Role of different levels of CNS in motor function regulation. (I)

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Spinal cord is made up of 31 segments (correspondingly to roots pairs number).

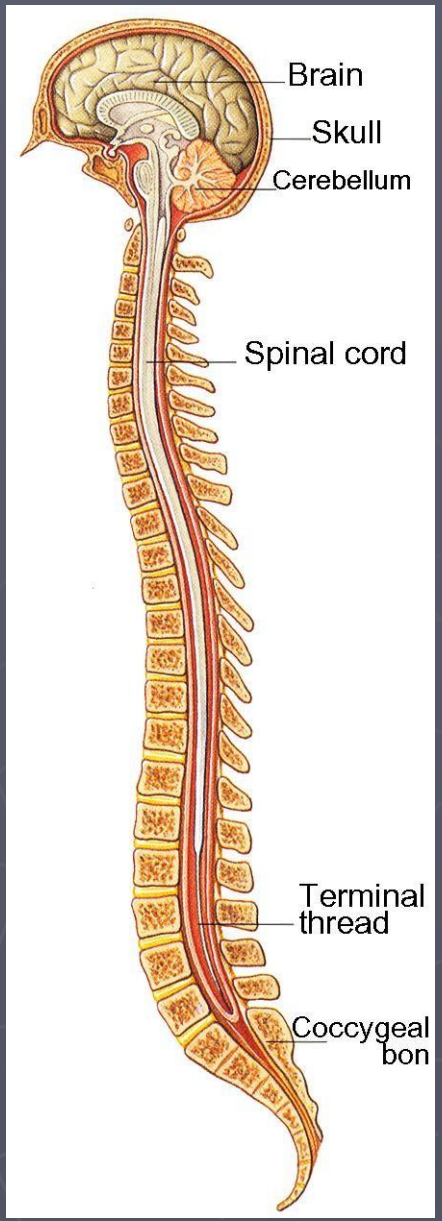
Cervical segments = 8

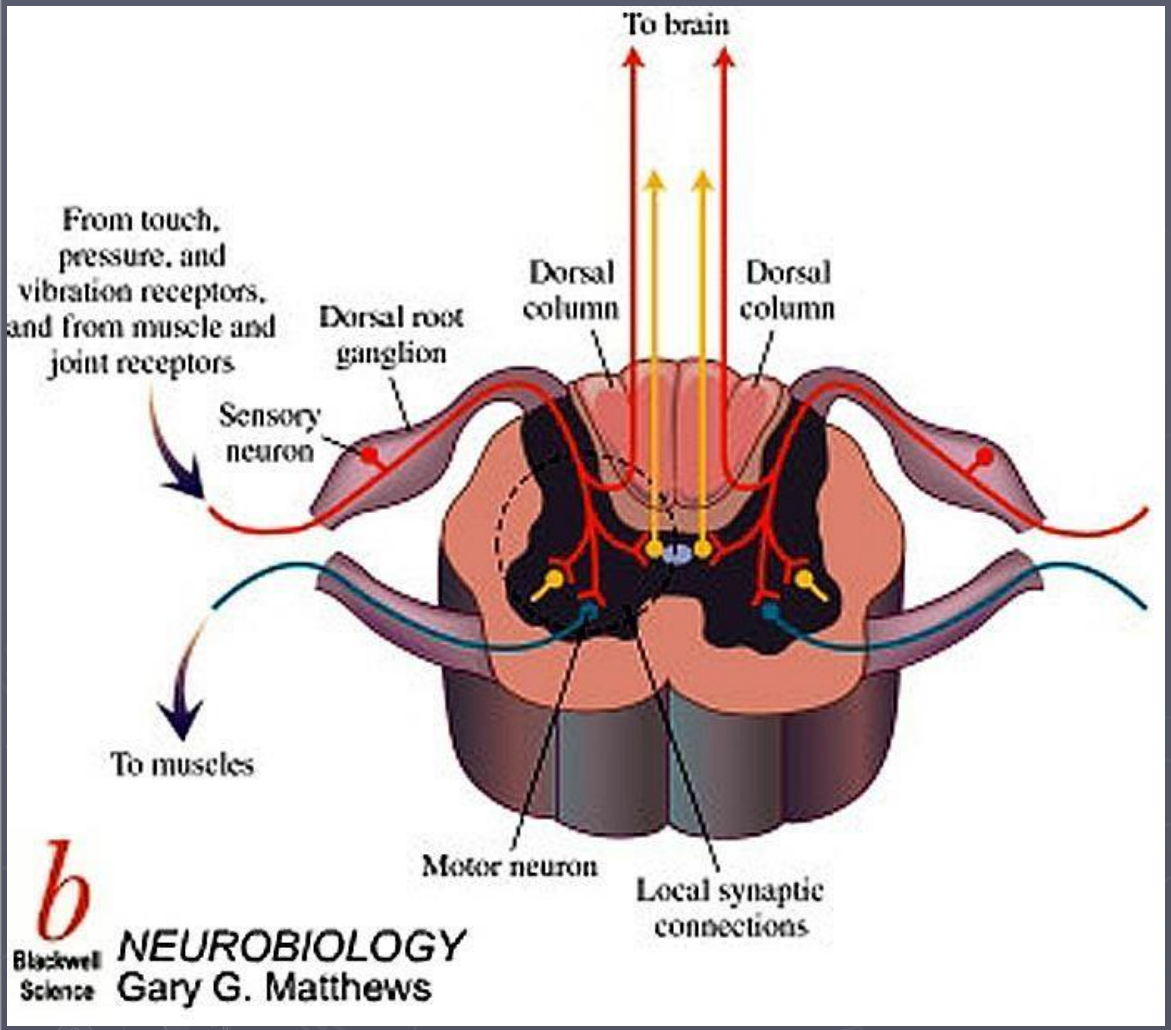
Thoracic segments = 12

Lumbar segments = 5

Sacral segments = 5

Coccygeal segment = 1



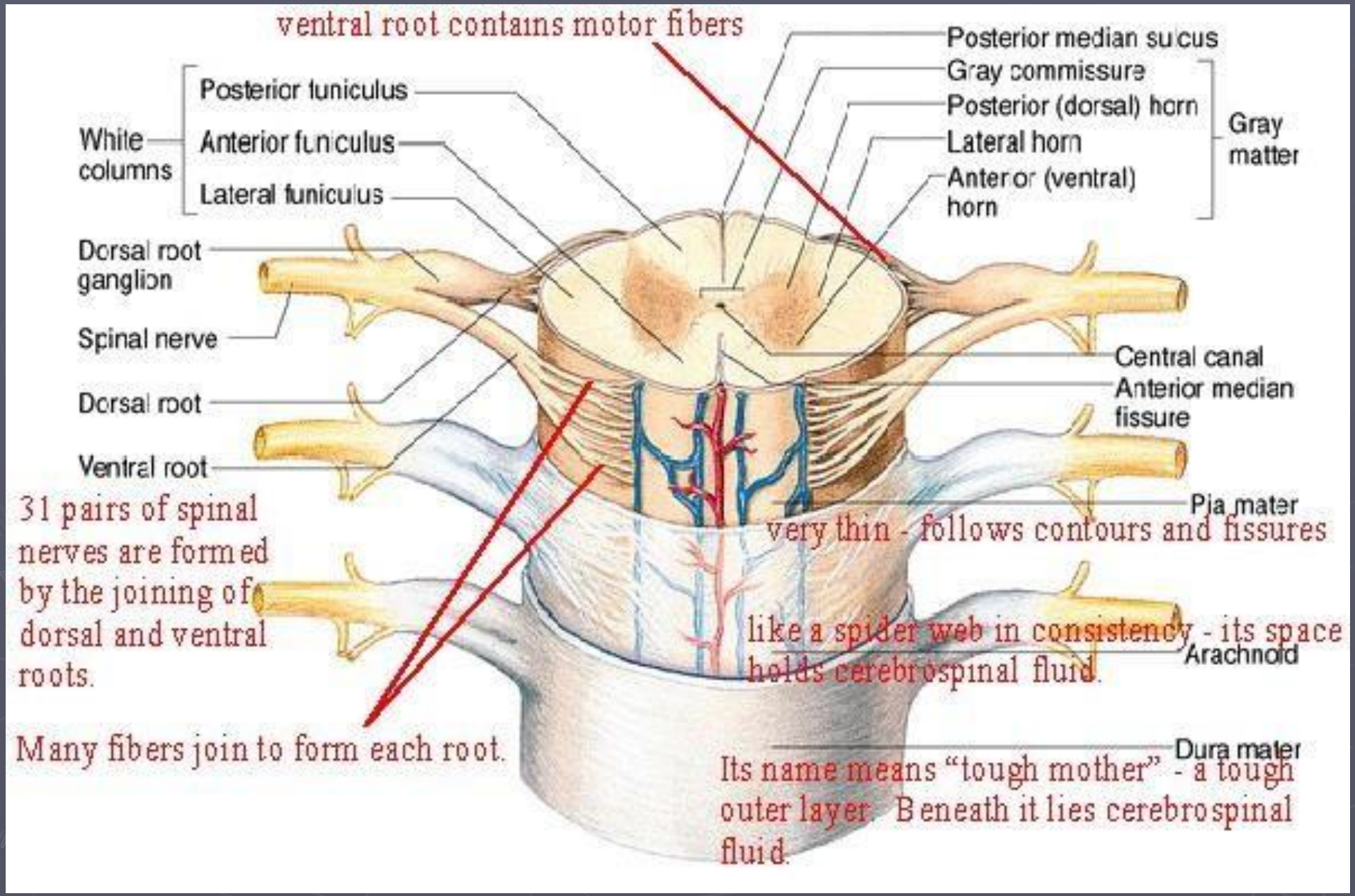


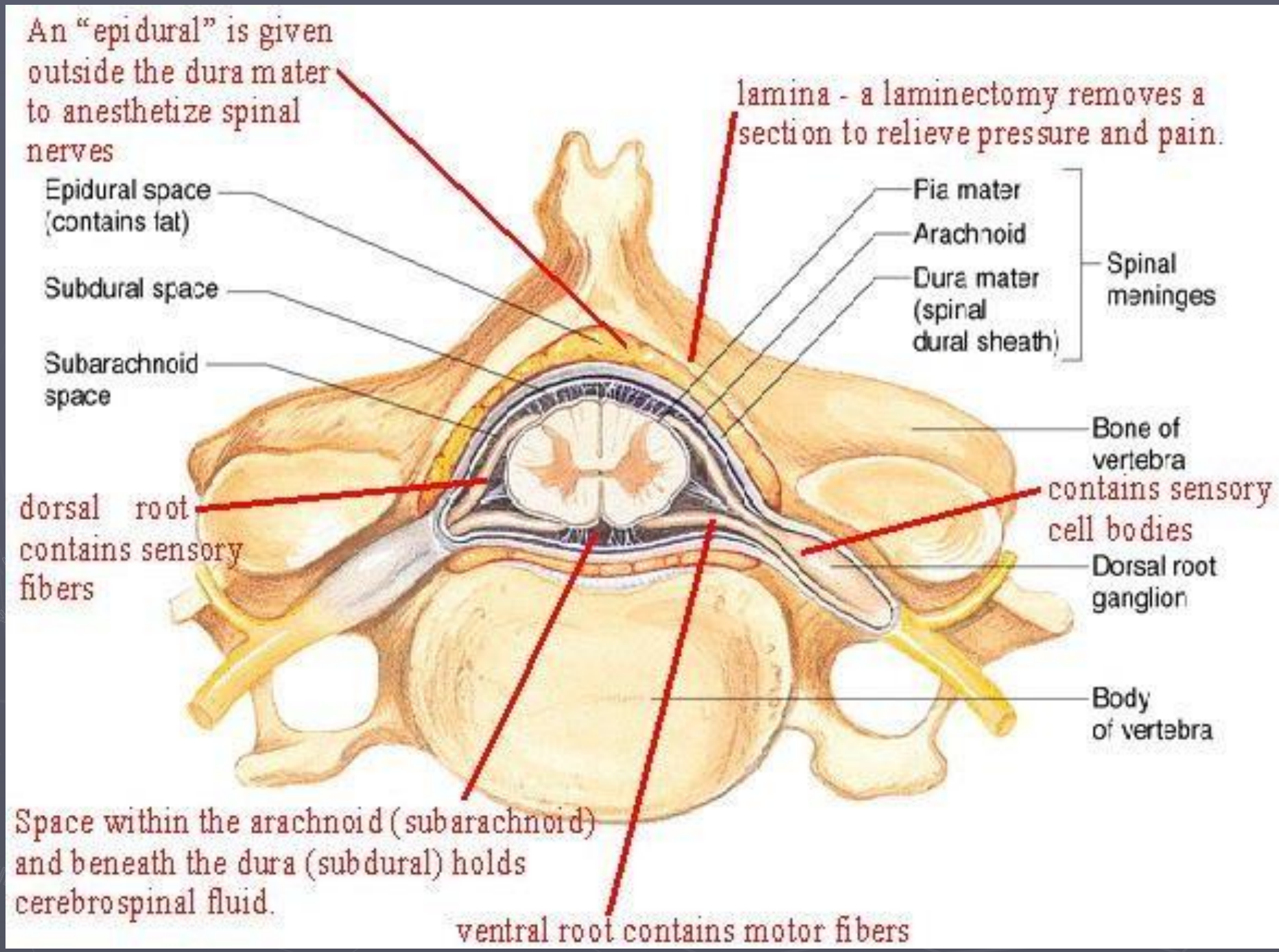
Spinal cord lies in the vertebral canal. The length of the spinal cord is about 45 cm in males and about 43 cm in females.

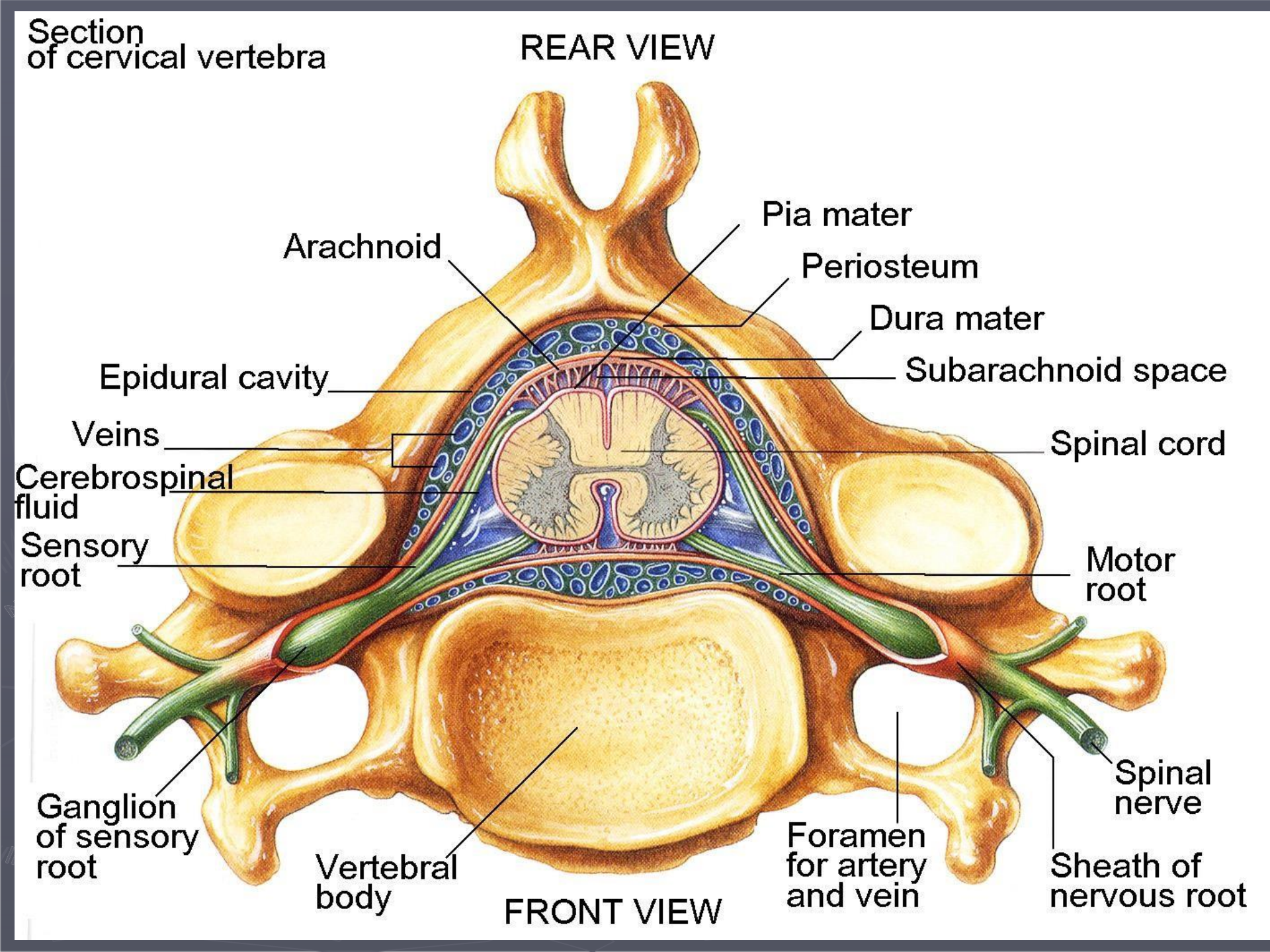
Anterior (motor) and posterior (sensory) fibers leave spine. The fibers distribution is according to Bell-Magendie law.

Spine nerve is formed after fascicles convergence in one.

- The segments of spinal cord correspond to 31 pairs of spinal nerves in a symmetrical manner.
- Spinal cord is cylindrical in cross-section shape with two intumescences — cervical (C5-C7, T1-T2) and lumbar (lumbosacral, L5- S1-2) intumescences.


ventral root contains motor fibers
Posterior median sulcus
Gray commissure
Posterior (dorsal) horn
Lateral horn
Anterior (ventral) horn
Gray matter
White columns
Posterior funiculus
Anterior funiculus
Lateral funiculus
Dorsal root ganglion
Spinal nerve
Dorsal root
Ventral root
Central canal
Anterior median fissure
Pia mater
very thin - follows contours and fissures
31 pairs of spinal nerves are formed by the joining of dorsal and ventral roots.
like a spider web in consistency - its space holds cerebrospinal fluid.
Arachnoid
Many fibers join to form each root.
Dura mater
Its name means "tough mother" - a tough outer layer. Beneath it lies cerebrospinal fluid.


An "epidural" is given outside the dura mater to anesthetize spinal nerves
