SREE NARAYANA
NURSING COLLEGE

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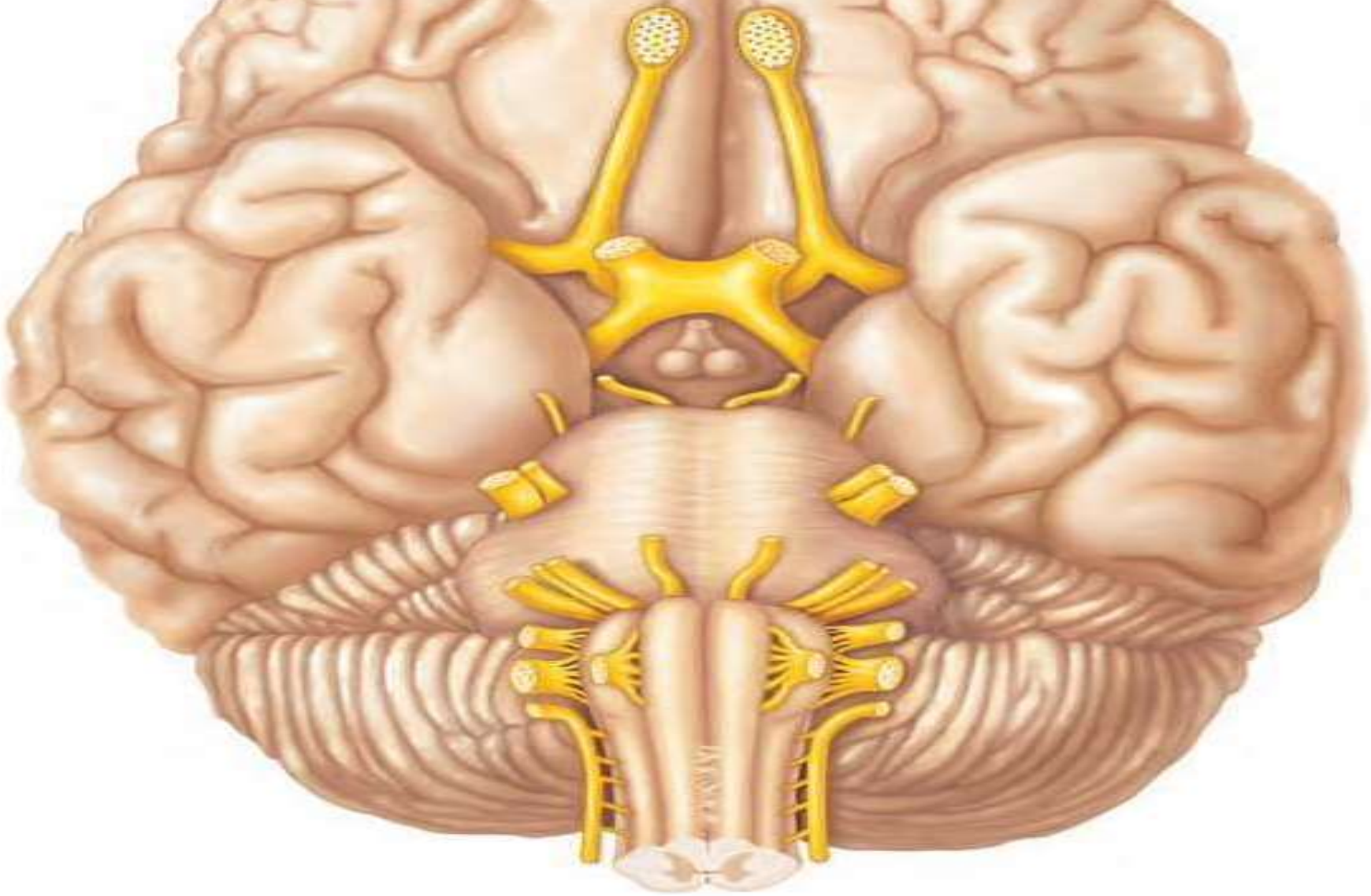
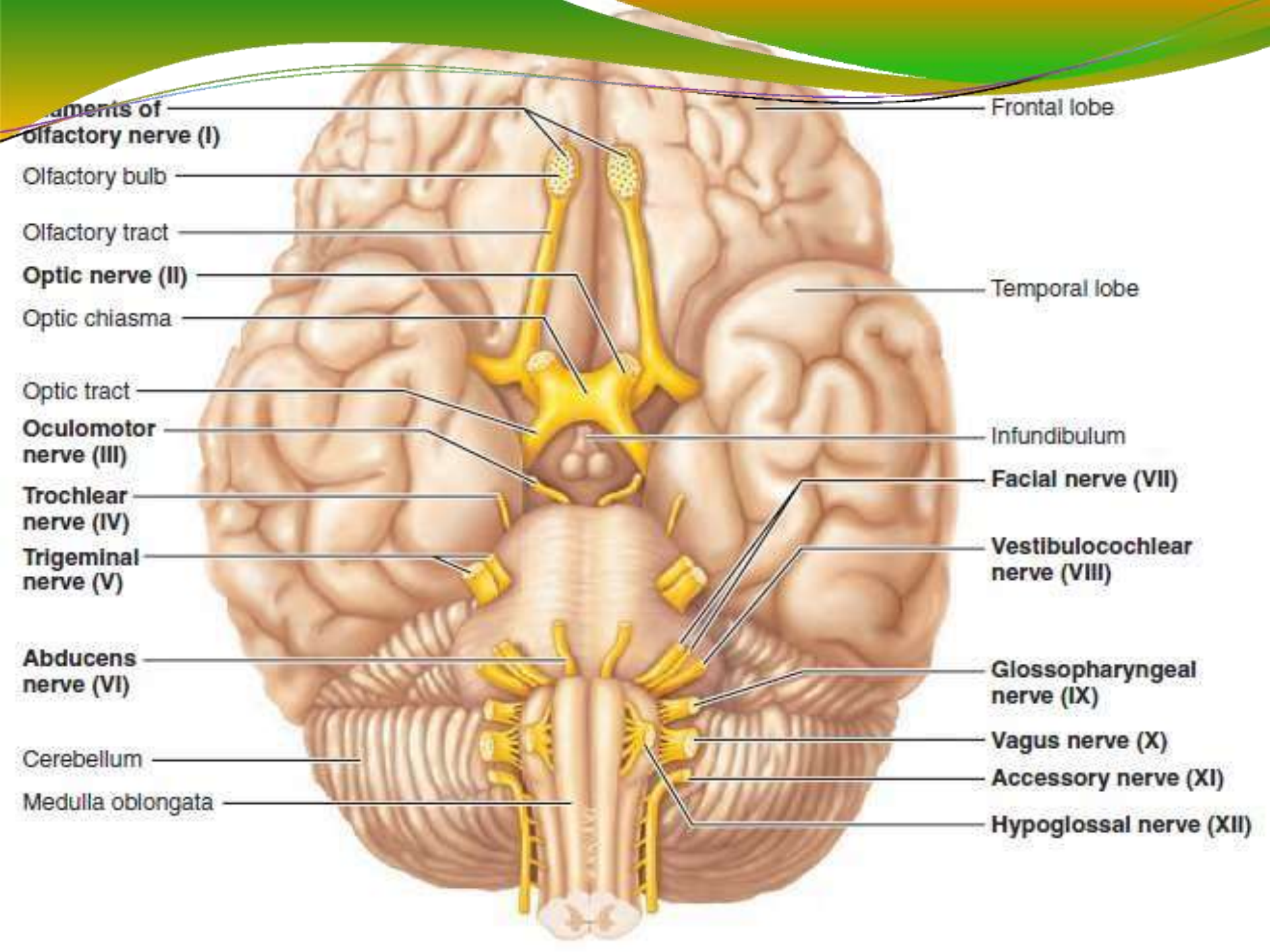
Cranial Nerves



Cranial Nerves

- Twelve pairs of **cranial nerves are associated with the brain**
- The first two pairs attach to the forebrain, and the rest are associated with the brain stem.
- Other than the vagus nerves, which extend into the abdomen, cranial nerves serve only head and neck structures.

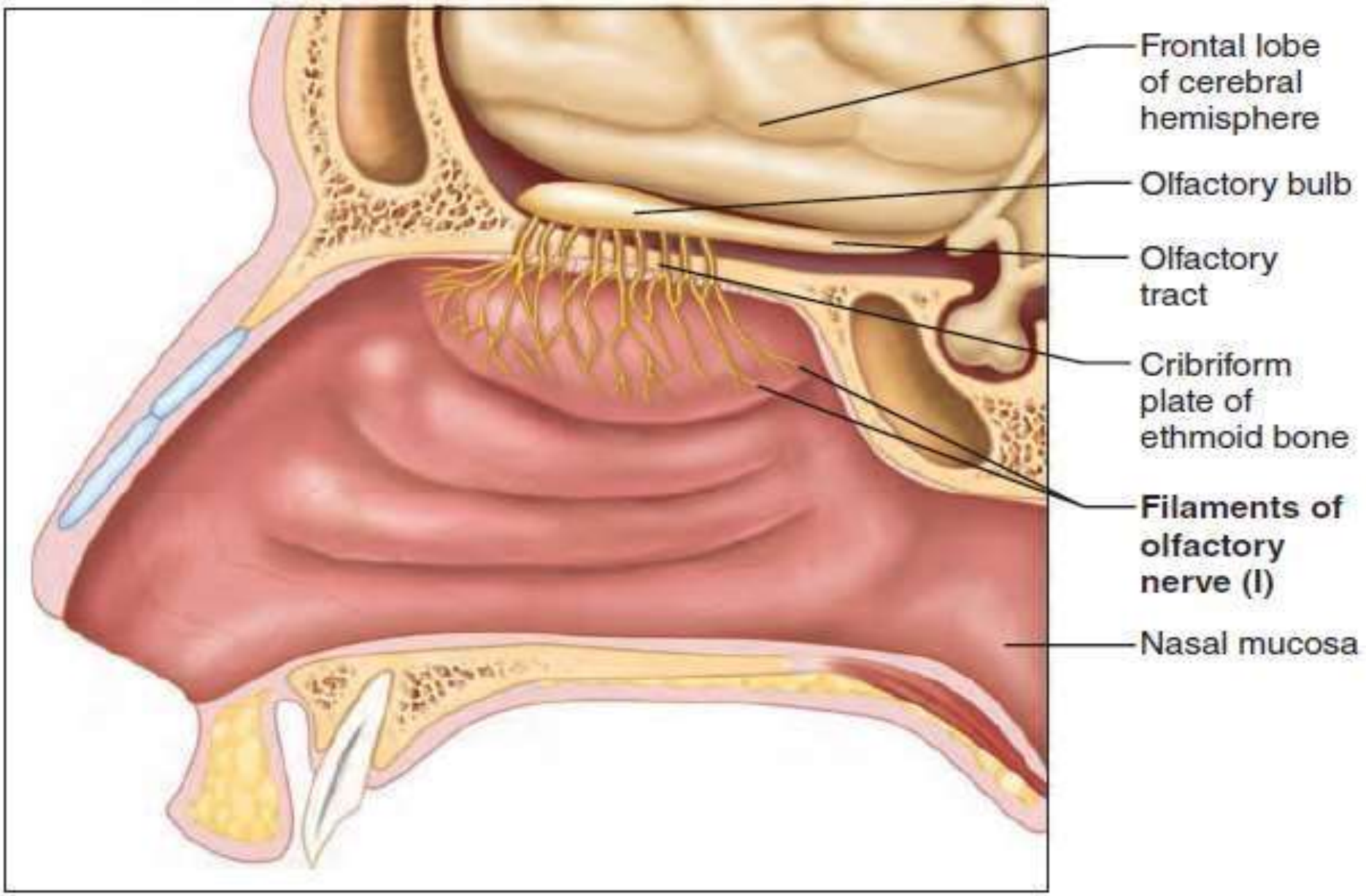

aments of
olfactory nerve (I)
Olfactory bulb
Olfactory tract
Optic nerve (II)
Optic chiasma
Optic tract
Oculomotor nerve (III)
Trochlear nerve (IV)
Trigeminal nerve (V)
Abducens nerve (VI)
Cerebellum
Medulla oblongata
Frontal lobe
Temporal lobe
Infundibulum
Facial nerve (VII)
Vestibulocochlear nerve (VIII)
Glossopharyngeal nerve (IX)
Vagus nerve (X)
Accessory nerve (XI)
Hypoglossal nerve (XII)

Cranial nerves	Sensory function	Motor function	PS* fibers
I Olfactory	Yes (smell)	No	No
II Optic	Yes (vision)	No	No
III Oculomotor	No	Yes	Yes
IV Trochlear	No	Yes	No
V Trigeminal	Yes (general sensation)	Yes	No
VI Abducens	No	Yes	No
VII Facial	Yes (taste)	Yes	Yes
VIII Vestibulocochlear	Yes (hearing and balance)	Some	No
IX Glossopharyngeal	Yes (taste)	Yes	Yes
X Vagus	Yes (taste)	Yes	Yes
XI Accessory	No	Yes	No
XII Hypoglossal	No	Yes	No

*PS = parasympathetic

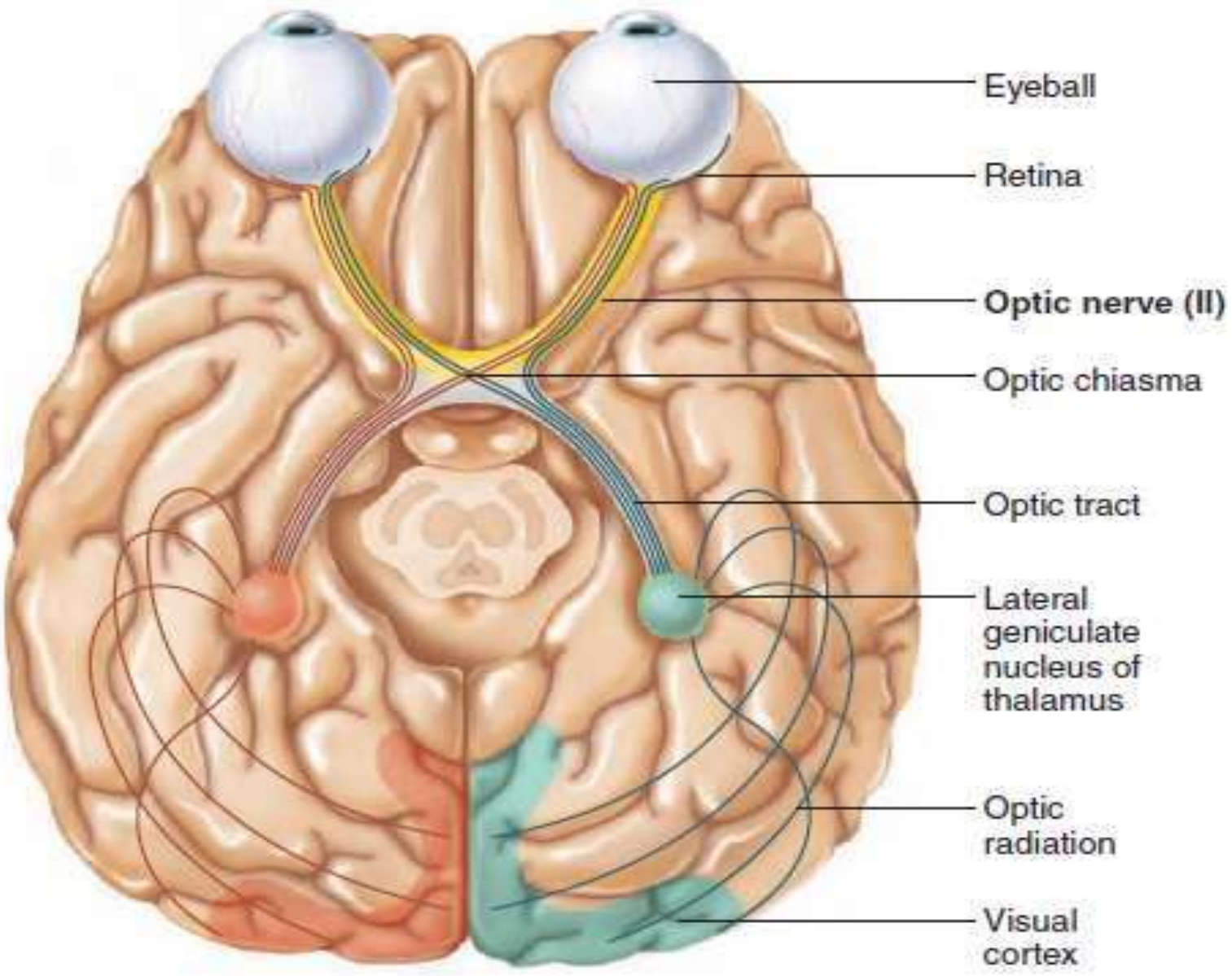
I. Olfactory

- These are the tiny sensory nerves (filaments) of smell, which run from the nasal mucosa to synapse with the olfactory bulbs.
- **Origin and course: Olfactory nerve fibers arise from** olfactory sensory neurons located in olfactory epithelium of nasal cavity and pass through cribriform plate of ethmoid bone to synapse in olfactory bulb. Fibers of olfactory bulb neurons extend posteriorly as olfactory tract, which runs beneath frontal lobe to enter cerebral hemispheres and terminates in primary olfactory cortex.
- **Function: Purely sensory; carry afferent impulses for** sense of smell.
- **Clinical testing: Ask subject to sniff and identify aromatic** substances, such as oil of cloves and vanilla.
- **Applied Anatomy:- Fracture of** ethmoid bone or lesions of olfactory fibers may result in partial or total loss of smell, a condition known as *anosmia*


Frontal lobe of cerebral hemisphere
Olfactory bulb
Olfactory tract
Cribriform plate of ethmoid bone
Filaments of olfactory nerve (I)
Nasal mucosa

II. Optic.

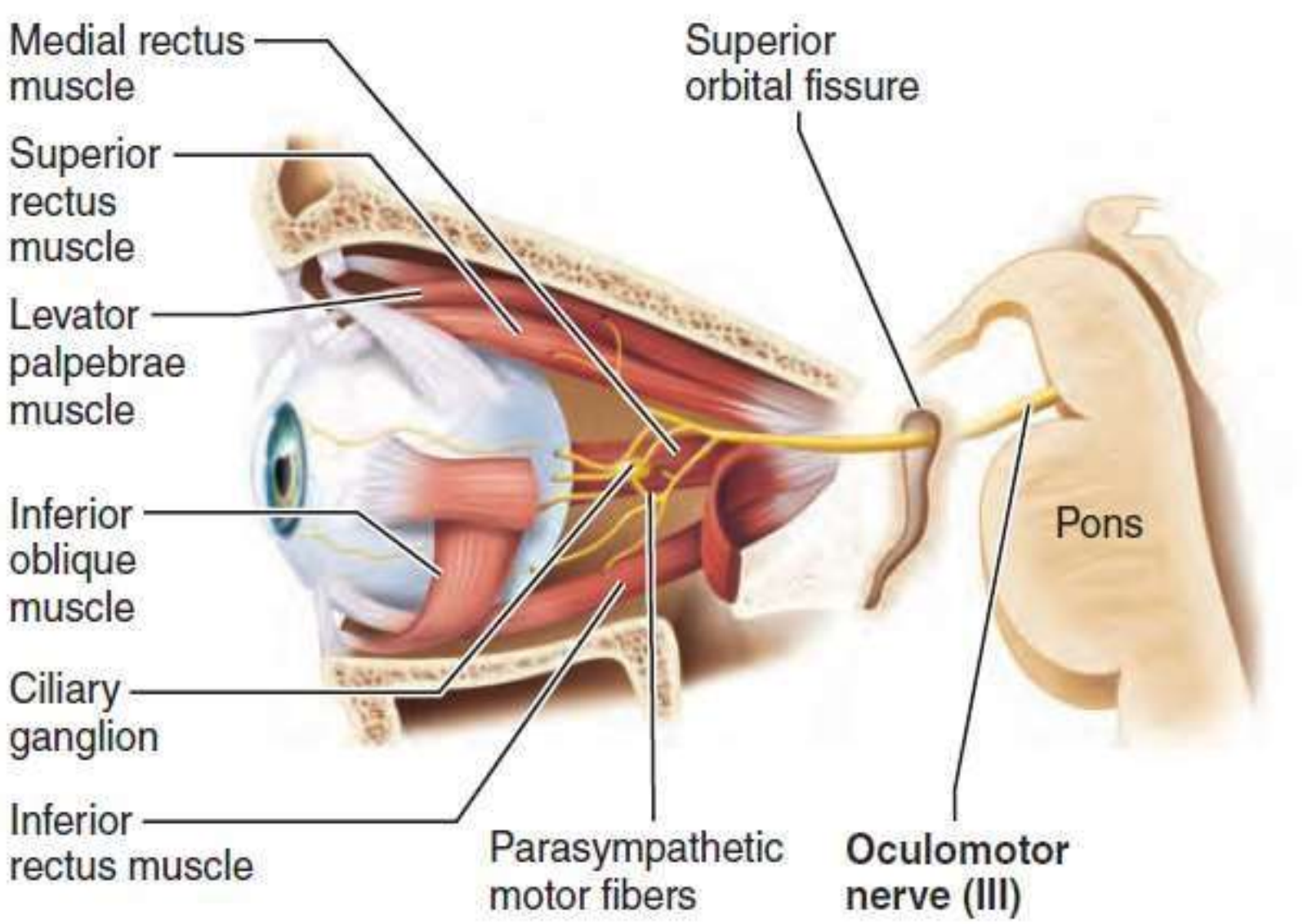
- **Origin and course:** Fibers arise from retina of eye to form optic nerve, which passes through optic canal of orbit. The optic nerves converge to form the optic chiasma where fibers partially cross over, continue on as optic tracts, enter thalamus, and synapse there.
- Thalamic fibers run (as the optic radiation) to occipital (visual)
  cortex, where visual interpretation occurs.
- **Function:** Purely sensory; carry afferent impulses for vision.
- **Clinical testing:** Assess vision and visual field with eye
- **Applied Anatomy:-** Damage to optic nerve results in blindness in eye served by nerve. Damage to visual pathway beyond the optic chiasma results in partial visual losses. Visual defects are called *anopsias*


Eyeball
Retina
Optic nerve (II)
Optic chiasma
Optic tract
Lateral geniculate nucleus of thalamus
Optic radiation
Visual cortex

