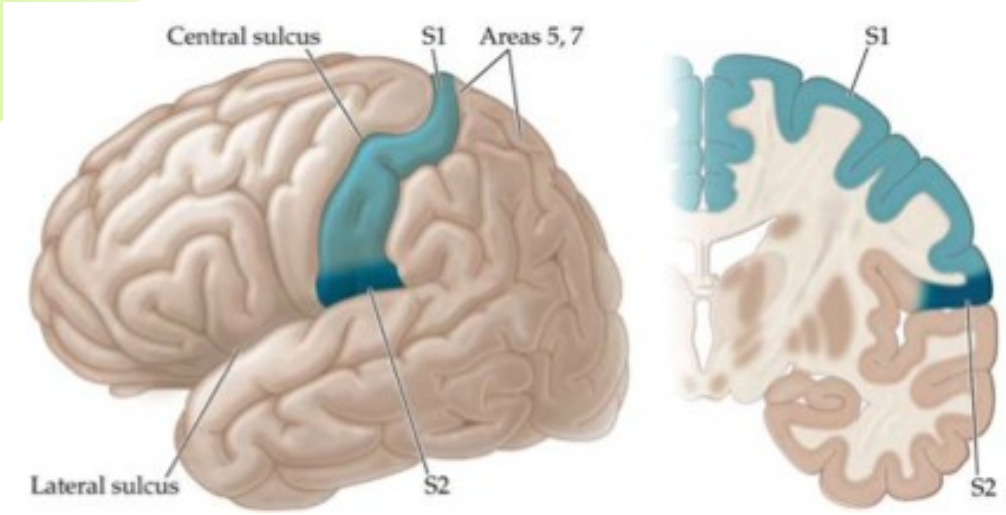
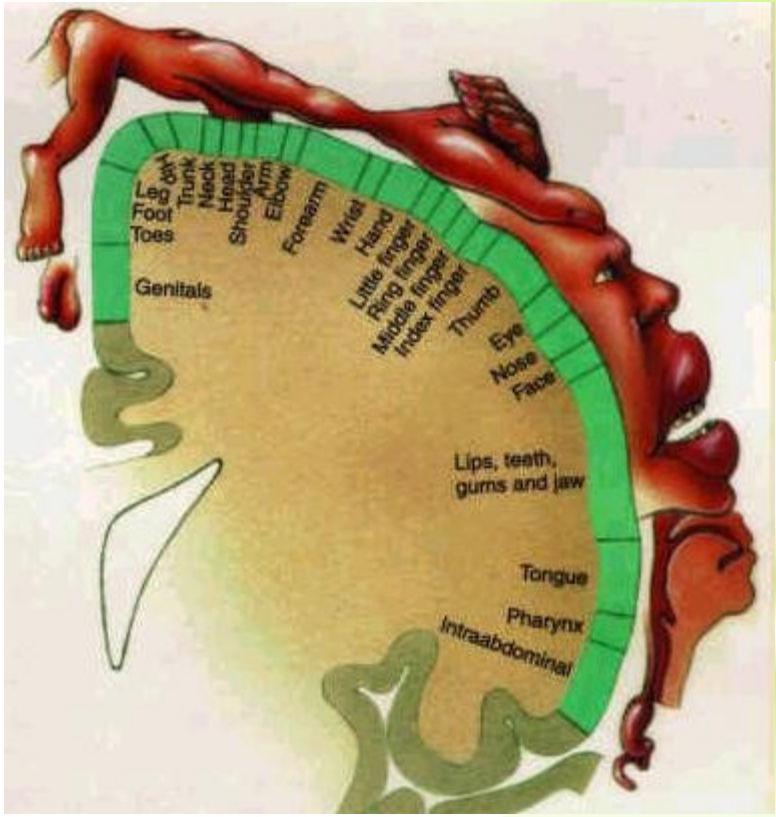
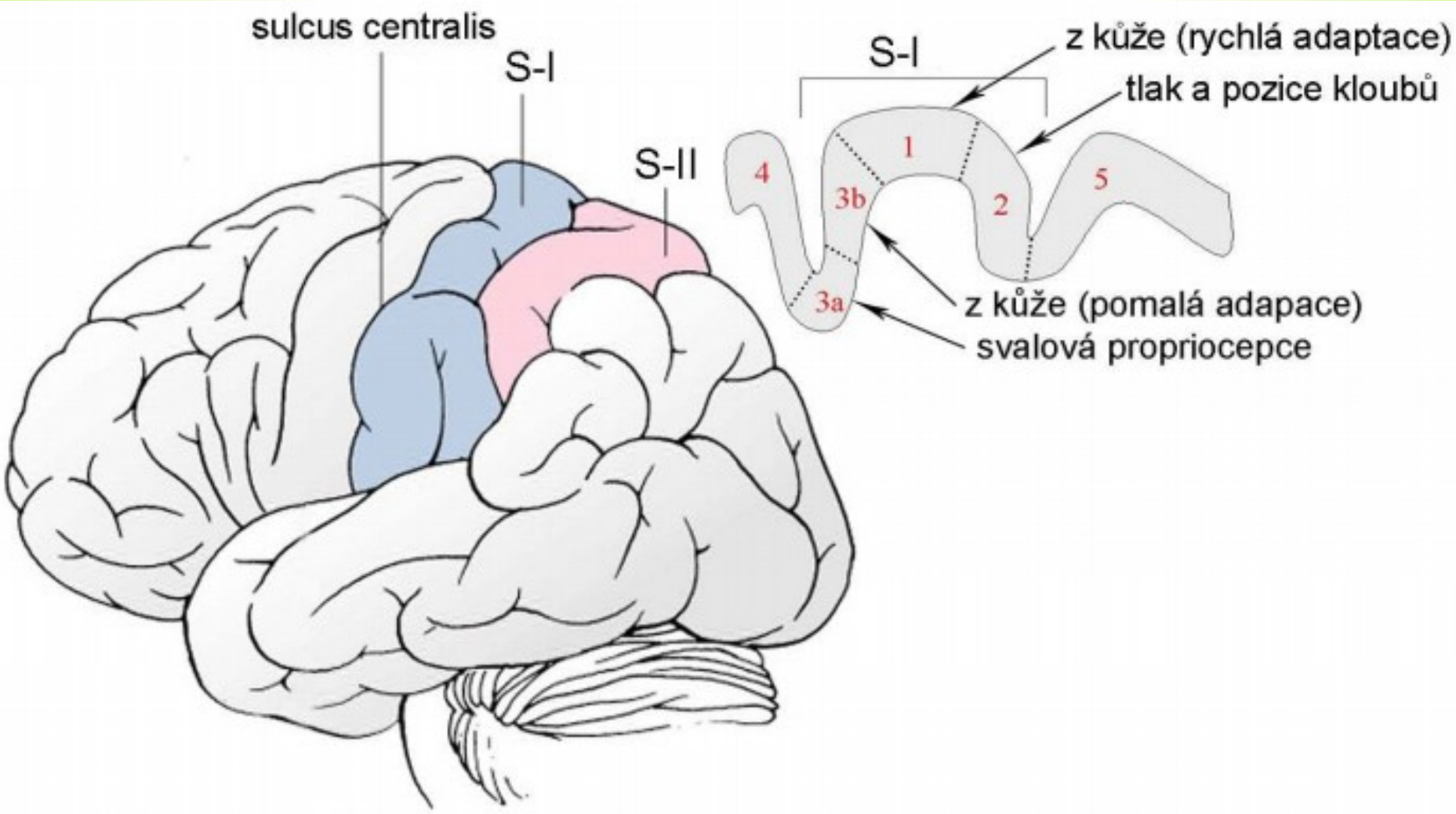
CENTRAL REPRESENTATION OF THE TOUCH

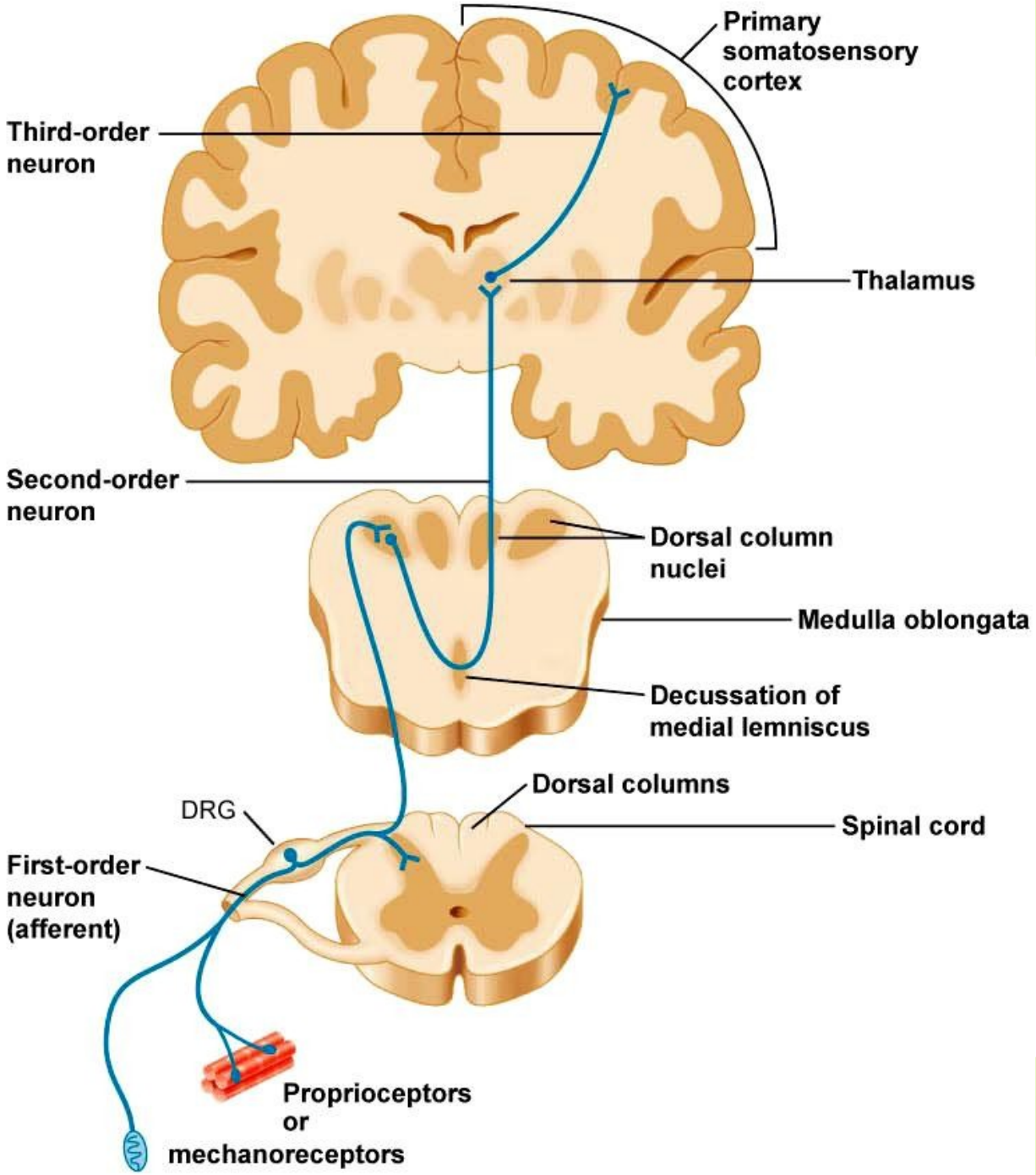
Primary somatosensory (somesthetic) cortex (SI)