lamina - a laminectomy removes a section to relieve pressure and pain.
Epidural space (contains fat)
Subdural space
Subarachnoid space
Pia mater
Arachnoid
Dura mater (spinal dural sheath)
Spinal meninges
Bone of vertebra
dorsal root contains sensory fibers
contains sensory cell bodies
Dorsal root ganglion
Body of vertebra
Space within the arachnoid (subarachnoid) and beneath the dura (subdural) holds cerebrospinal fluid.
ventral root contains motor fibers


Section
of cervical vertebra
REAR VIEW
Pia mater
Arachnoid
Periosteum
Dura mater
Epidural cavity
Subarachnoid space
Veins
Spinal cord
Cerebrospinal
fluid
Sensory
root
Motor
root
Spinal
nerve
Ganglion
of sensory
root
Vertebral
body
Foramen
for artery
and vein
Sheath of
nervous root
FRONT VIEW

Spinal and vertebral segments are located not in one level: segment are located higher on 1 vertebra in cervical part; on 2 – in superior-thoracic; on 3 – in lower-thoracic.

Lumbal segments are situated at T10-T12; sacral - T12 and L1.

Spine gray matter is neurons accumulation. Canal with various lumen is in the center. Sympathetic center (thoracic nucleus) is at C8-T1. It innervates dilator of pupil, eyeball cartillague superior muscle dilator and orbital muscle dilator. Exit is in anterior fascicles compound after which there is an inflow in sympathetic internal carotid plexus.

At C8-T3 lateral intermediate substance forms lateral corn from each side.

It is essential to know segments correlated with innervated muscles in injury of level proper assessment:

C1-C4 – innervate cervical muscles;

from C4 – diaphragmal nerve origin;

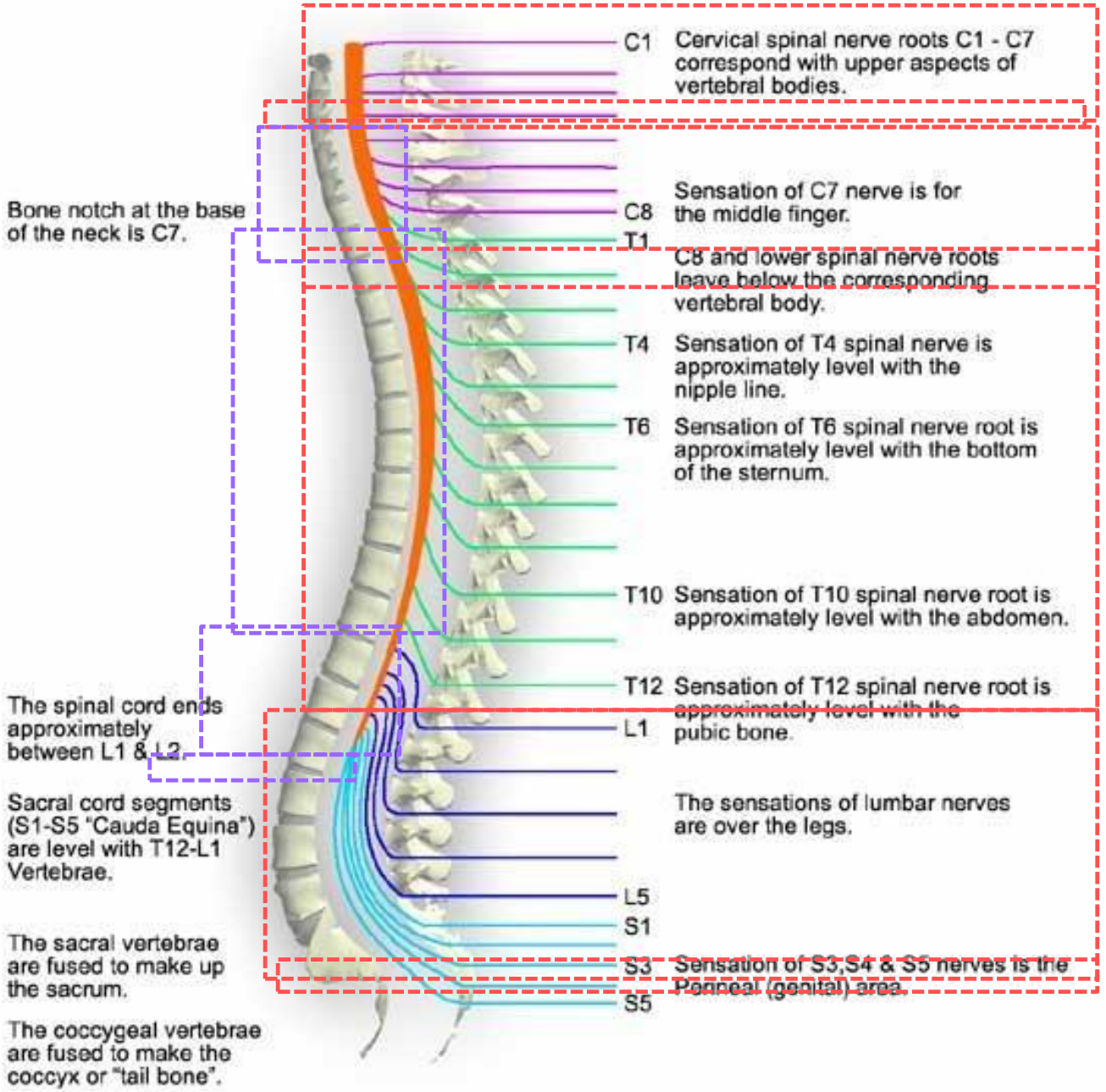
C5-C8; T1-T2 – superior extremities;

T2-T12 – trunk muscles;

L1-L5; S1-S3 – lower extremities muscles;

S4-S5 – perineum and uro-sexual system muscles.