III Oculomotor Nerves

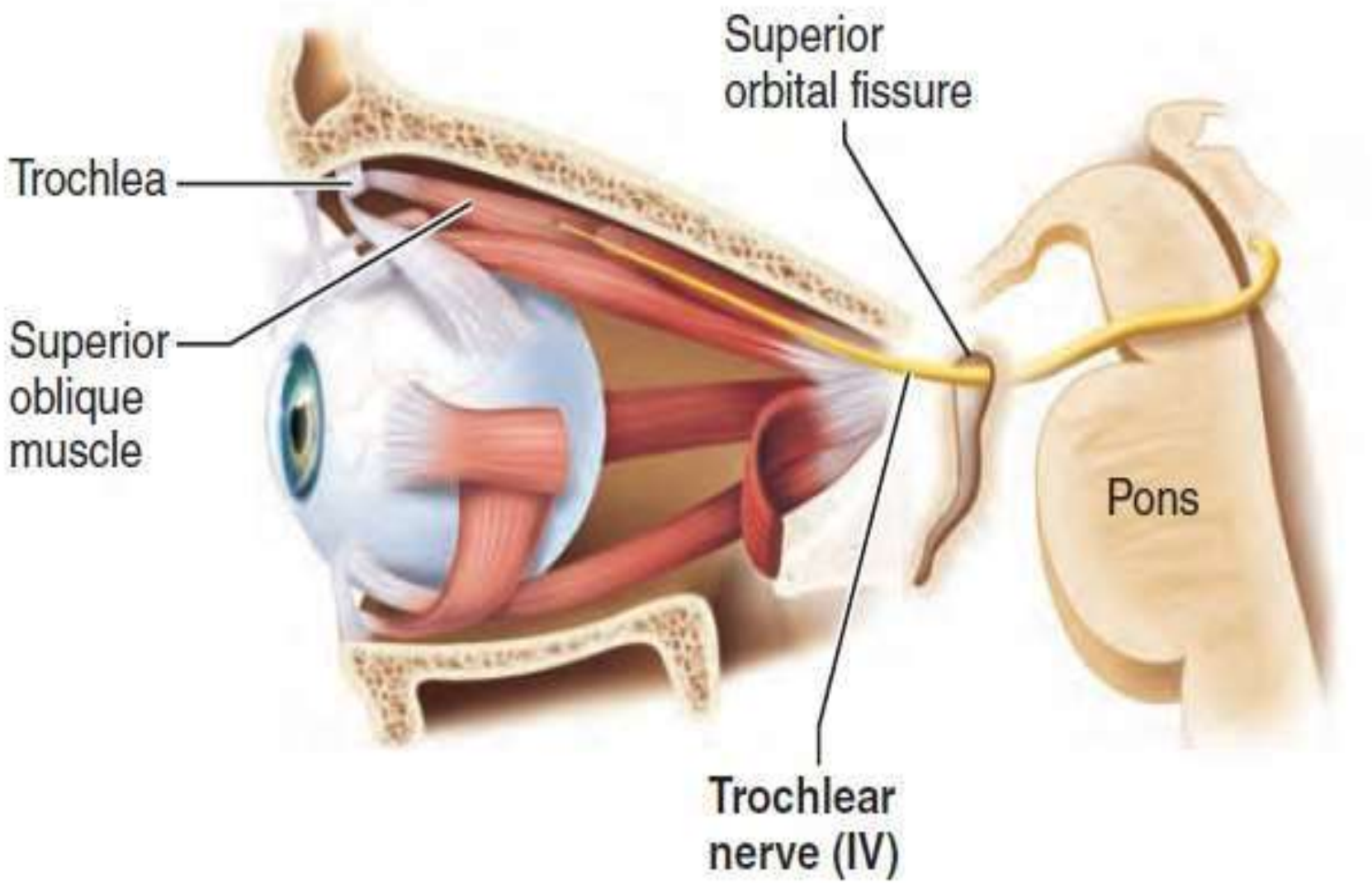
- **Origin and course:** Fibers extend from ventral midbrain and pass through bony orbit, via superior orbital fissure, to eye.
- **Function:** Each nerve includes the following:
  - Somatic motor fibers to four of the six extrinsic eye muscles (inferior oblique and superior, inferior, and medial rectus muscles) that help direct eyeball, and to levator palpebrae superioris muscle, which raises upper eyelid.
  - Parasympathetic (autonomic) motor fibers to sphincter pupillae (circular muscles of iris), which cause pupil to constrict, and to ciliary muscle, controlling lens shape for visual focusing. Some parasympathetic cell bodies are in the ciliary ganglia.
  - Sensory (proprioceptor) afferents, which run from same four extrinsic eye muscles to midbrain.

- **Clinical testing: Examine pupils for size, shape, and equality.** Test pupillary reflex with penlight. Test convergence for near vision and subject's ability to follow objects with the eyes.
- **Applied anatomy:- In oculomotor nerve** paralysis, eye cannot be moved up, down, or inward. At rest, eye rotates laterally [external strabismus] because the actions of the two extrinsic eye muscles not served by cranial nerves III are unopposed. Upper eyelid droops (ptosis), and the person has double vision and trouble focusing on close objects.


Medial rectus muscle
Superior rectus muscle
Levator palpebrae muscle
Inferior oblique muscle
Ciliary ganglion
Inferior rectus muscle
Superior orbital fissure
Pons
Parasympathetic motor fibers
Oculomotor nerve (III)

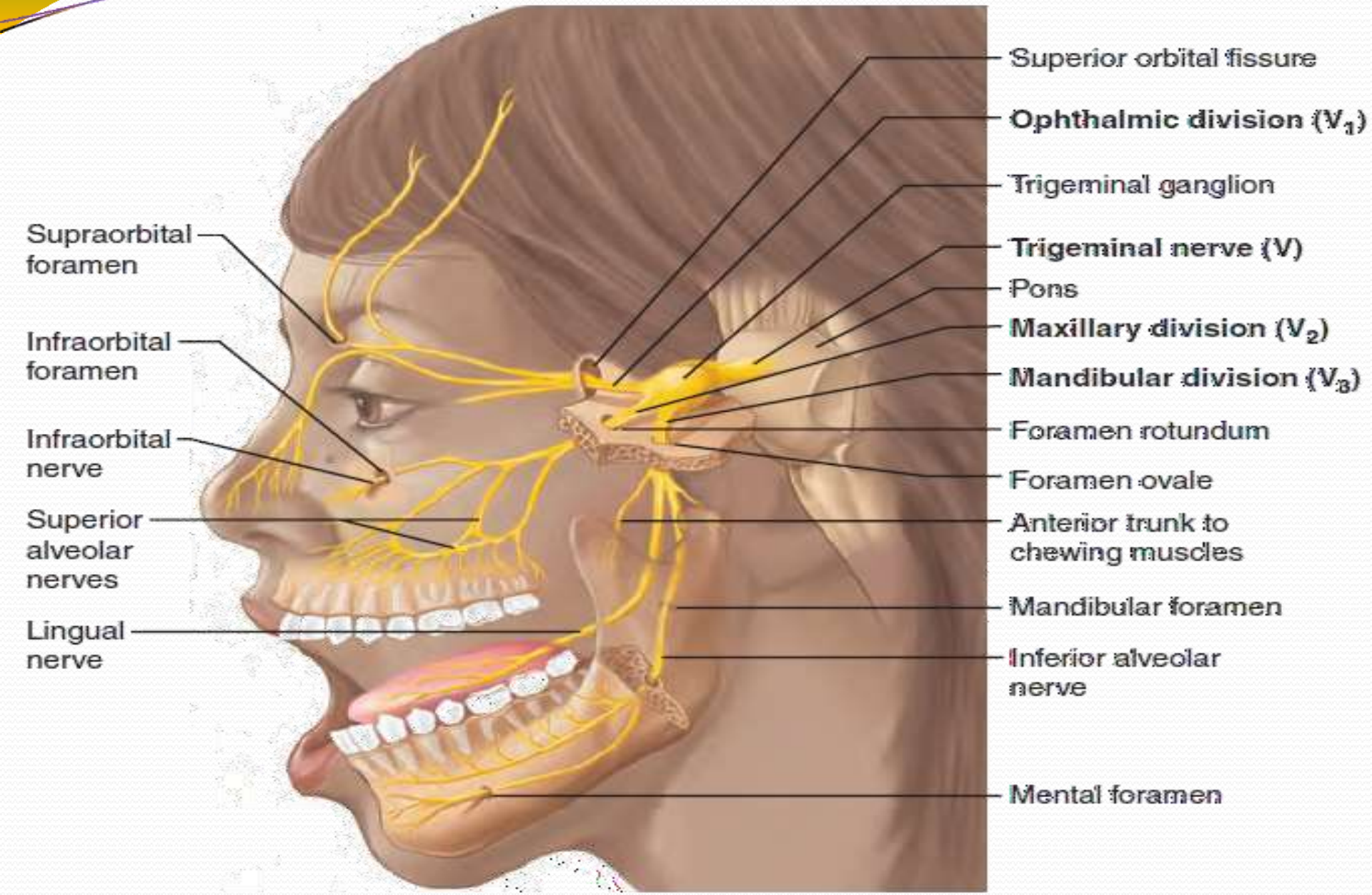
IV Trochlear Nerves

- **Origin and course: Fibers emerge from dorsal midbrain and course** ventrally around midbrain to enter orbit through superior orbital fissure along with oculomotor nerves.
- **Function:** Primarily motor nerves; supply somatic motor fibers to (carry proprioceptor fibers from) one of the extrinsic eye muscles, the superior oblique muscle, which passes through the pulley-shaped trochlea.
- **Clinical testing:** Test with cranial nerve III (oculomotor).
- **Applied Anatomy:** Damage to a trochlear nerve results in double vision and impairs ability to rotate eye inferolaterally.


Superior orbital fissure
Trochlea
Superior oblique muscle
Pons
Trochlear nerve (IV)

V Trigeminal Nerves

- Largest cranial nerves; fibers extend from pons to face, and form three divisions (*trigemina 5 threefold):*
  - *Ophthalmic*
  - *maxillary,*
  - mandibular
- As main general sensory nerves of face, transmit afferent impulses from touch, temperature, and pain receptors. Cell bodies of sensory neurons of all three divisions are located in large *trigeminal ganglion.*
- The mandibular division also contains motor fibers that innervate chewing muscles.


Supraorbital foramen
Infraorbital foramen
Infraorbital nerve
Superior alveolar nerves
Lingual nerve
Superior orbital fissure
Ophthalmic division (V_1)
Trigeminal ganglion
Trigeminal nerve (V)
Pons
Maxillary division (V_2)
Mandibular division (V_3)
Foramen rotundum
Foramen ovale
Anterior trunk to chewing muscles
Mandibular foramen
Inferior alveolar nerve
Mental foramen

Ophthalmic division (V1)

- **Origin and course:-Fibers run from face to pons** via superior orbital fissure.
- **Function Conveys:-** sensory impulses from skin of anterior scalp, upper eyelid, and nose, and from nasal cavity mucosa, cornea, and lacrimal gland.
- **Clinical testing Corneal reflex test:-** Touching cornea with wisp of cotton should elicit blinking.

Maxillary division (V2)

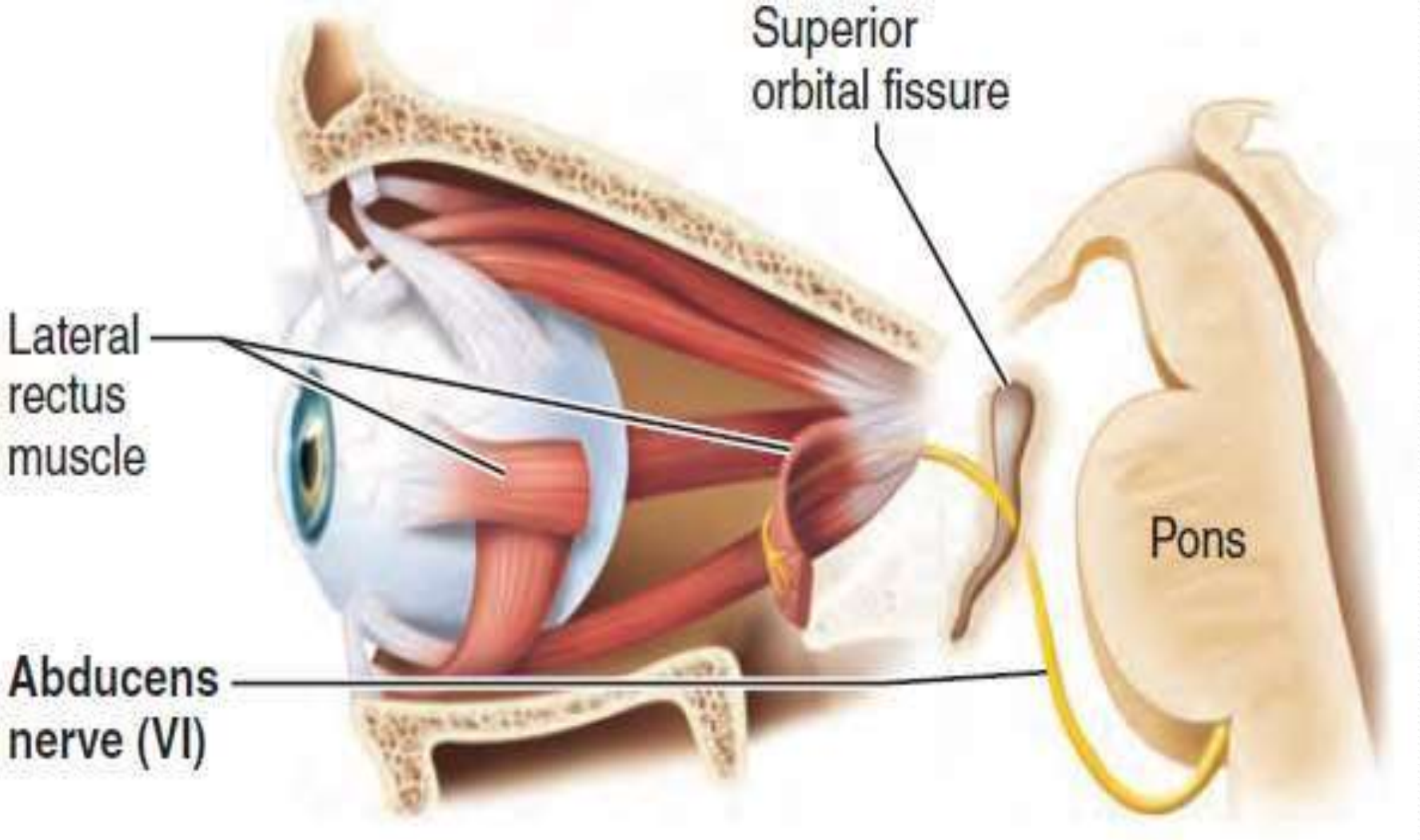
- **Origin and course:-** Fibers run from face to pons via foramen rotundum.
- **Function Conveys:-** Conveys sensory impulses from nasal cavity mucosa, palate, upper teeth, skin of cheek, upper lip, lower eyelid.
- **Clinical testing Corneal reflex test:-** Test sensations of pain, touch, and temperature with safety pin and hot and cold objects.

Mandibular division (V3)

- **Origin and course:-** Fibers pass through skull via foramen ovale.
- **Function:-** Conveys sensory impulses from anterior tongue (except taste buds), lower teeth, skin of chin, temporal region of scalp. Supplies motor fibers to, and carries proprioceptor fibers from, muscles of mastication.
- **Clinical testing Corneal reflex test:-** Assess motor branch by asking person to clench his teeth, open mouth against resistance, and move jaw side to side.

VI Abducens Nerves

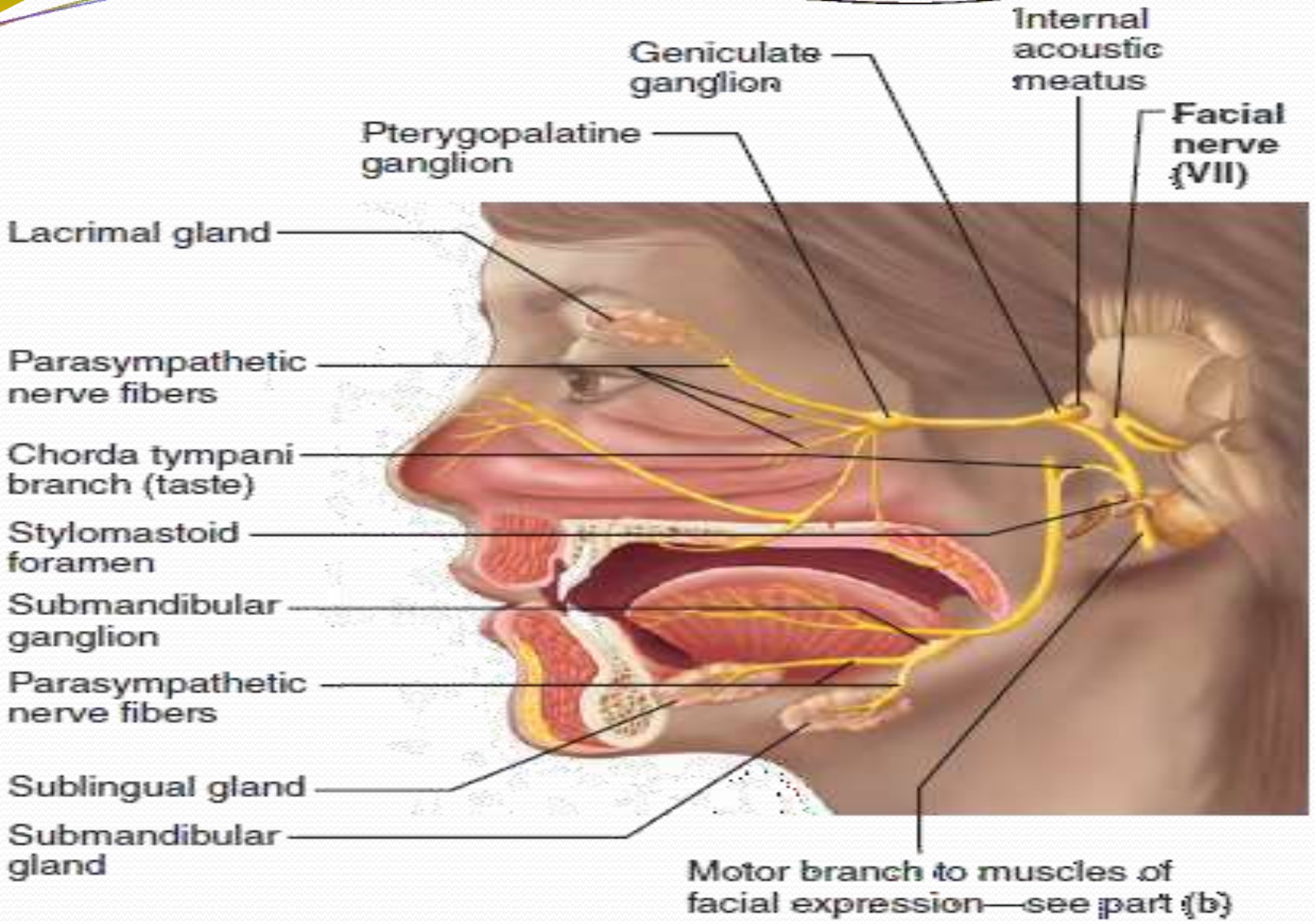
- **Origin and course:** Fibers leave inferior pons and enter orbit via superior orbital fissure to run to eye.
- **Function:** Primarily motor; supply somatic motor fibers to lateral rectus muscle, an extrinsic muscle of the eye. Convey proprioceptor impulses from same muscle to brain.
- **Clinical testing: Test in common with cranial nerve III (oculomotor).**
- **Applied Anatomy: In abducens nerve** paralysis, eye cannot be moved laterally. At rest, eyeball rotates medially *(internal strabismus).*


Superior
orbital fissure
Lateral
rectus
muscle
Pons
Abducens
nerve (VI)

VII Facial Nerves

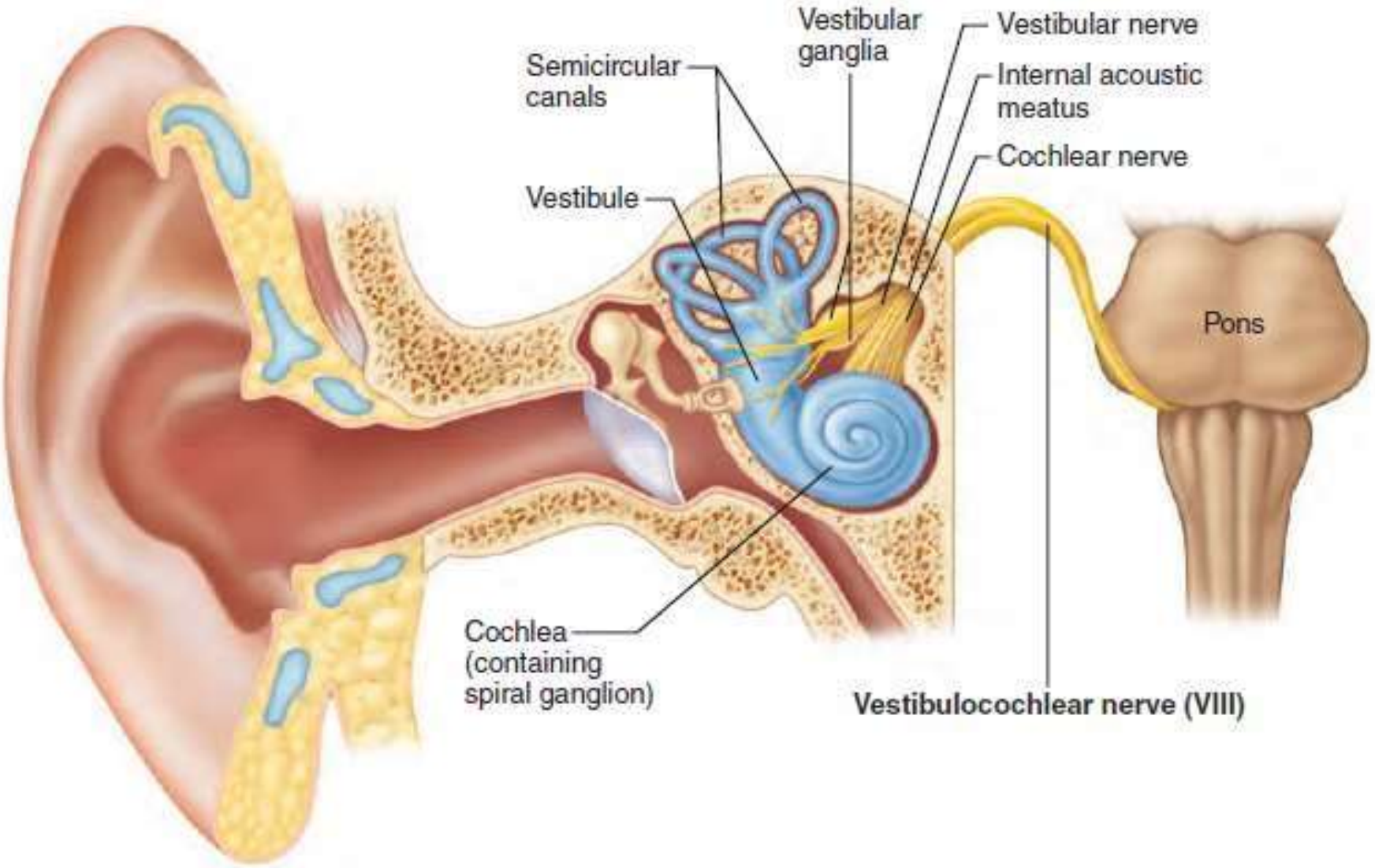
- **Origin and course:** Fibers issue from pons, just lateral to abducens nerves enter temporal bone via internal acoustic meatus, and run within bone (and through inner ear cavity) before emerging through stylomastoid foramen. Nerve then courses to lateral aspect of face.
- **Function:** Mixed nerves that are the chief motor nerves of face. Five major branches: temporal, zygomatic, buccal, mandibular, and cervical
  - Convey motor impulses to skeletal muscles of face (muscles of facial expression), except for chewing muscles served by trigeminal nerves, and transmit proprioceptor impulses from same muscles to pons.
  - Transmit parasympathetic (autonomic) motor impulses to lacrimal (tear) glands, nasal and palatine glands, and submandibular and sublingual salivary glands. Some of the cell bodies of these parasympathetic motor neurons are in pterygopalatine and submandibular ganglia on the trigeminal nerve.
  - Convey sensory impulses from taste buds of anterior two-thirds of tongue; cell bodies of these sensory neurons are in geniculate ganglion.

