Conduction speed

Conduction speed

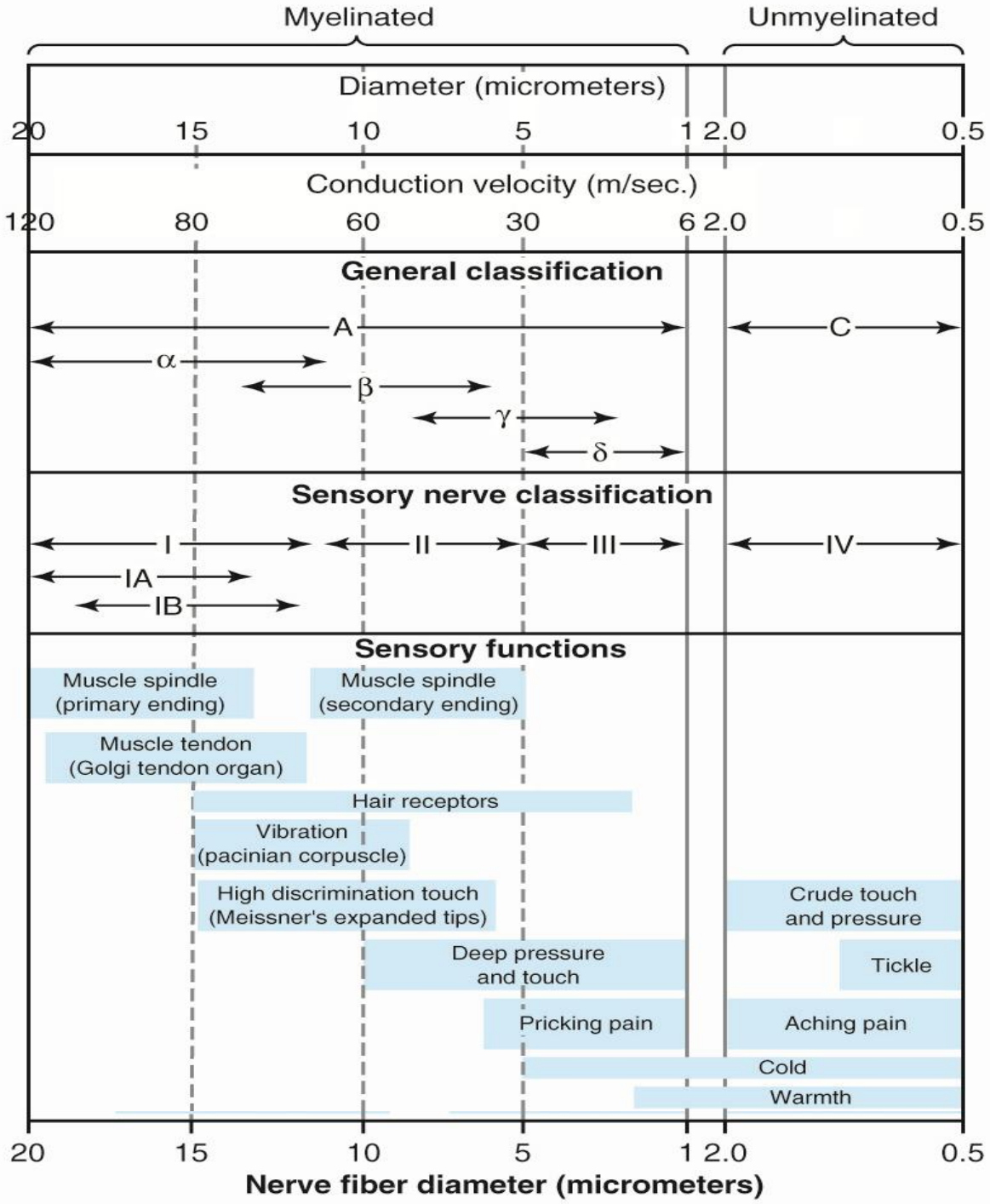
- **Number of synapses**

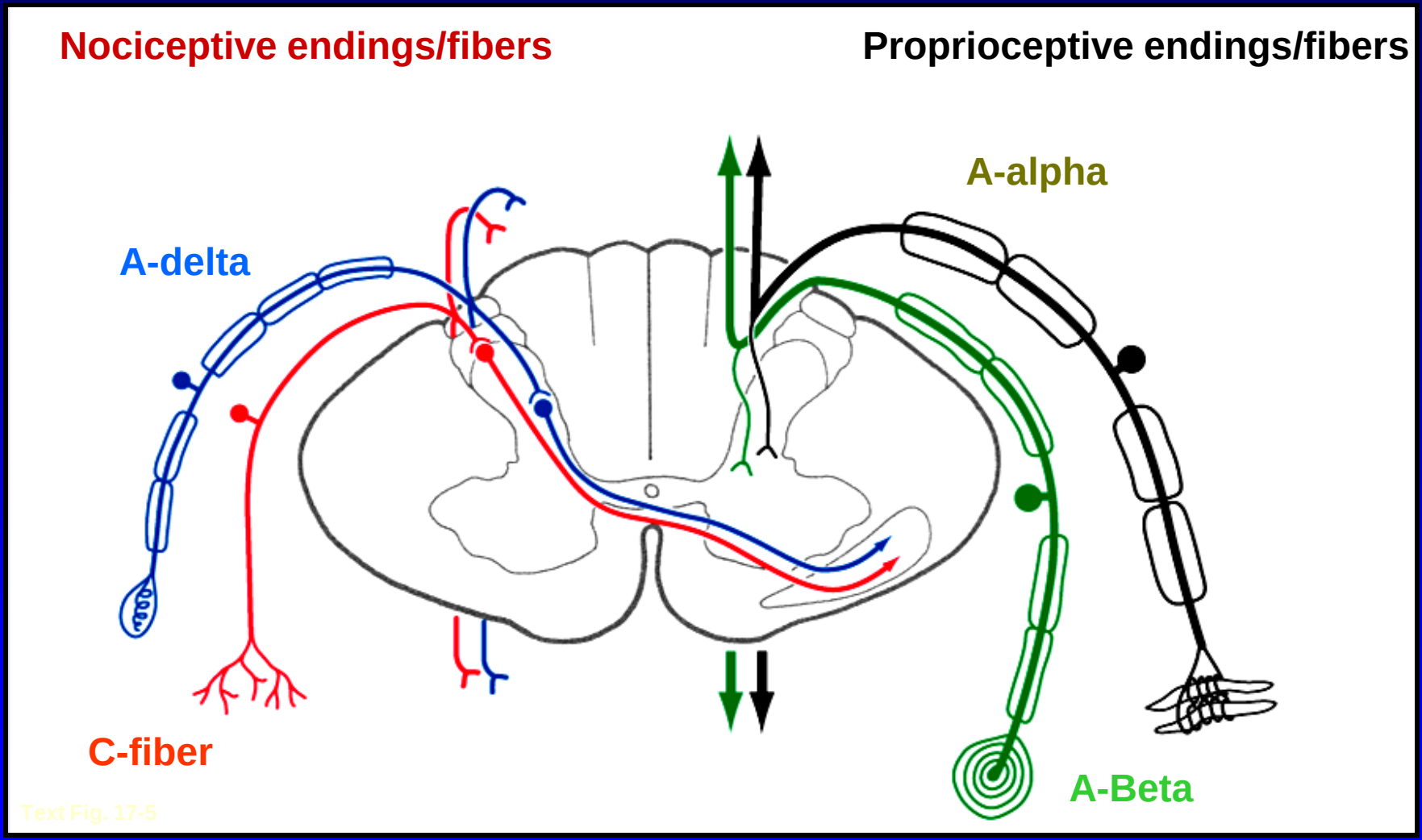
Conduction speed

- **Number of synapses**
- **Myelination**

Conduction speed

- **Number of synapses**
- **Myelination**
- **Nerve axon size**

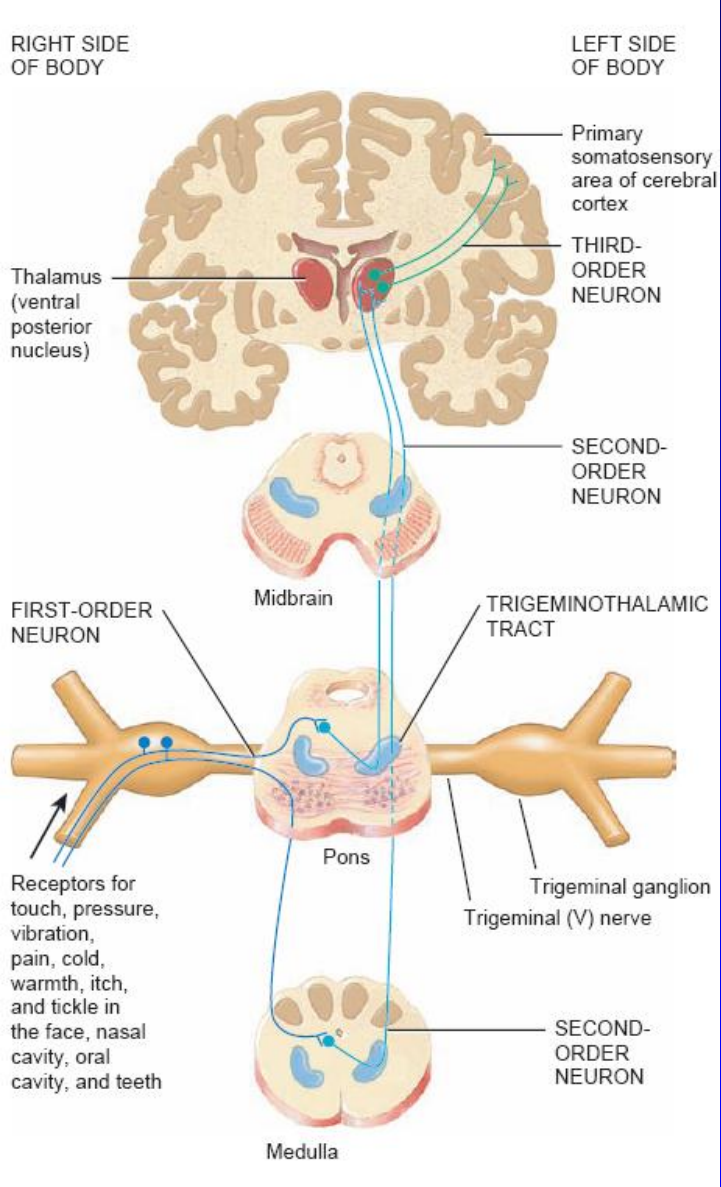

Myelinated
Unmyelinated