SPINAL NERVES

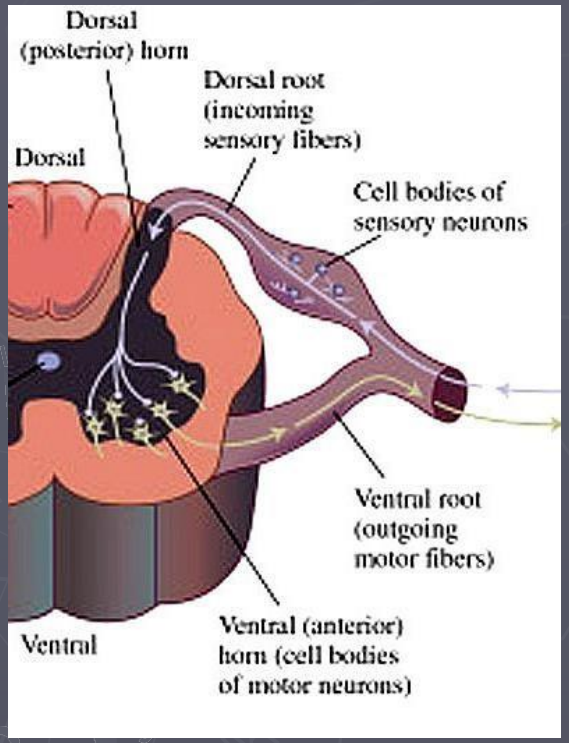


C1-C4 – innervate cervical muscles & form phrenic nerve

from C4 – diaphragm

C5-C8, T1-T2 – trunk muscles, L1-L5, S1-S3 – lower extremities

S4-S5 – perineum and uro-genital system



Peripheral motoneuron. Motor activity represents complicated reflex. Anterior corn motor cells are located in groups and are responsible for trunk or extremities muscles contraction.

There are 3 cellular groups in spine superior-cervical and thoracic parts:

anterior – extremities flexion and extension performance;

posterior-medial – trunk flexion and extension performance;

central – innervation of diaphragm, brachial and pelvic girdle.

Cells innervating extremities of flexors and extensors are added to them in cervical and lumbal intumescences.

There are 3 neurons types in cranial nerves motor nucleus:

alpha-large (phasic) motoneurons with the speed 60-100 m/sec; they innervate "white" fast muscles and are connected with pyramid system;

alpha-little (tonic) motoneurons receive impulses from extrapyramidal system; they provide posture-tonic influencings and innervate slow "red" muscles;

gamma-neurons – receive impulses from reticular formation; ~~in~~nervate intrafusal (inside spindle) muscles in providing segmentar-reflectory activity level constancy.

CONDUCTIVE PATHWAYS

Nervous fibers form conductives pathways (ascending and descending tracts).

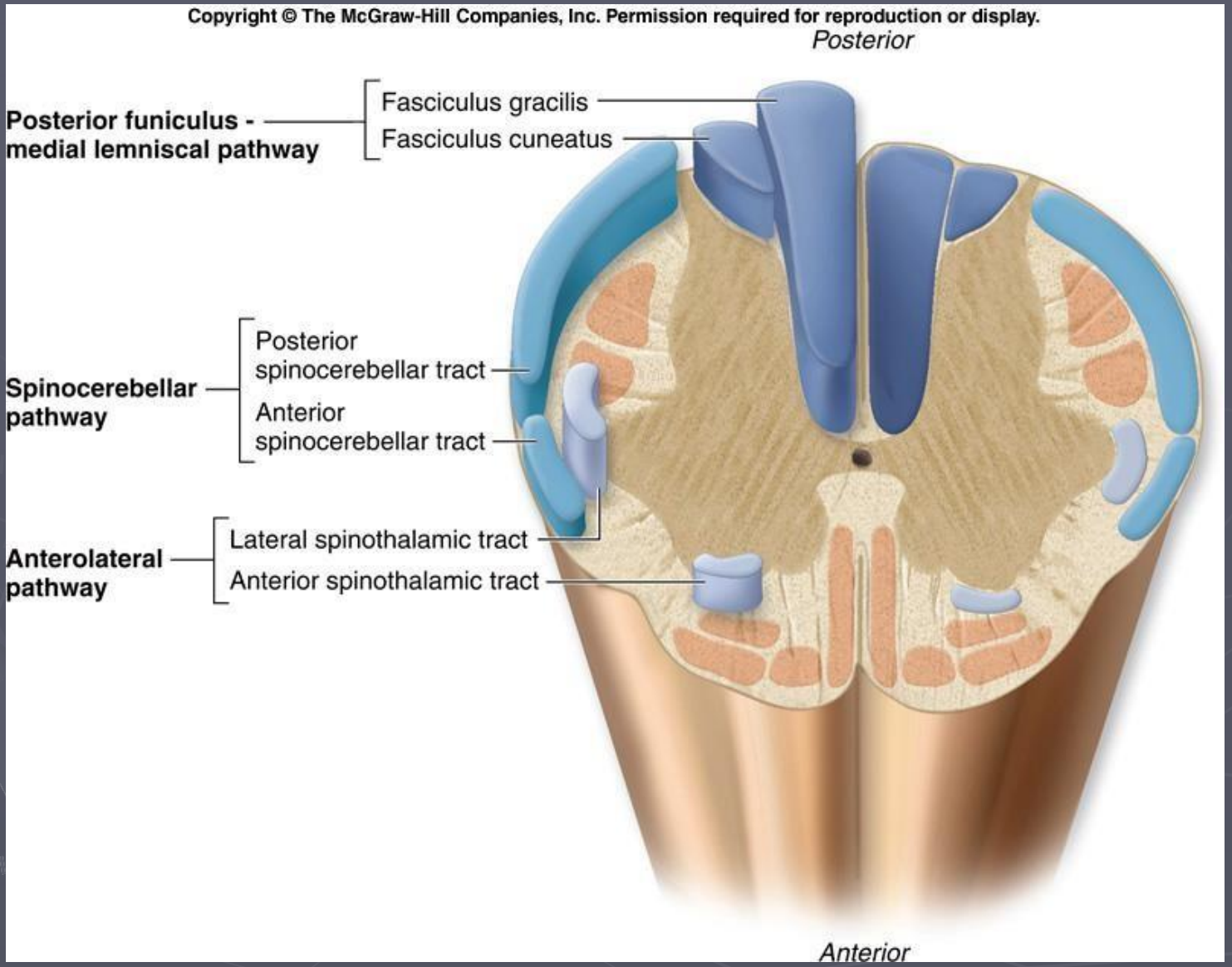
By functional peculiarities:

- associative fibers – perform one-sided connections between spine separate parts (different segments);
- commissural – bind functionally equal opposite parts of spine different parts;
- projectional – bind spine with higher-located parts.

ASCENDING AND DESCENDING TRACTS

ASCENDING tracts:	Funiculus of spinal cord
Fasciculus gracilis (tract of Goll)	Dorsal [posterior] white column
Cuneate or wedge-shaped fascicle (tract of Burdach)	Dorsal [posterior] white column
Lateralis spinothalamic tract	Lateral
Anterior spinothalamic tract	Anterior ventral funiculus
Posterior spinothalamic tract	Lateral
Anterior spinocerebellar tract	Lateral