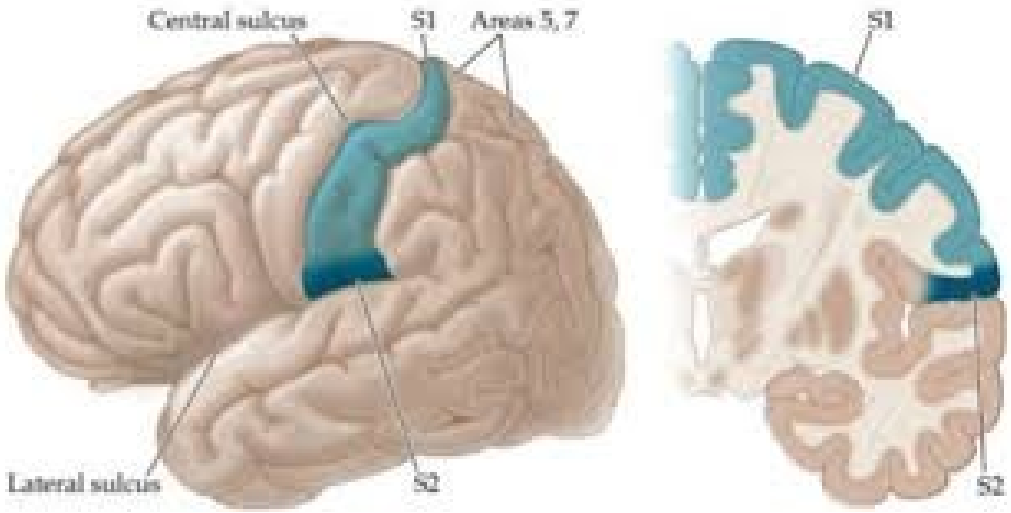


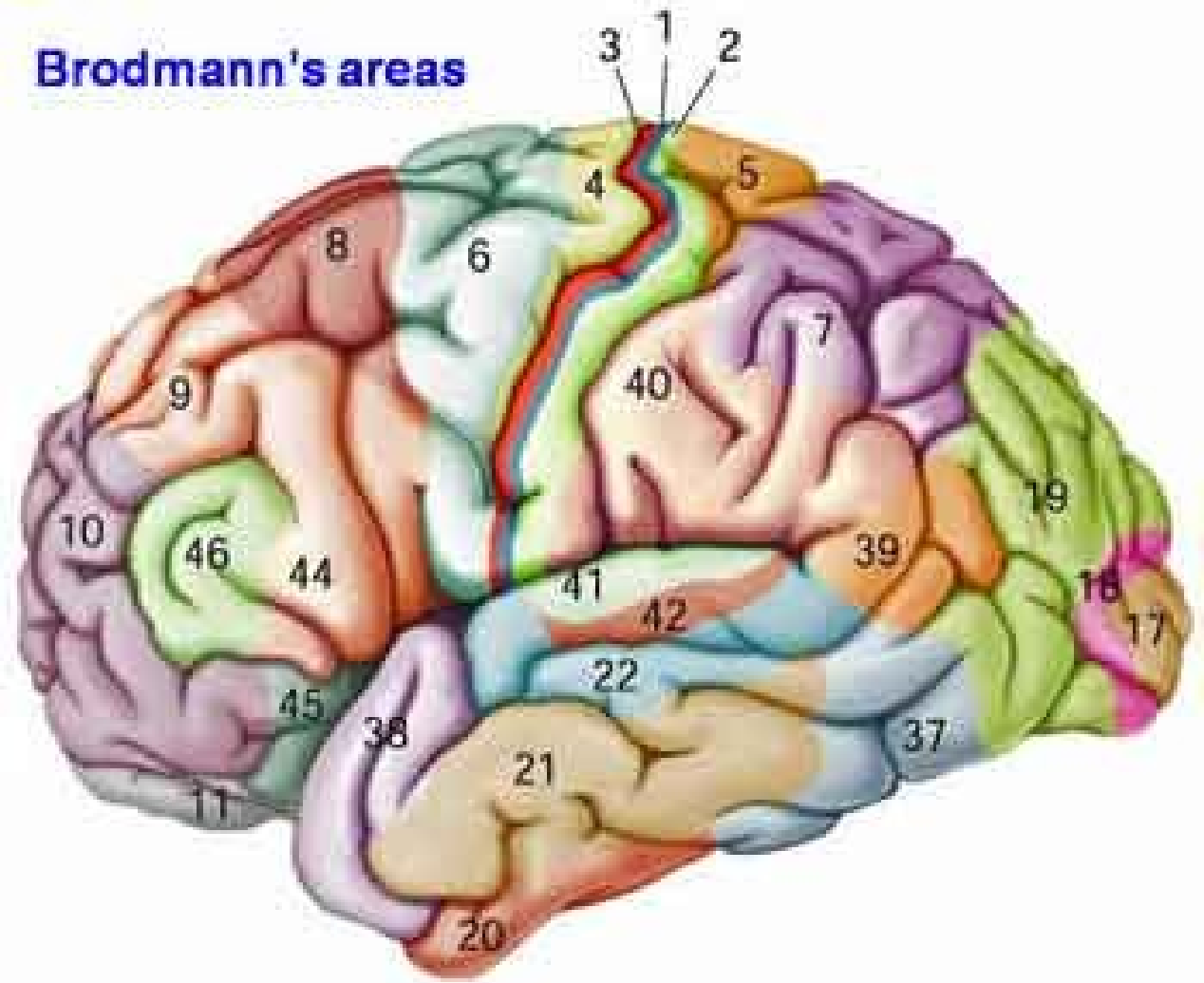
Somatosensory cortex – a. 3,1,2




Primary somatosensory cortex
Third-order neuron
Thalamus
Second-order neuron
Dorsal column nuclei
Medulla oblongata
Decussation of medial lemniscus
Dorsal columns
DRG
Spinal cord
First-order neuron (afferent)
Proprioceptors or mechanoreceptors

Secondary somatic sensory area (SII)




Brodmann's areas
3
1
2
4
5
8
6
7
40
9
10
46
44
41
42
39
19
18
17
22
45
38
37
21
11
20

PAIN

PAIN

- pain is a protective modality
- International Association for the Study of Pain (IASP):
  „Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage“.
- pain threshold: individual and social influences

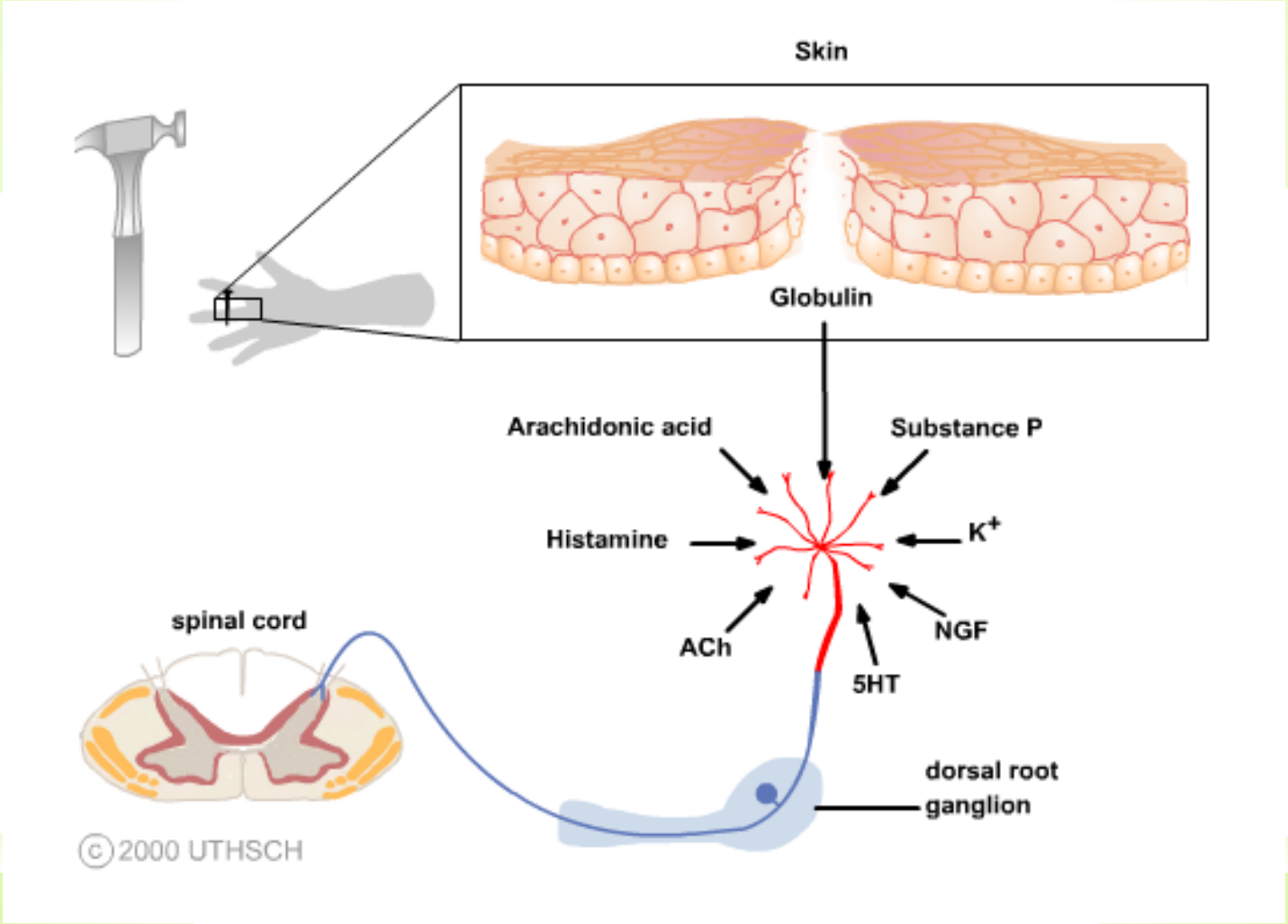
Nociceptors/nocisensors

- nocer – to injure or to hurt in Latin
- are activated by noxious mechanical, thermal or chemical stimuli
- detect signals from damaged tissue or the threat of damage
- free nerve endings found in the skin, muscles, joints, bones and viscera

