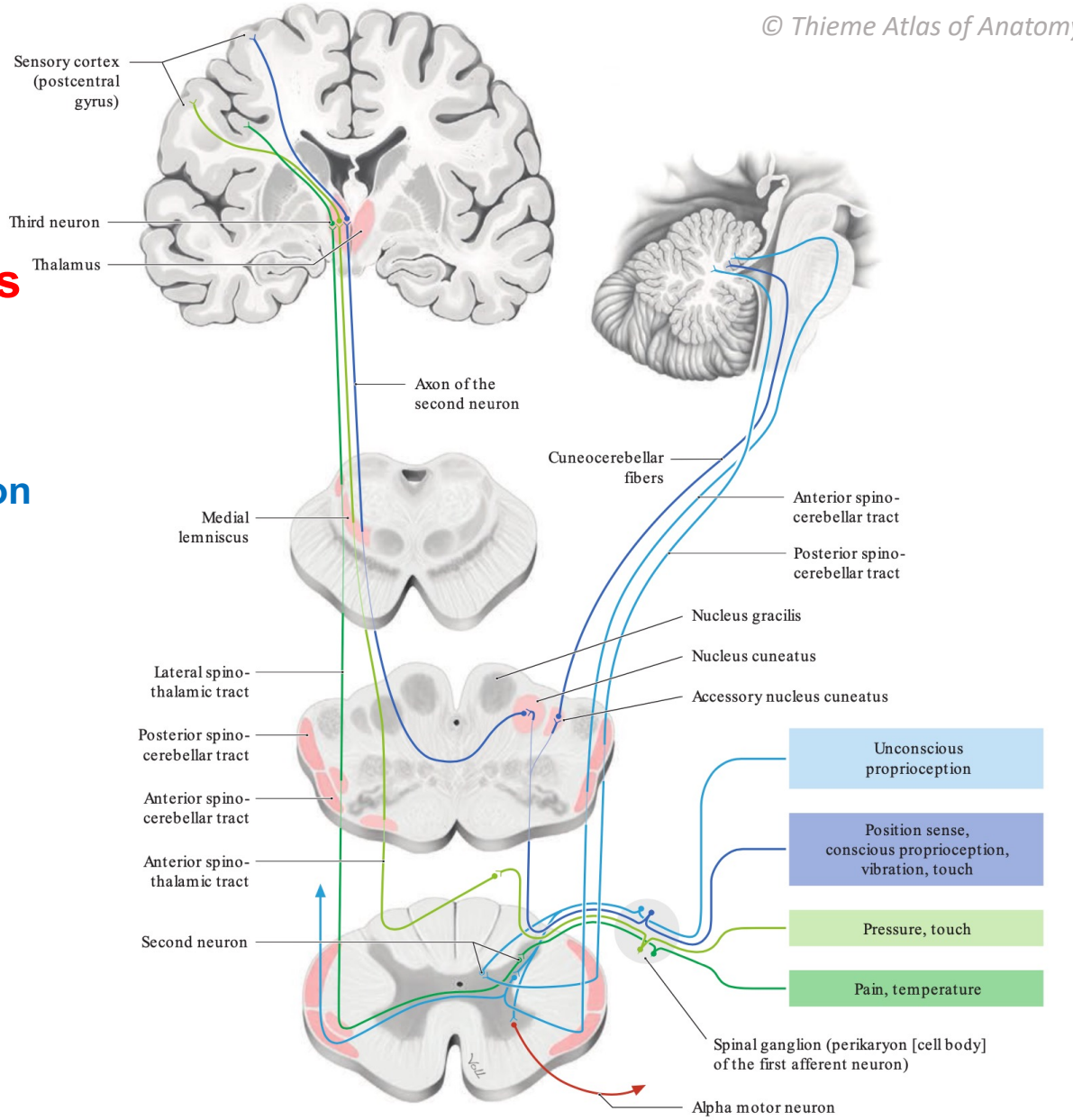
Tractus medullae spinalis



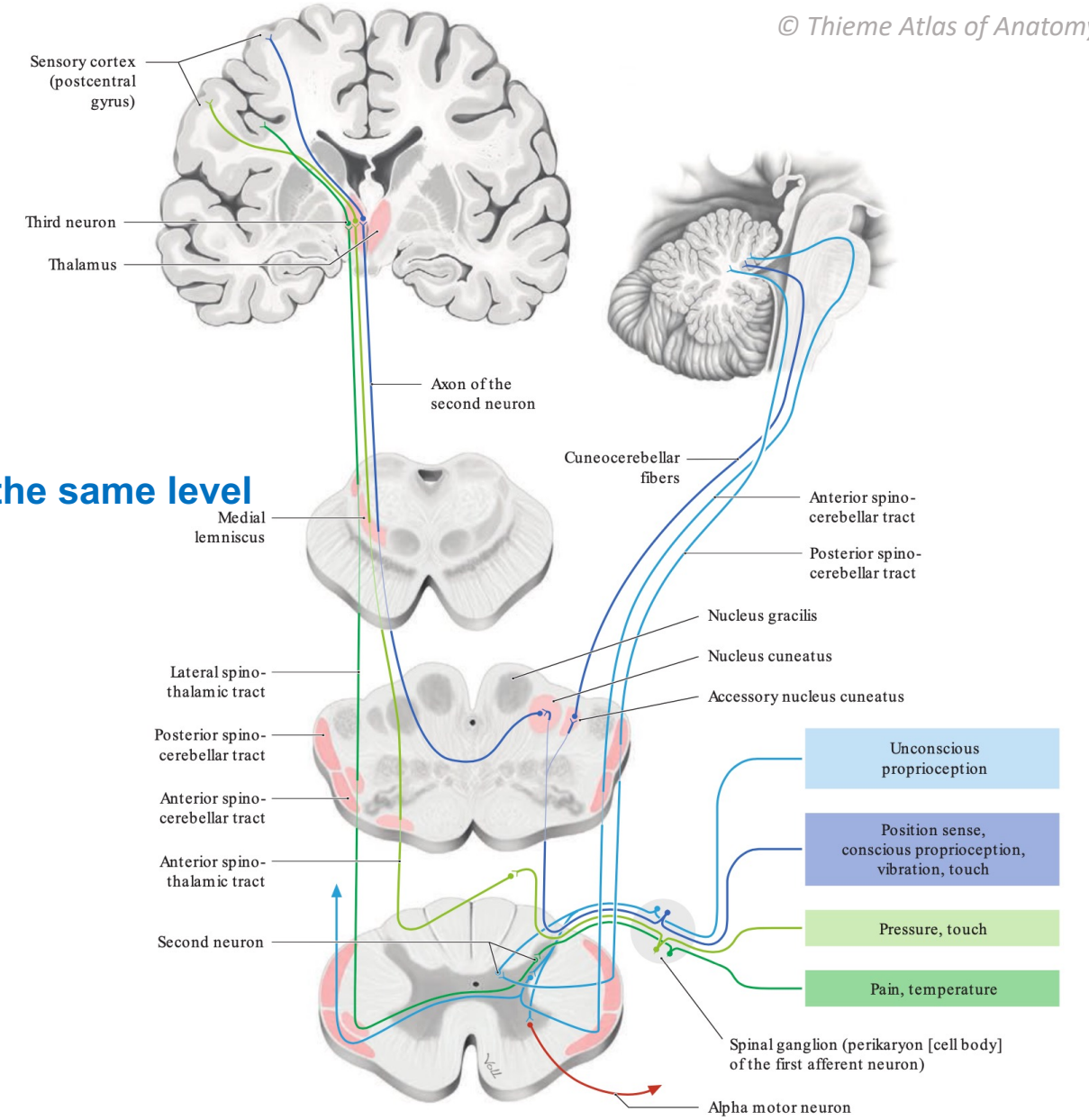
Tractus spinothalamicus anterior

- 1st neuron
  - *Pseudounipolar in spinal ganglion*
  - Crude touch
  - Receptors in hair follicles and skin receptors
- 2nd neuron
  - in posterior horn – nucleus proprius
    - -15. to +2. segment entry os pseudounipolar neuron
  - Spinal lemniscus
  - Ventral posterolateral nucleus of thalamus
- 3rd neuron
  - projects to postcentral gyrus