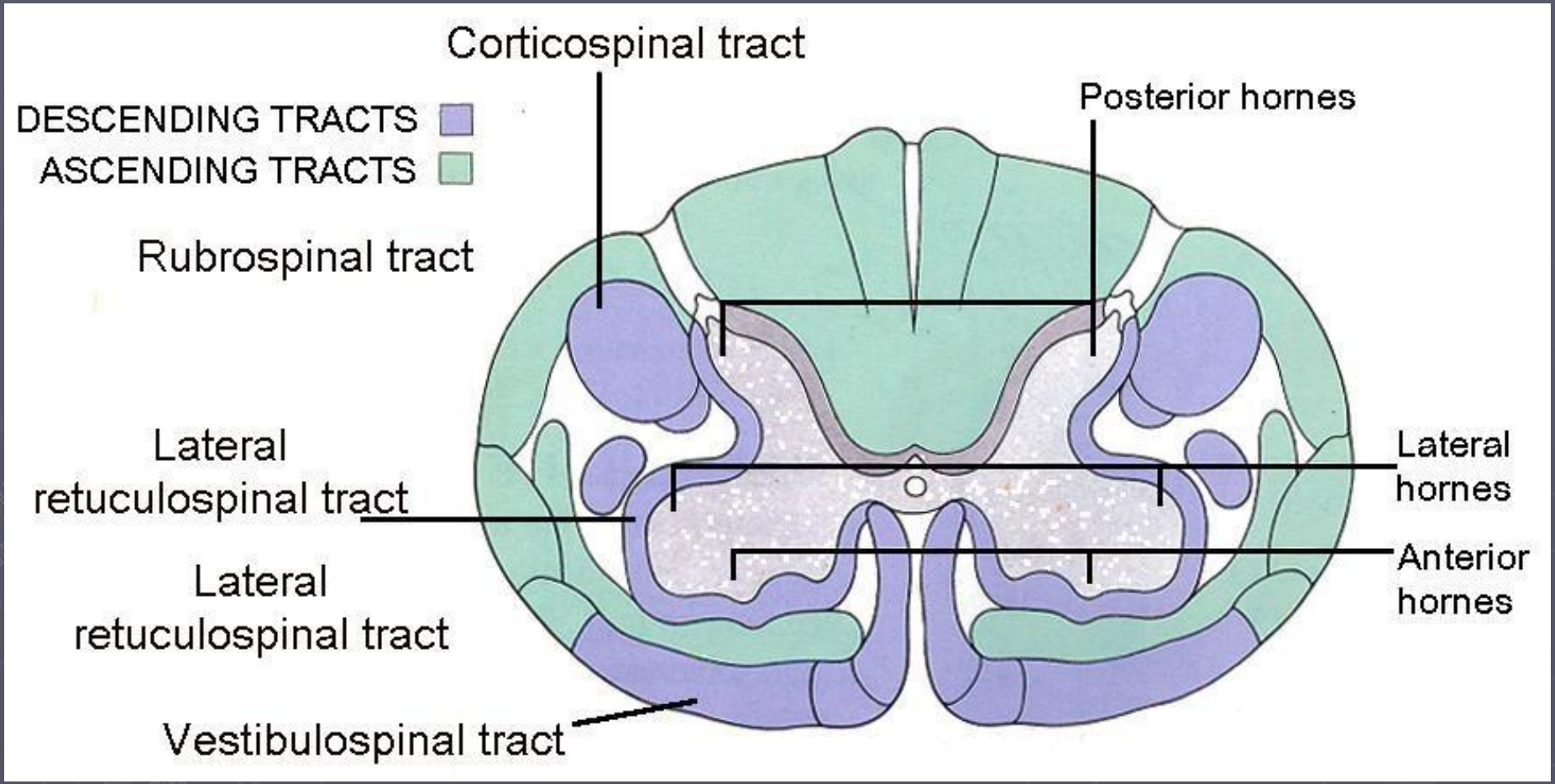
SENSITIVE TRACTS



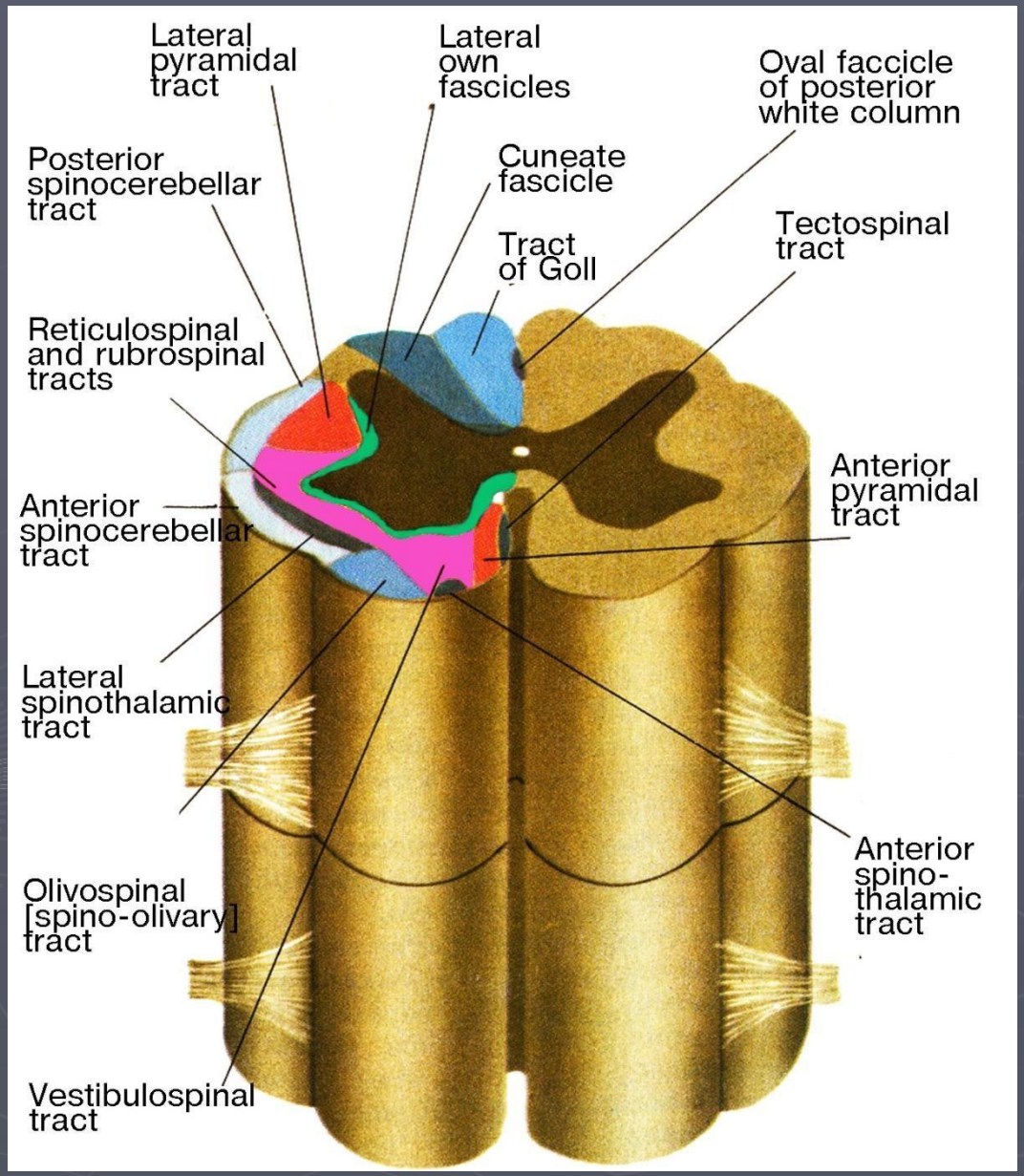
ASCENDING AND DESCENDING TRACTS

DESCENDING tracts:	Funiculus of spinal cord
Lateral pyramidal [lateral corticospinal] tract	Lateral
Rubrospinal tract	Lateral
Anterior pyramidal [anterior corticospinal] tract	Anterior
Vestibulospinal tract	Lateral
Reticulospinal tract	Lateral
Dorsal longitudinal fascicle	Anterior

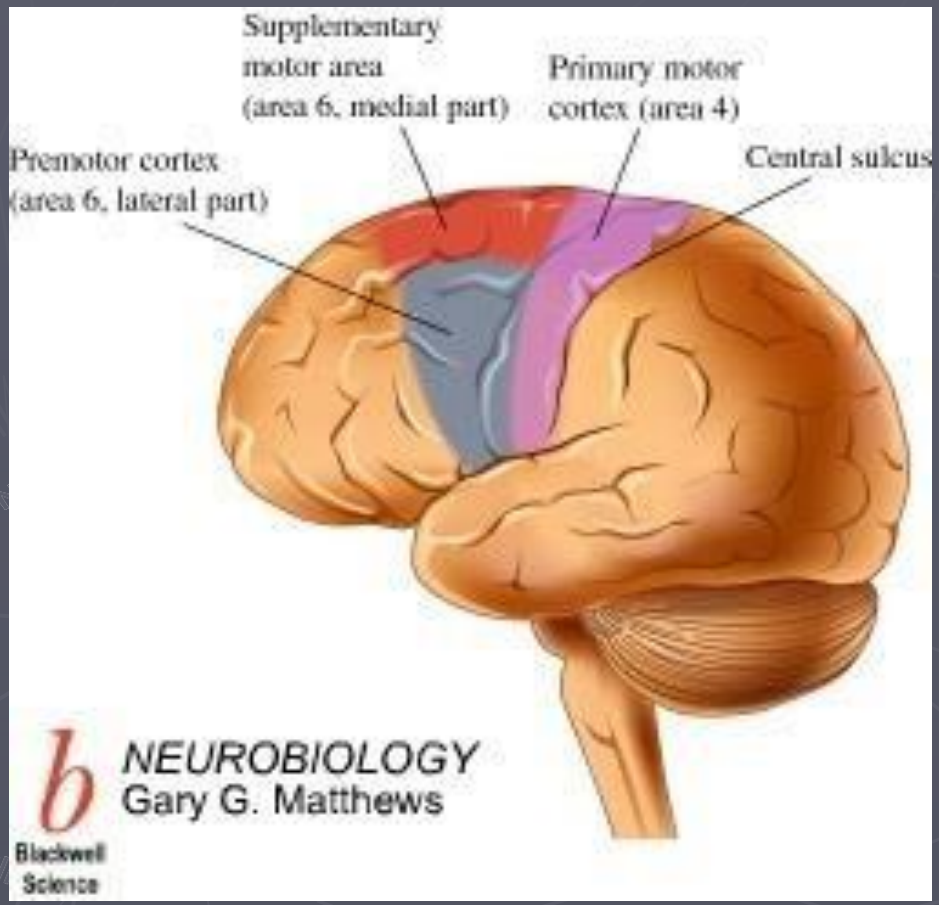
ASCENDING AND DESCENDING TRACTS



ASCENDING AND DESCENDING TRACTS



PYRAMIDAL TRACT (motor)

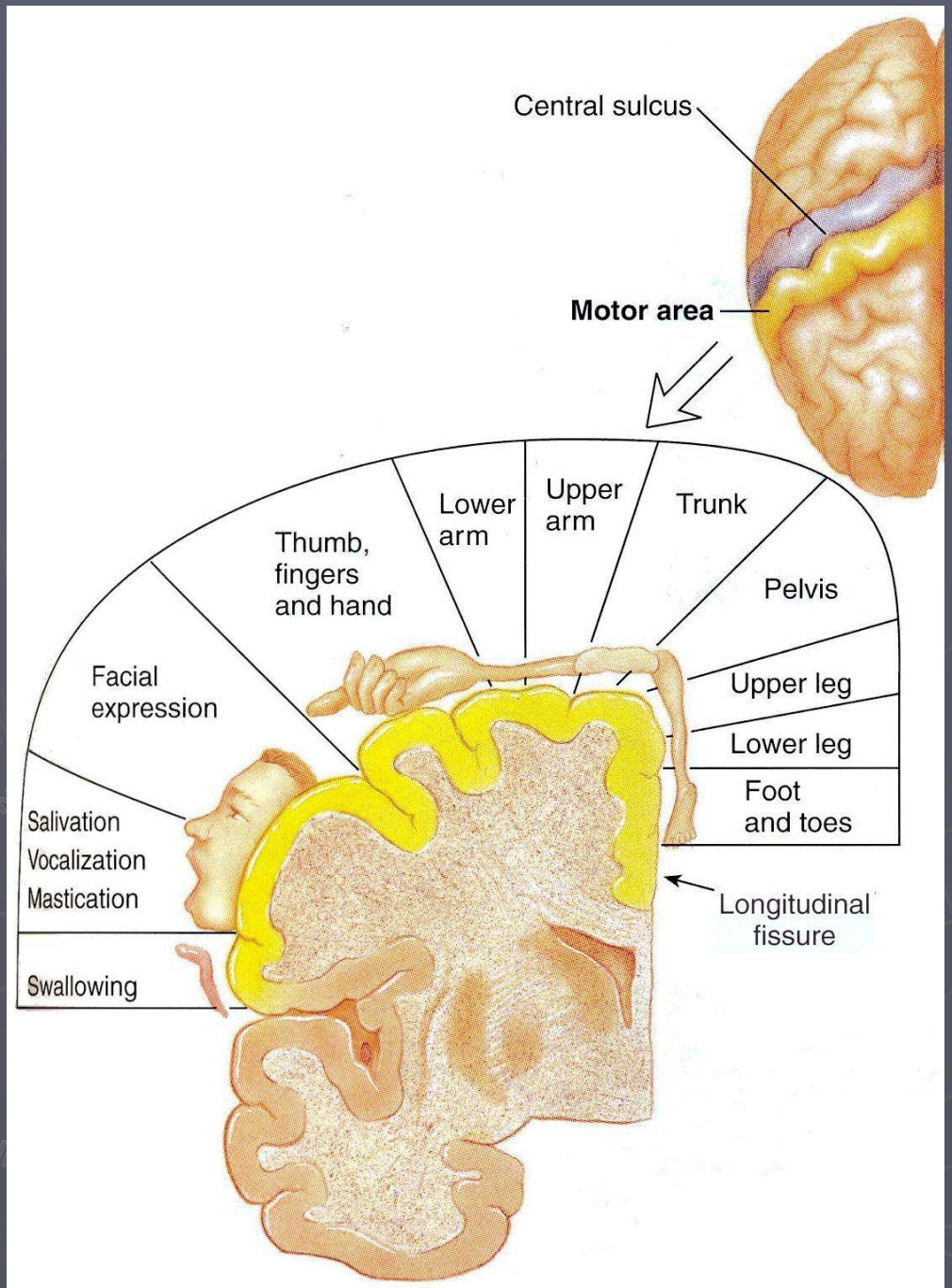


Pyramidal tract in spine gives fibers to alpha-large motoneurons of anterior corn and then to muscle. These fibers course is segment by segment.