Diameter (micrometers)
20 15 10 5 1 2.0 0.5
Conduction velocity (m/sec.)
120 80 60 30 6 2.0 0.5
General classification
A
C
α
β
γ
δ
Sensory nerve classification
I
II
III
IV
IA
IB
Sensory functions
Muscle spindle (primary ending)
Muscle spindle (secondary ending)
Muscle tendon (Golgi tendon organ)
Hair receptors
Vibration (pacinian corpuscle)
High discrimination touch (Meissner's expanded tips)
Crude touch and pressure
Deep pressure and touch
Tickle
Pricking pain
Aching pain
Cold
Warmth
20 15 10 5 1 2.0 0.5
Nerve fiber diameter (micrometers)

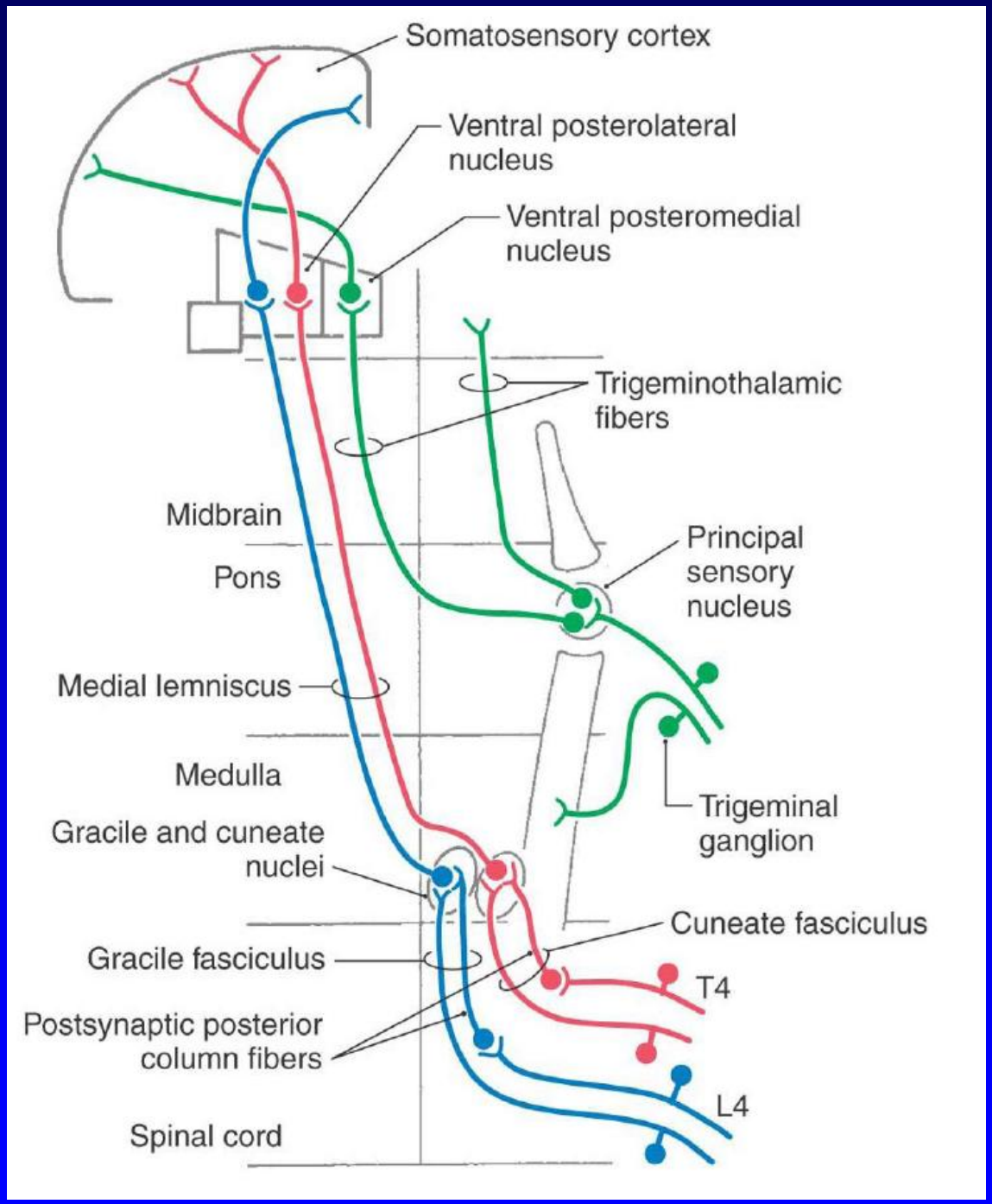

Nociceptive endings/fibers
Proprioceptive endings/fibers
A-alpha
A-delta
C-fiber
A-Beta
Text Fig. 17-5