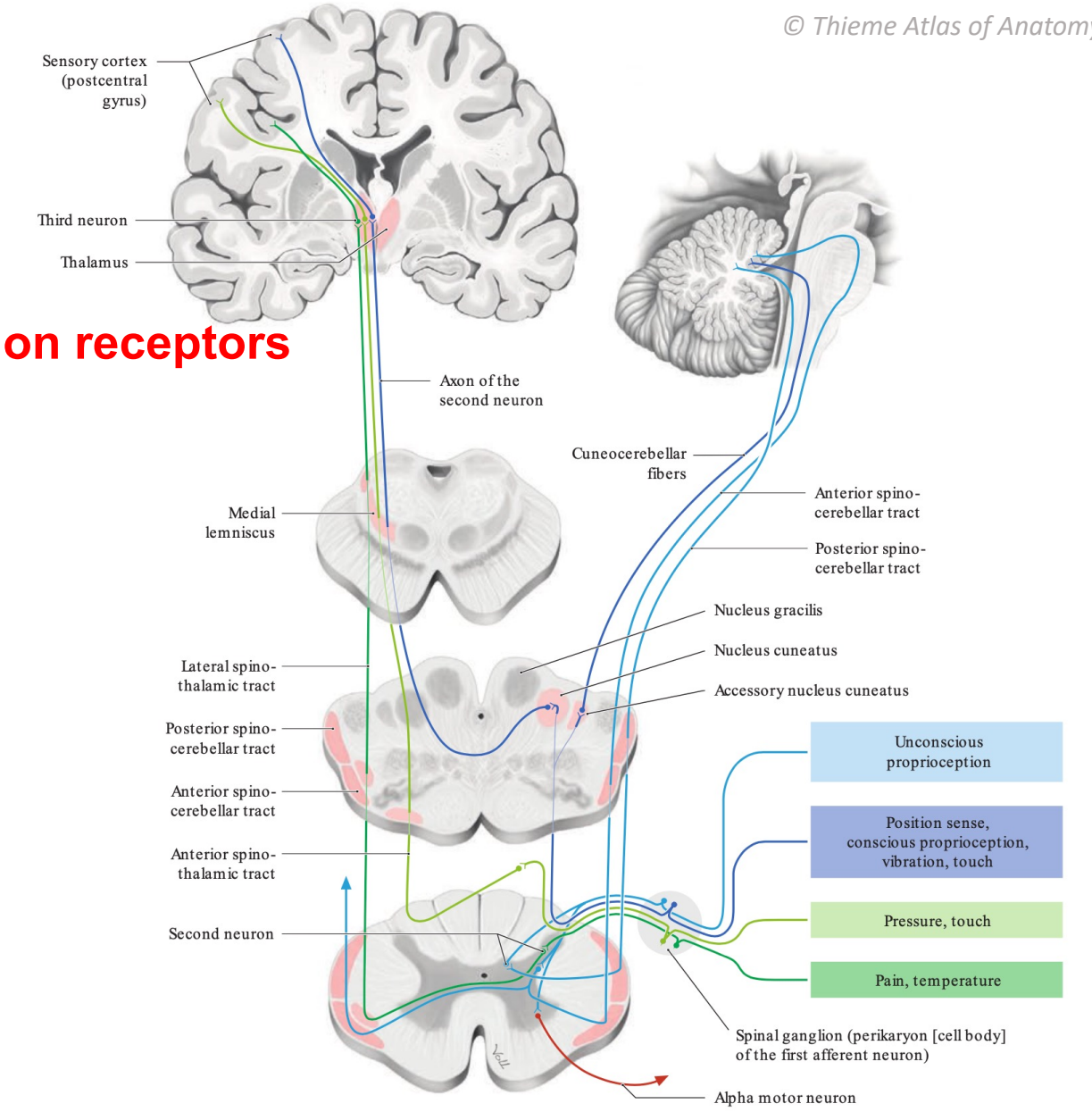
Tractus spinothalamicus lateralis

- 1st neuron
  - *Pseudounipolar in spinal ganglion*
  - Pain and heat
  - Free nerve endings
- 2nd neuron
  - substantia gelatinosa
    - Axon crosses midline in anterior commissure at the same level
  - Spinal lemniscus
  - Ventral posterolateral nucleus of thalamus
- 3rd neuron
  - projects to postcentral gyrus