This pathway has ***2 neurons:***

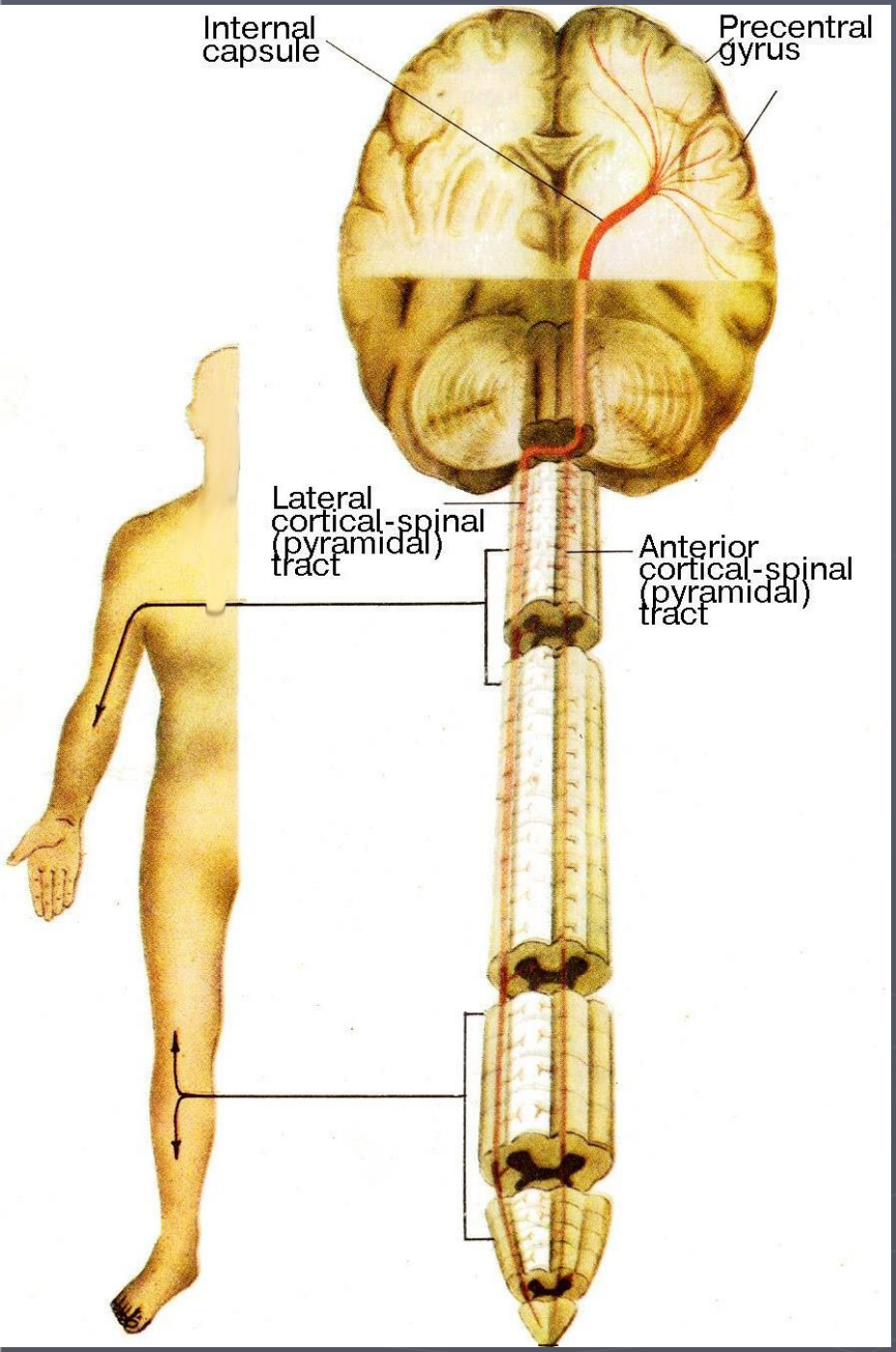
1) central – cell of Betz;
2) peripheral – motoric neuron.

PYRAMIDAL TRACT



It is origined from Betz' cells in anterior central gyrus, posterior parts of superior and middle frontal gyruses.

Lower extremities muscles motor centers are in superior parts of precentral gyrus; upper extremities muscles are in middle parts. Centers innervating muscles of neck, face, tongue, larynx and pharynx are located below.

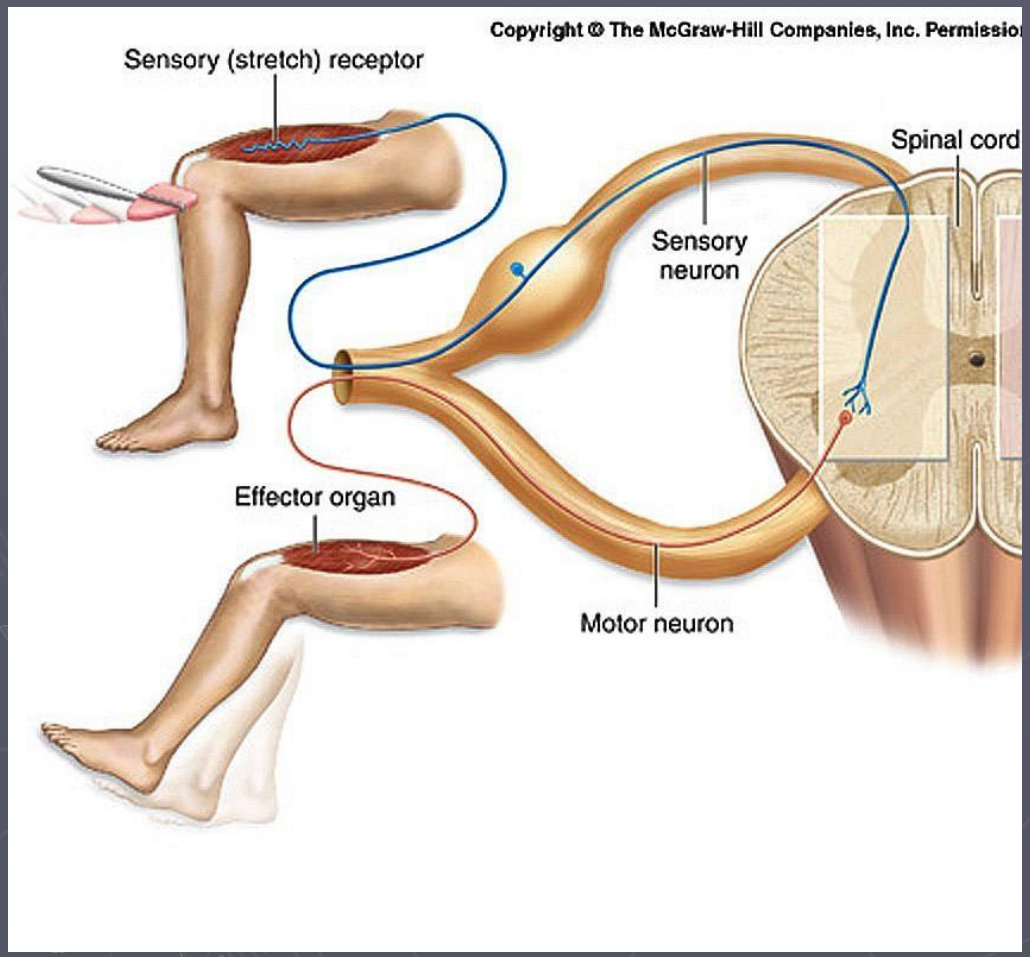


PYRAMIDAL TRACT

Betz' cell give process forming corona radiate. Then course is to internal capsule and brain stem.

In midbrain fibers location is following: fibers to legs muscles are located laterally; to arms and face – medially. In brain stem one part of fibers comes to cranial nerves nuclei forming cortical-nuclear tract.

On the boarder of medulla oblongata and spine the biggest part of pyramidal (cortical-spinal) tract fibers form the crossing and pass in spine lateral fascicles. Less part (without crossing) comes in spine anterior fascicles.



- Corpuses second (motor) neuroni are located in anterior horns of spinal cord.
- Fibers of motoneuron direct to effector organs - muscles.

PYRAMIDAL TRACT

Central motoneuron (Betz' cells) injury (central paralysis) is observed due to disorder of segmentar motor apparatus binding with cortex. Peripheral motoric neuron excitability is increased without central influencings regulation.

Peripheral motoneuron injury (peripheral paralysis) in anterior corn, anterior fascicle, plexus or peripheral nerve leads to complete stoppage of nervous impulses passage to the muscle from cortex through pyramidal tract. The muscle activity is absent: both arbitrary and the simplest reflectory movements are absent.

PYRAMIDAL TRACT

Paralysis (plegia) is arbitrary movements complete absence.

Paresis – is movements volume limiting and force reducing.

Monoplegia – one extremity paralysis.

Monoparesis – one extremity paresis.

Paraparesis – paresis of both lower extremities (inferior paraparesis) and upper extremities (superior).

Hemiplegia – leg and arm on 1 side are without movements.

INVESTIGATION METHODS OF MOVEMENTS METHODY S OF MOVEMENTS

Muscular tone investigation includes assessment of movements passiveness and resistance founding out.

Tone decreasing, atony are observed at peripheral neuron injury.

Muscular hypertony is observed at central paralysis; muscular rigidity takes place because of pallidar system injury.

ACTIVITY

SPINAL REFLEXES

Reflexes are organism answer reaction to irritation performed by nervous system.

Every reflex has its own reflectory arc through which nervous impulse passes from receptor to effector organ.

Region of receptors location the irritation of which leads to the definite reflex appearance is known as reflexogenic zone.

Non-conditioned reflexes are investigated in nervous diseases clinics. They are divided into:

1) deep (proprioreceptive) – tendineal, articular;
2) superficial (exteroreceptive) – cutaneous, from mucosae, delt with sensory organs.