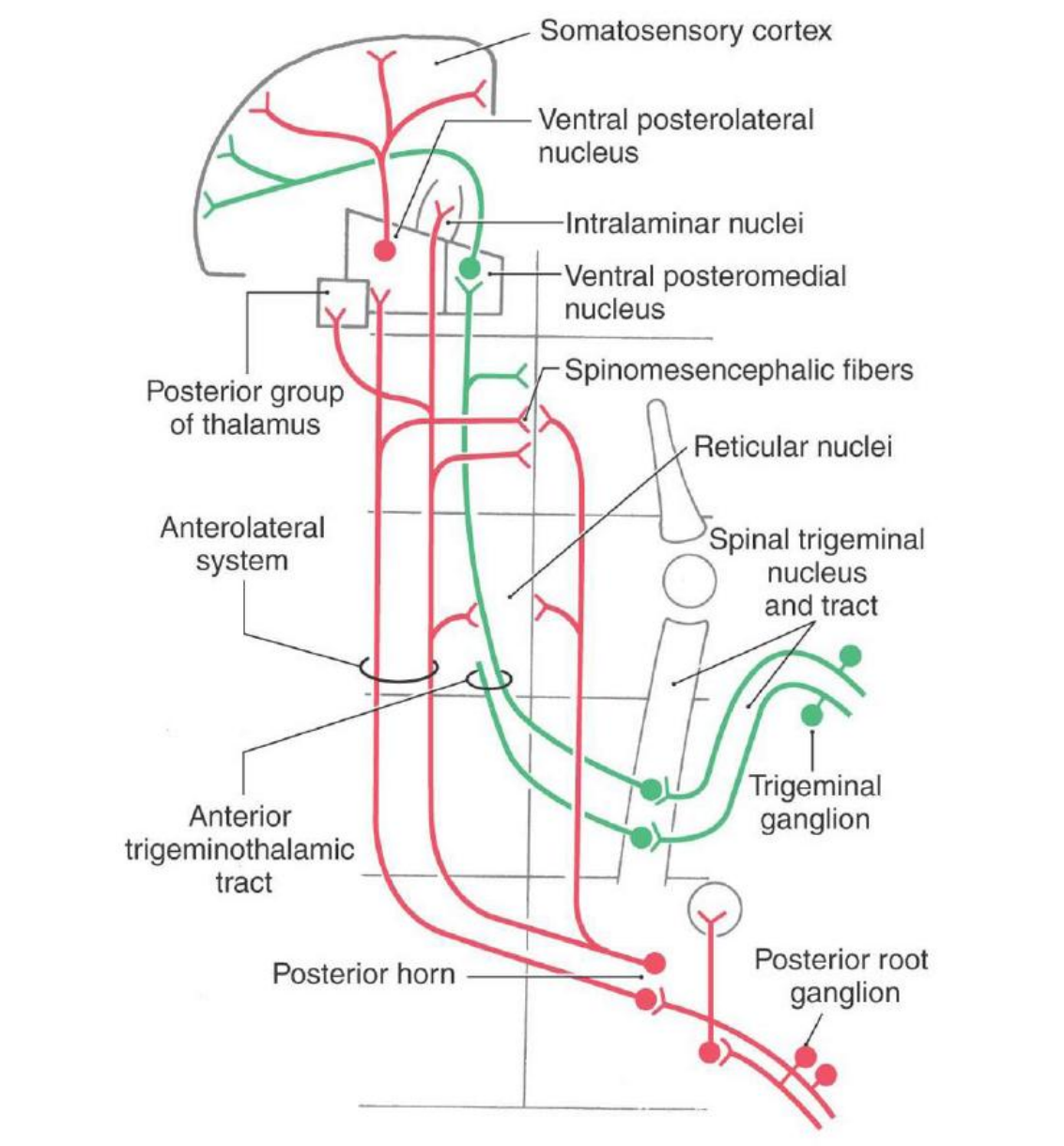
Somatosensory from The Face

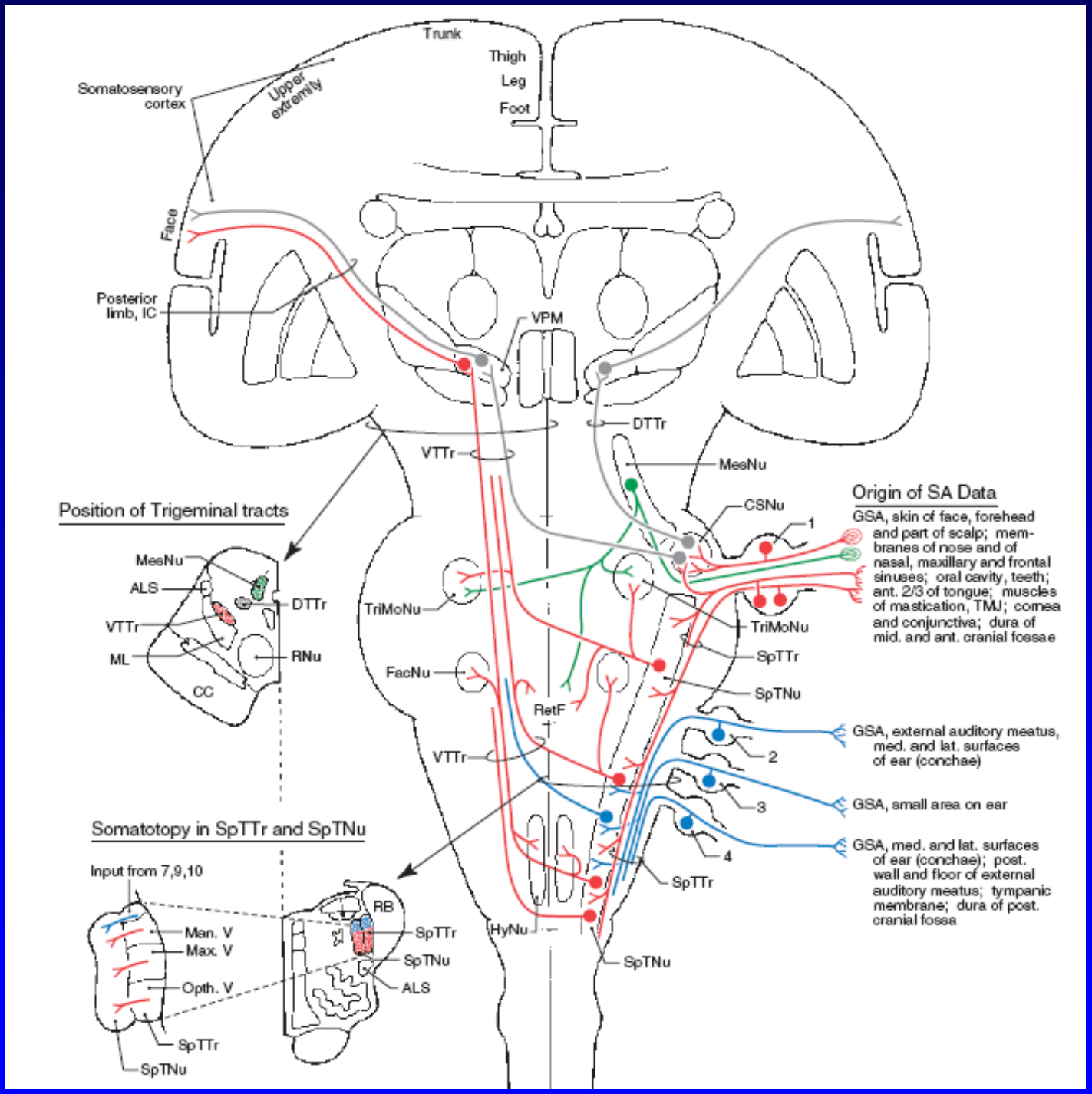
(Trigeminal system)

- Carry all the sensation modalities from the face to the brain




Somatosensory cortex
Ventral posterolateral nucleus
Ventral posteromedial nucleus
Trigeminothalamic fibers
Midbrain
Pons
Principal sensory nucleus
Medial lemniscus
Medulla
Trigeminal ganglion
Gracile and cuneate nuclei
Cuneate fasciculus
Gracile fasciculus
T4
Postsynaptic posterior column fibers
L4
Spinal cord