Nociceptors

- nociceptors of Aδ fibres (5-40 meters/sec)
  - Aδ mechanical nociceptors
  - Aδ thermal nociceptors
- nociceptors of C fibres (0.5-2.0 meters/sec)
  - C polymodal nociceptors – react to thermal, mechanical and chemical stimuli
- silent nociceptors (MIA = mechanically insensitive afferents) - responsive after inflammation and tissue injury

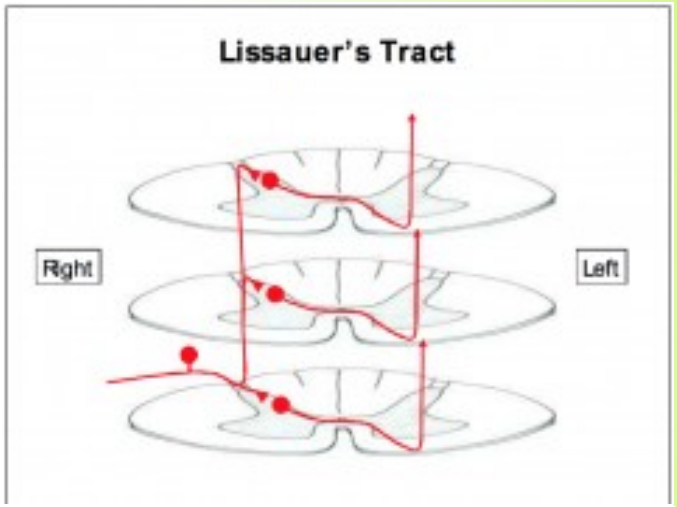
Factors that activate nociceptors

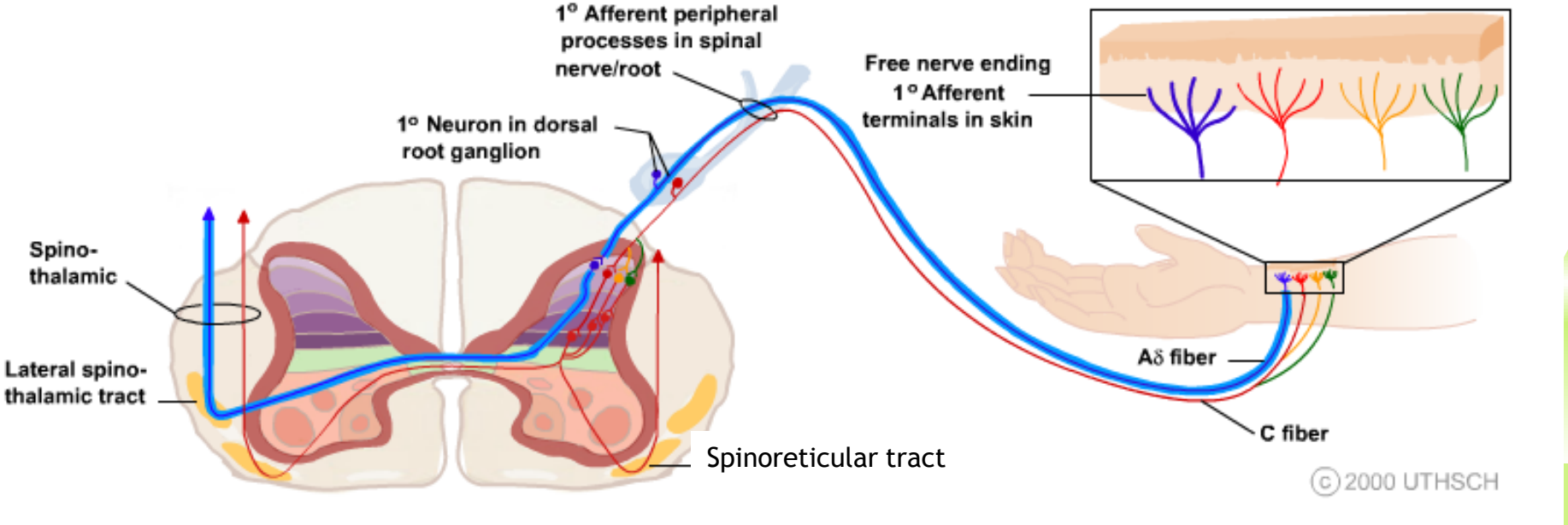


- **Peripheral sensitization**
- **Central sensitization** = activity- or use-dependent neuronal plasticity in the spinal cord
  - **hyperalgesia** - exaggerated or prolonged response to noxious inputs
  - **allodynia** - pain induced by normally innocuous inputs

Nociceptive afferents

- Aδ fibres – thin myelinated fibres
  - sharp, localized pain
- C non-myelinated fibres
  - dull, non-localized pain





Pain pathways from trunk and limbs

PALEOSPINOTHALAMIC PATHWAY

- tr. spino-reticulo-thalamicus
  - diffuse, non-localized pain
  - autonomic and reflexive responses to pain stimuli
  - emotional and affective reactions to pain
  - intralaminar nuclei of the thalamus
  - postcentral gyrus, insula and cingulate gyrus

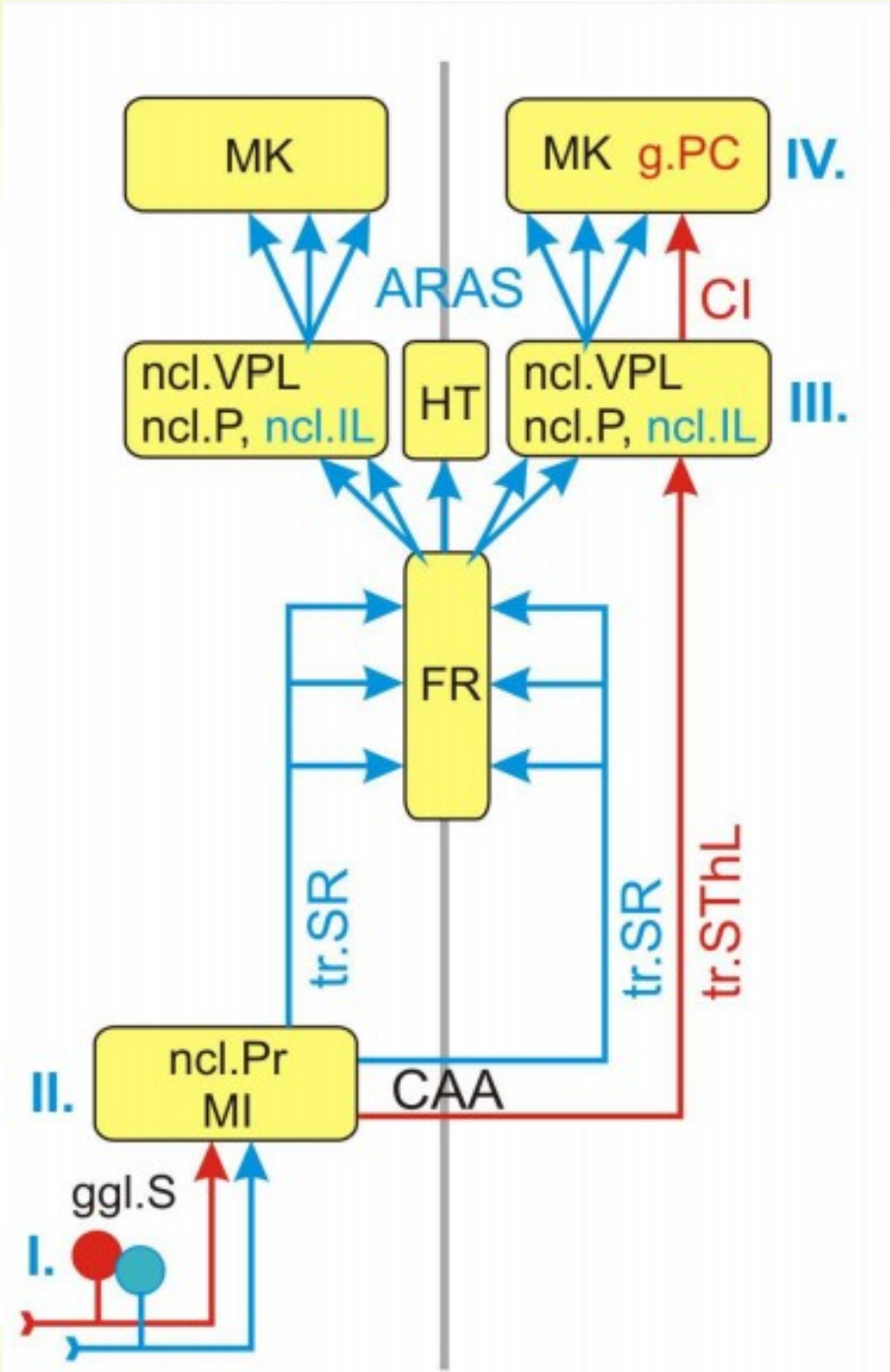
NEOSPINOTHALAMIC PATHWAY

- tr. spino-thalamicus lat.
  - sharp, localized pain
  - ventral posterolateral (VPL) and posterior nucleus of the thalamus
  - postcentral gyrus