- **Clinical testing:** Test anterior two-thirds of tongue for ability to taste sweet (sugar), salty, sour (vinegar), and bitter (quinine) substances. Check symmetry of face. Ask subject to close eyes, smile, whistle, and so on. Assess tearing with ammonia fumes.
- **Applied Anatomy:-** Bell's palsy is characterized by paralysis of facial muscles on affected side and partial loss of taste sensation.


Geniculate ganglion
Internal acoustic meatus
Facial nerve (VII)
Pterygopalatine ganglion
Lacrimal gland
Parasympathetic nerve fibers
Chorda tympani branch (taste)
Stylomastoid foramen
Submandibular ganglion
Parasympathetic nerve fibers
Sublingual gland
Submandibular gland
Motor branch to muscles of facial expression—see part (b)

VIII Vestibulocochlear Nerves

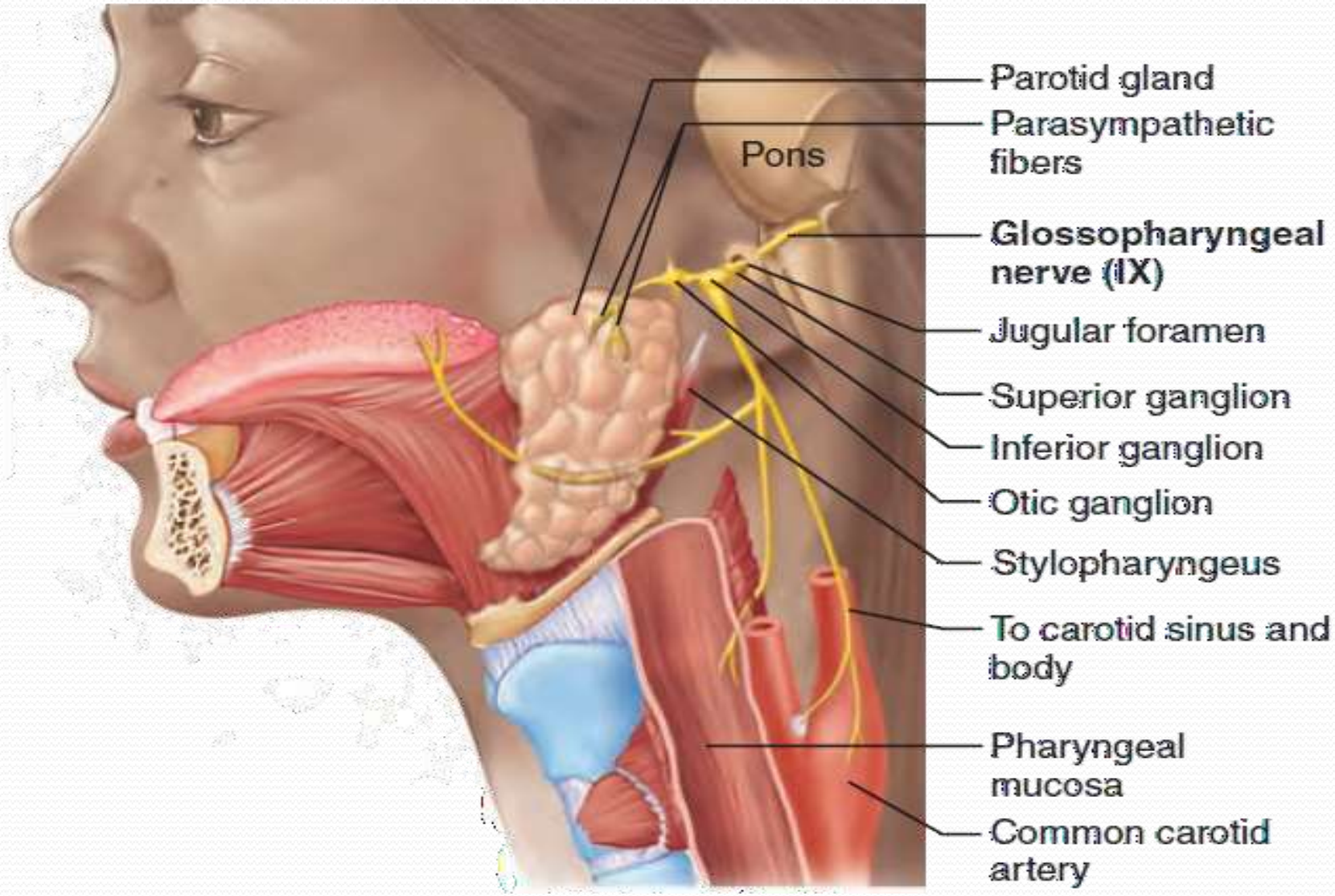
- **Origin and course: Fibers arise from** hearing and equilibrium apparatus located within inner ear of temporal bone and pass through internal acoustic meatus to enter brain stem at pons-medulla border. Afferent fibers from hearing receptors in cochlea form the cochlear division; those from equilibrium receptors in semicircular canals and vestibule form the vestibular division (vestibular nerve). The two divisions merge to form vestibulocochlear nerve.
- **Function: Mostly sensory. Vestibular** branch transmits afferent impulses for sense of equilibrium, and sensory nerve cell bodies are located in vestibular ganglia. Cochlear branch transmits afferent impulses for sense of hearing, and sensory nerve cell bodies are located in spiral ganglion within cochlea. Small motor component adjusts the sensitivity of sensory receptors.
- **Clinical testing: Check hearing by air** and bone conduction using tuning fork.
- **Applied Anatomy:- Lesions of cochlear** nerve or cochlear receptors result in central, or nerve, deafness. Damage to vestibular division produces dizziness, rapid involuntary eye movements, loss of balance, nausea, and vomiting.


Vestibular ganglia
Vestibular nerve
Semicircular canals
Internal acoustic meatus
Cochlear nerve
Vestibule
Pons
Cochlea (containing spiral ganglion)
Vestibulocochlear nerve (VIII)

IX Glossopharyngeal Nerves

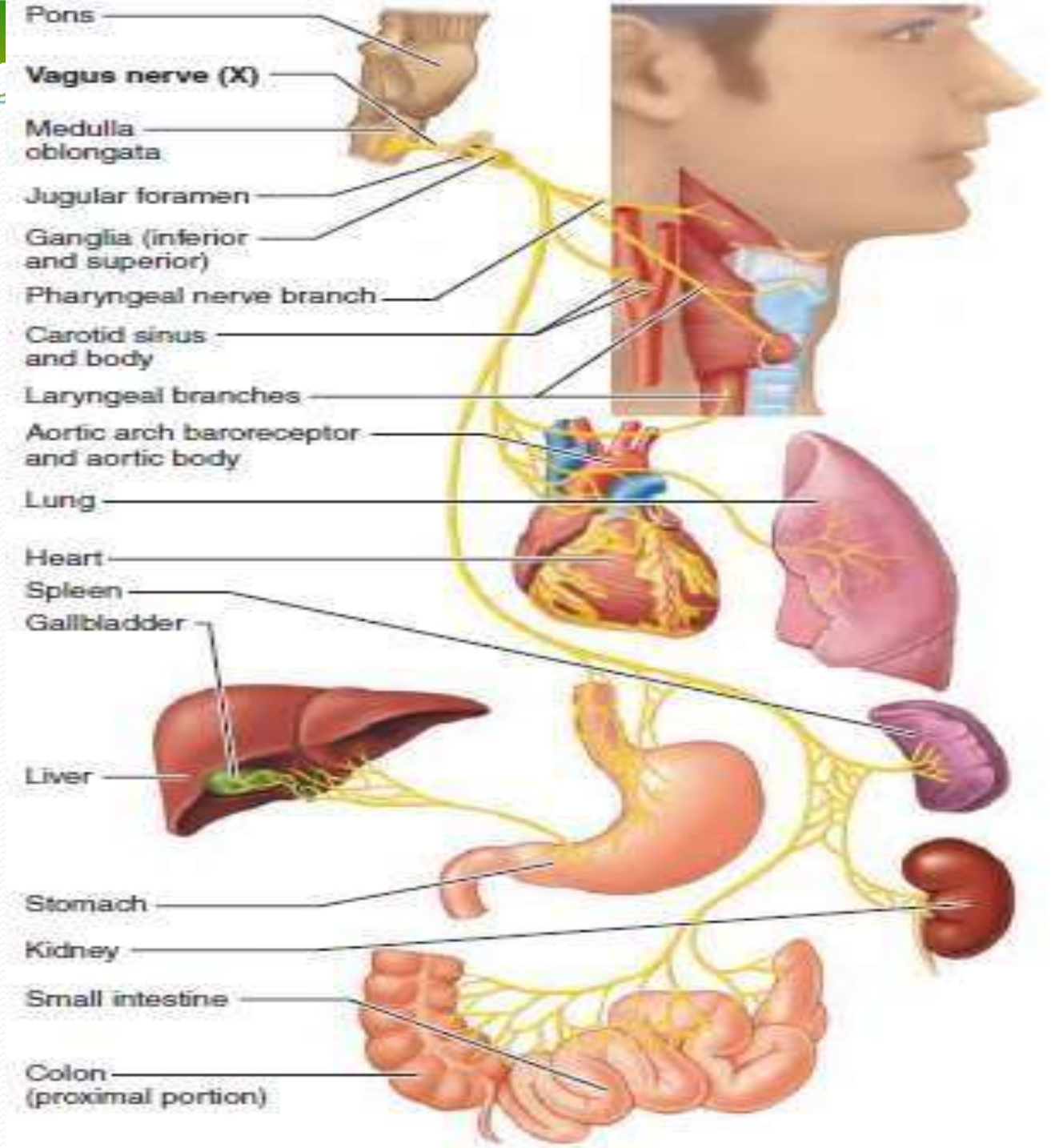
- **Origin and course:** Fibers emerge from medulla and leave skull via jugular foramen to run to throat.
- **Function:** Mixed nerves that innervate part of tongue and pharynx**.** Provide somatic motor fibers to, and carry proprioceptor fibers from, a superior pharyngeal muscle called the stylopharyngeus, which elevates the pharynx in swallowing. Provide parasympathetic motor fibers to parotid salivary glands. **Sensory fibers** conduct taste and general sensory (touch, pressure, pain) impulses from pharynx and posterior tongue, from **chemoreceptors** in the carotid body (which monitor O_2 and CO_2 levels in the blood and help regulate respiratory rate and depth), and from baroreceptors of carotid sinus (which monitor blood pressure). Sensory neuron cell bodies are located in superior and inferior ganglia.
- **Clinical testing:** Check position of uvula; check gag and swallowing reflexes.

  Ask subject to speak and cough. Test posterior third of tongue for taste.
- **Applied Anatomy:-** Injured or inflamed glossopharyngeal nerves impair swallowing and taste.


Parotid gland
Parasympathetic fibers
Pons
Glossopharyngeal nerve (IX)
Jugular foramen
Superior ganglion
Inferior ganglion
Otic ganglion
Stylopharyngeus
To carotid sinus and body
Pharyngeal mucosa
Common carotid artery

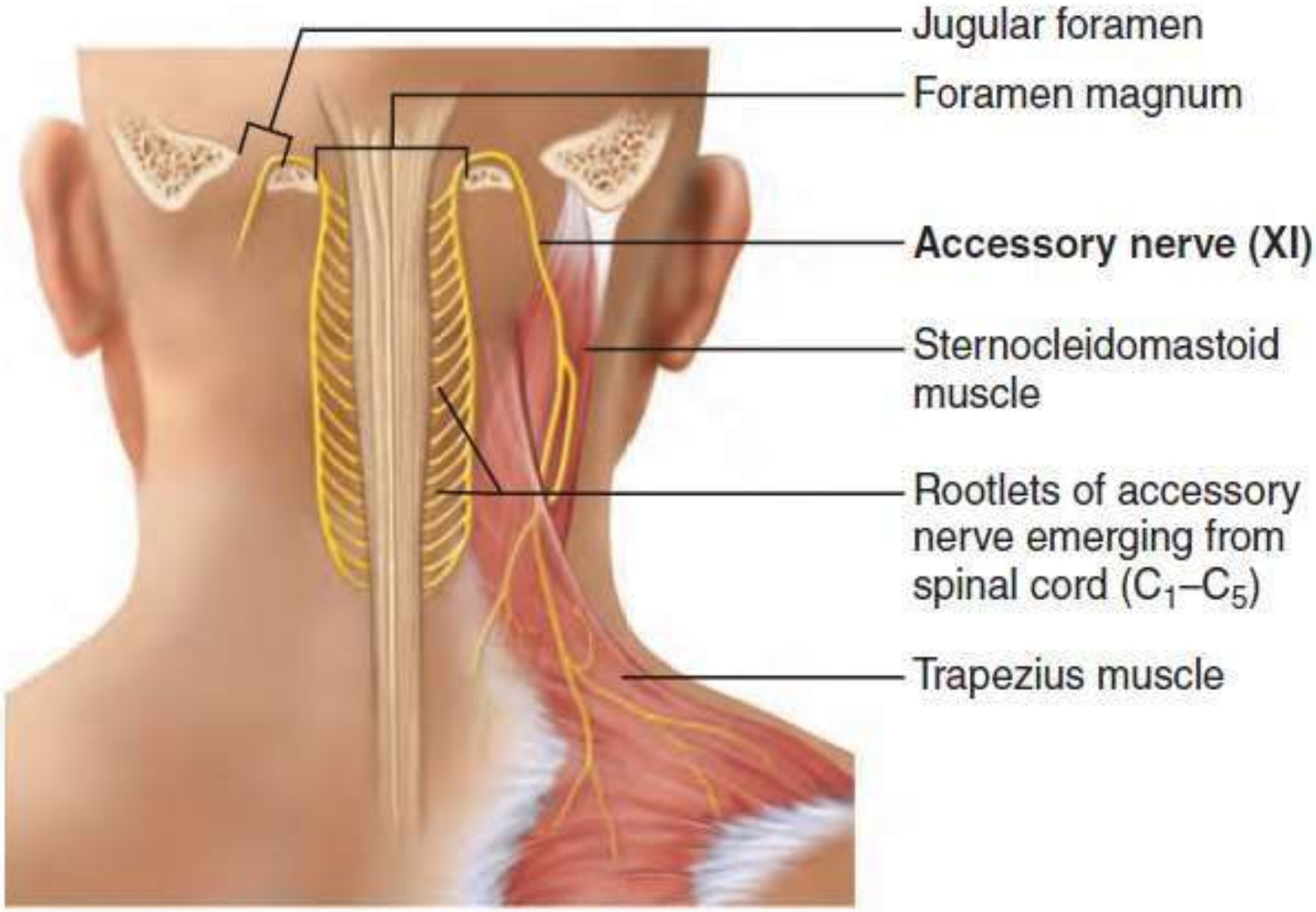
X Vagus Nerves

- **Origin and course:** The only cranial nerves to extend beyond head and neck region. Fibers emerge from medulla, pass through skull via jugular foramen, and descend through neck region into thorax and abdomen.
- **Function:** Mixed nerves. Nearly all motor fibers are parasympathetic efferents, except those serving skeletal muscles of pharynx and larynx. Parasympathetic motor fibers supply heart, lungs, and abdominal viscera and are involved in regulating heart rate, breathing, and digestive system activity. Transmit sensory impulses from thoracic and abdominal viscera, from the aortic arch baroreceptors (for blood pressure) and the carotid and aortic bodies (chemoreceptors for respiration), and taste buds on the epiglottis. Carry proprioceptor fibers from muscles of larynx and pharynx.
- **Clinical testing**: As for cranial nerve IX.
- **Applied Anatomy:- Since laryngeal branches** of the vagus innervate nearly all muscles of the larynx, vagal nerve paralysis can lead to hoarseness or loss of voice.
  - Other symptoms are difficulty swallowing and impaired digestive system motility.


Pons
Vagus nerve (X)
Medulla oblongata
Jugular foramen
Ganglia (inferior and superior)
Pharyngeal nerve branch
Carotid sinus and body
Laryngeal branches
Aortic arch baroreceptor and aortic body
Lung
Heart
Spleen
Gallbladder
Liver
Stomach
Kidney
Small intestine
Colon (proximal portion)

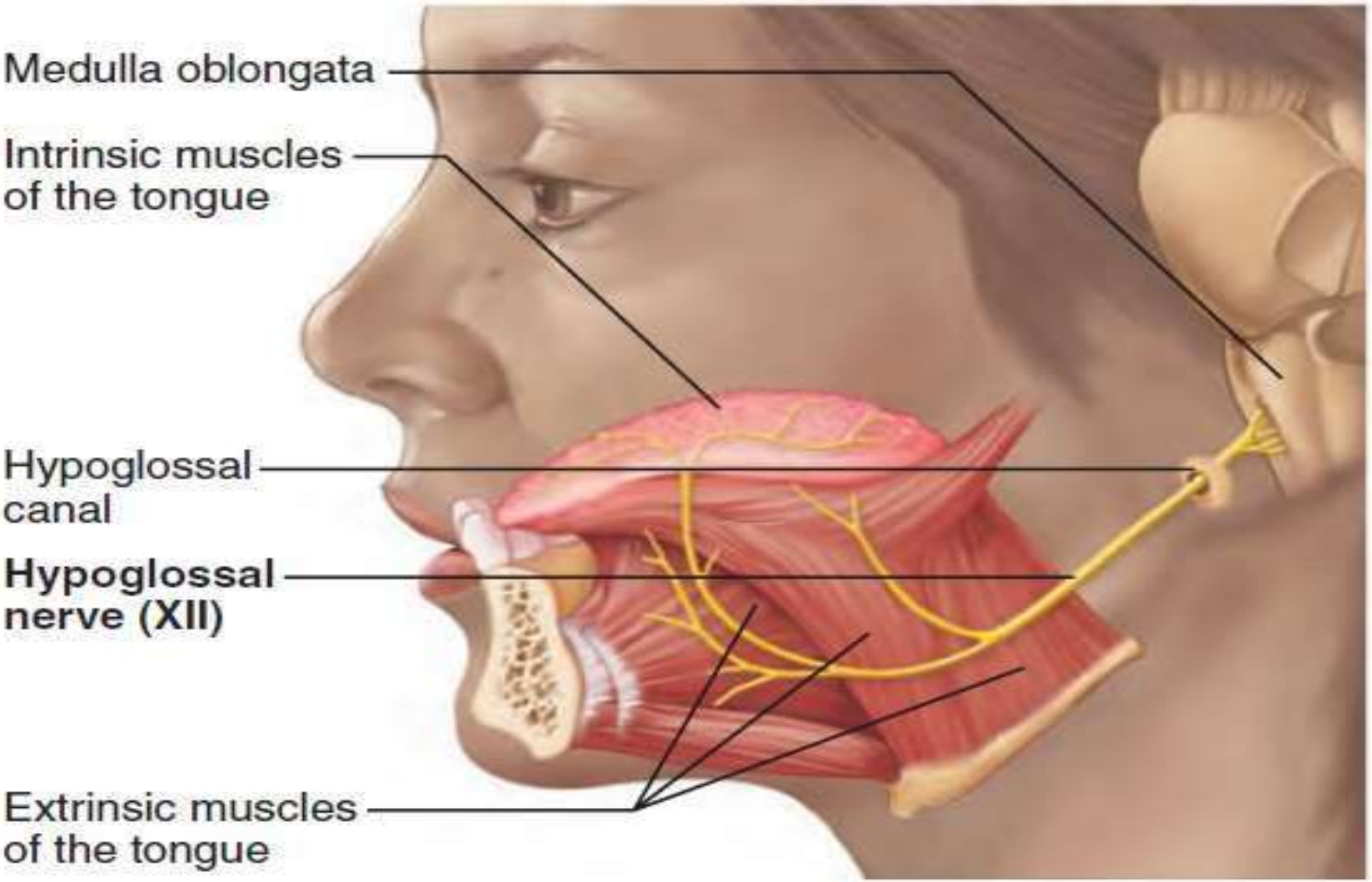
XI Accessory Nerves

- **Origin and course: Unique in that they form from rootlets that emerge** from the spinal cord, not the brain stem. These rootlets arise laterally from superior region (C1–C5) of spinal cord, pass upward along spinal cord, and enter the skull as the accessory nerves via foramen magnum. The accessory nerves exit from skull through jugular foramen together with the vagus nerves, and supply two large neck muscles.
- **Function:** Mixed nerves, but primarily motor in function. Supply motor fibers to trapezius and sternocleidomastoid muscles, which together move head and neck, and convey proprioceptor impulses from same muscles.
- **Clinical testing: Check strength of sternocleidomastoid and trapezius** muscles by asking person to rotate head and shrug shoulders against resistance.
- **Applied Anatomy:-** Injury to one accessory nerve causes head to turn toward injury side as result of sternocleidomastoid muscle paralysis. Shrugging that shoulder (role of trapezius muscle) becomes difficult.


Jugular foramen
Foramen magnum
Accessory nerve (XI)
Sternocleidomastoid muscle
Rootlets of accessory nerve emerging from spinal cord (C_1–C_5)
Trapezius muscle

XII Hypoglossal Nerves

- **Origin and course:** hypoglossal nerves mainly serve the tongue. Fibers arise by a series of roots from medulla and exit from skull via *hypoglossal canal* to travel to tongue.
- **Function:** Mixed nerves, but primarily motor in function. Carry somatic motor fibers to intrinsic and extrinsic muscles of tongue, and proprioceptor fibers from same muscles to brain stem. Hypoglossal nerve control allows tongue movements that mix and manipulate food during chewing, and contribute to swallowing and speech.
- **Clinical testing:** Ask subject to protrude and retract tongue. Note any deviations in position.
- **Applied Anatomy:- Damage to hypoglossal** nerves causes difficulties in speech and swallowing. If both nerves are impaired, the person cannot protrude tongue. If only one side is affected, tongue deviates toward affected side.