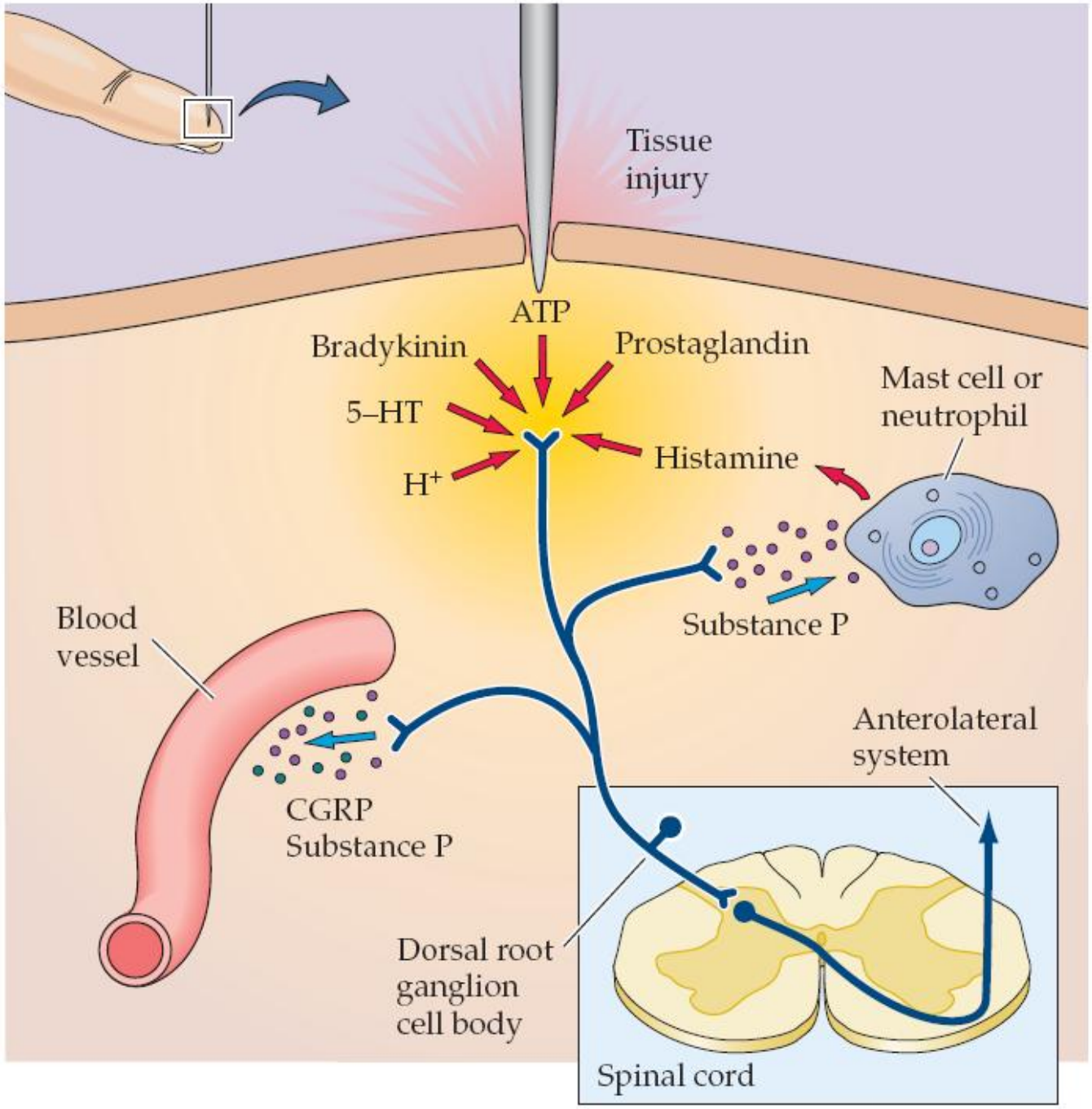

Somatosensory cortex
Ventral posterolateral nucleus
Intralaminar nuclei
Ventral posteromedial nucleus
Spinomesencephalic fibers
Posterior group of thalamus
Reticular nuclei
Anterolateral system
Spinal trigeminal nucleus and tract
Trigeminal ganglion
Anterior trigeminothalamic tract
Posterior horn
Posterior root ganglion


Trunk
Thigh
Leg
Foot
Somatosensory cortex
Upper extremity
Face
Posterior limb, IC
VPM
DTTr
VTTr
MesNu
CSNu
Origin of SA Data
GSA, skin of face, forehead and part of scalp; membranes of nose and of nasal, maxillary and frontal sinuses; oral cavity, teeth; ant. 2/3 of tongue; muscles of mastication, TMJ; cornea and conjunctiva; dura of mid. and ant. cranial fossae
1
Position of Trigeminal tracts
MesNu
ALS
DTTr
VTTr
ML
RNu
CC
TriMoNu
TriMoNu
SpTTr
SpTNu
FacNu
RetF
VTTr
GSA, external auditory meatus, med. and lat. surfaces of ear (conchae)
2
3
GSA, small area on ear
4
GSA, med. and lat. surfaces of ear (conchae); post. wall and floor of external auditory meatus; tympanic membrane; dura of post. cranial fossa
SpTTr
HyNu
SpTNu
Somatotopy in SpTTr and SpTNu
Input from 7,9,10
Man. V
Max. V
Opth. V
SpTTr
SpTNu
RB
SpTTr
SpTNu
ALS

PAIN

TERMINOLOGIE

TERM	DESCRIPTION
ALLODYNIA	PERCEPTION OF NON-NOXIOUS STIMULUS AS PAIN
ANALGESIA	ABSENCE OF PAIN PERCEPTION
ANESTHESIA	ABSENCE OF ALL SENSATIONS
ANESTHESIA DOLOROSA	PAIN IN AN AREA THAT LACKS SENSATION
DYSESTHESIA	UNPLEASANT SENSATION WITH OR WITHOUT STIMULUS
HYPOALGESIA	DIMINISHED RESPONSE TO NOXIOUS STIMULUS
HYPERALGESIA	INCREASED RESPONSE TO NOXIOUS STIMULUS
HYPERASTHESIA	INCREASED RESPONSE TO MILD STIMULUS
HYPOASTHESIA	REDUCED CUTANEOUS SENSATION
NEURALGIA	PAIN IN THE DISTRIBUTION OF A NERVE
PARASTHESIA	ABNORMAL SENSATION PERCEIVED WITHOUT AN APPARENT STIMULUS
RADICULOPATHY	FUNCTIONAL ABNORMALITY OF NERVE ROOTS


Tissue
injury
ATP
Bradykinin
Prostaglandin
5–HT
Mast cell or
neutrophil
Histamine
H+
Substance P
Blood
vessel
Anterolateral
system
CGRP
Substance P
Dorsal root
ganglion
cell body
Spinal cord

NEUROCHEMISTRY

PERIPHERY - injury produces release of endogenous chemicals:

- **Bradykinin**
- **Histamine**
- **Serotonin**
- **Prostaglandins**
- **Substance P**

ASCENDING PATHWAYS

- **ANTEROLATERAL System**
  - **SPINOTHALAMIC TRACT**
    - **originating neurones in laminae I, V, VI, IX**
    - **Neospinothalamic tract**
      - **project to VPL, VPM**
      - **synapse and project to somatosensory cortex**
    - **Paleospinothalamic tract**
      - **from deeper laminae**
      - **to thalamus (other nuclei) , midbrain, pontine and medullary reticular formation (Spinoreticular tract), periaqueductal grey (Spinomesencephalic tract), and hypothalmus (Spinohypothalamic tract)**