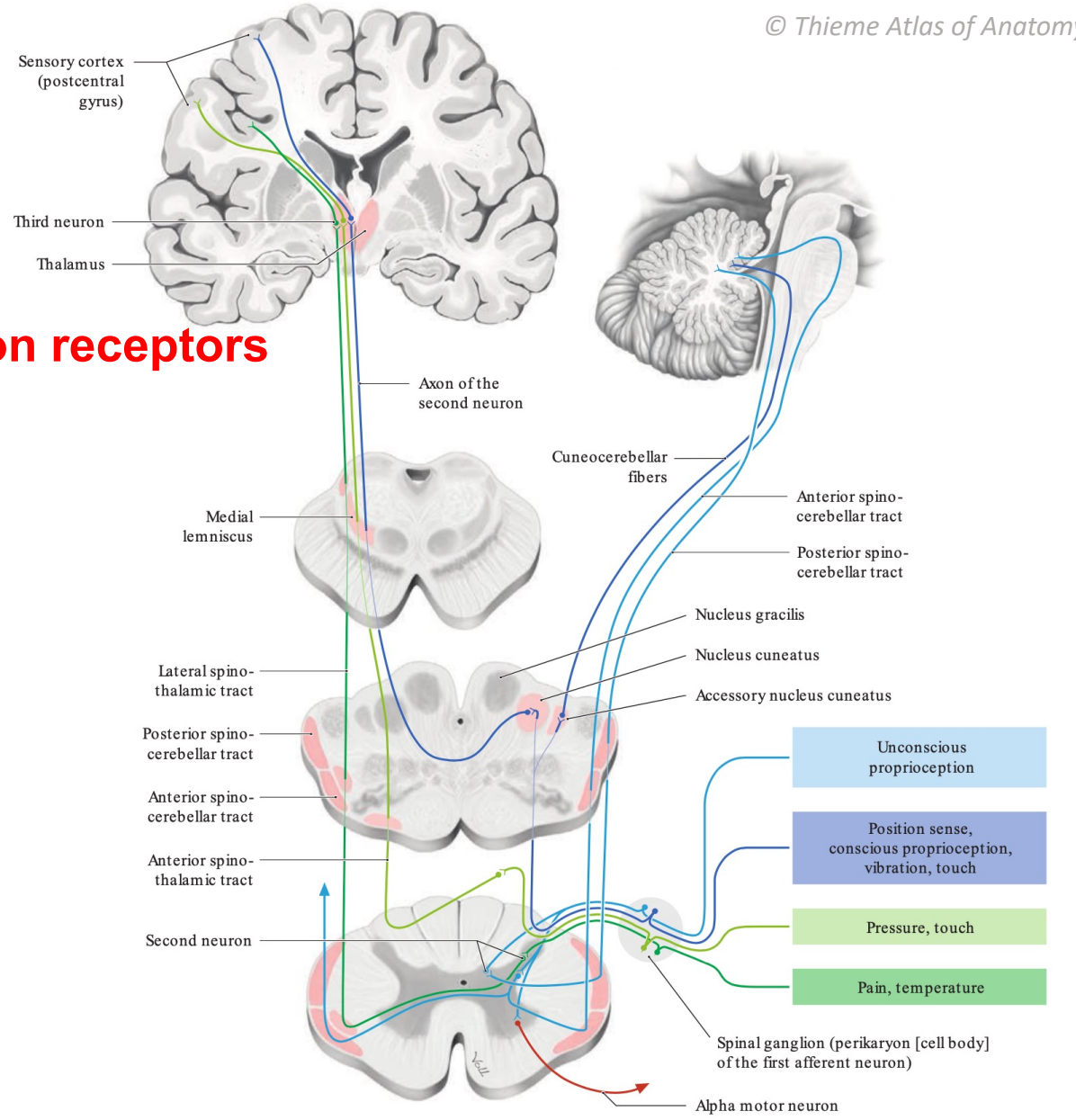
Fasciculus gracilis

- 1st neuron
  - *Pseudounipolar in spinal ganglion*
  - Fine touch and conscious proprioception
  - lower limb
  - Vater-Paccini corpuscula, muscle and tendon receptors
- 2nd neuron
  - nucleus gracilis in medulla oblongata
    - Axon crosses midline at the level of brainstem
  - Medial lemniscus
  - Ventral posterolateral nucleus of thalamus
- 3rd neuron
  - projects to postcentral gyrus