Medulla oblongata
Intrinsic muscles of the tongue
Hypoglossal canal
Hypoglossal nerve (XII)
Extrinsic muscles of the tongue

MOTOR SYSTEM - II

MIDDLE LEVEL OF MOTOR CONTROL

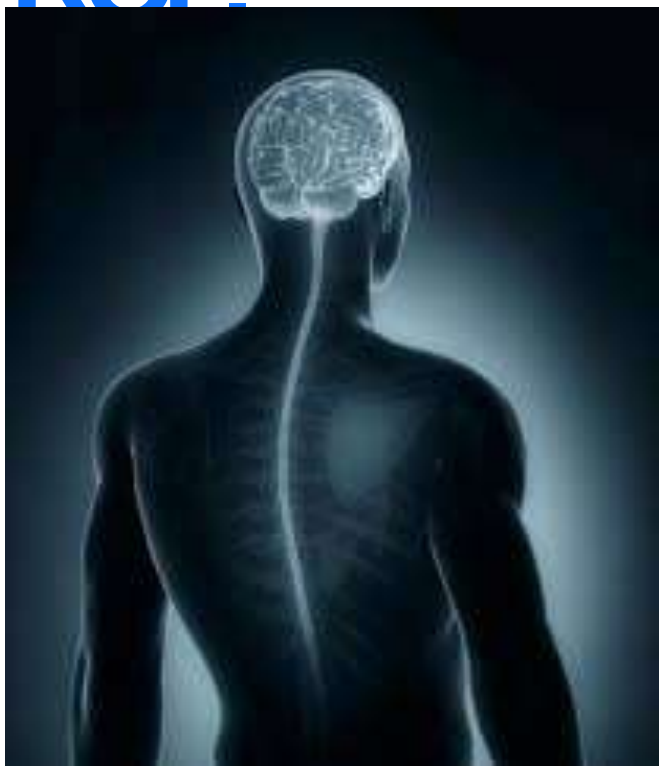
- Basal ganglia.
- Role of basal ganglia in somatic motor activity.

MIDDLE LEVEL OF MOTOR CONTROL.

- **Cerebellum**
  -
  -
  -
- **Brain stem.**
  -
  -

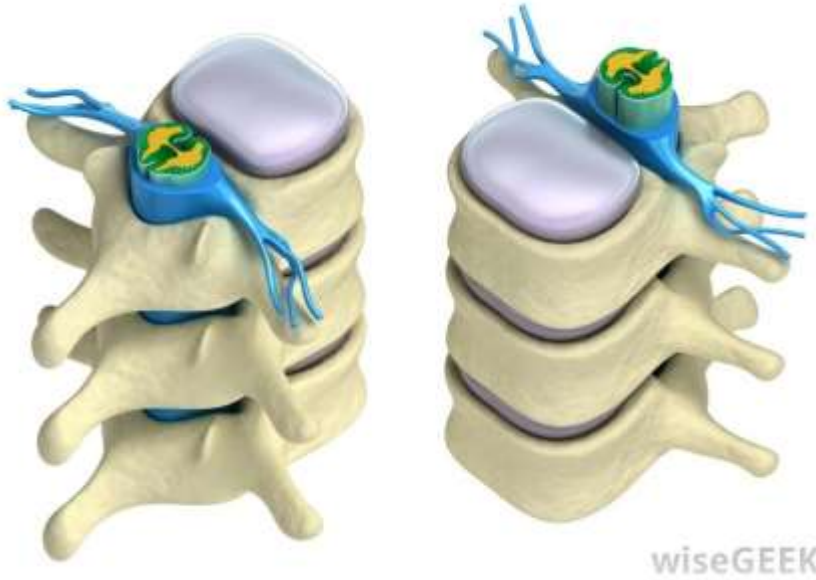
LOWEST LEVEL OF MOTOR CONTROL .

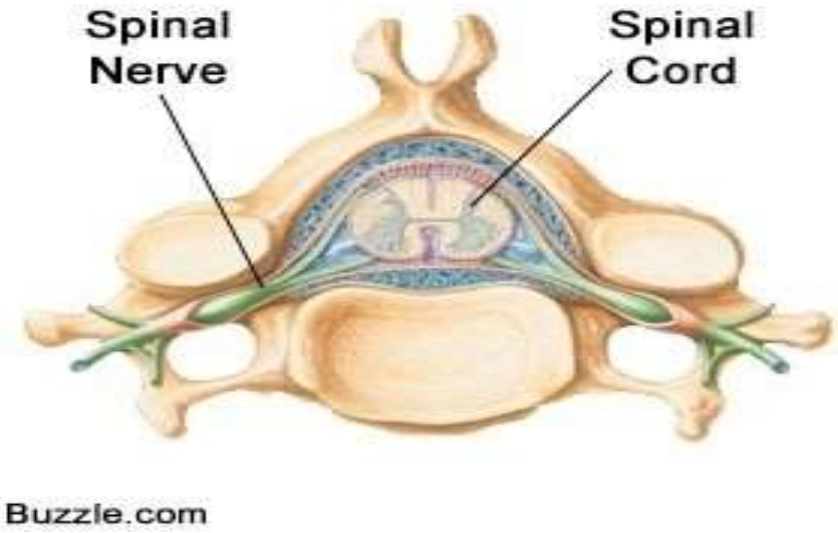
- Spinal cord.
- Motor neurons.
  -
  -
  -
  -



SPINAL CORD.

Objectives



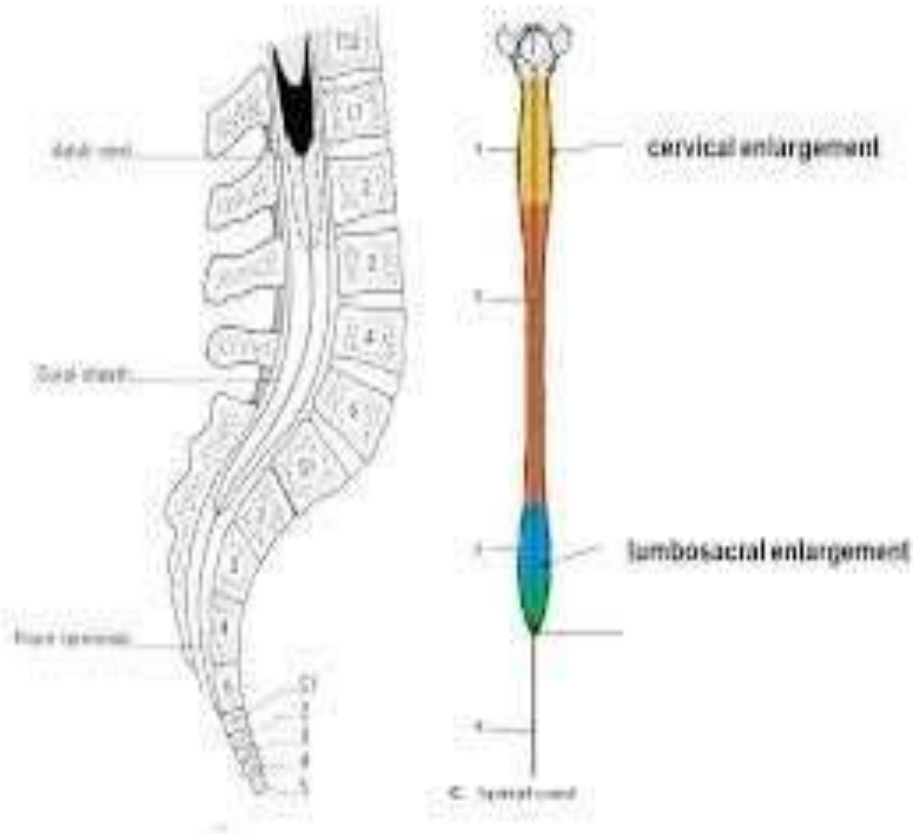


PHYSIOLOGICAL ANATOMY & FUNCTIONS OF SPINAL CO

- Physiological anatomy.
  -
  -
  -
- Functions.
  -
  -
  -

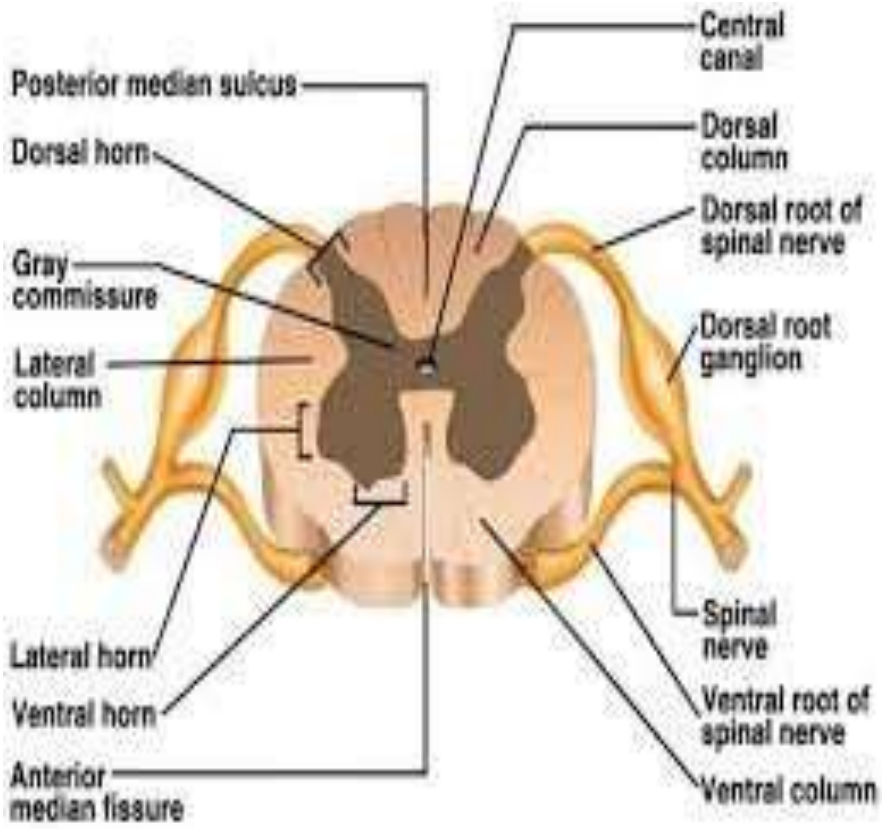
GROSS ANATOMY SPINAL CORD

- cervical
  lumbar
- Upper
  Medulla lower
  Conus
- Enlargements-



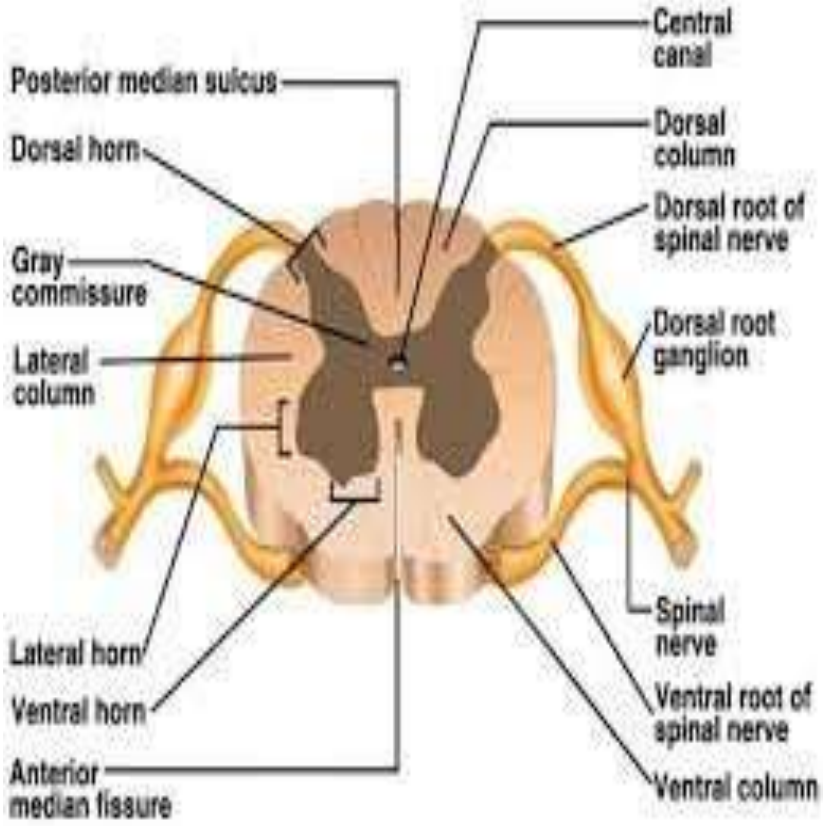
SPINALCORD

- Anterior median fissure
- Posterior median sulcus
-



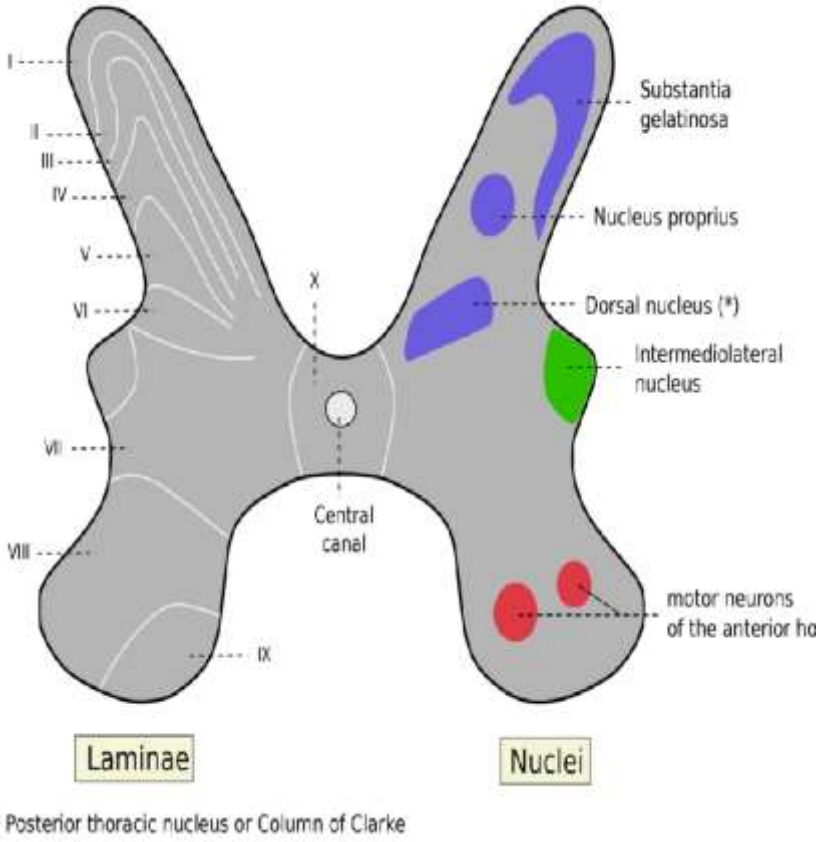
INTERNAL STRUCTURE.

- Spinal grey matter
- Dorsal horn
- Ventral horn
- Lateral horn
- Grey commissure



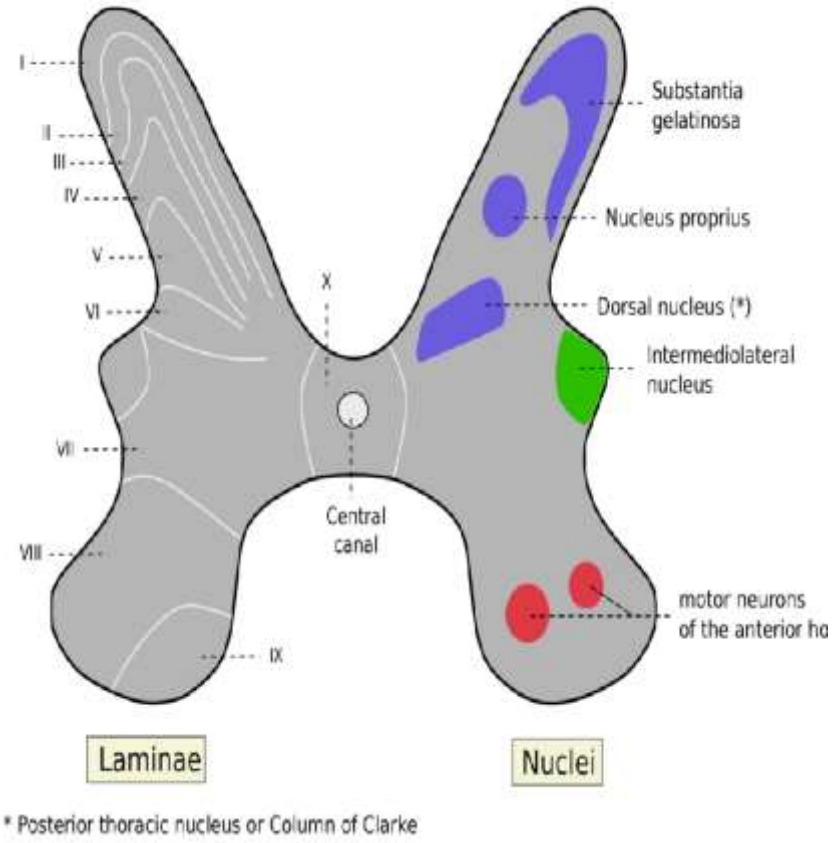
NEURONS IN SPINAL GREY M

- Neurons in ventral horn(Motor functions)
  -
  -
  -
- Neurons in dorsal horn (Sensory functions)
  -
  -



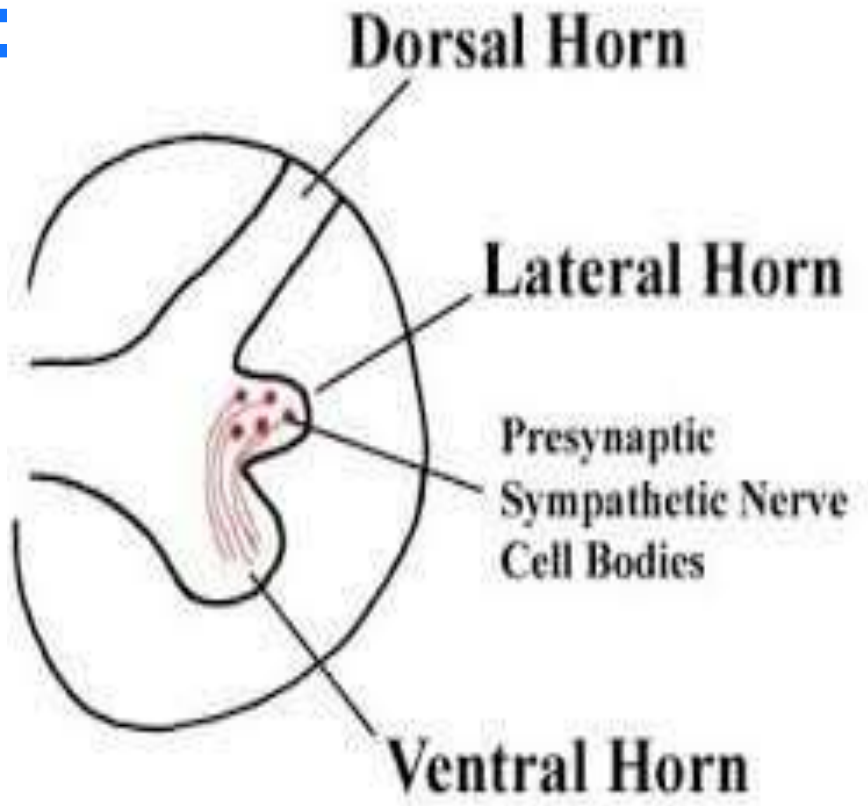
GROUP OF DORSAL HORN NE

- Substantia Gelatinosa of Rolando
- N. Proprius
- Dorsal Nucleus (C8-L2)
- Posteromarginal nucleus.



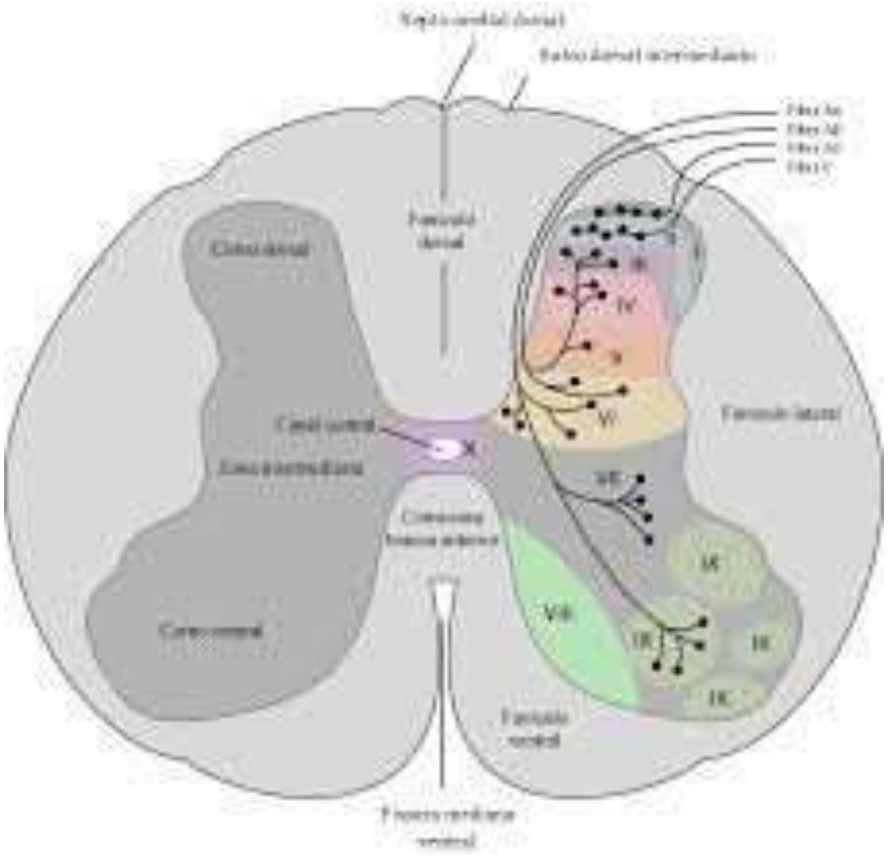
GROUP OF LATERAL HORN NE

- **T1-L2 lateral horn –**
  -
- **S2-S4 lateral horn –**
  -



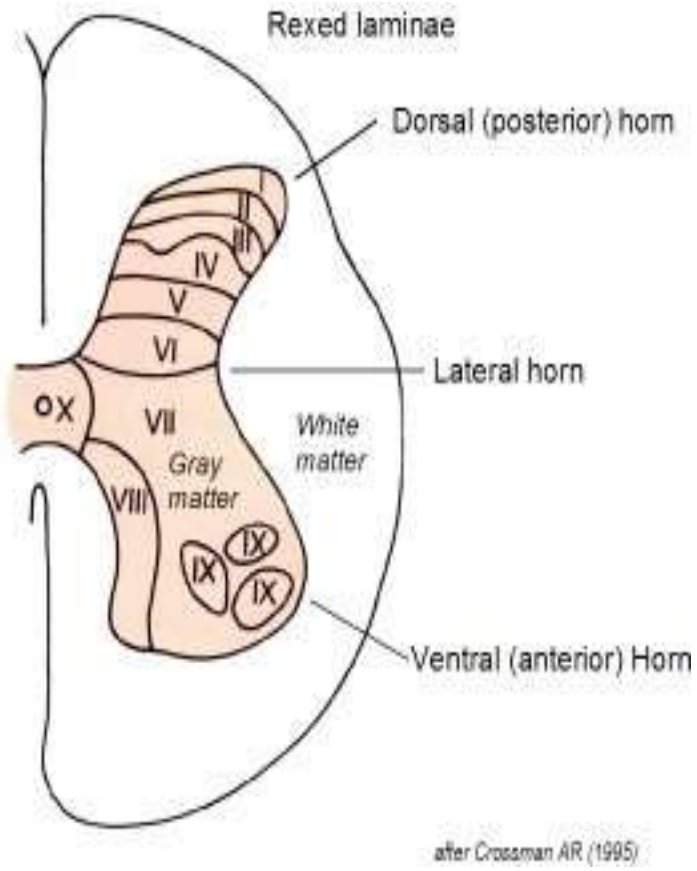
DIVISIONS OF SPINAL GREY MATTER INTO LAMINAE.