Cortex

Thalamus

Spinal cord



Paleospino-thalamic pathway

Neospino-thalamic pathway

Pain pathways from head

TRACTUS TRIGEMINO-RETICULO-THALAMICUS

- diffuse, non-localized pain

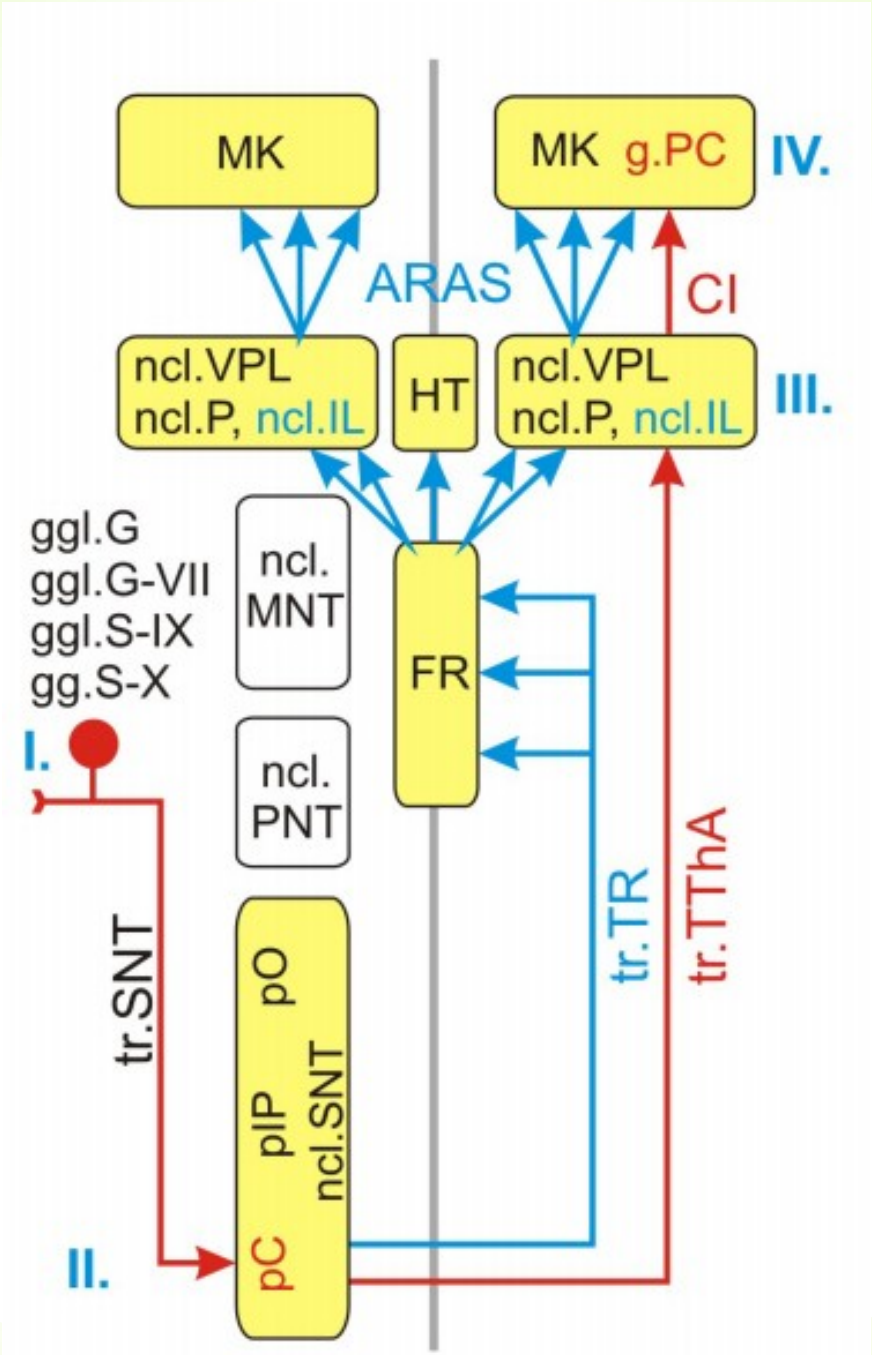
TRACTUS TRIGEMINO-THALAMICUS ANTERIOR

- sharp, localized pain

Cortex

Thalamus

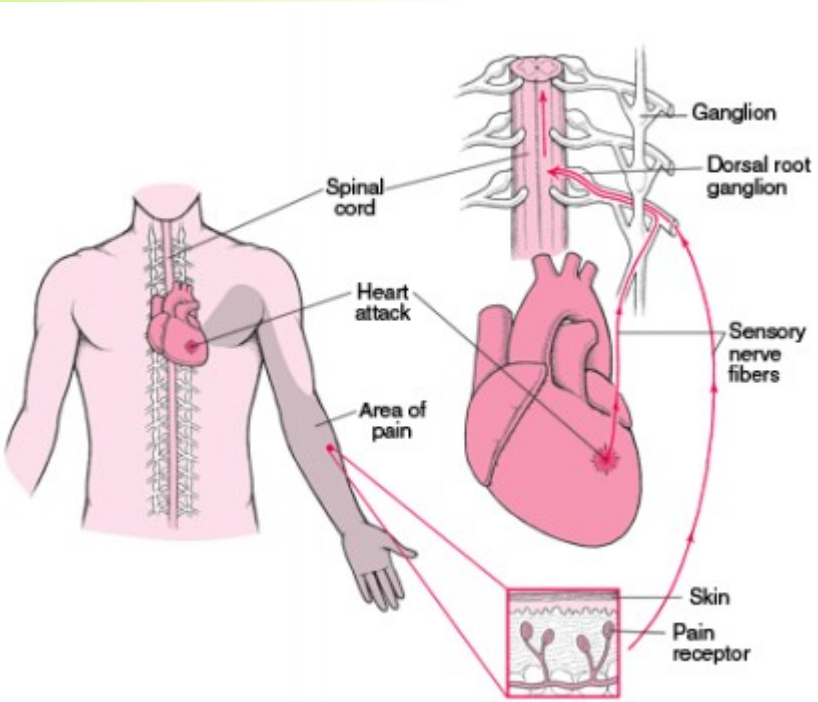
Medulla

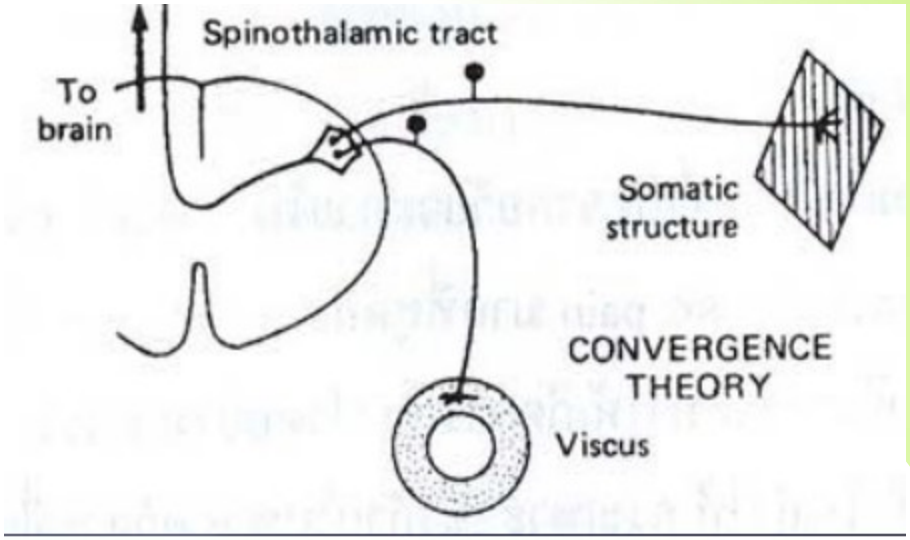


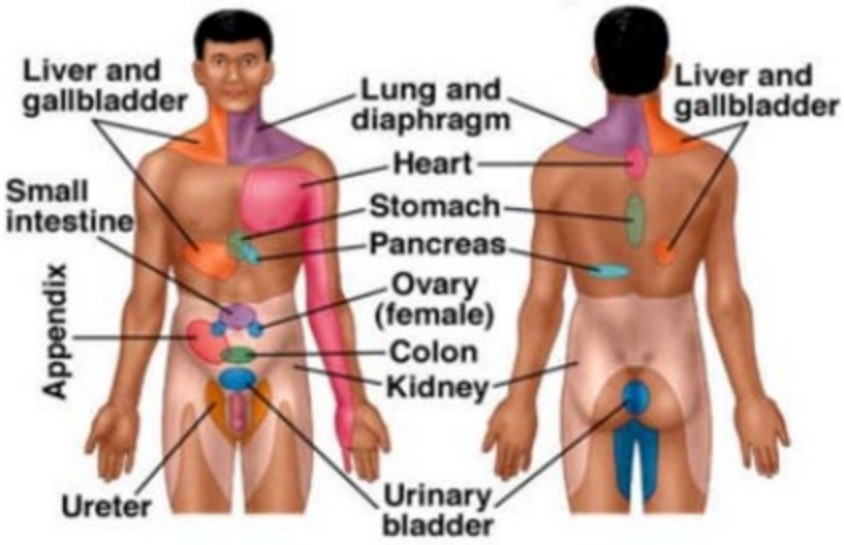
The phylogenetically old, **paleospinothalamic and trigemino-reticulothalamic**, pathways through the RF are concerned with the arousal and affective (emotional) aspects of somatic sensory stimuli.

In contrast, the direct, **neospinothalamic and anterior trigeminothalamic,** pathways are analytic, encoding information about modality, intensity, and location.