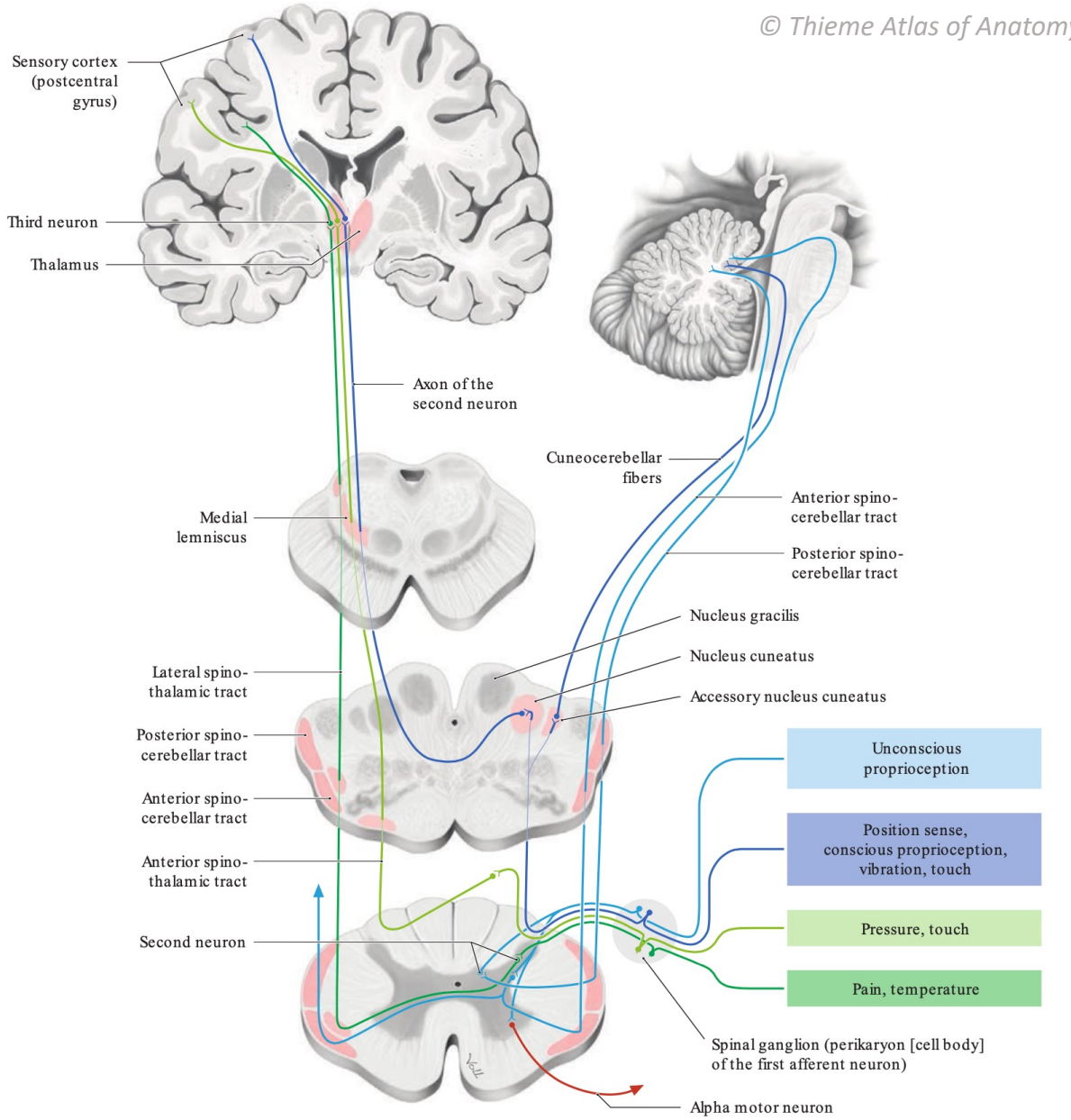
Fasciculus cuneatus

- 1st neuron
  - *Pseudounipolar in spinal ganglion*
  - Fine touch and conscious proprioception
  - lower limb
  - Vater-Paccini corpuscula, muscle and tendon receptors
- 2nd neuron
  - nucleus cuneatus in medulla oblongata
    - Axon crosses midline at the level of brainstem
  - Medial lemniscus
  - Ventral posterolateral nucleus of thalamus
- 3rd neuron
  - projects to postcentral gyrus