ASCENDING PATHWAYS

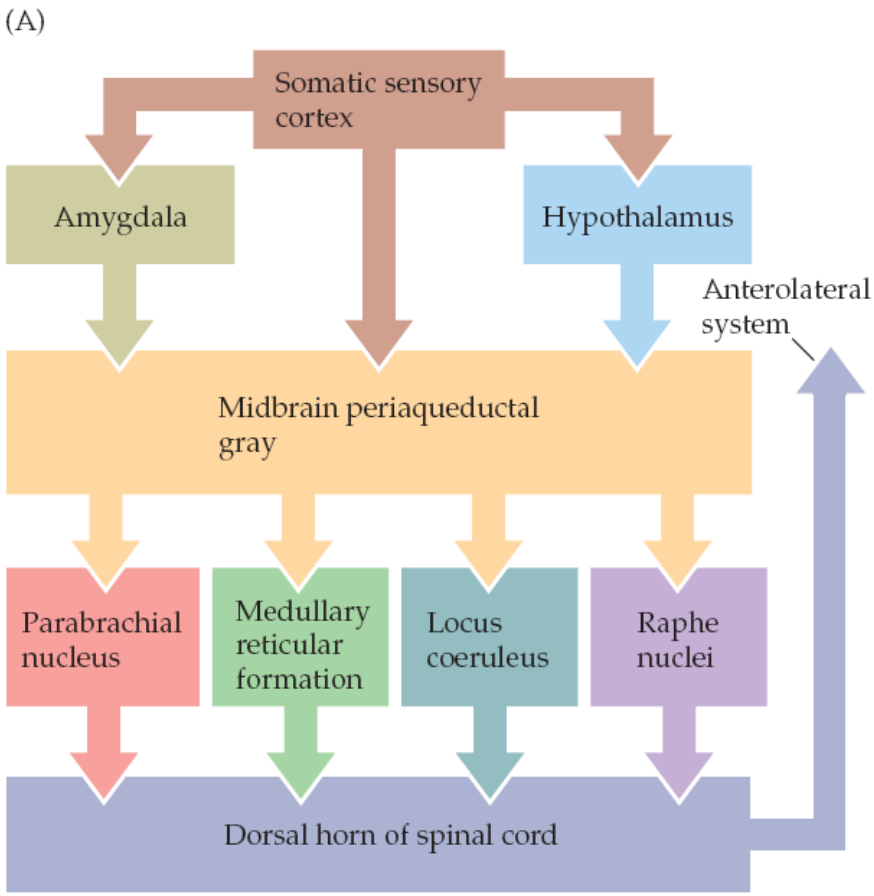
- **Spinoreticular tract**
  - projects to medullary and pontine reticular formation
  - involved in motivational and affective responses to pain
  - ascend medially to spinothalamic tract
- **Spinomesencephalic tract**
  - project to caudal midbrain areas including periaqueductal gray
- **Spinohypothalamic tract**