Referred pain



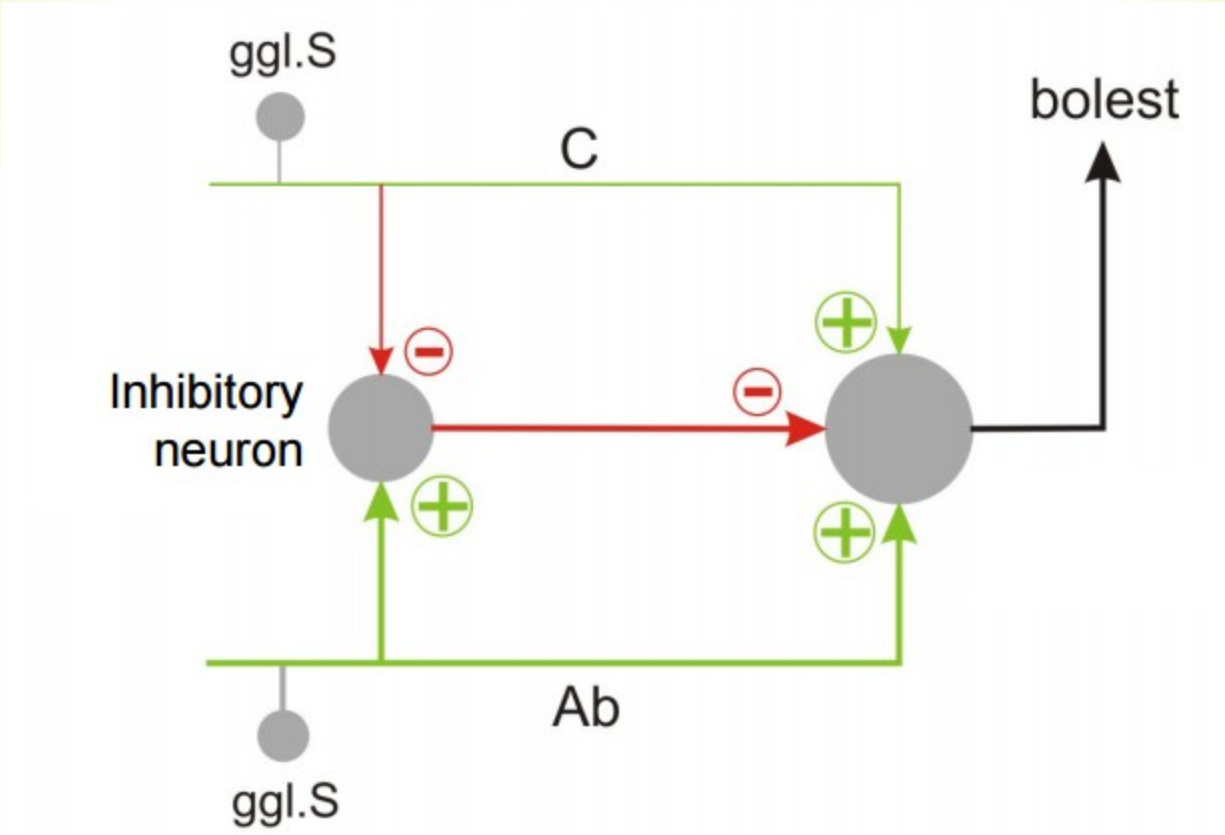




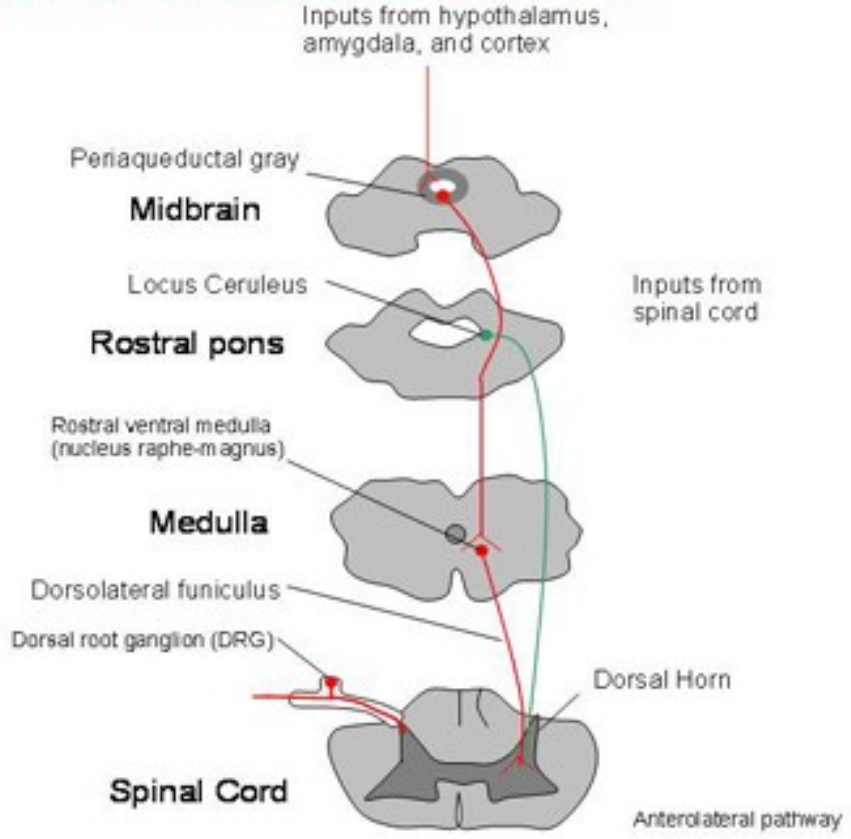
MODULATING SYSTEMS OF NOCICEPTIVE PATHWAYS

- level of modulation of nociceptive pathways
  - spinal cord (“gate control theory”)
  - RF of brain stem
  - periaquaeductal gray matter (PAG)

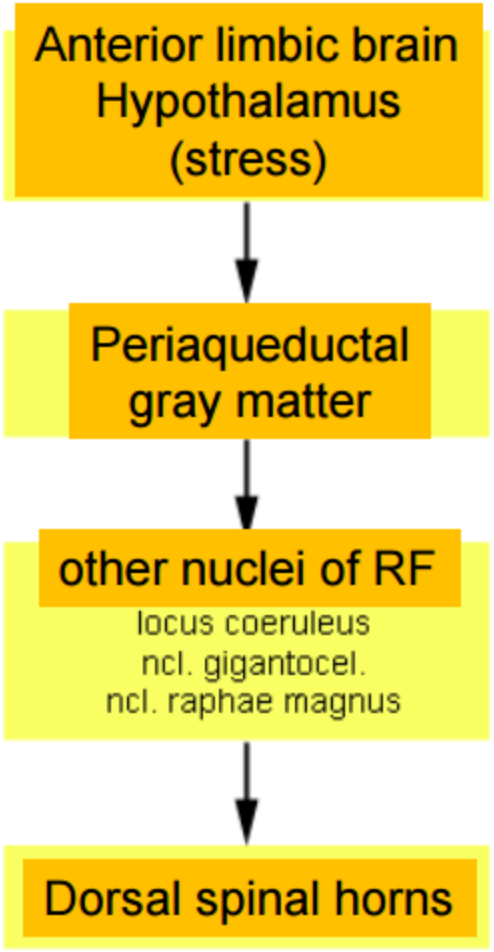
“Gate control theory”



Central Pain Modulation



Stress-induced analgesia



SOMATOMOTOR PATHWAYS

Some necessary components of proper motor control

- Volition
- Coordination of signals to many muscle groups
- Proprioception
- Postural adjustments
- Sensory feedback
- Compensation for the physical characteristics of the body and muscles
- Unconscious processing
- Adaptability

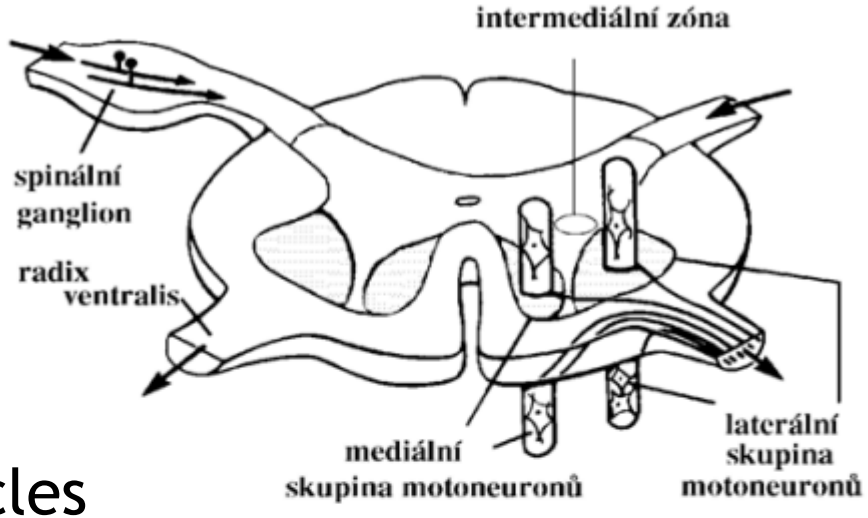
Levels of movement regulation

- spinal cord
- brain stem
- cortex

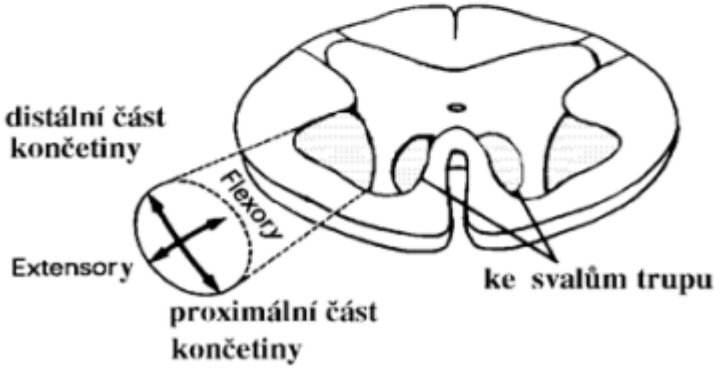
- cerebellum
- basal ganglia

Lower motor neurons – spinal cord

- α motoneurons
- γ motoneurons

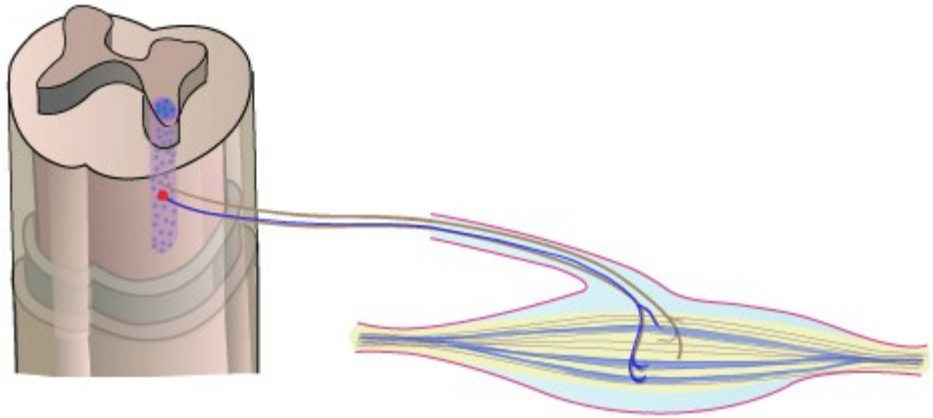


- Somatotopic organization
  - medial column – axial muscles
  - lateral column – limb muscles
  - anteriorly – extensors
  - posteriorly - flexors



- **Motor neurons** have highly branched, elaborate dendritic trees, enabling them to integrate the inputs from large numbers of other neurons and to calculate proper outputs.