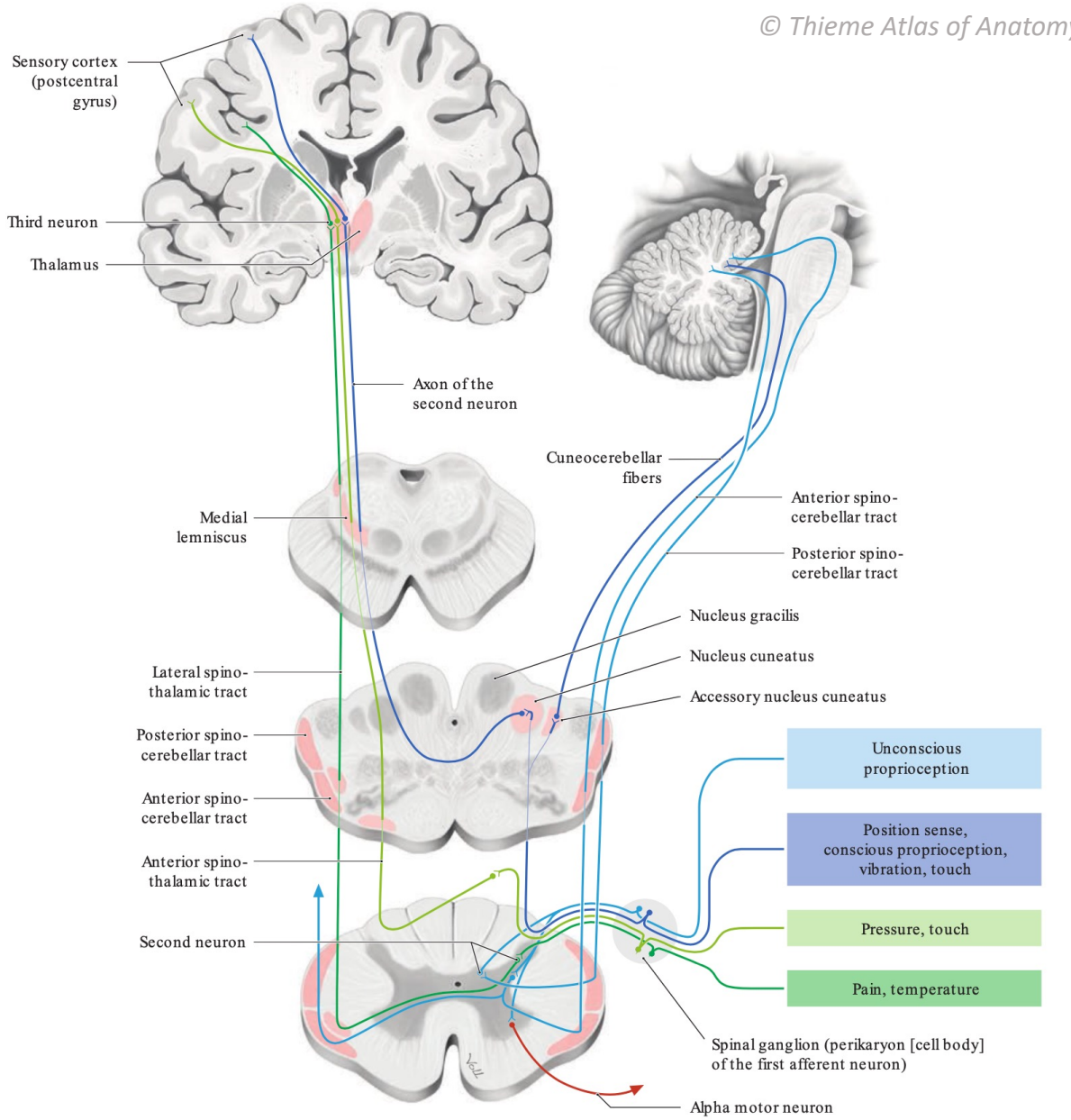
Fasciculus spinocerebellaris anterior (Gowers)

- **1st neuron**
  - *Pseudounipolar in spinal ganglion*
  - **Unconscious extero - and proprioception**
  - **crossed and uncrossed**
  - *Muscle spindles, tendon receptors*
  - *joint receptors, skin receptors*
- **2nd neuron**
  - **posterior horn**
    - **Axon crosses or does not cross midline**
  - **2nd neuron projects directly to cerebellum**
    - **Pedunculus cerebelli superior**
    - **Pars vermiana spinocerebelli**