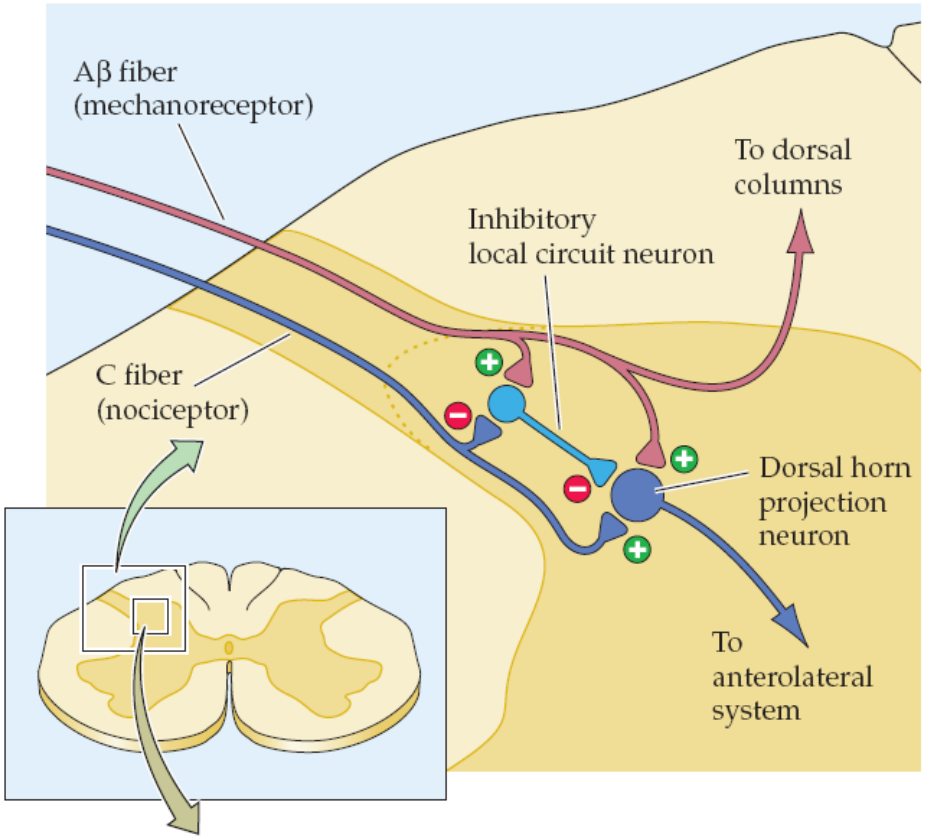
DESCENDING CONTROL

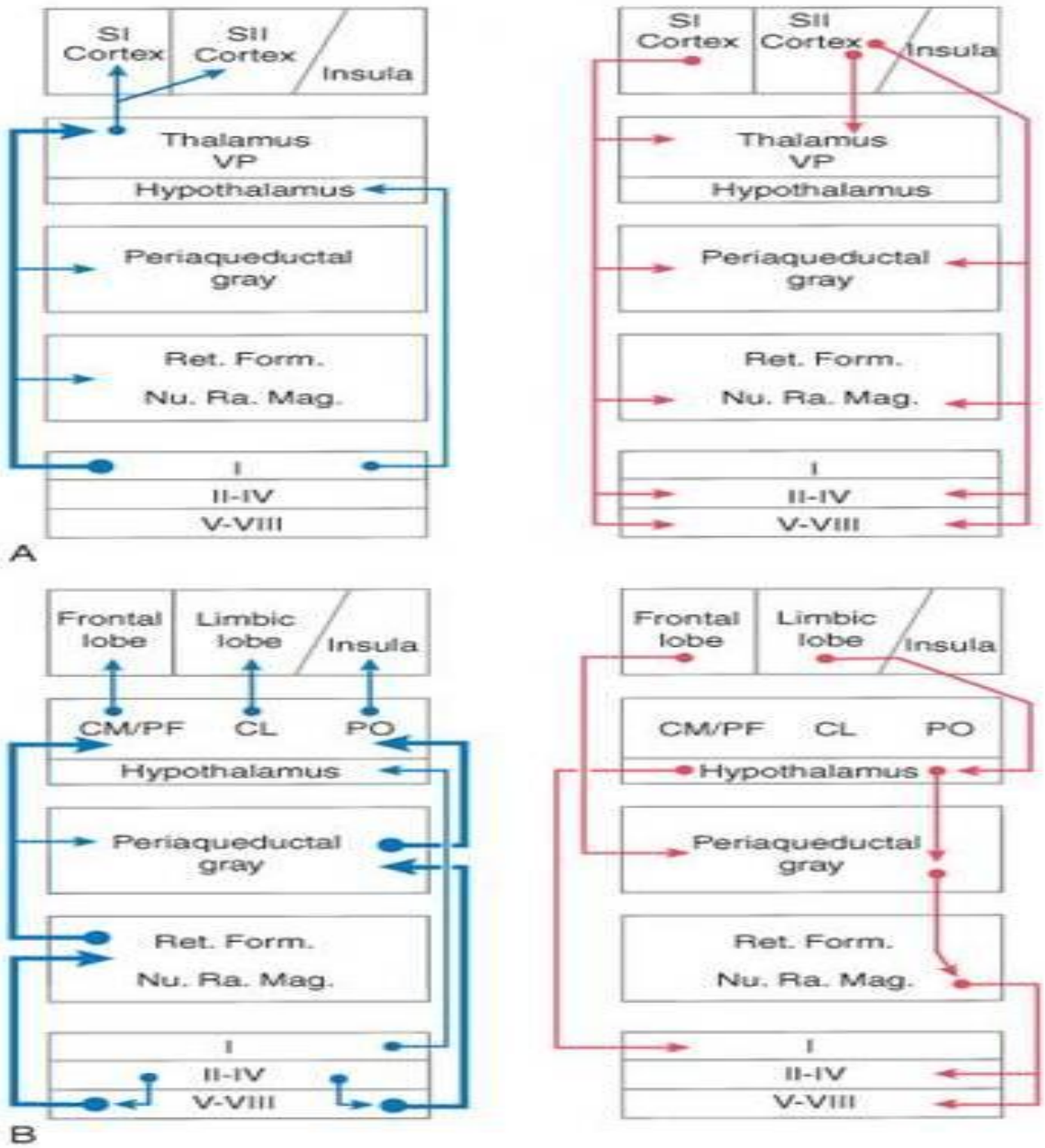
- Studies in animals and man show anti-nociception and analgesia from stimulation or opioid administration to many supraspinal centres
- CORTEX
  - via corticospinal efferents
  - terminations in superficial laminae
  - may be inhibitory *or* excitatory and influence non-noxious stimuli as well
- HYPOTHALAMUS
  - many afferents and efferents - including NTS, PAG, LC, parabrachial nuclei, raphe nuclei
  - widespread reciprocal innervation
  - direct projection to lamina I
  - may be bulbospinal relay for descending inhibition

MID BRAIN

- PERIAQUECDUCTAL GRAY (PAG)
  - surrounds cerebral aqueduct
  - extensive afferent and efferent projections
  - morphine and electrical stimulation produce potent antinociception
  - PAG descending inhibition is via NRM
    - EAA are neurotransmitters there
- LOCUS COERULEUS (LC)
  - noradrenergic containing neurones
  - adjacent to 4th ventricle
  - diffusely innnervates CNS at all levels
  - descending NAD fibres inhibit dorsal horn nociceptive activity and spinal nociceptive reflexes


(A)
Somatic sensory cortex
Amygdala
Hypothalamus
Anterolateral system
Midbrain periaqueductal gray
Parabrachial nucleus
Medullary reticular formation
Locus coeruleus
Raphe nuclei
Dorsal horn of spinal cord


(B)
Aβ fiber (mechanoreceptor)
To dorsal columns
Inhibitory local circuit neuron
C fiber (nociceptor)
Dorsal horn projection neuron
To anterolateral system



Text Fig. 18-19