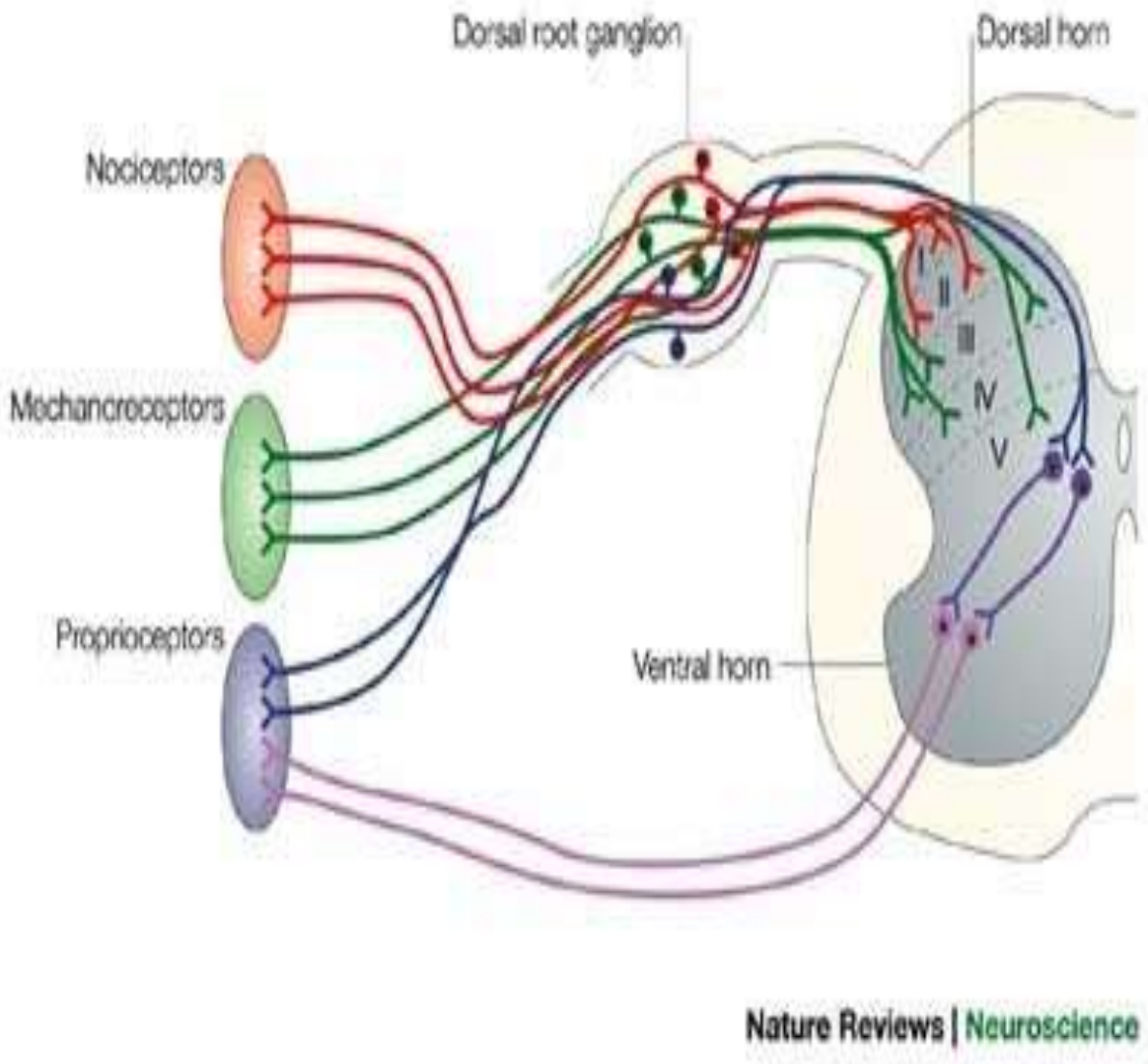
- Rexed laminae (10)
  Dorsal grey column
- I.
- II.
- III.& IV
- V
- VI



DIVISIONS OF SPINAL GREY MATTER INTO LAMINAE.

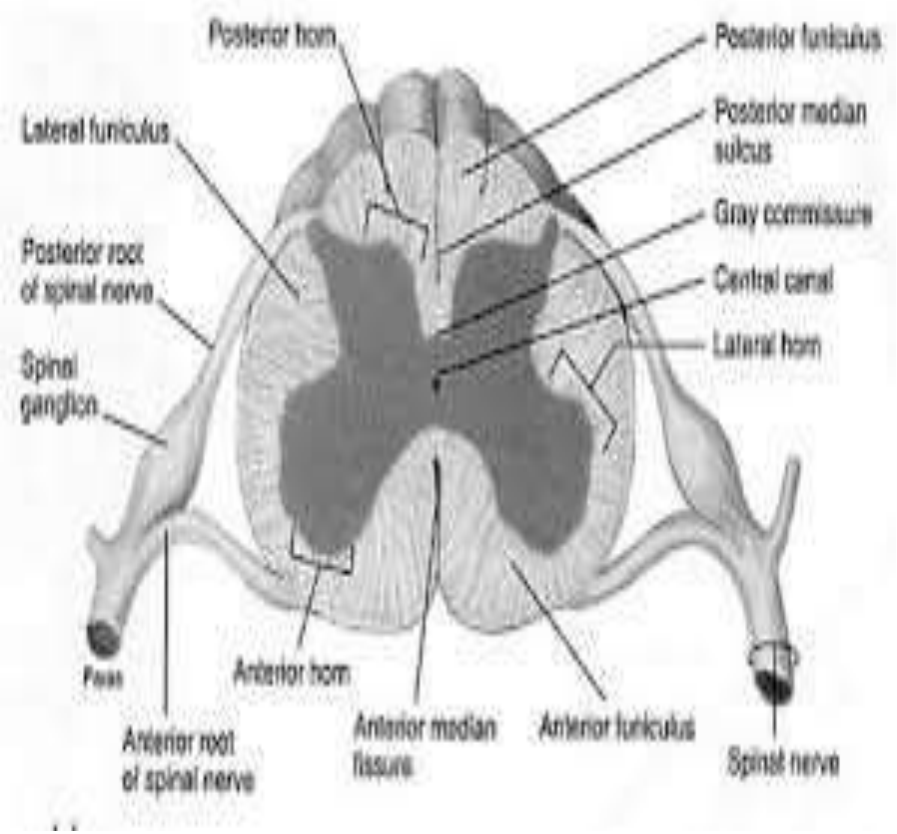
- VII
- VIII
- IX
- X




Dorsal root ganglion
Dorsal horn
Nocioceptors
Mechanoreceptors
Proprioceptors
Ventral horn
I
II
III
IV
V
Nature Reviews | Neuroscience

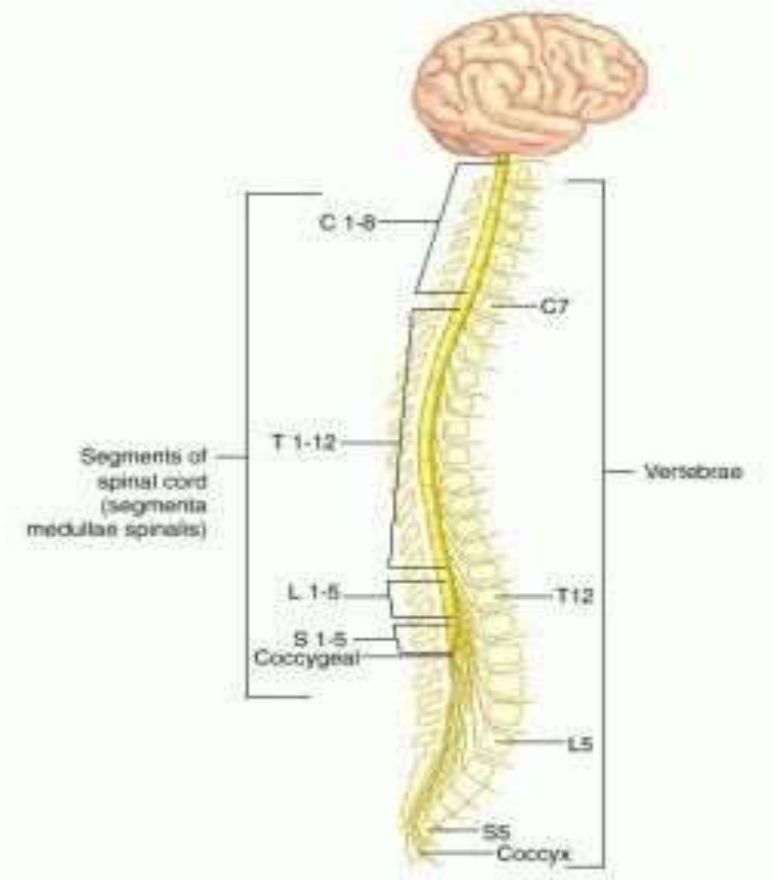
WHITE MATTER OF SPINAL

- Post funiculus/post white column.
- Ant funiculus/ant white column.
- Lateral funiculus.
- Dorsal white commissure
- Ventral white commissure



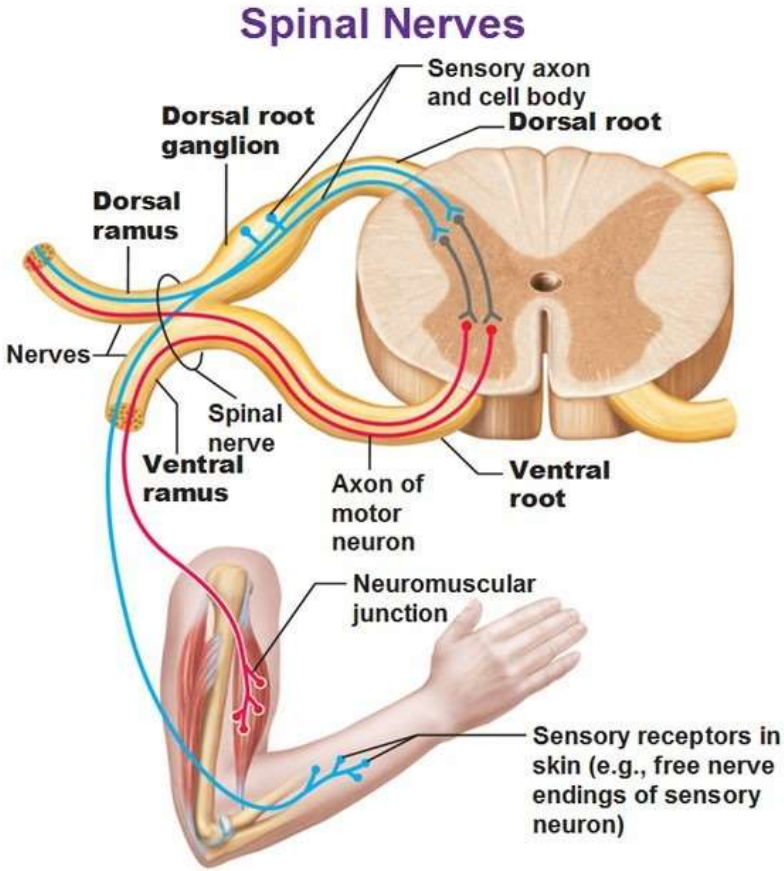
SPINAL SEGMENTS

- Cervical - 8
- Thoracic - 12
- Lumbar - 5
- Sacral - 5
- Coccygeal - 1



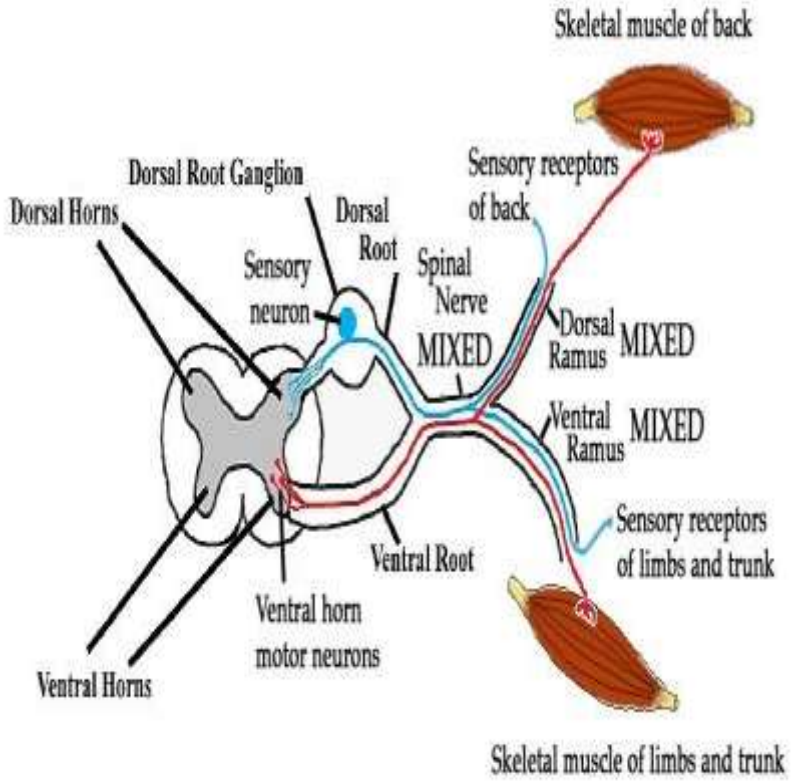
SPINAL NERVES.

- Spinal Nerve
- Ventral Nerve Root

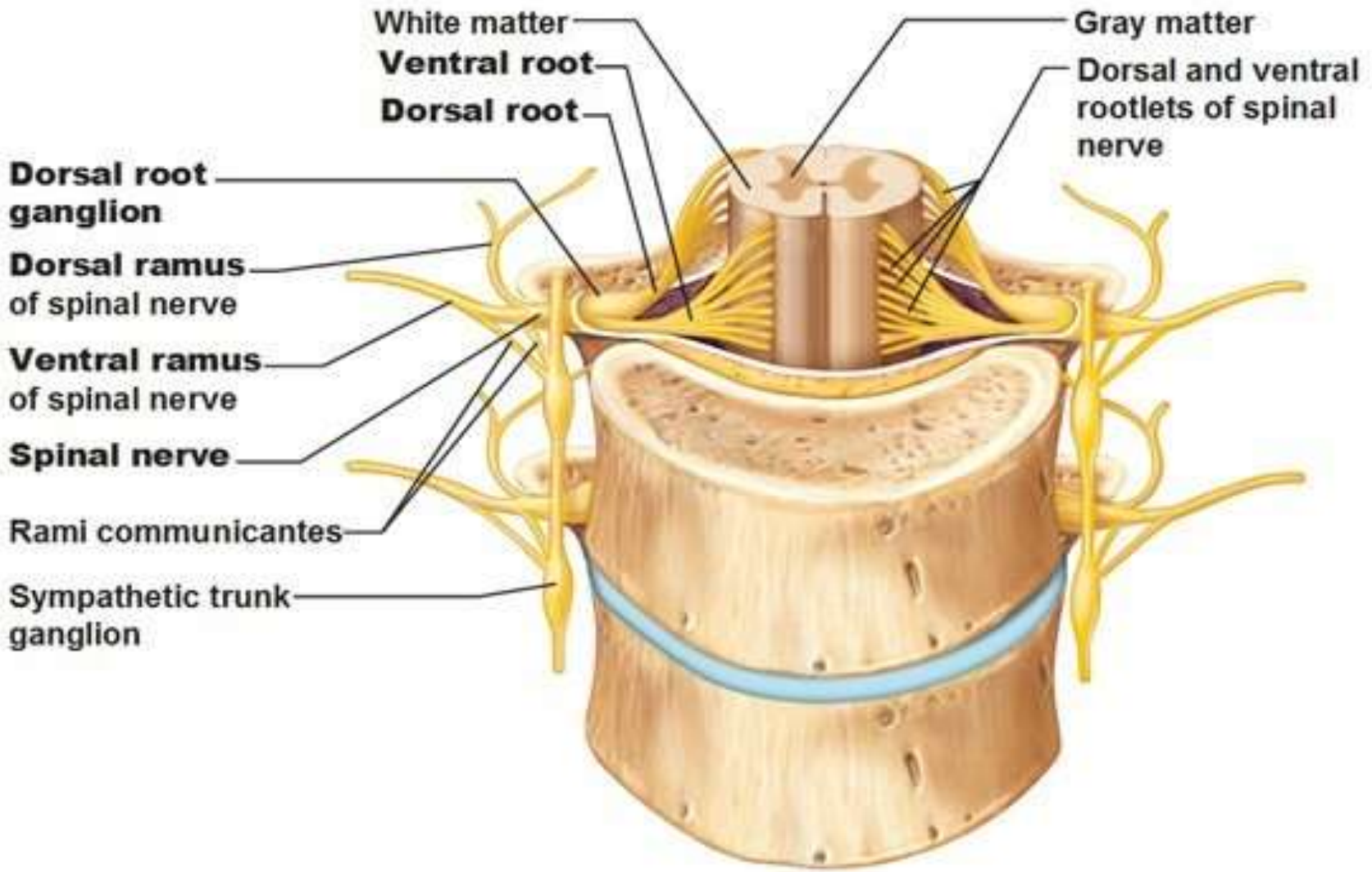


DORSAL NERVE ROOT

- Spinal Ganglia
- Medial division
- Lateral division

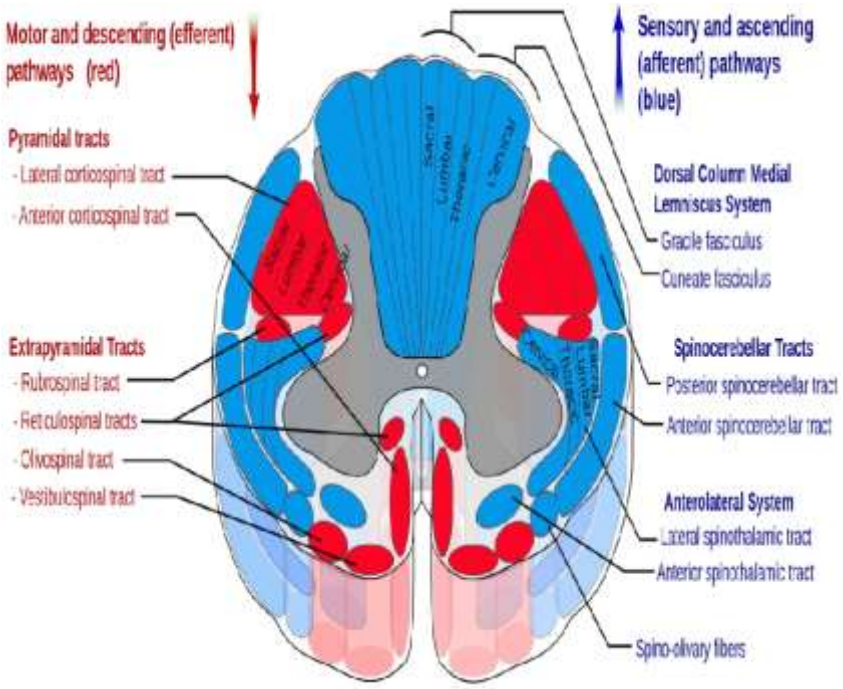


Spinal Nerves – Note position of dorsal root ganglion

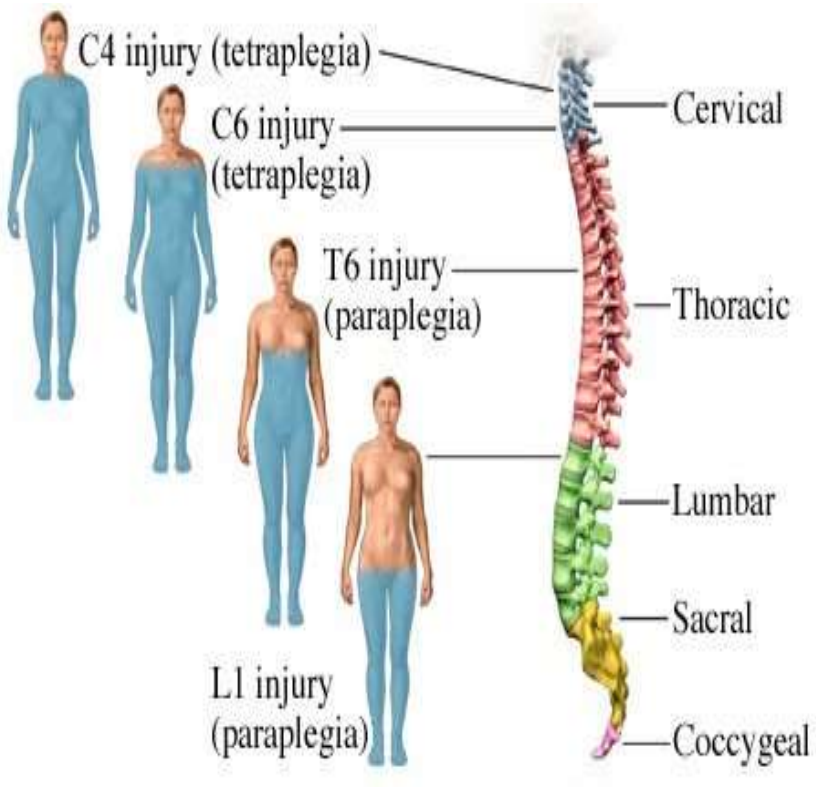


FUNCTIONS OF SPINAL CORD.