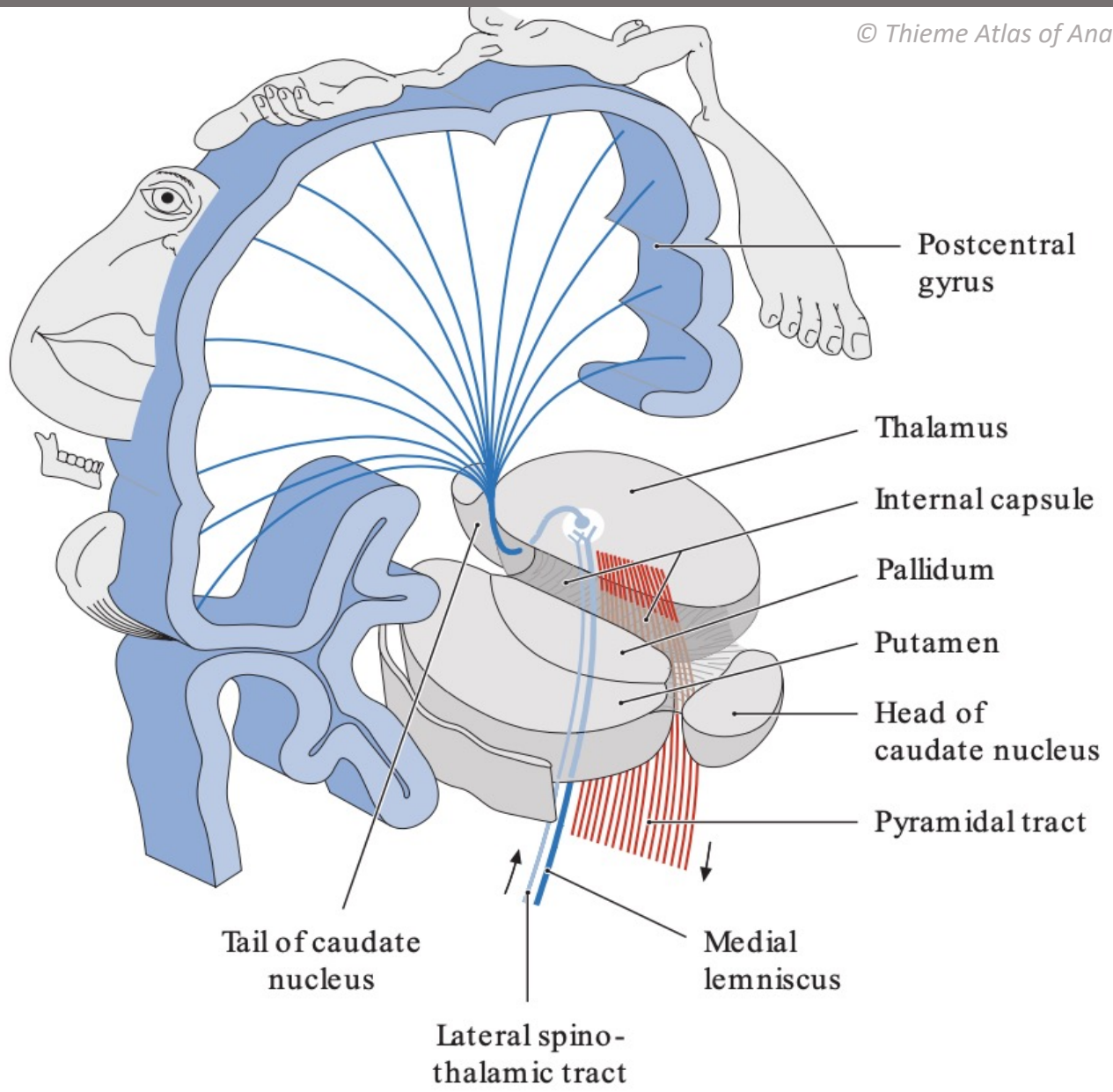
Fasciculus spinocerebellaris posterior (Flechsig)

- 1st neuron
  - *Pseudounipolar in spinal ganglion*
  - Unconscious extero - and proprioception
  - uncrossed
  - Muscle spindles, tendon receptors
  - joint receptors, skin receptors
- 2nd neuron
  - Clarke column - Stilling nucleus
    - base of posterior horn
    - Axon does not cross midline
  - 2nd neuron projects directly to cerebellum
    - Pedunculus cerebelli inferior
    - Pars vermiana spinocerebelli