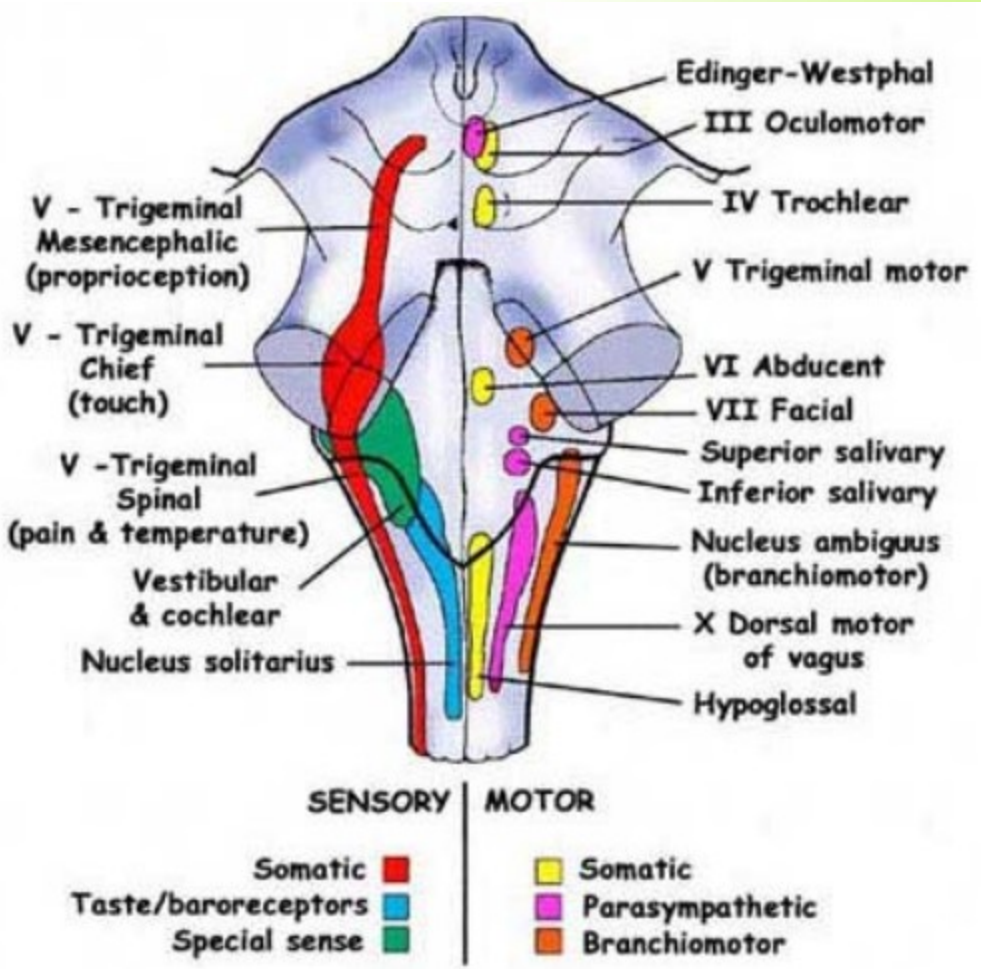
- The combination of an individual motor neuron and all of the muscle fibers that it innervates is called a **motor unit**.



- size of motor unit
  - small motor unit – 1 motoneuron innervates several muscle fibers (extraocular muscles, muscles of hand)
  - large motor unit – 1 motoneuron innervates 500 – 1000 muscle fibers (back muscles)

Lower motor neurons – brain stem

- Somatomotor nuclei
  CN III, IV, VI, XII
- Branchiomotor nuclei
  CN V, VII, IX, X, XI

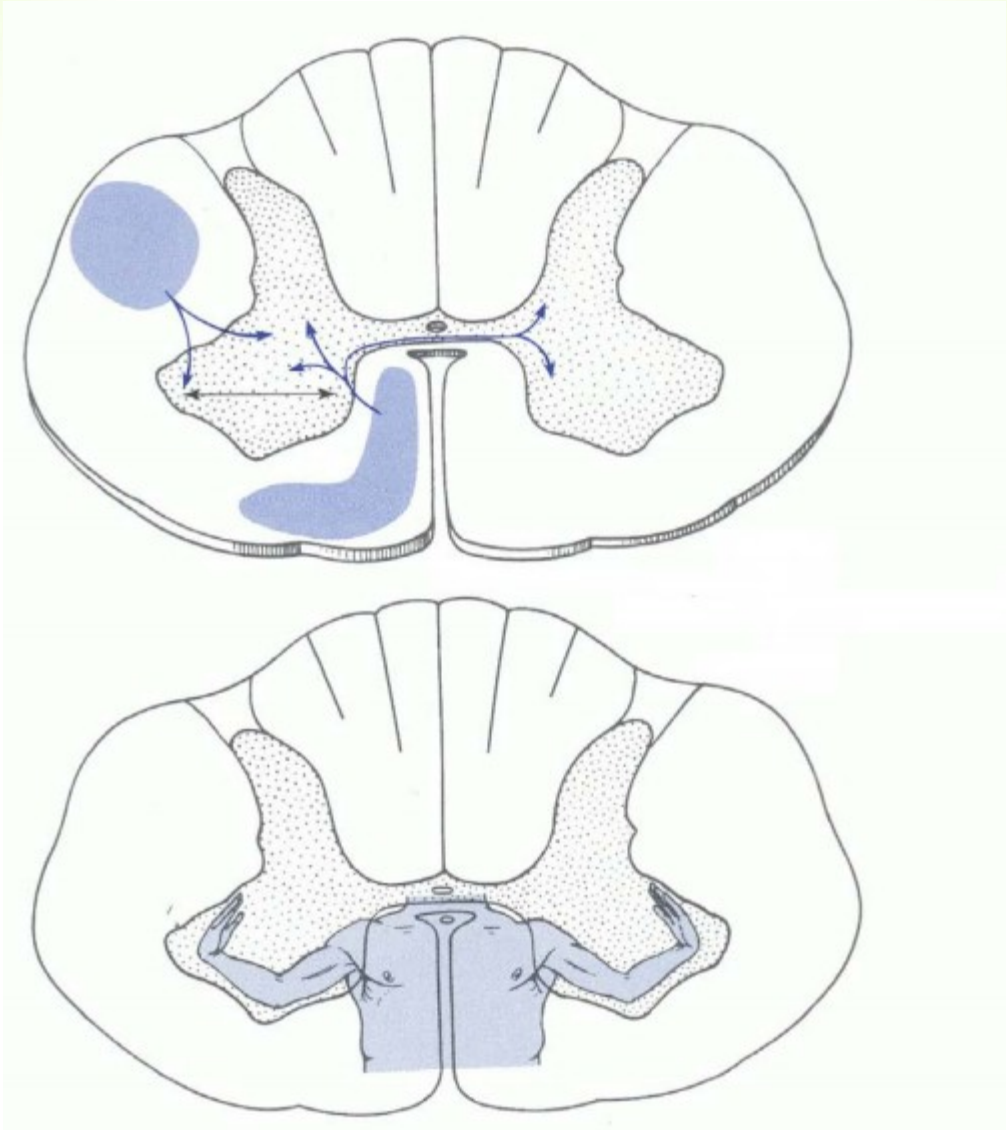


Supraspinal system of movement control

- Medial system
  - bilateral
  - terminates on the interneurons or the medial column of lower motor neurons
  - controls maintenance of balance and postural movements

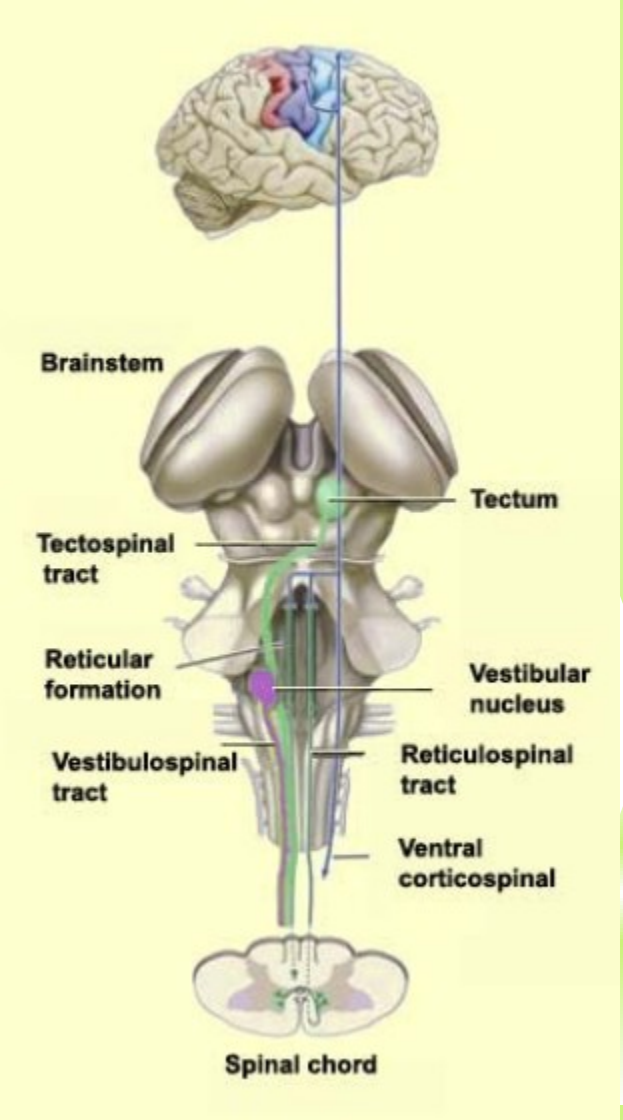
- Lateral system
  - mostly cross the midline and descend contralaterally
  - terminates on the interneurons or the lateral column of lower motor neurons
  - controls fine manipulative movements of the hand and fingers

- The “third” motor system
  - aminergic pathways of the brain stem



Medial system

- Subcortical pathways
  - **Medial** and **lateral vestibulospinal tracts** - control of balance and postural movements
  - **Tectospinal tract** (sup. colliculus) – coordination of movements of the head and eyes during watching
  - **Medial** (pontine) and **lateral** (medullary) **reticulospinal tracts** - control of postural movements