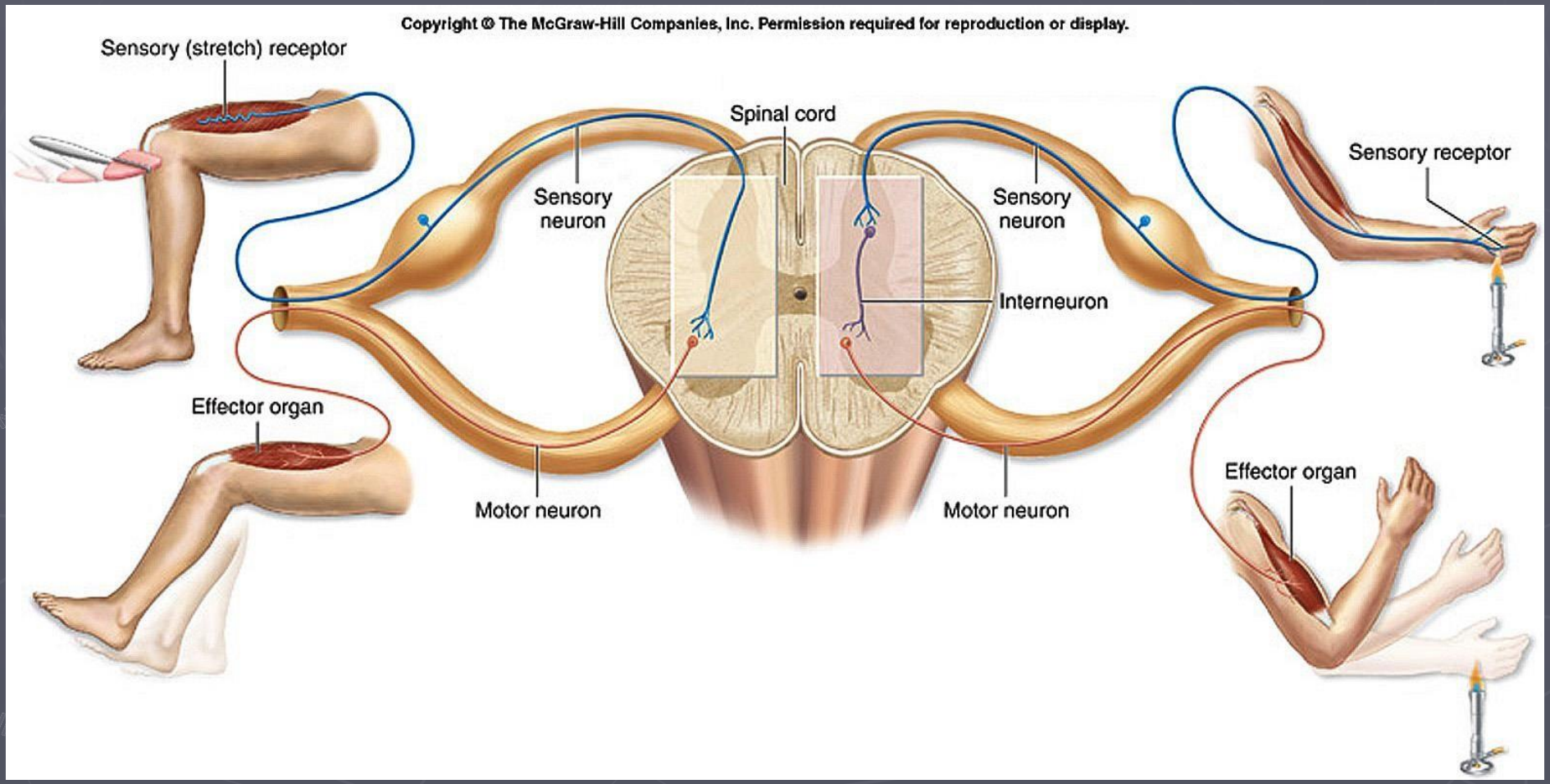
Detection significance:

Reflexes examination allows to testify not only about whether central or peripheral neuron is injured but also about injury level in brain and spine.

SPINAL REFLEXES

Deep (proprioreceptive) reflexes

Superficial (exteroreceptive) reflexes



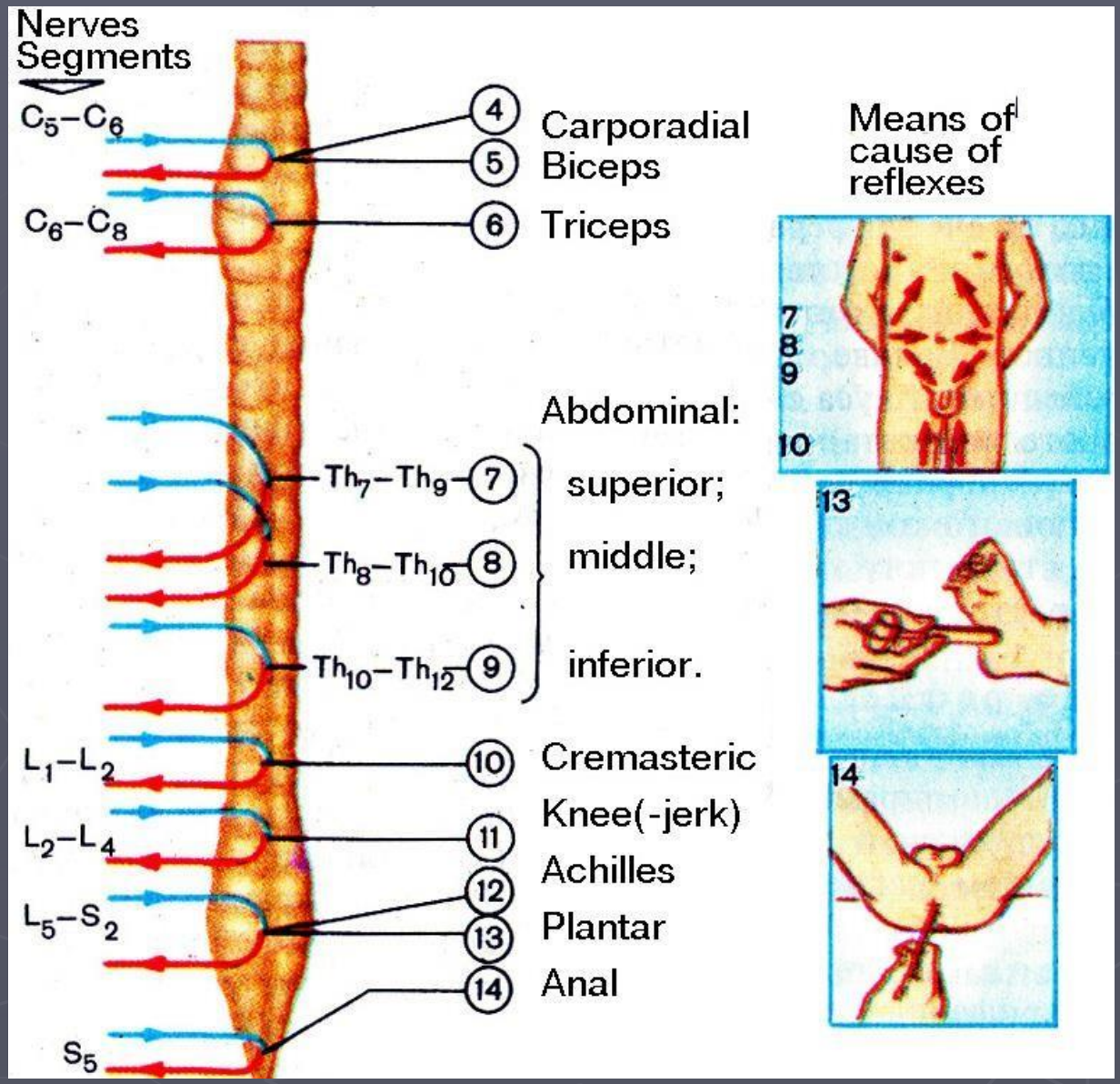
SUPERFICIAL REFLEXES (CUTANEOUS)

Cutaneous reflexes are appeared in age of 6 months – 2 years after fibers myelinization ending in pyramidal tract. They are caused by featured movement:

- Abdominal:

1)superior – in parallel to rib arc – T7-T8 is their closage level;
2)middle – navel level – T9-T10 is their closage level;
3)inferior – above inguinal plica – T11-T12.

- Plantar – featured short foot skin irritation leads to plantar flexion of toes; reflectory arc is closed at L5-S1.

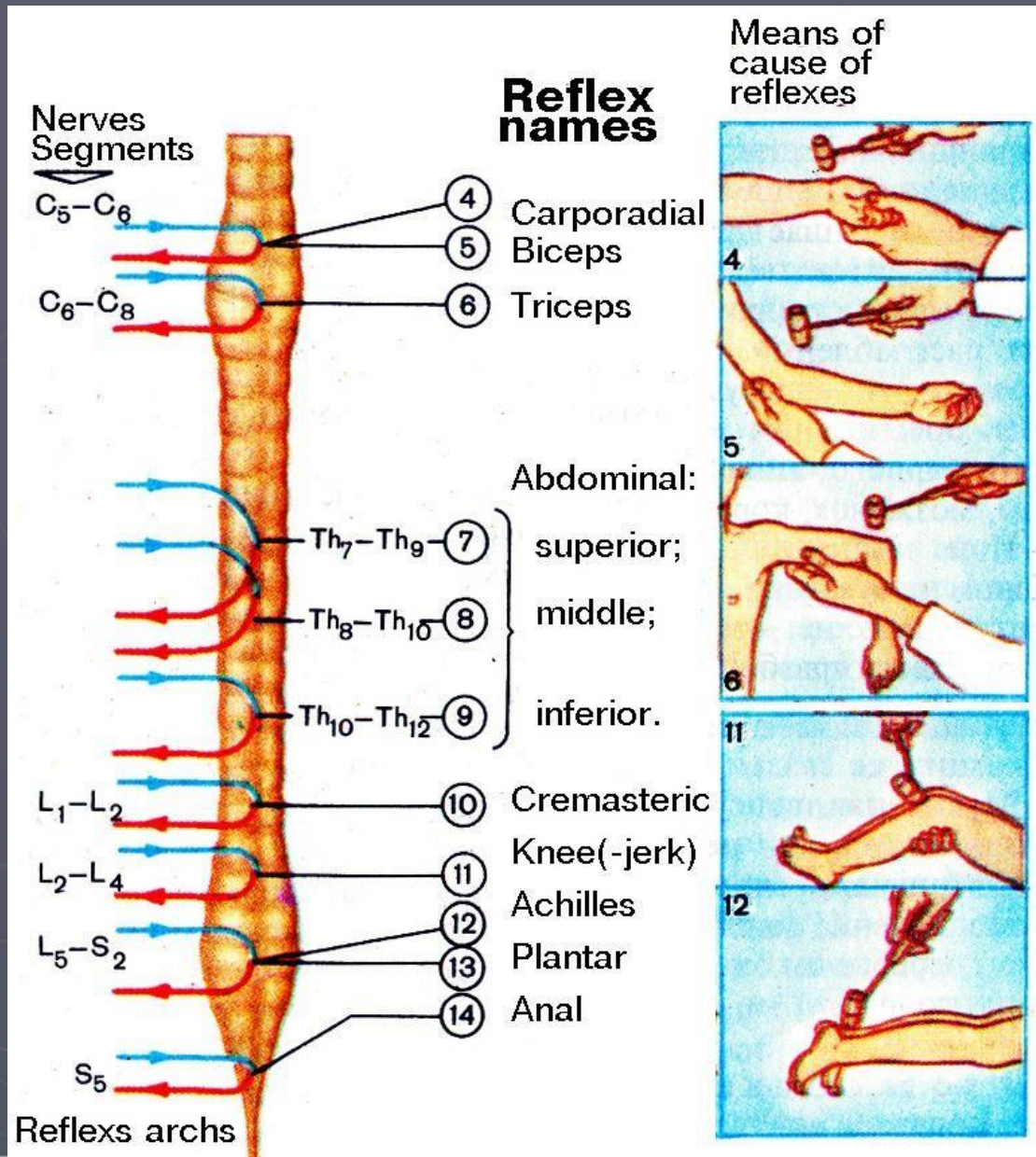


DEEP REFLEXES (TENDINEAL)

1.Carpal-radial – shock onto radial bone styloid process leads to the flexion in elbow joint and antebrachium pronation.

2.Reflex from brachial biceps jerk – strike on biceps tendon above elbow bend; answer: arm flexion in elbow joint. Reflectory arc is closed at C5-C6.