Somatosensoric cortex

- **Postcentral gyrus**
- **Projection through thalamus**
  - **ventral posterolateral nucleus**

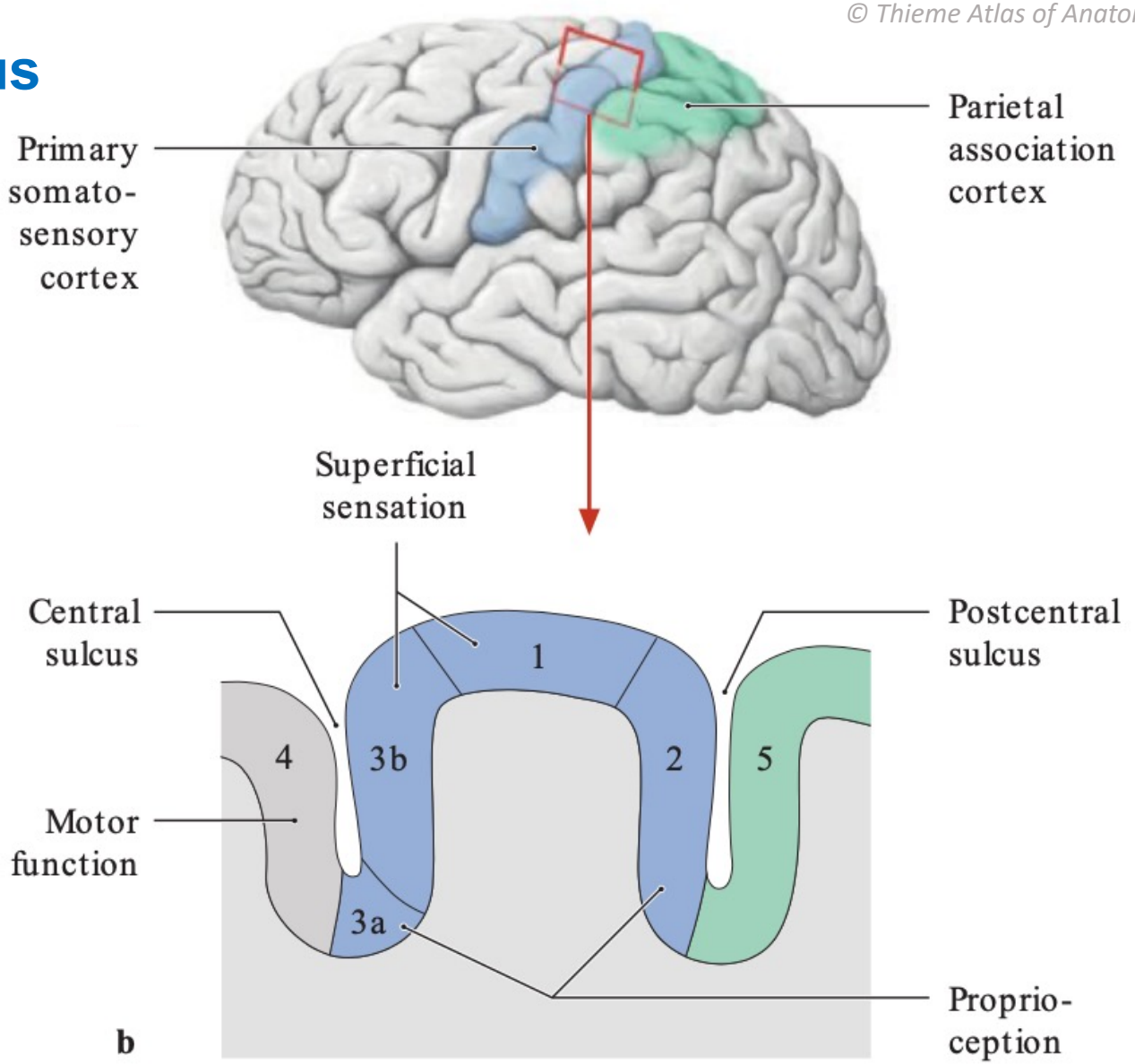


Somatosensoric cortex

- Projection through postcentral sulcus
- Proprioception
- Superficial sensations

- Motor functions

- The spatial recognition



somatosensoric and motor system

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