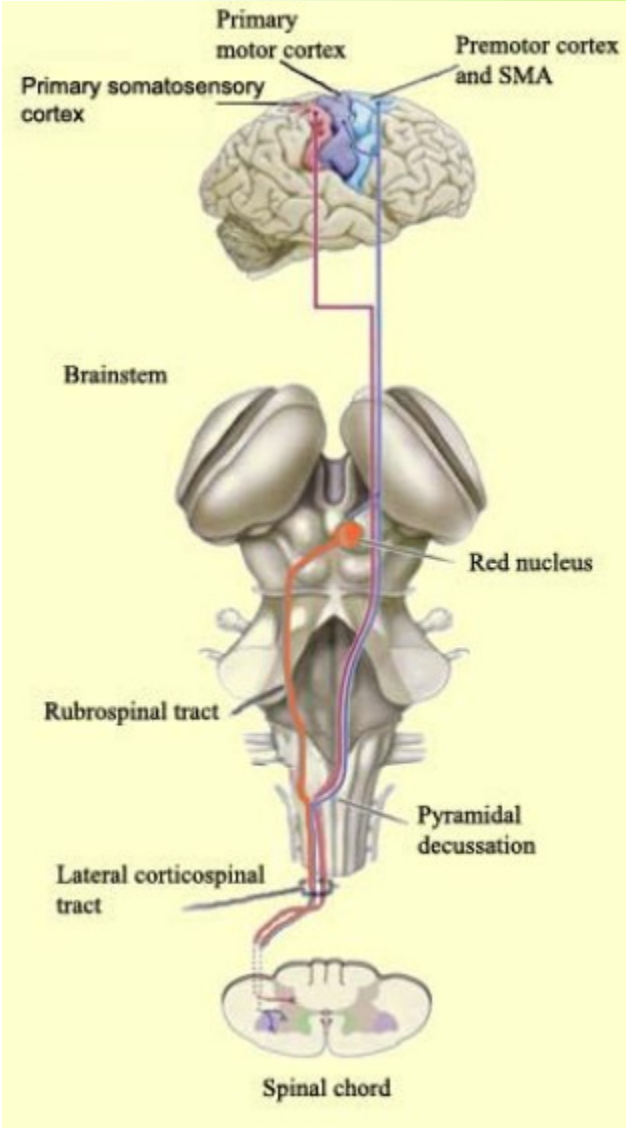


- Cortical pathways
  - **Anterior corticospinal tract** - bilateral, medial column of lower motor neurons

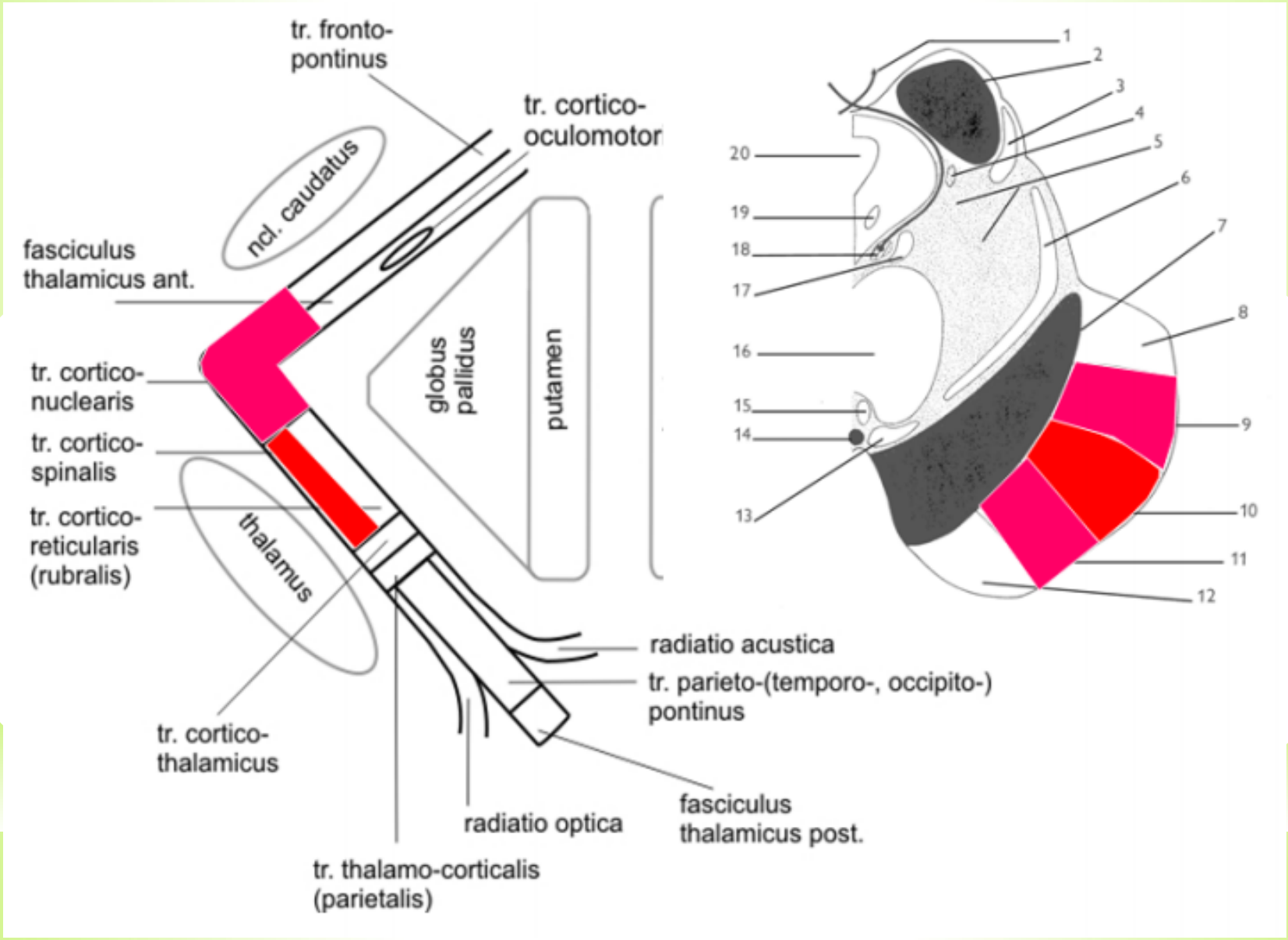
Lateral system

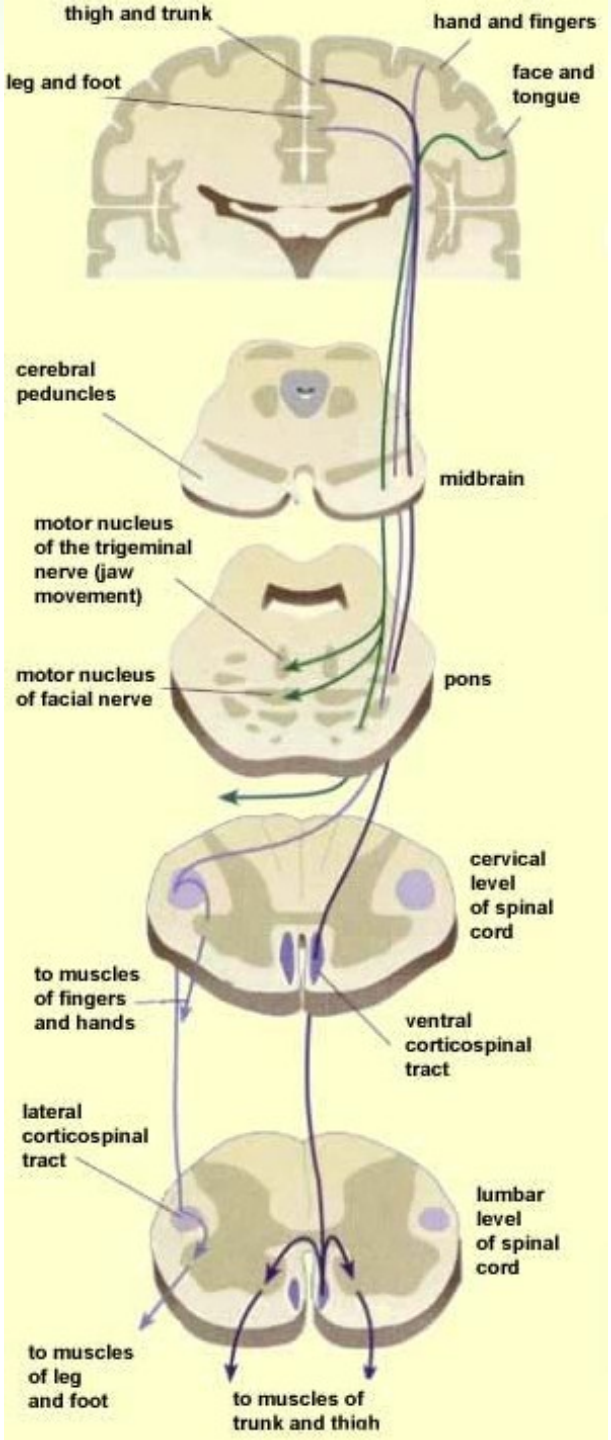
- Subcortical pathways
  - **Rubrospinal tract**
    - contralaterally descends to the lateral column

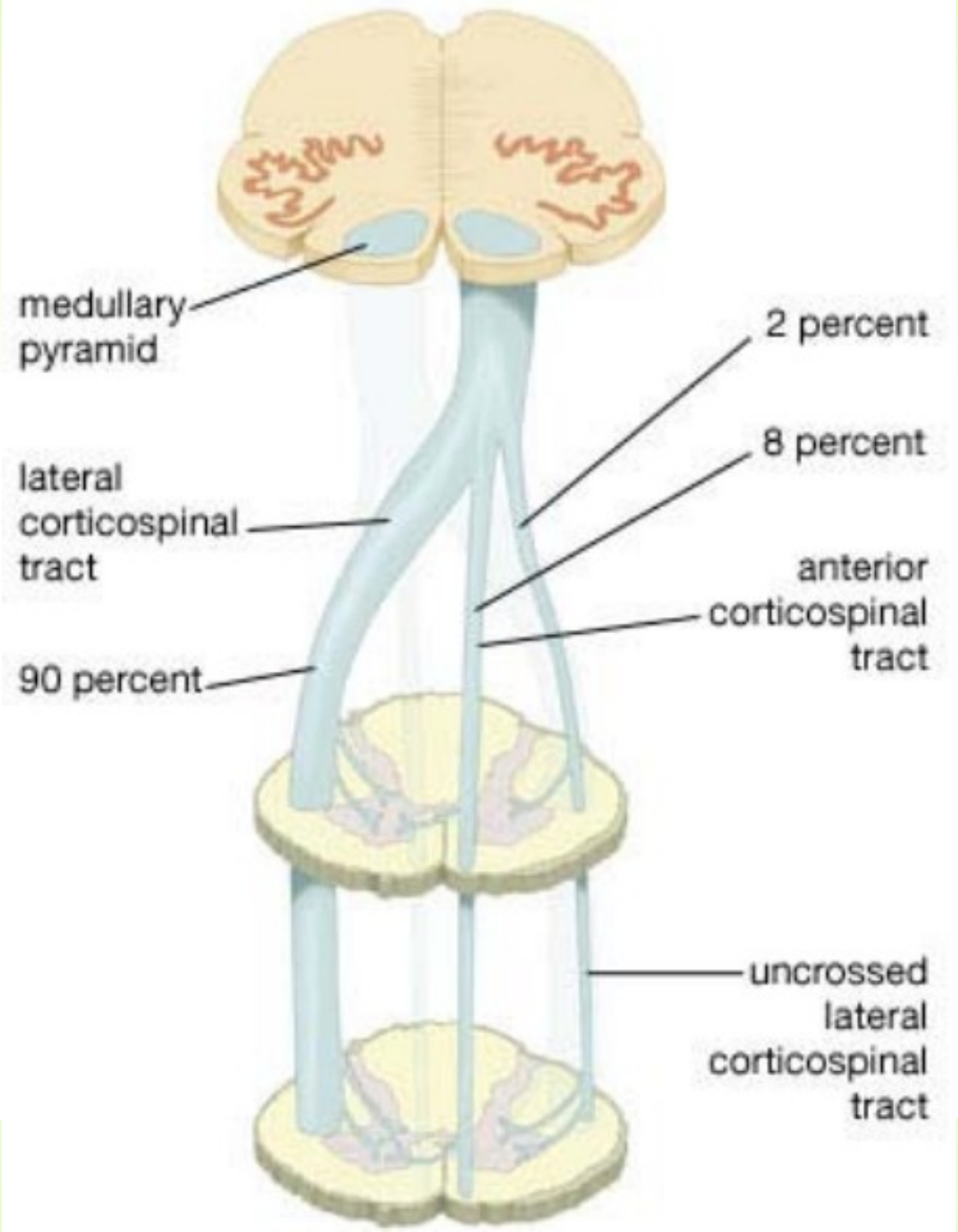
- Cortical pathways
  - **Lateral corticospinal tract**