- Sensory function
- Motor Function
- Autonomic Function

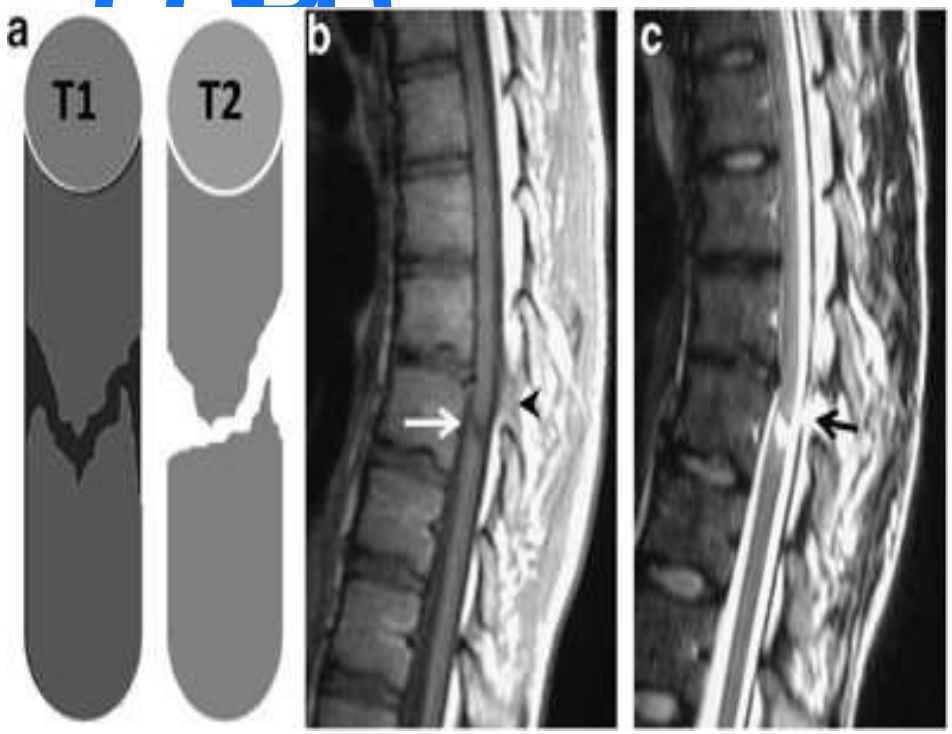


LESIONS OF SPINAL CORD.



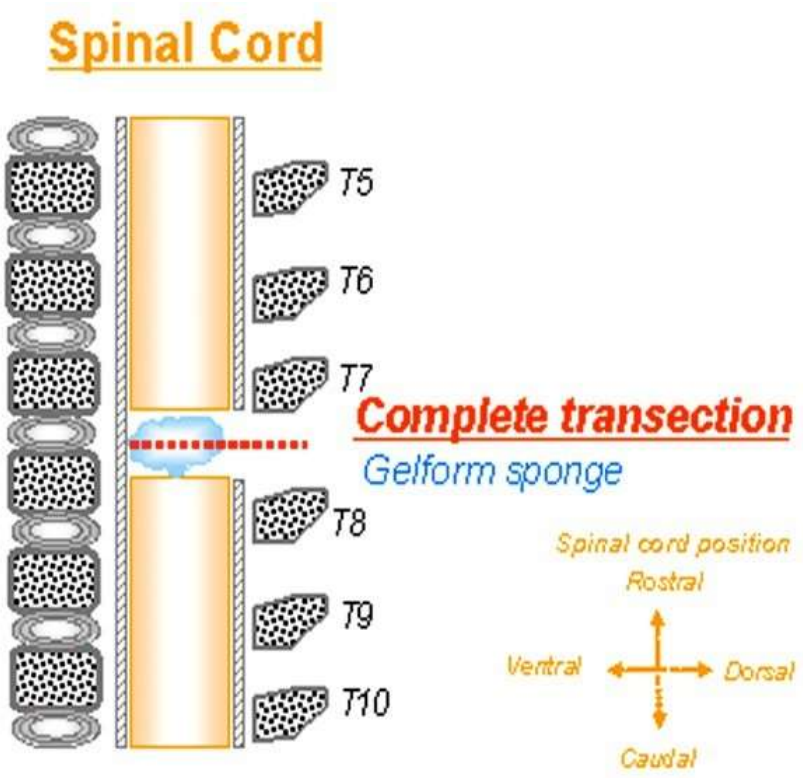
TRANSECTION OF SPINAL CORD

- Complete Transection
- Incomplete Transection
- Hemisection.



COMPLETE TRANSECTION

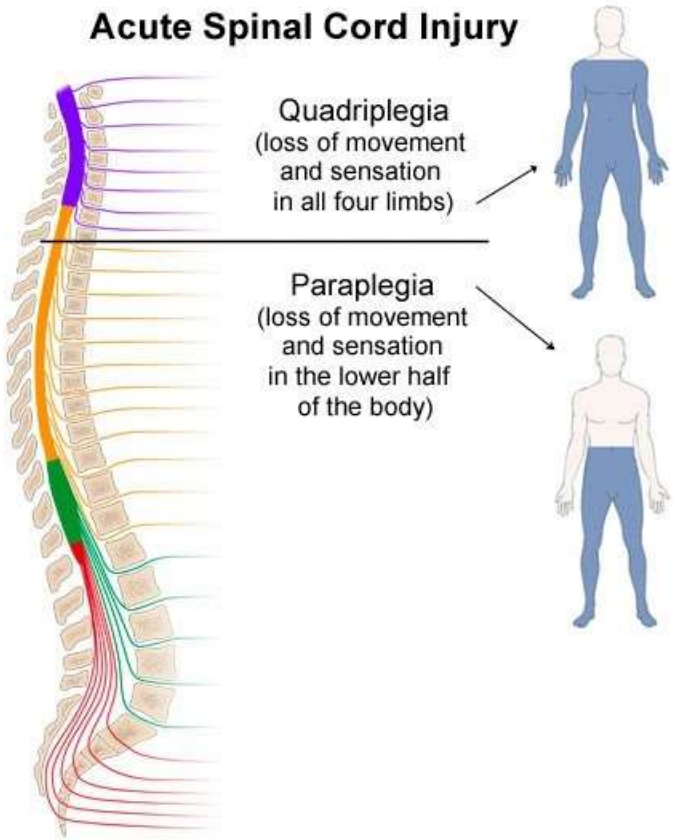
- **Causes –**
  -
  -
  -
- **Site**
- **Stages –**
  -
  -
  -



STAGE OF SPINAL SHOCK

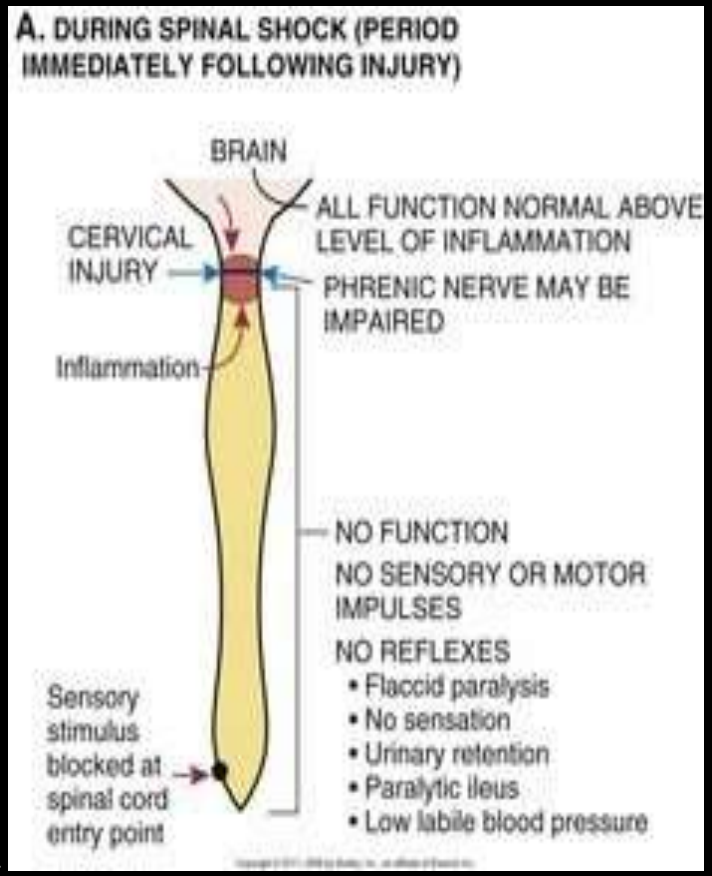
- Spinal shock
- Depend on site of lesion
- Cause
- Duration & Severity

Encephalization



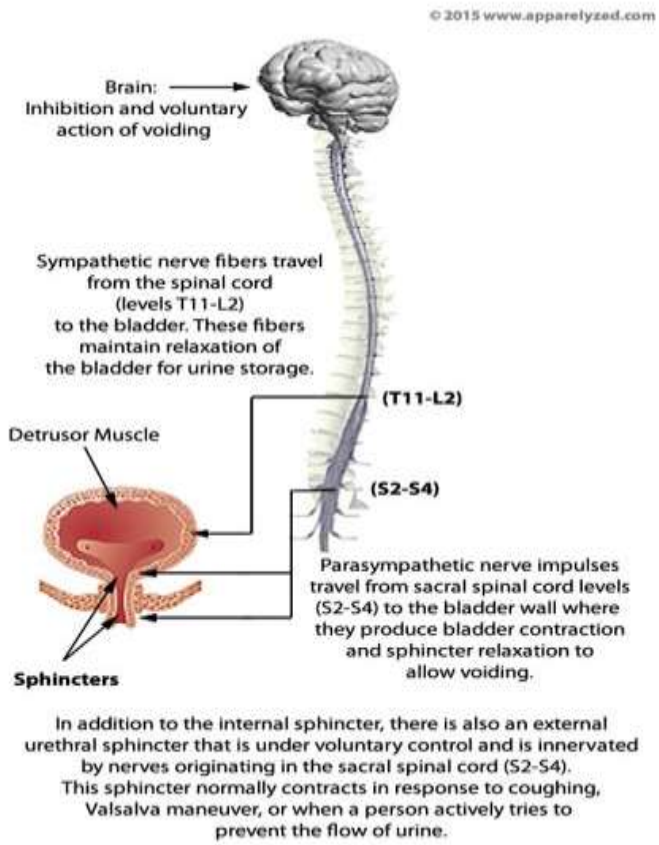
EFFECTS

- ~~Motor Effects~~
  - Paralysis of muscles
  - Loss of tone
  - Areflexia
- **Sensory Effects**
- **Vasomotor Effects**
  - Below L2 no effect
  - Above T1 –loss of symp dischare from medullary centers, vasodilatation & Fall BP



EFFECTS

- **Visceral Effects.**
  -
  -
  -



STAGE OF REFLEX ACTIVITY STAGE OF RECOVERY.

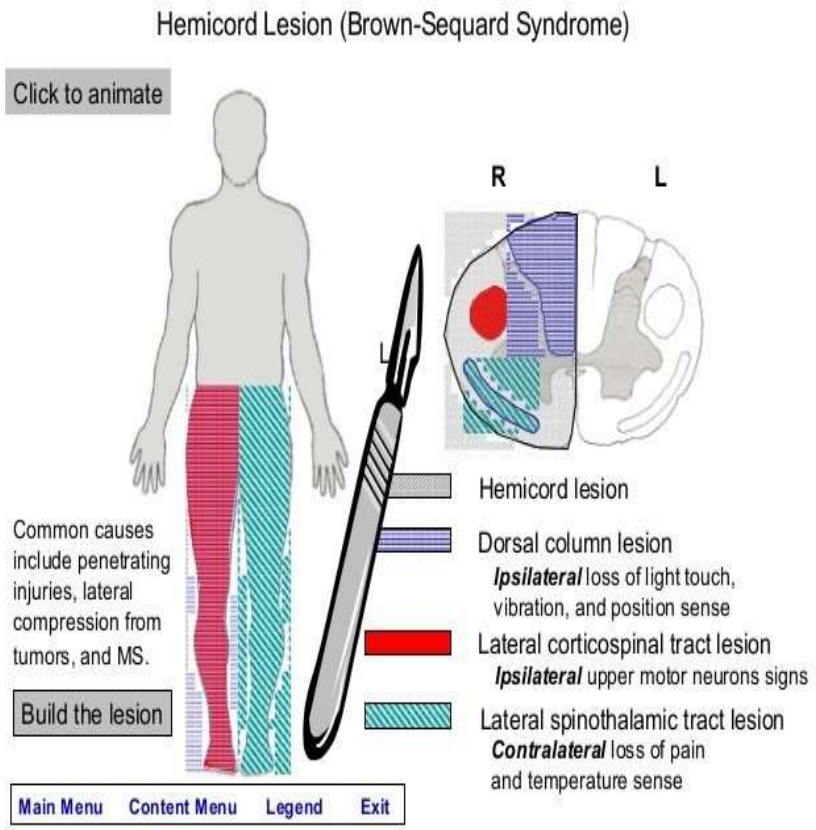
- Micturition & Defaecation reflex.
- BP normal
- Flexors first, paraplegia in flexion
-

STAGE OF REFLEX FAILURE.

- Difficult reflexes.
- Threshold increases.
- Mass reflex abolished.
- Muscle –flaccid & wasting.

INCOMPLETE TRANSECTION

- **Brown-sequard syndrome**
- **Stages**
  -
  -
  -



STAGE OF REFLEX ACTIVITY

- **Extensor Muscle** tone

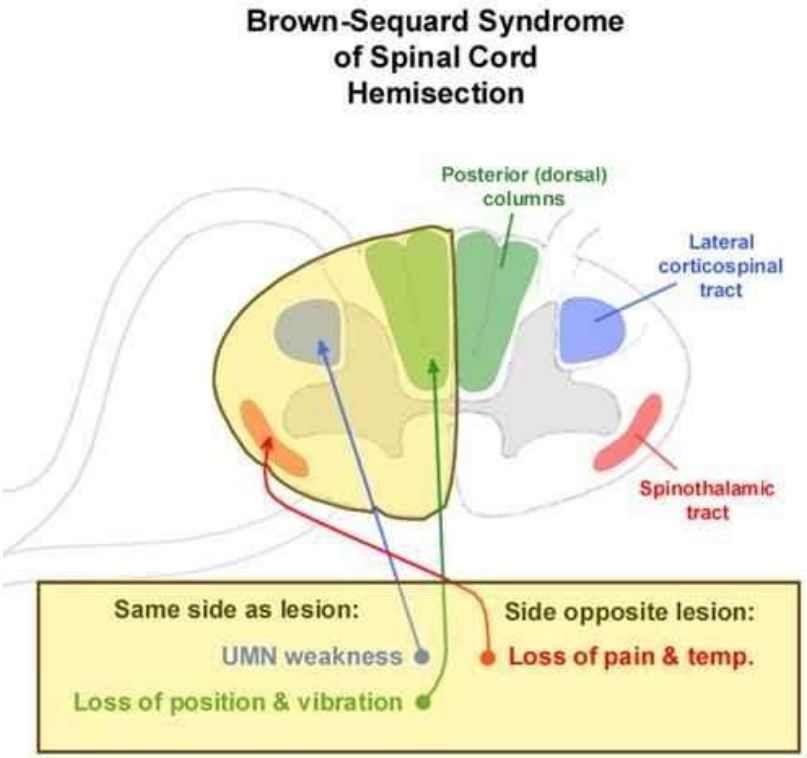
  Paraplegia in extension.

- **Extensor Reflexes**

- **Mass reflex**

HEMISECTION.

- Effects
  - Immediate Effects
  - Late effects



CHANGES AT THE LEVEL OF HEMISECTION

- Changes on same side
  - Sensory changes –
  - Motor changes
- Changes on opposite side.
  - Sensory changes
  - Motor changes

CHANGES BELOW THE LEVEL OF HEMISECTION

- Changes on same side.
- Changes on opposite side.

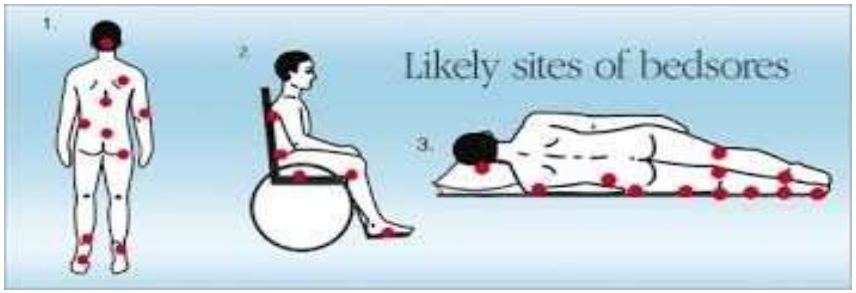
CHANGES ABOVE THE LEVEL OF HEMISECTION

- Changes on same side.
- Changes on opposite side.

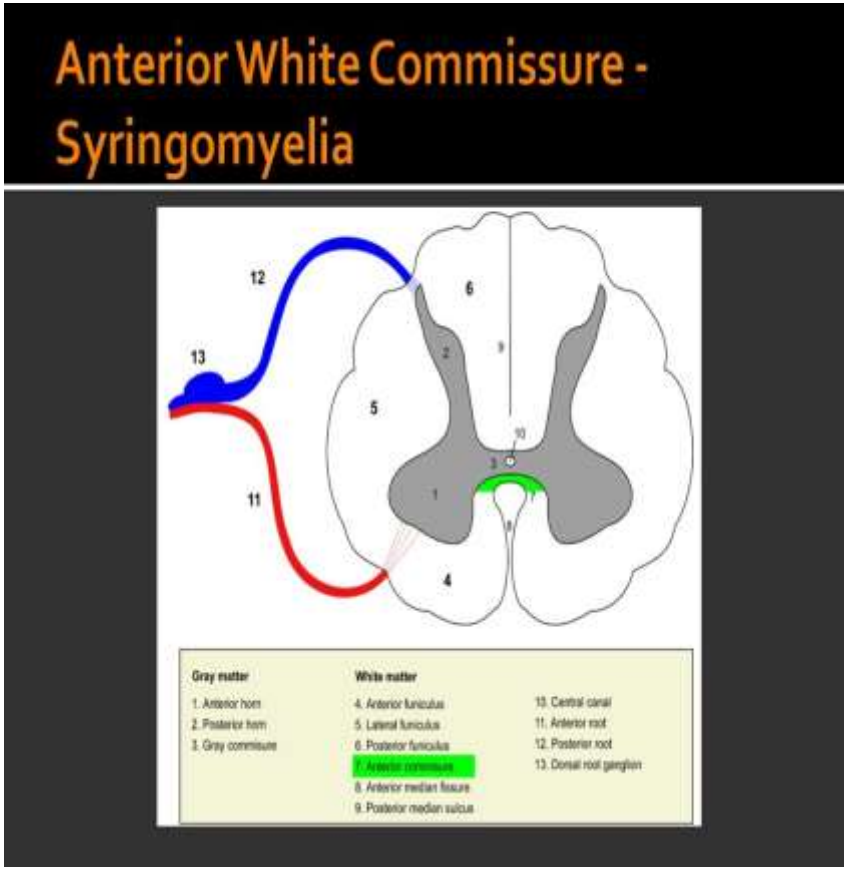
REGIONAL PECULARITIES IN HEMISECTION

- Cervical region –
  -
  -
  -
- Lumbar region –
-
-
- Lumbosacral region

COMPLICATIONS IN TRANSECTION.

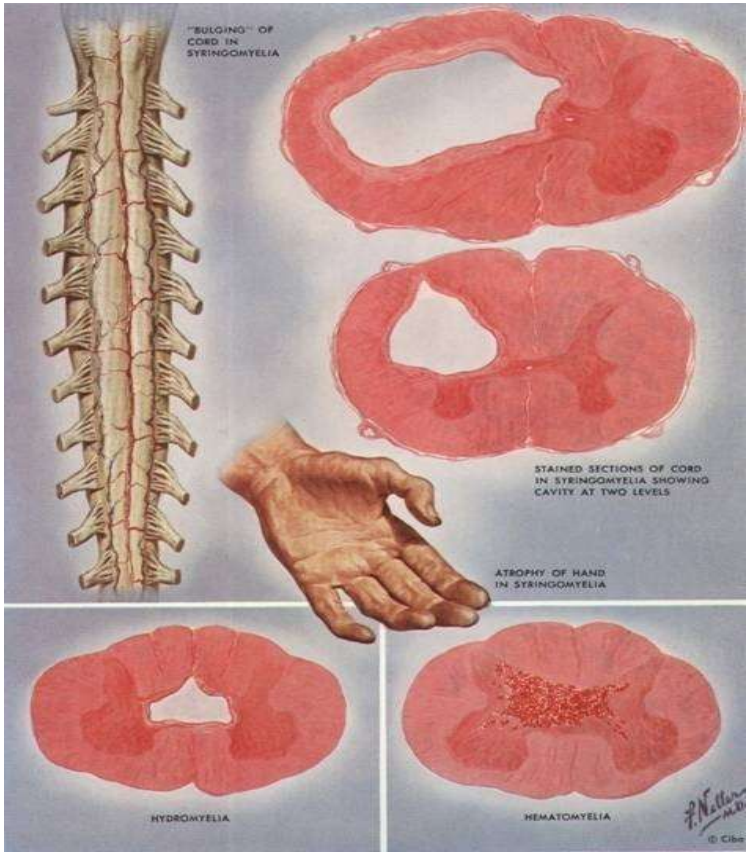


SYRINGOMYELIA

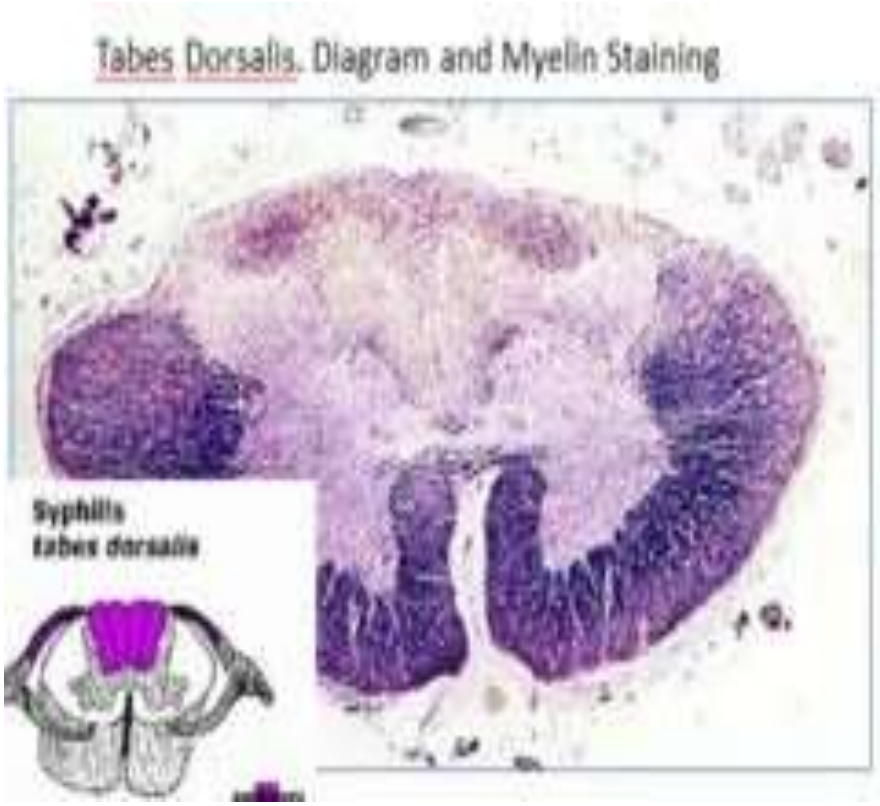


CHARACTERISTIC FEATURES.