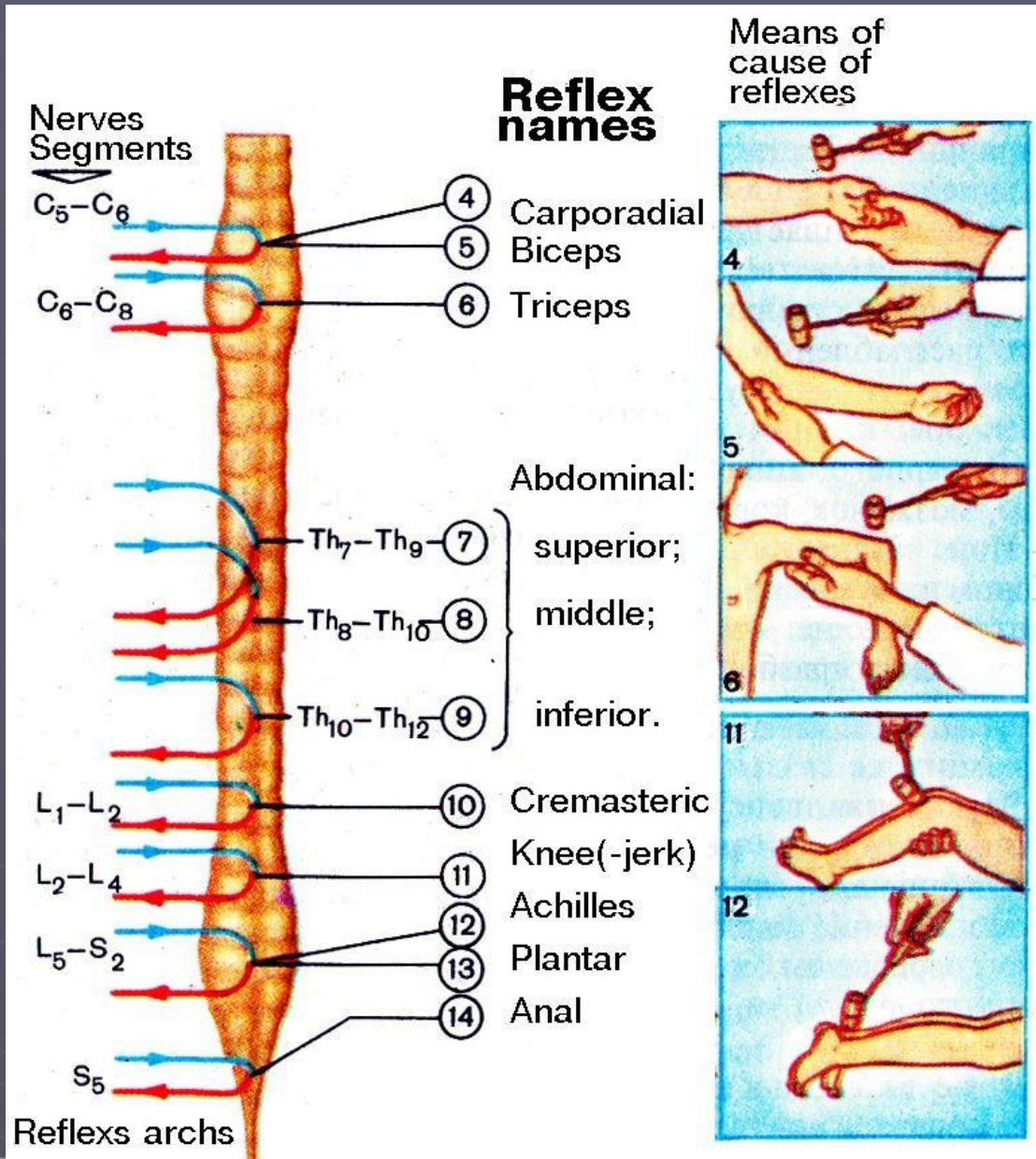
3.Reflex from brachial triceps – strike on muscle tendon above elbow process; answer is arm extension; reflectory arc is closed at C7- C8;



DEEP REFLEXES (TENDINEAL)

4.Knee jerk – shock on quadriceps tendon leads to an answer reaction – tibia extension; reflex arc is closed at L2-L4.

5.Achilles' reflex – shock with hummer on achilles' (calcaneus) tendon leads to answer reaction – musculus gastrocnemius contraction and plantar foot flexion; reflexory arc is closed at S1-S2.



SPINAL REFLEXES

Hyperreflexy is observed in case of injury of central motor neuron, disorder of connection between motor apparatus with big hemispheres cortex. It leads to peripheral motor neuron reflectory excitability increasing.

Hyporeflexy (areflexy) is observed in case of peripheral motor neuron inhibiting.

SENSITIVITY

It is delt with receptors type.

2 main types.

***Superficial*:**

- nociceptive (pain),
- temperature,
- tactile.

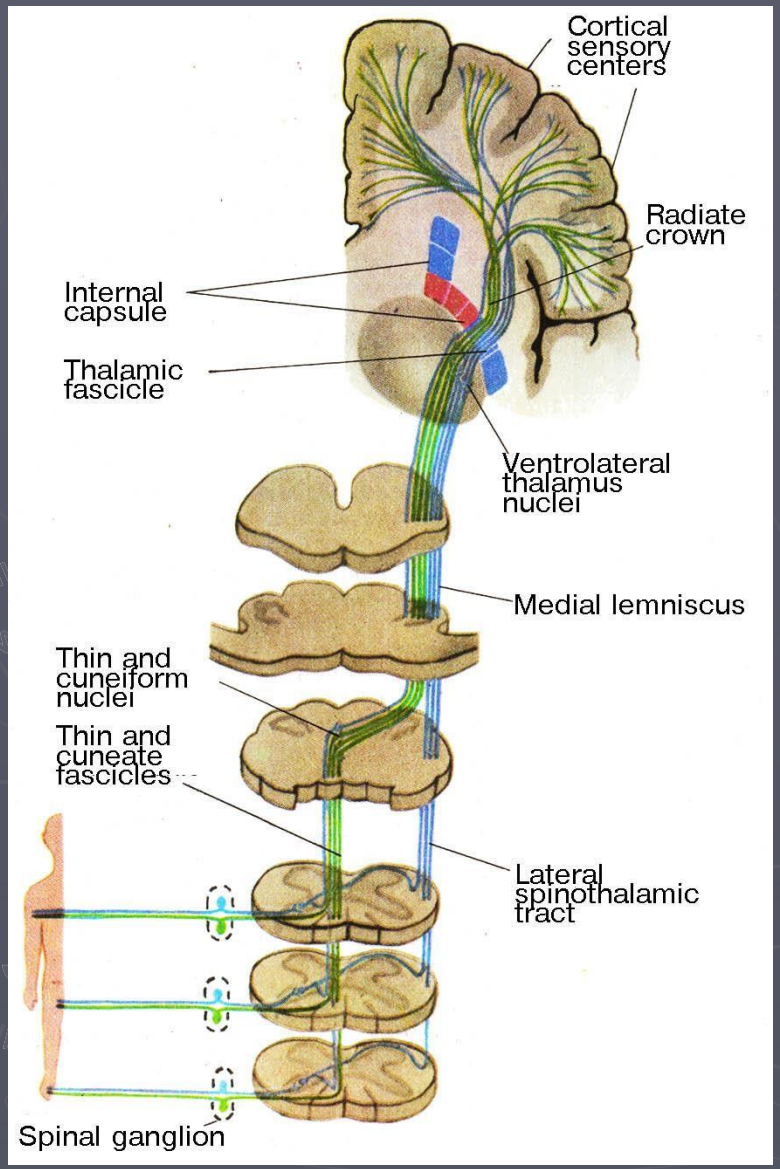
Prophound or deep:

- muscular-articular sense;
- trunk and extremities location in space;
- pressure and body weight sense;
- vibration sense.

Distribution of superficial and deep sensitivity impulses to subcortical parts is performed through ***3-neuronal pathway:***

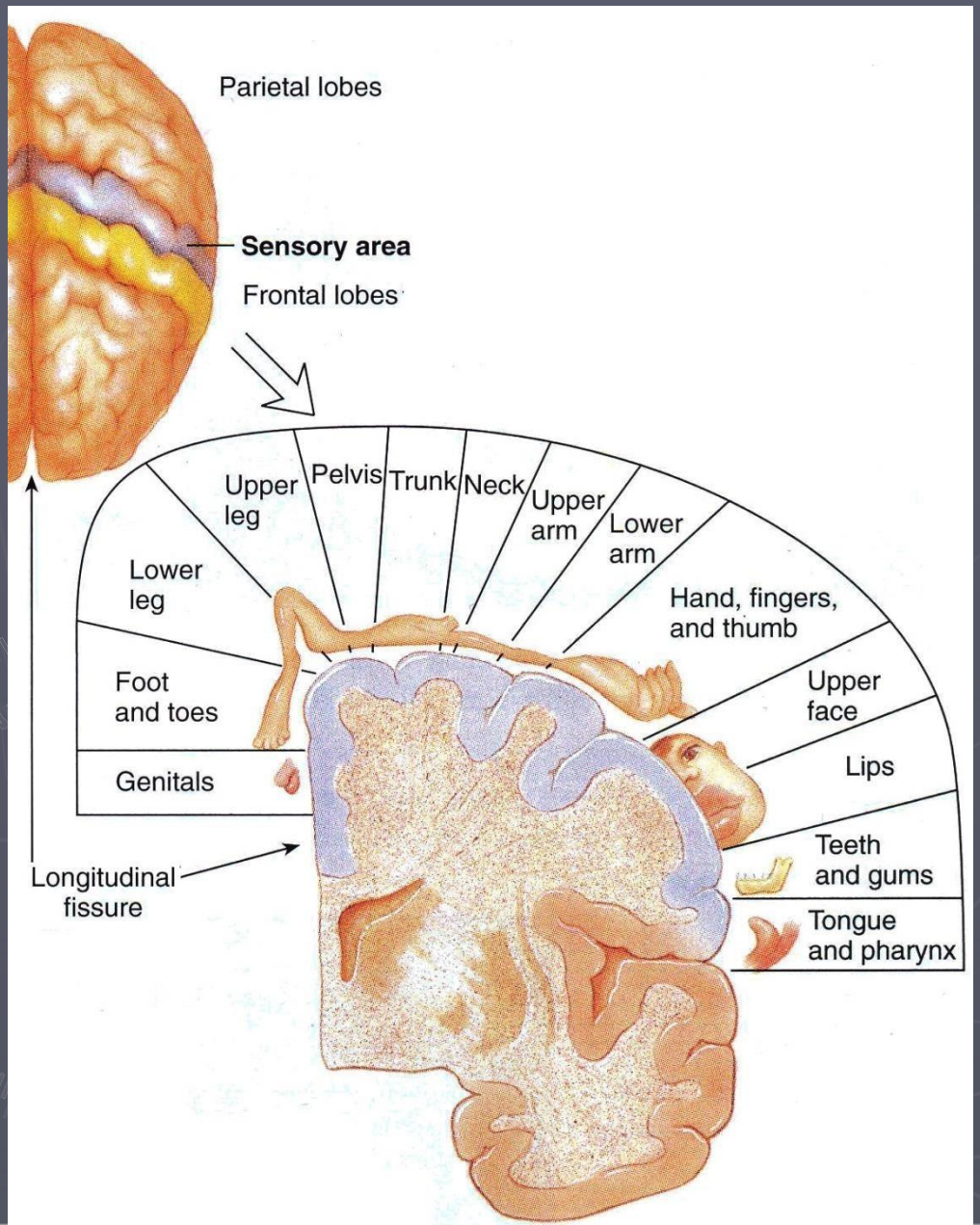
I-st neuron for all types of sensitivity is located in spine nodes. II-nd neurons make crossing.

SENSITIVE TRACTS
(blue – superficial, green – deep)



Superficial sensitivity pathway – through posterior radices impulse comes in posterior corns, where II-nd neuron is located; then fibers pass through anterior comissure to opposite side, ascend obliquely on 2-3 segments higher in a consisting of spine lateral funicles up to thalamus (visual tubercle nucleus). It is spinothalamic tract.