Corticospinal and corticonuclear tracts



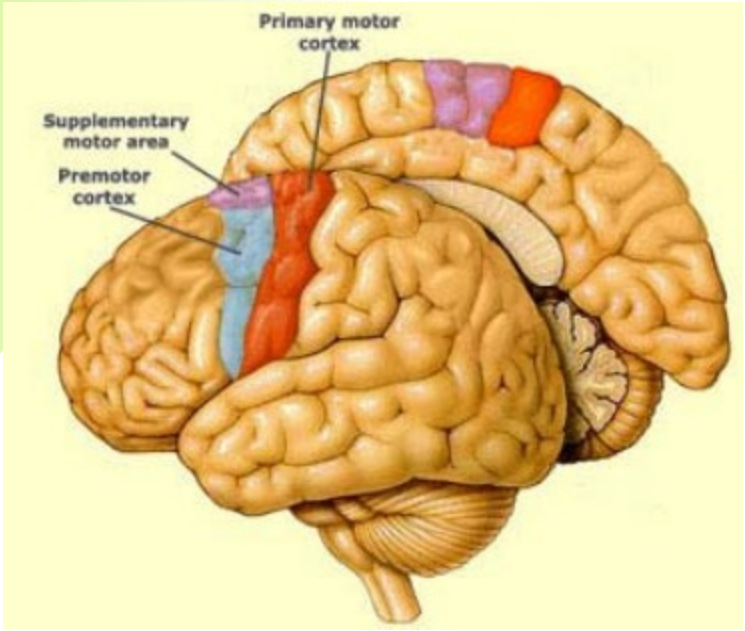

thigh and trunk
hand and fingers
leg and foot
face and tongue
cerebral peduncles
midbrain
motor nucleus of the trigeminal nerve (jaw movement)
motor nucleus of facial nerve
pons
cervical level of spinal cord
to muscles of fingers and hands
ventral corticospinal tract
lateral corticospinal tract
lumbar level of spinal cord
to muscles of leg and foot
to muscles of trunk and thigh

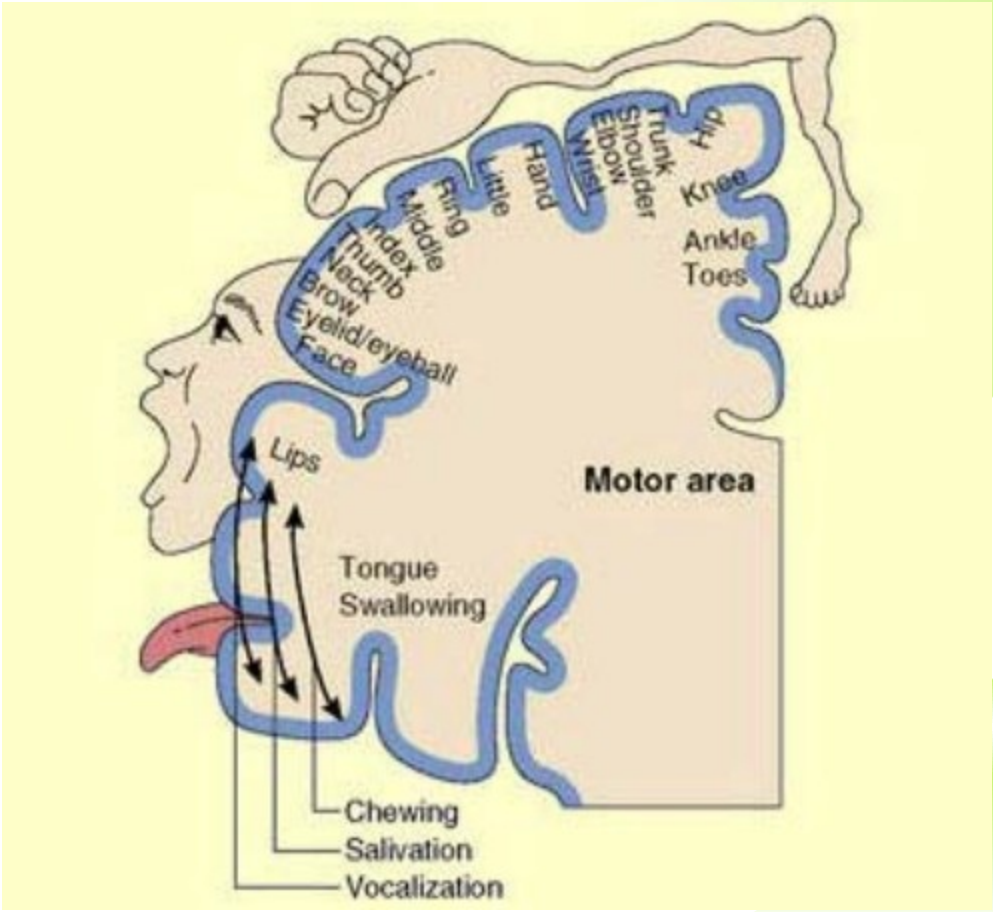

medullary pyramid
2 percent
8 percent
lateral corticospinal tract
anterior corticospinal tract
90 percent
uncrossed lateral corticospinal tract

The third system

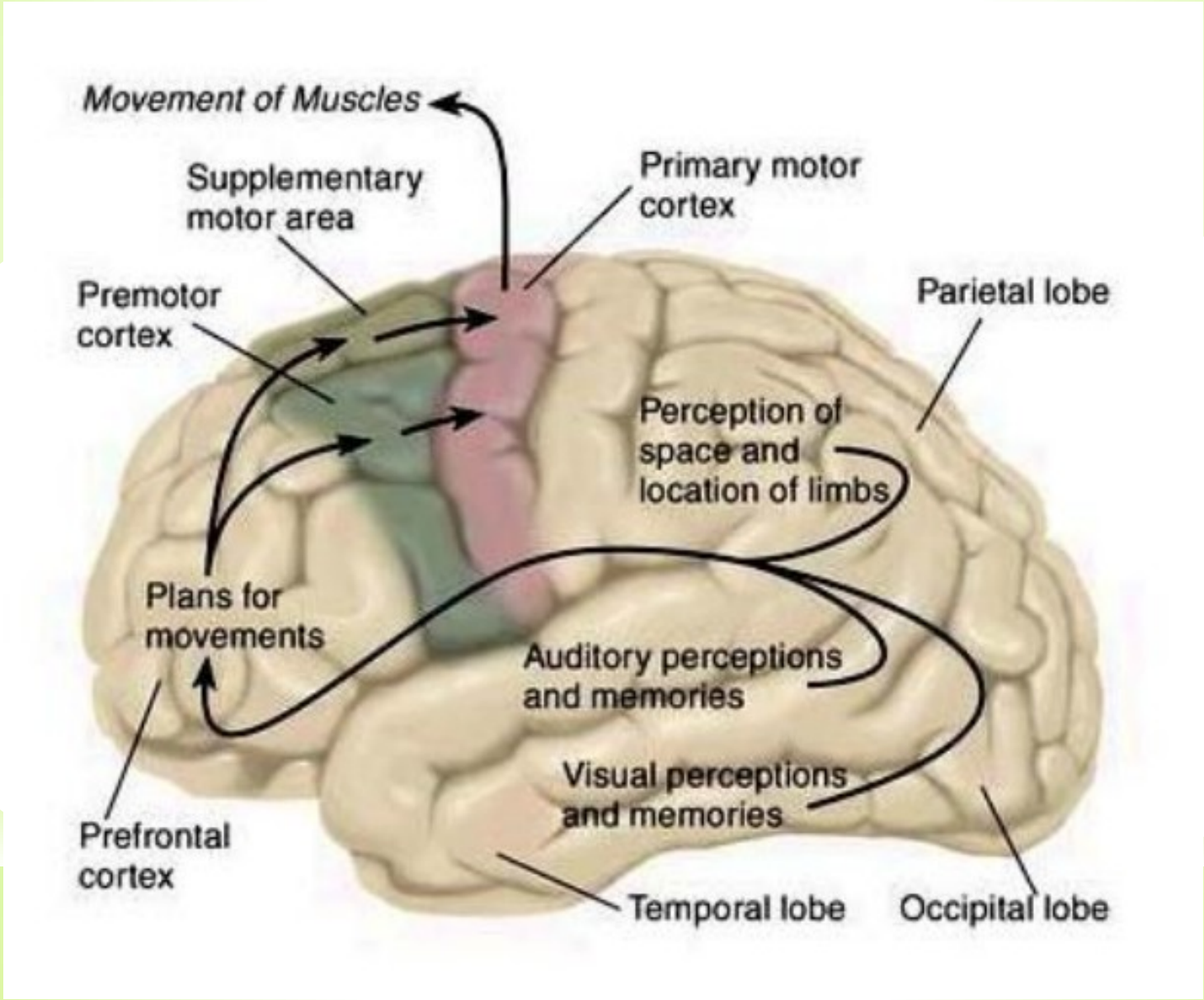
- the oldest one
- nuclei of RF – **raphespinal** and **coeruleospinal tracts**
- control of involuntary emotional movements

Motor cortex





Planning of movements



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