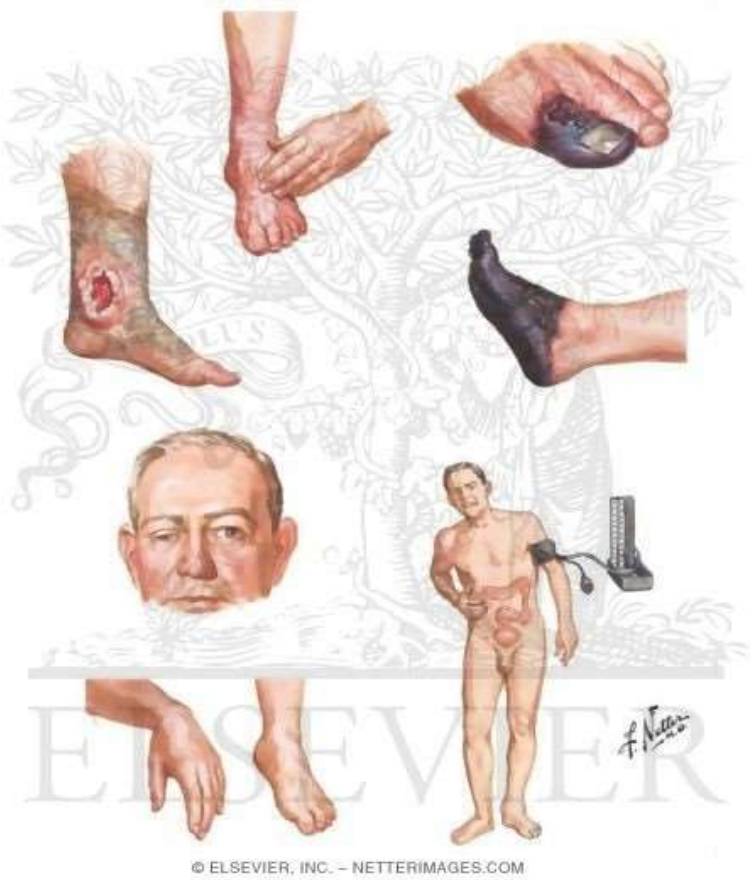
- **Sensory features**
  -
  -
- **Motor features.**
  - **UMNtype paralysis**
  - **UMN**



TABES DORSALIS



CHARACTERISTIC FEATURES.



SRNO	UMN	LMN
1	From cortex to spinal motor neurons or cranial nerve nuclei	From spinal motor neuron or cranial nerve nuclei to effector organ (α &γ)
2	Vascular accidents & Space occupying lesion (SOL)	Poliomyelitis
3	Group of muscles affected	Single or individual muscle affected.
4	Nutrition –no degeneration or wasting	Muscle degeneration & wasting.
5	Tone –hypertonia as inhibitory higher control lost	Tone lost
6	Paralysis –spastic	Flaccid.
7	Power –No Loss	Loss
8	Reflexes –superficial lost & deep exagerrated.	Both lost
9	Babinski sign –positive	Negative –normal
10	Clonus –present	Absent

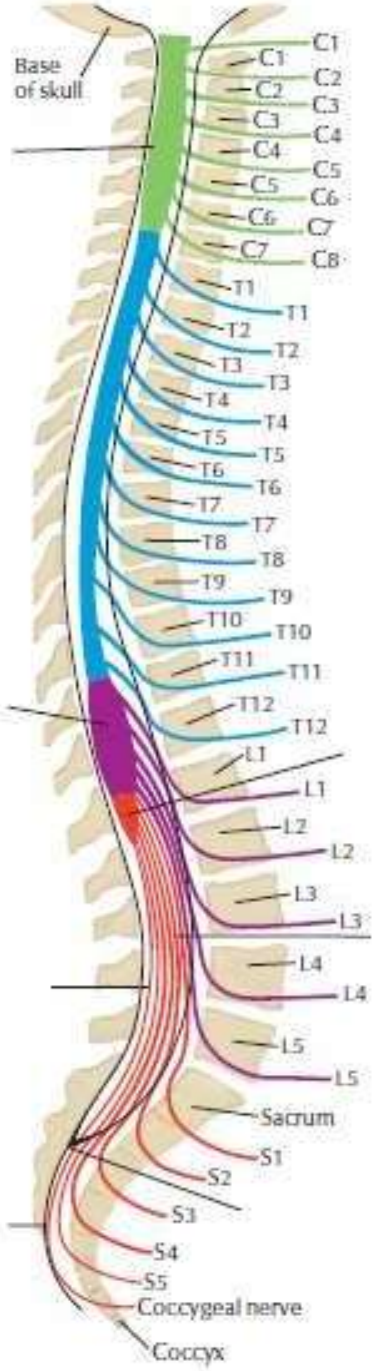
Insanity:

Doing the same thing over and over again and expecting different results.

– Albert Einstein

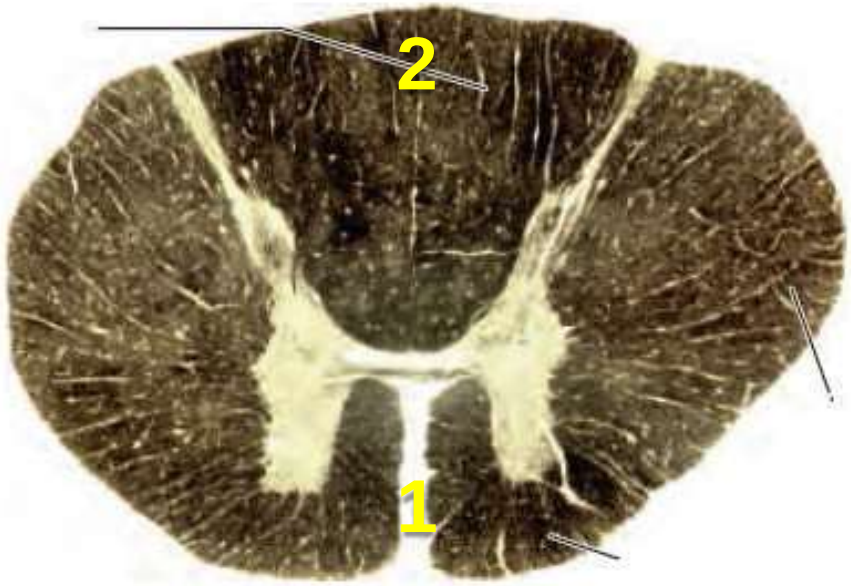
THANK YOU.

Spinal Cord Anatomy



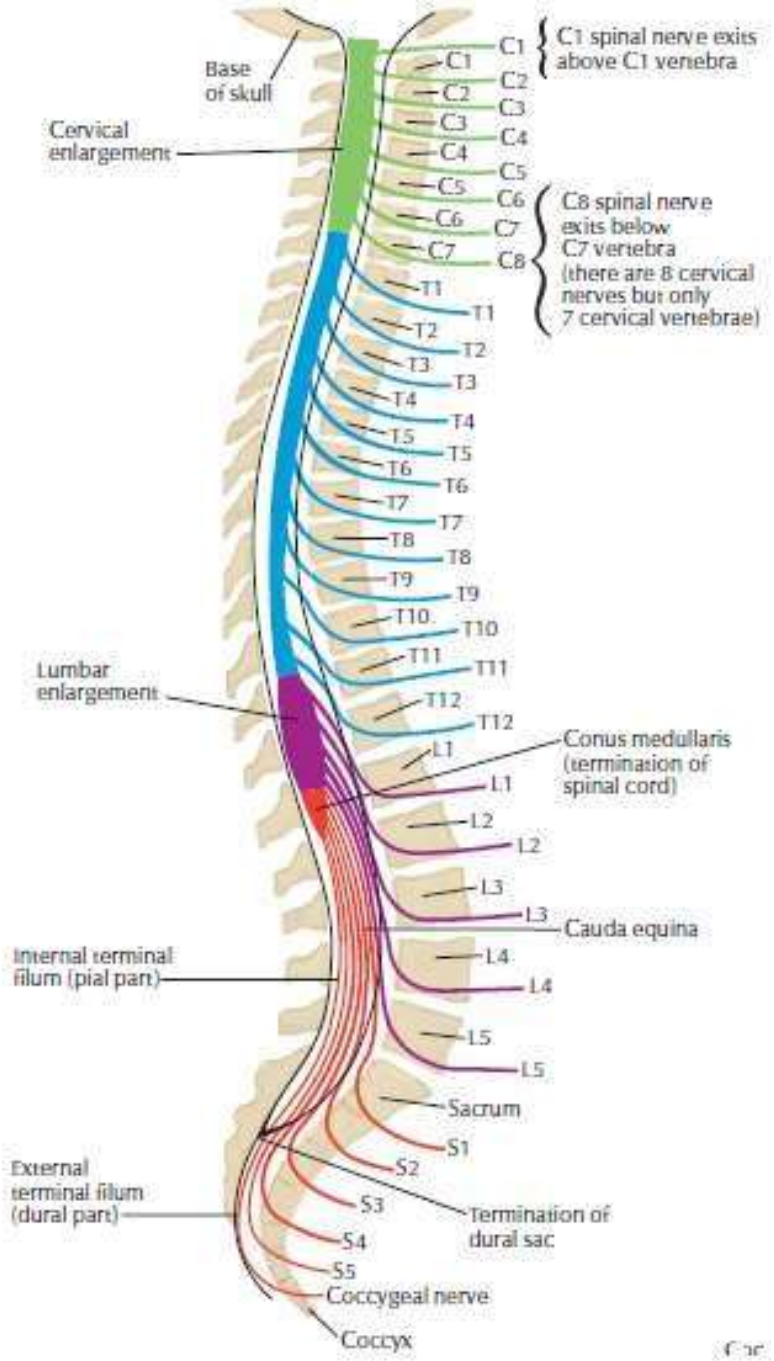
Spinal cord

- Ventrally it possesses a deep midline groove, the anterior median fissure (1) , and dorsally a shallow posterior median sulcus (2) , from which a posterior median septum of neuroglia extends into its substance.
- The posterior median septum attaches to the posterior median sulcus and is continuous with the arachnoid in the subarachnoid space.



Lower limit of spinal cord

- In the fetus the spinal cord extends to the lower limit of the spinal dura mater at the level of S2 vertebra.
- The spinal dura remains attached at this level throughout life, but the spinal cord becomes relatively shorter, which is to say that the bony spinal column and the dura mater grow more rapidly than the spinal cord.
- Thus at birth the conus medullaris lies opposite L3 vertebra and does not reach its permanent level opposite L1 or L2 until about the age of 20 years.
- The spinal nerve roots, especially those of the lumbar and sacral segments, thus come to slope more and

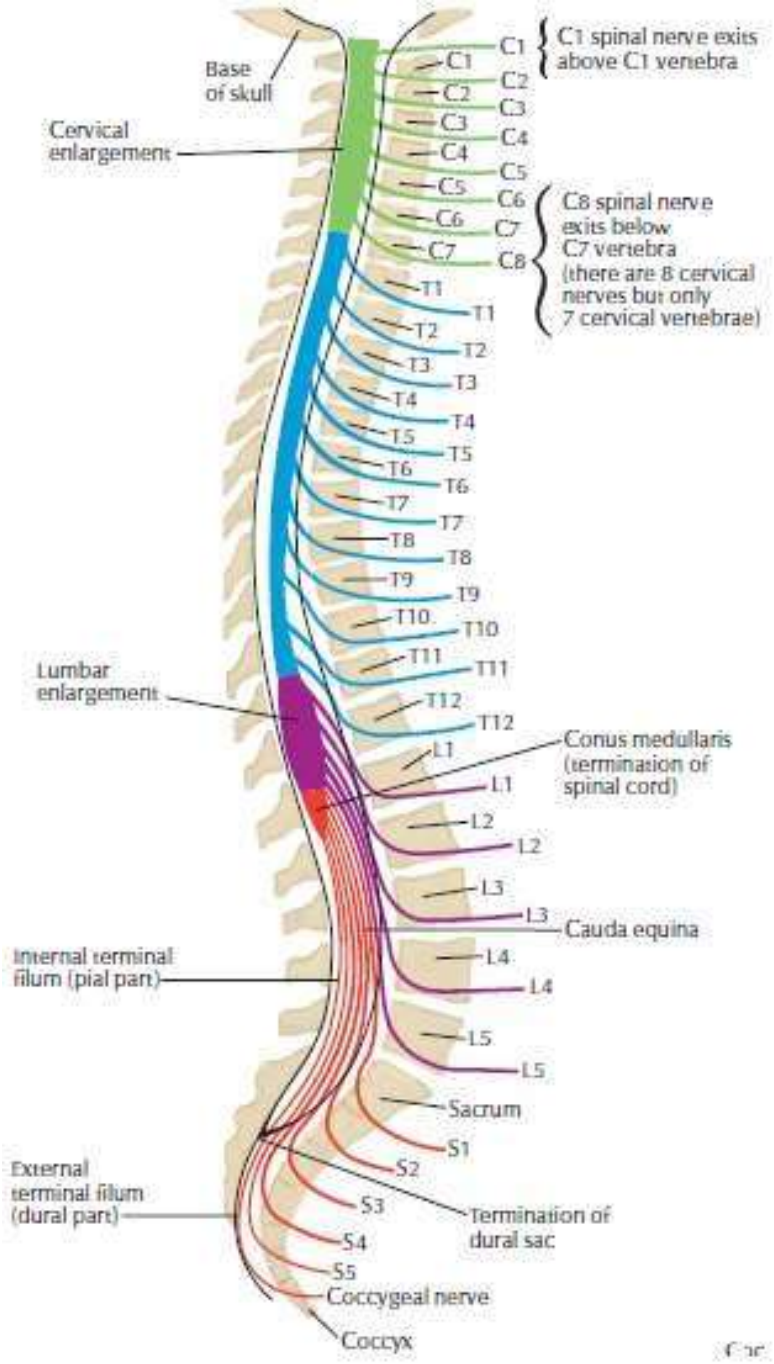


Lower limit of spinal cord

- **In fetus**
  - conus medullaris (lower limit of spinal cord) = S2
  - Spinal dura mater = S2

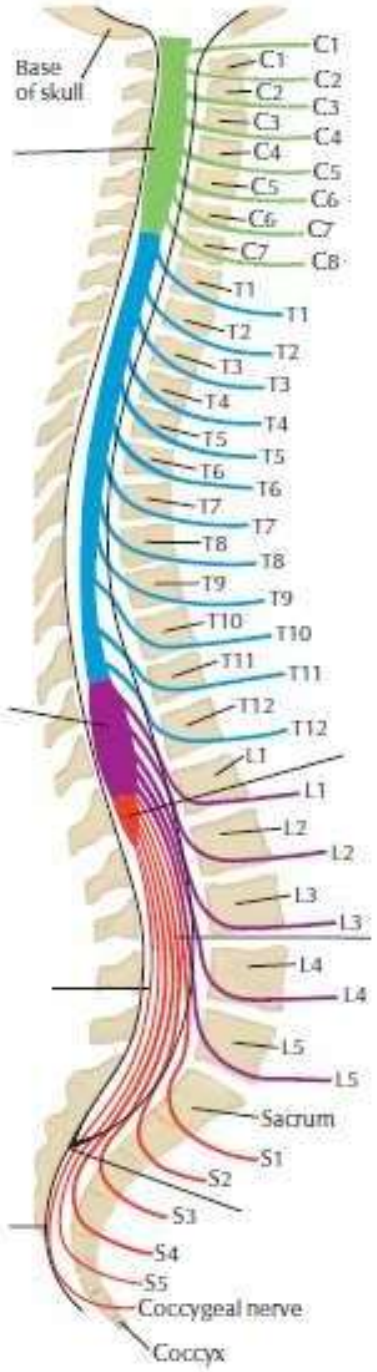
- **At birth**
  - Conus medullaris = L3
  - Spinal dura mater = S2

- **In Adults**
  - Conus medullaris = L1 or L2
  - Spinal dura mater = S2
  - Subarachnoid space = S2



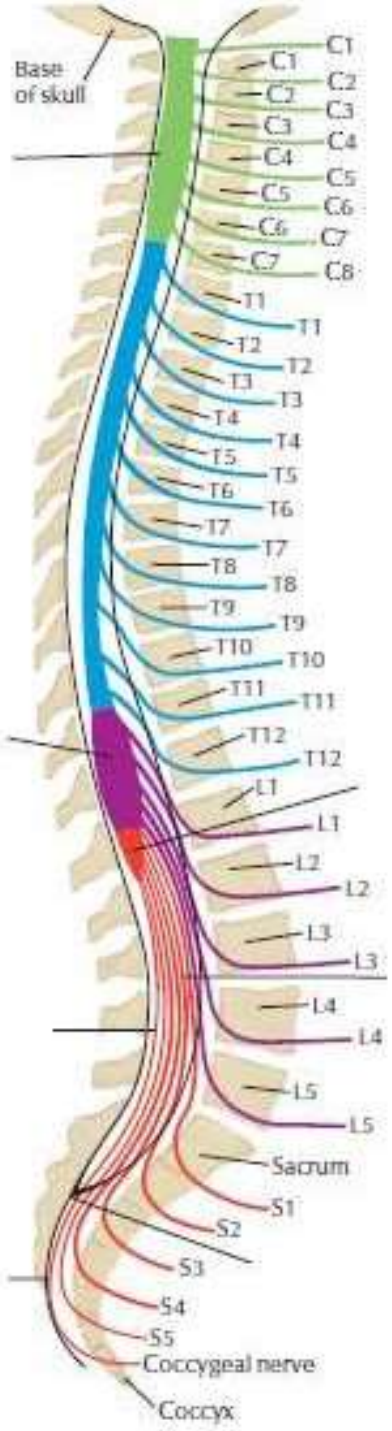
Spinal cord enlargement

- They occupy, in the cord, the segmental levels of the plexuses concerned C5 to Tl for the cervical enlargement and L2 to S3 for the lumbosacral enlargement), but their levels measured by vertebrae are, of course, quite different.
- Thus the cervical enlargement roughly correspondi to the lies C3 to Tl vertebrae
- lumbosacral extends only from T9 to L1
- Both enlargements are due to the greatly increased mass of motor cells in the anterior horns of grey matter in these situations.



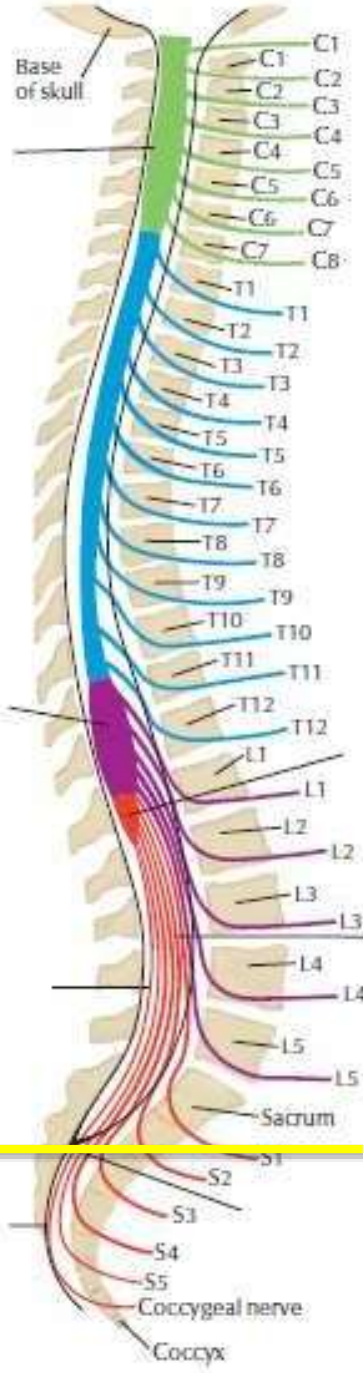
Spinal cord segments

- Spinal cord segments with related to the vertebral levels
- Cervical = C1-C7
- Thoracic = C7-T11
- Lumbar = T11-L1
- Thoracic = L1-L2



Spinal dura mat

- **a prolongation of the inner layer of the dura mater of the posterior cranial fossa.**
- **It extends downwards through the foramen magnum to the level of S2 vertebra.**
- **It is attached rather firmly to the tectorial membrane (in cochlea) and to the posterior longitudinal ligament on the** body of the axis vertebra, but e n the spinal canal it lies free of bony ntous attachments.
  - It is separated from the spinal can of fat in which lies the external vertebra us.
  - pierced segmentally by the ante sterior roots of the spinal nerves and i over these roots to form a series of ctions, one entering each inter vertebral foramen.