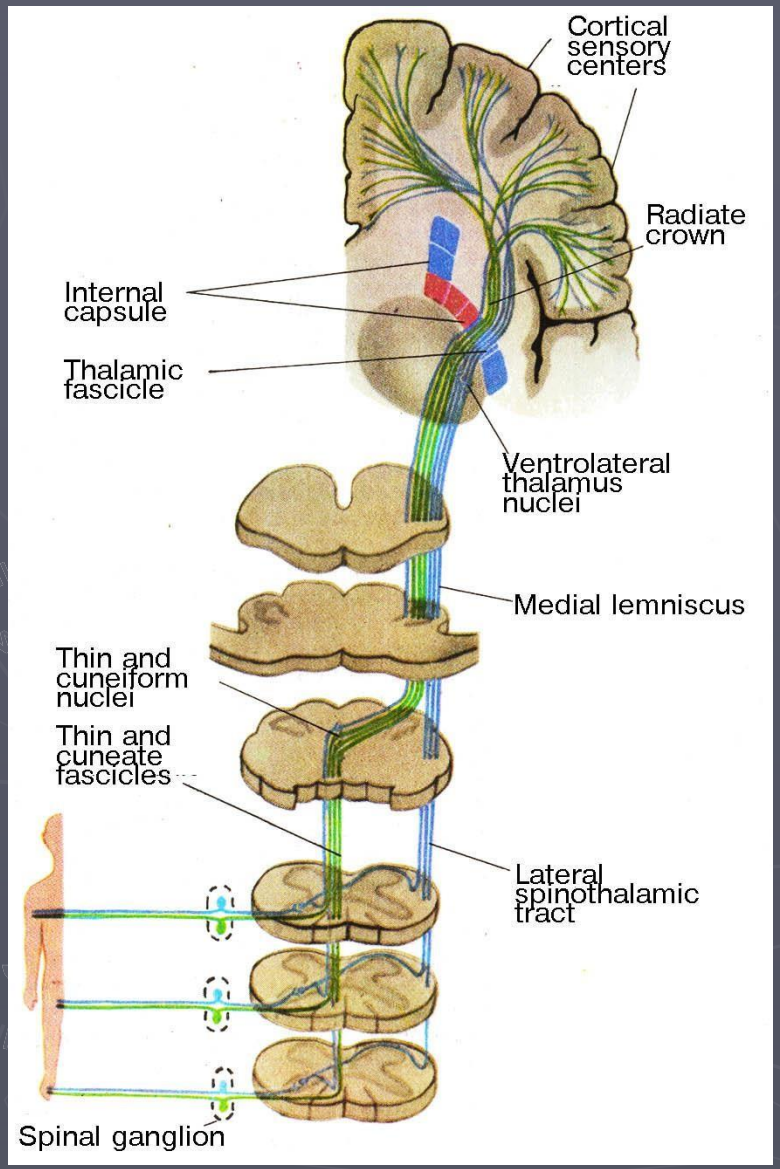
SENSITIVE TRACTS



III-rd neuron is in thalamus ventrolateral nucleus forming thalamocortical tract. Then impulse comes to internal capsule, radiate crown and finally postcentral gyrus.

In case of stem injury at any segment level superficial sensitivity disappears on opposite (contralateral) side of body surface on 2-3 segments lower than the injury level.

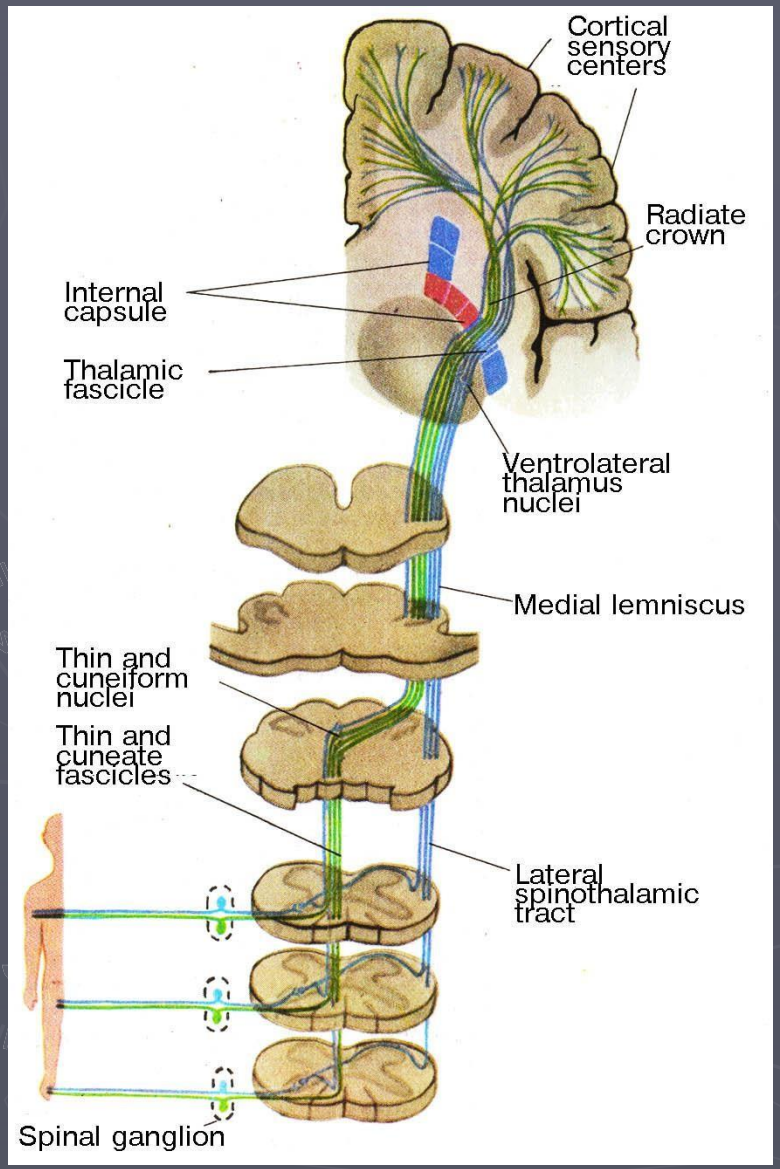
SENSITIVE TRACTS
(blue – superficial, green – deep)



Deep sensitivity pathway:

I-st neuron is in spinal ganglion without coming in corns passes to posterior funicles on one-named (ipsylateral) side. Fibers from lower extremities are located medially and form Goll's fascicle; from upper extremities – forming so-called cuneate fascicle of Burdach – passing to medulla oblongata to posterior funicles nuclei where II-nd neuron is located.

SENSITIVE TRACTS
(blue – superficial, green – deep)

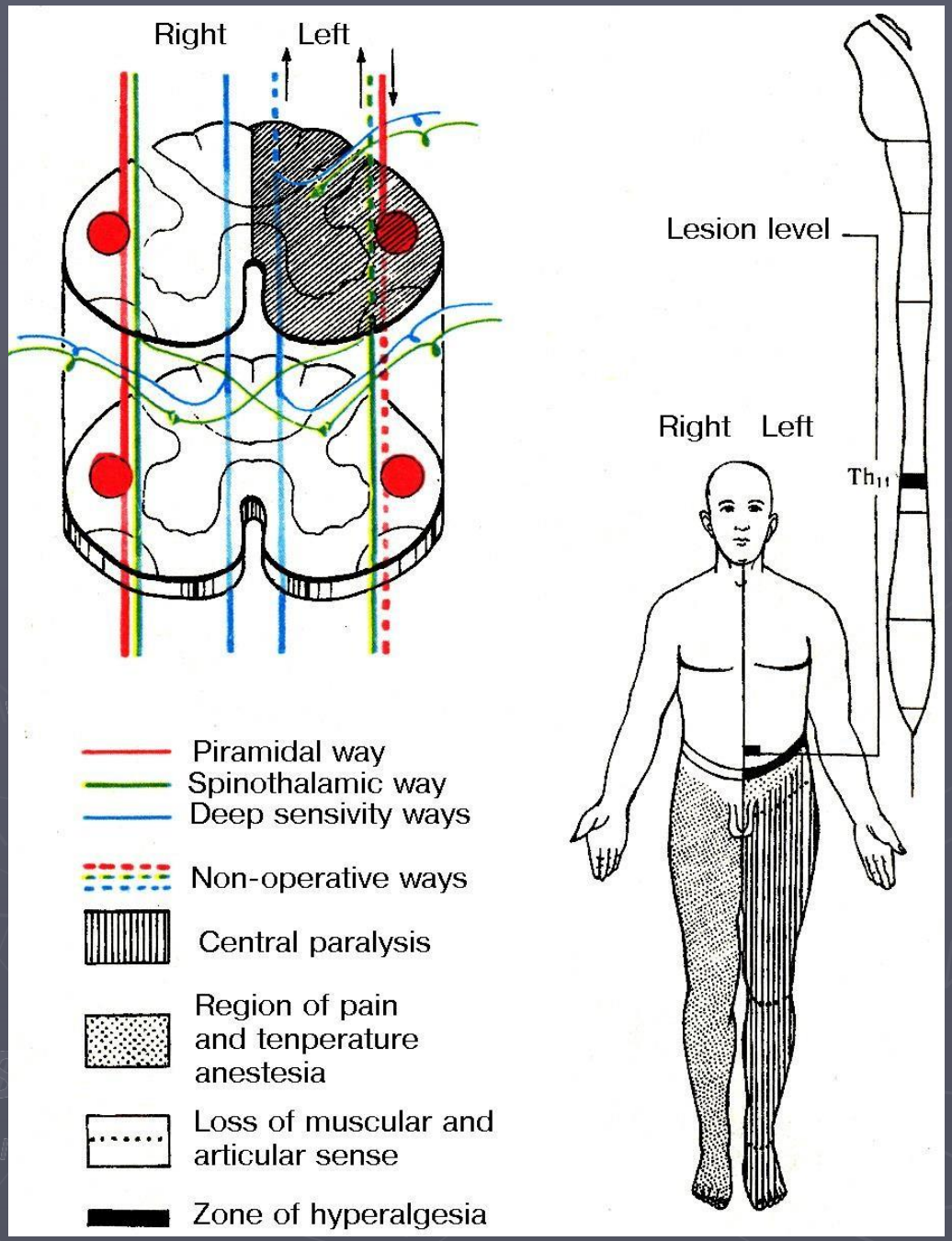


Then the pathways perform crossing (forming medial lemnisc) and enter into thalamus forming bulbar-thalamic tract. The tract ends in thalamus ventral-lateral nucleus where the III-rd neuron is origined from. Then thalamocortical pathway is formed and passes to internal capsule and cortex postcentral gyrus.

Sensitivity investigation

- sensitivity disappearance (falling out) – complete anesthesia;
- sensitivity increasing – hyperesthesia;
- sensitivity disappearance (falling out) on one extremity – monoanesthesia;
- paresthesias – burning, pricking, shivers running (crawling) sense.

Superficial sensitivity is checked by pin point, brush spike as well as cold and hot subjects.



Brown-Séquard's syndrome (syndrome of spinal cord half-lesion)

They are a central paralysis and a disappearance of deep sensitiveness on an explorer type develop on the side of injury.

There is disorder of superficial sensitiveness on an opposite side of an explorer type on 2-3 segments downward from the level of lesion.

Types of pain

Local pain – it appear in a zone of painful stimulation.

Projection pain – it appear in case of nervous trunk irritation and are projected in cutaneous zone innervated by a given nerve.

Spreading [radiating, excentric, referred] pain – it appear in a zone of innervation of one of branches of nerve in case of putting the irritations of other branch.

Referred [heterotopic] pain – it is observed in case of inner organs diseases and is located in a definite skin locus (so-called Zahar'in-Head's zones).

Phantom-limb [post-amputation] pains – they appear in patients after extremities amputation. Patient "feels" non-existing extremity, pain in it, itch. This pain type is determined by scared process involving nerve end and supporting nerve fibers irritation as well as excitement pathological locus in cortex projection zone. This pain is similar to projection pain.