S 2

Spinal dura mat

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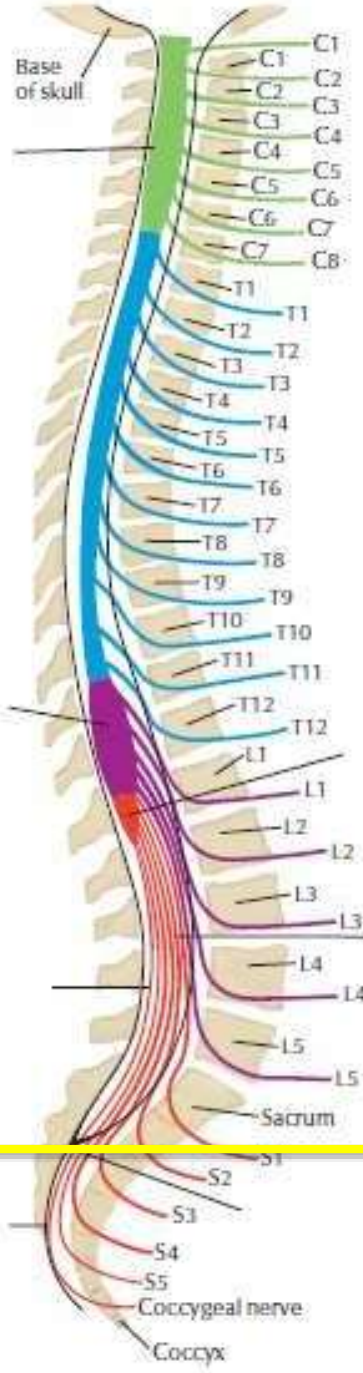
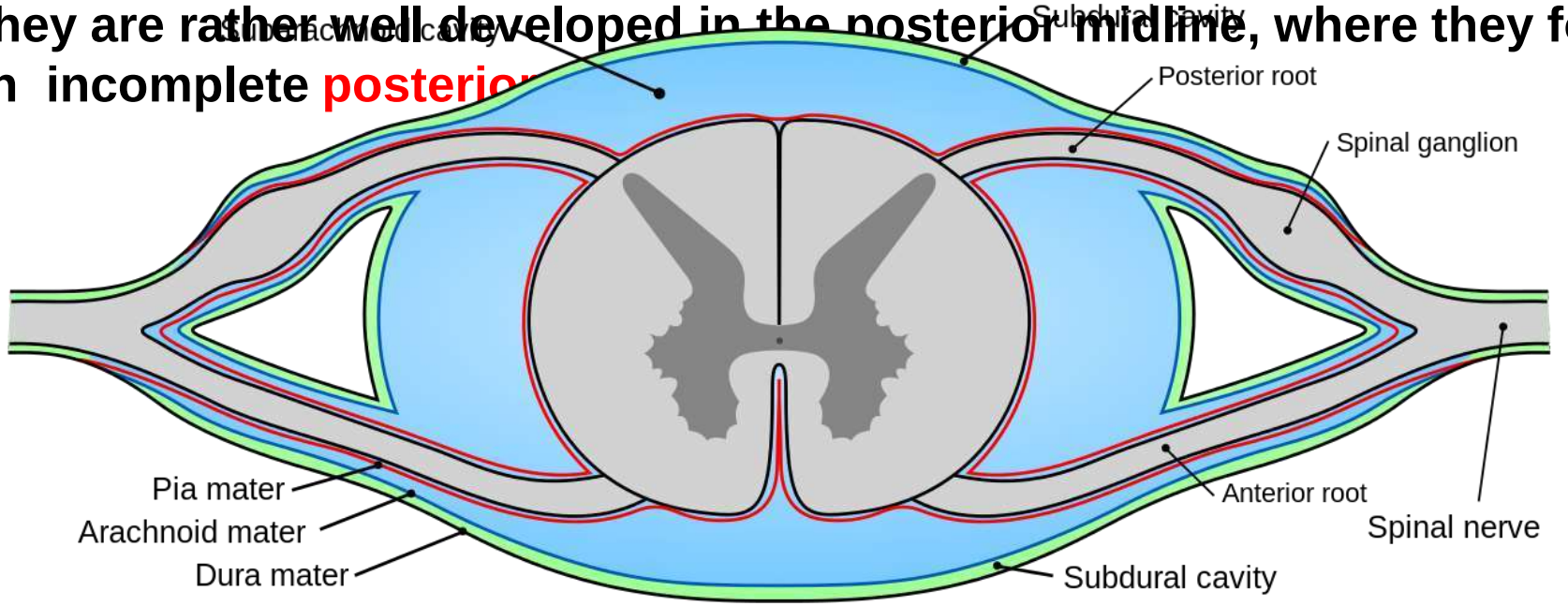


S 2

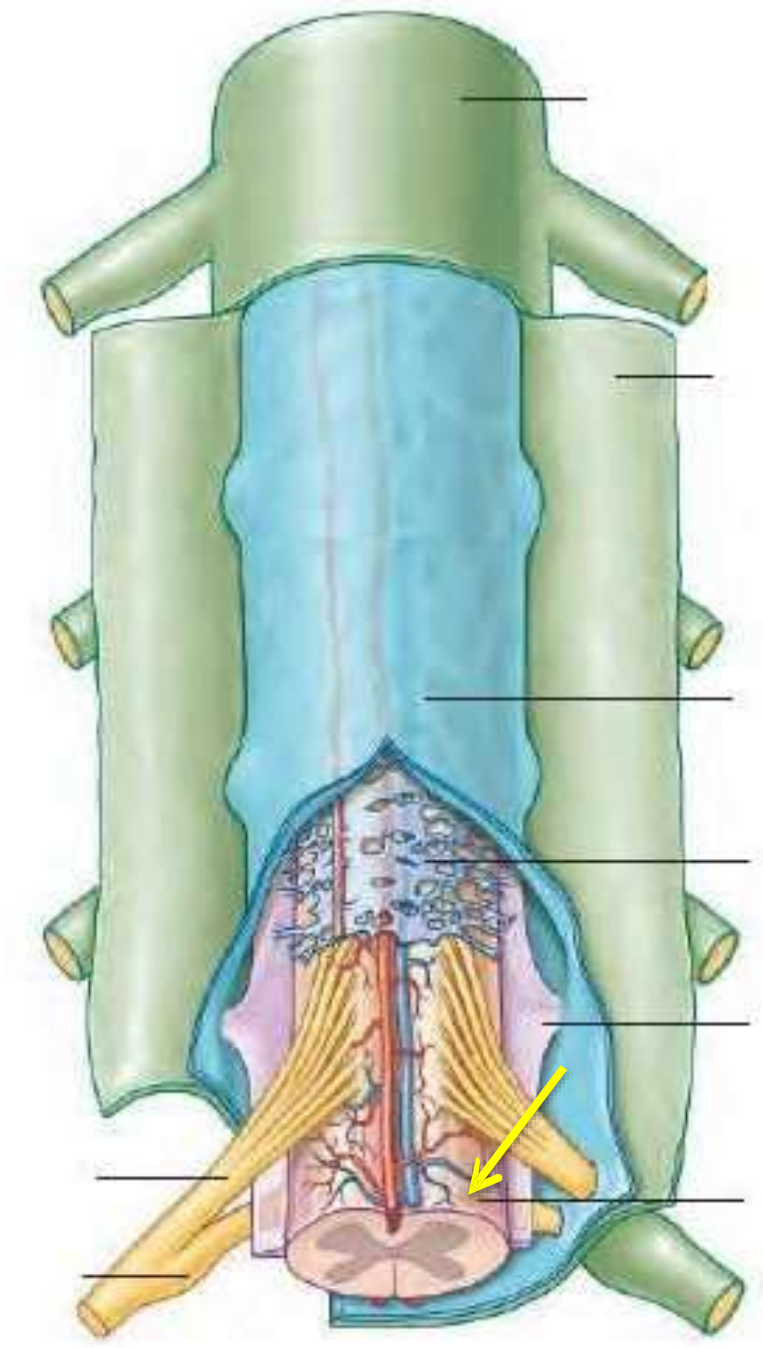
Spinal arachnoid matter

- The spinal arachnoid mater is supported by the inner surface of the spinal dura; nothing but a thin film of lymph separates these two membranes.
- The arrangement is similar to that in the skull. Below the level of the spinal cord (i.e. over the cauda equina) the arachnoid is nothing but a delicate membrane that is supported by the dura mater, but over the spinal cord itself the spinal arachnoid sends many delicate web-like processes across the subarachnoid space to the pia mater on the cord.
- They are rather well developed in the posterior midline, where they form an incomplete posterior



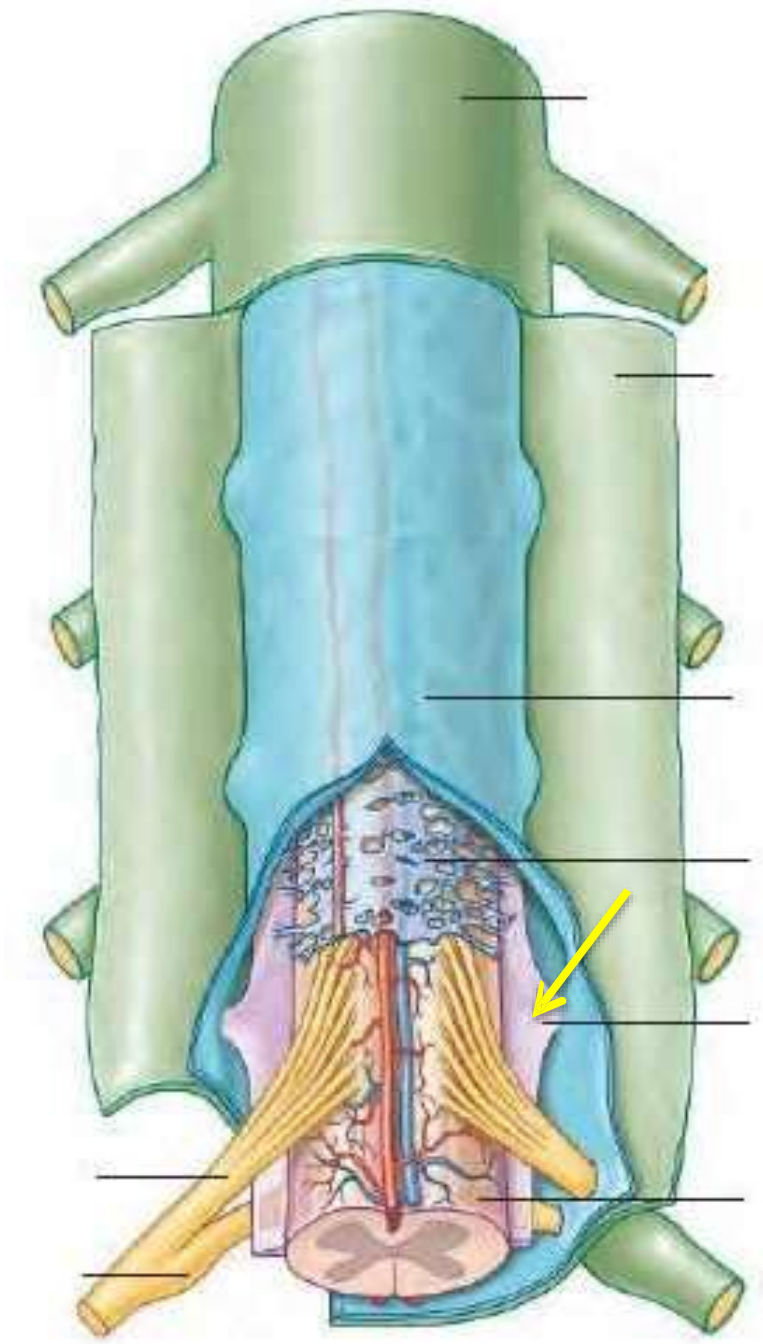
Spinal pia mater

- It clothes the spinal cord and enters to line the anterior median sulcus. It is prolonged over the spinal nerve roots and blends with their epineurium.
- It is projected below the apex of the conus medullaris, whence it extends as the filum terminale to perforate the spinal dura at the level of S2 vertebra. It then descends to the back of the coccyx .
- The filum terminale lies centrally in the cauda equina, but is not classified as part of the



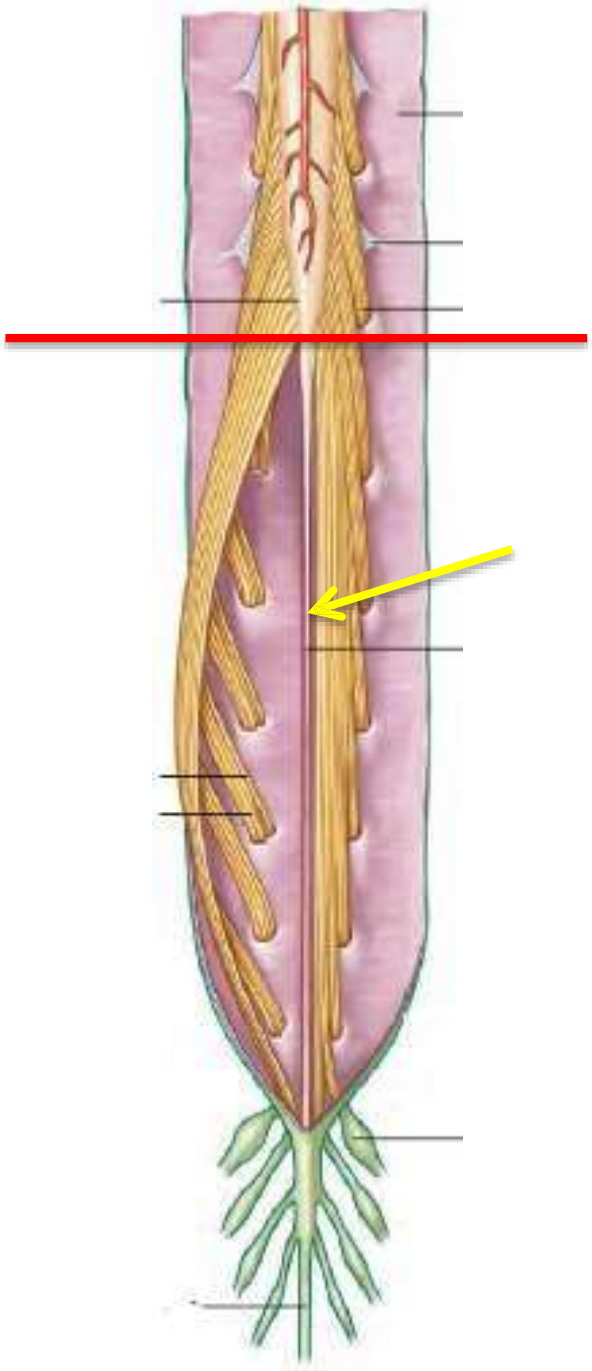
Spinal pia mater

- A lateral projection of pia mater on each side forms the denticulate ligament. This forms a flange which crosses the subarachnoid space and, piercing the arachnoid, connects the side of the spinal cord to the dura mater.
- Pia mater is attached in an unbroken line along the spinal cord from the foramen magnum to the conus medullaris, but its lateral edge is connected to the spinal dura by a series of 'teeth', which are attached to the spaces between the issuing nerve roots.
- The root of L1 lies at the lowest denticulation.
- The denticulate ligament, filum terminale and the attached nerve roots serve to stabilize the loose-fitting spinal cord within the spinal dura mater



Arrow is on L1 / L2 level

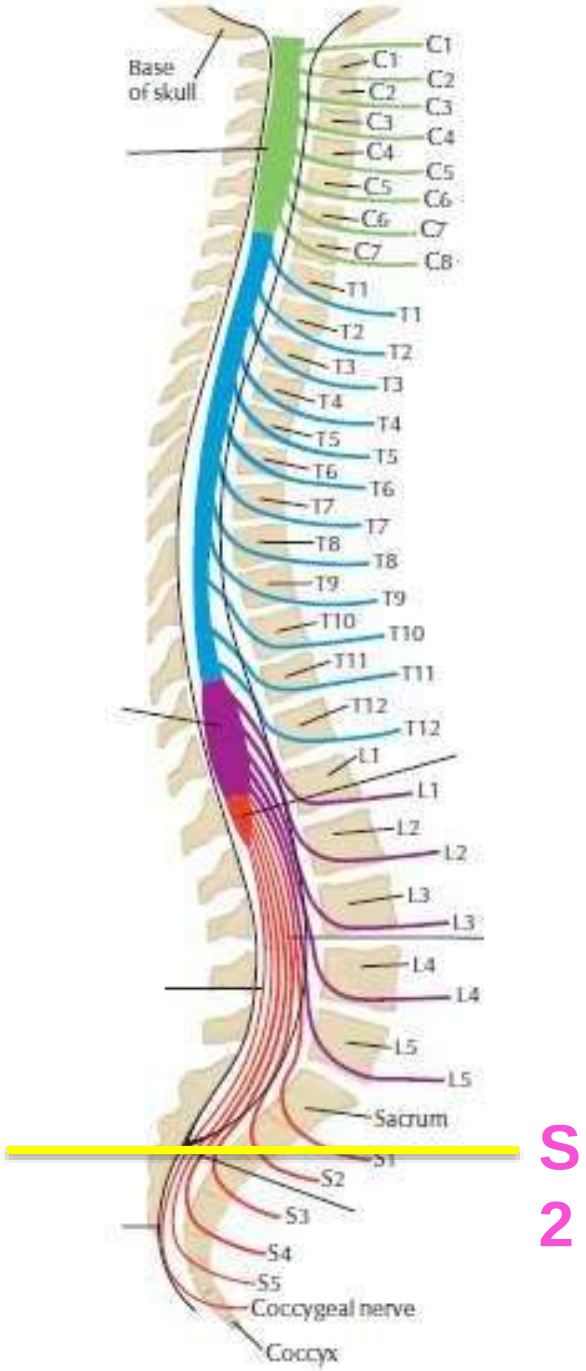
filum terminale !



Spinal dura matter

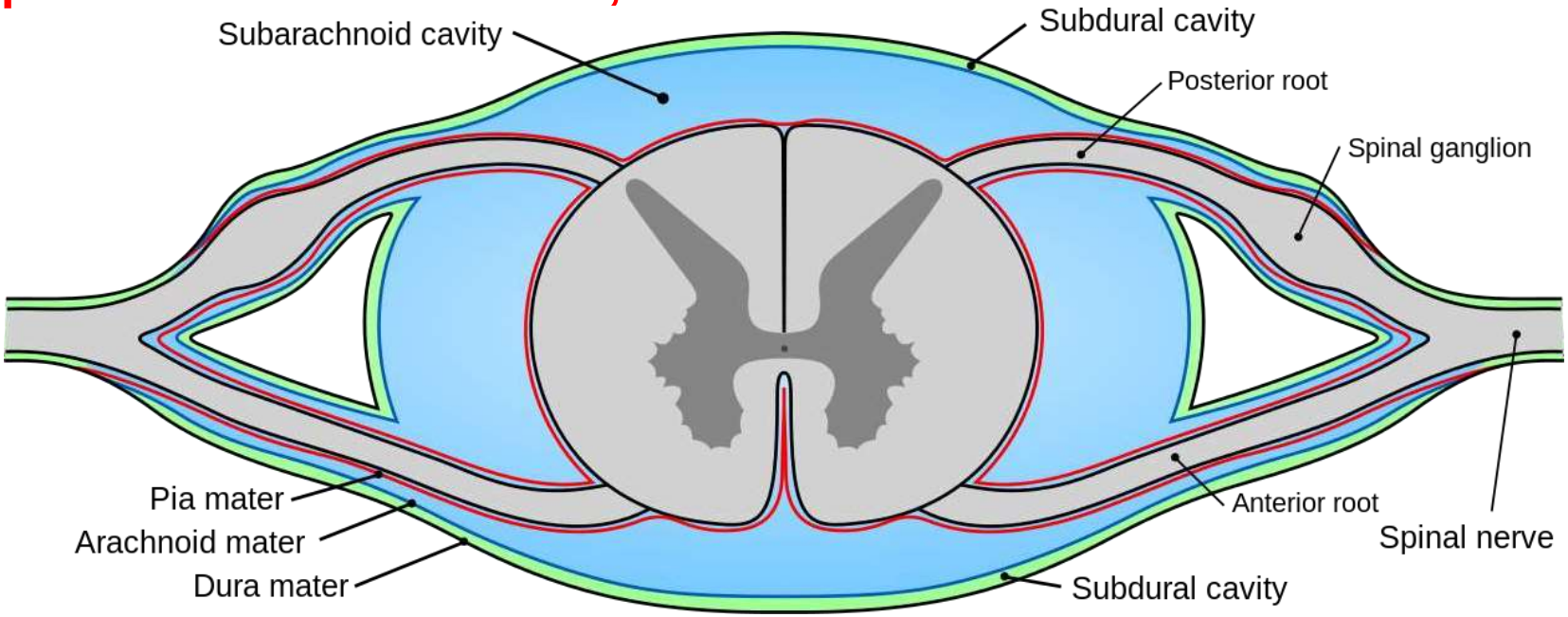
- **In summary , the stabilizing factors of theca (dura mater) in bony column ..**

1. **Attaching to Tectorial membrane**
2. **Attaching to PLL in level of axis**
3. **Segmentally piercing of anterior and posterior spinal roots in their way to pass through the intervertebral foramina.**
4. **denticulum ligament**
5. **Filum terminale**



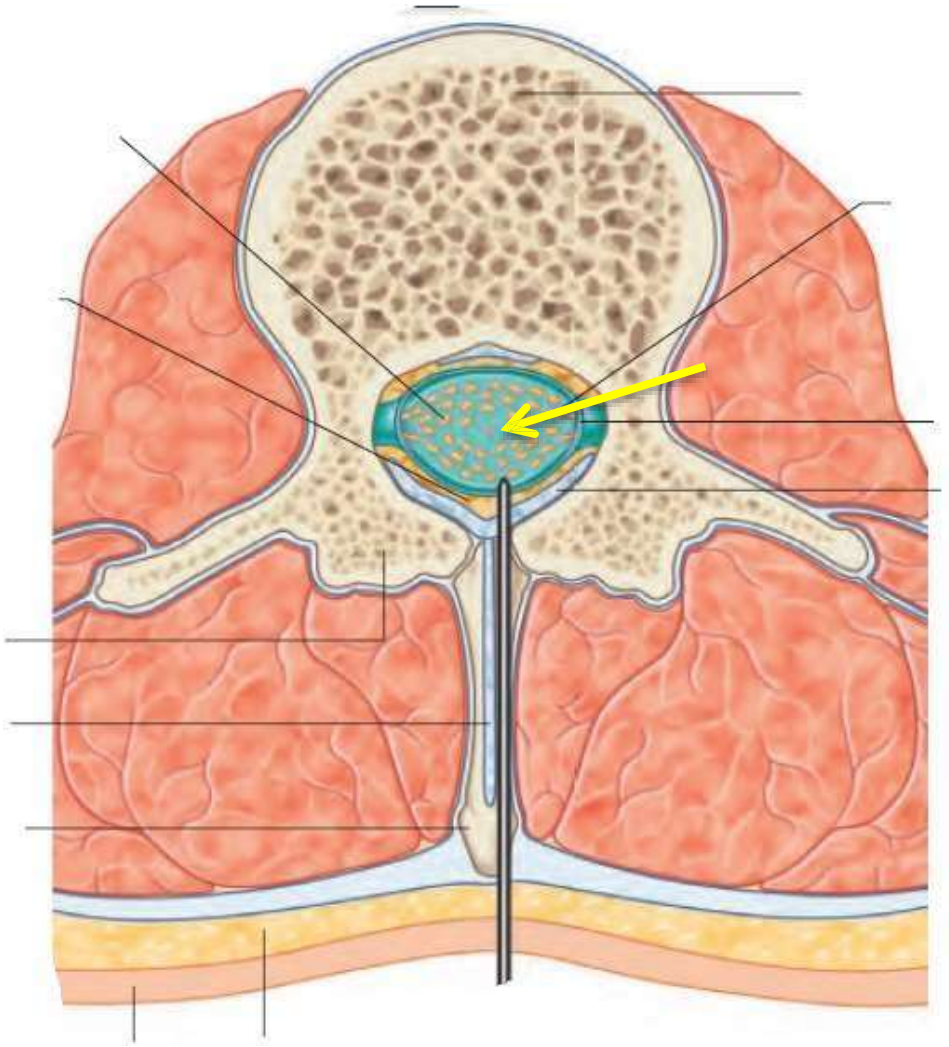
Subarachnid space

- The spinal subarachnoid space is relatively large, accommodating about half of the total volume of cerebrospinal fluid (75 ml out of 150 ml).
- It communicates through the foramen magnum with the subarachnoid space of the posterior cranial fossa.
- Some cerebrospinal fluid percolates away along the meningeal sheaths of the spinal nerves.
- Below the level of the conus medullaris it contains only the cauda equina and filum terminale, and it ends at the level of S2 vertebra.



Lumbar puncture

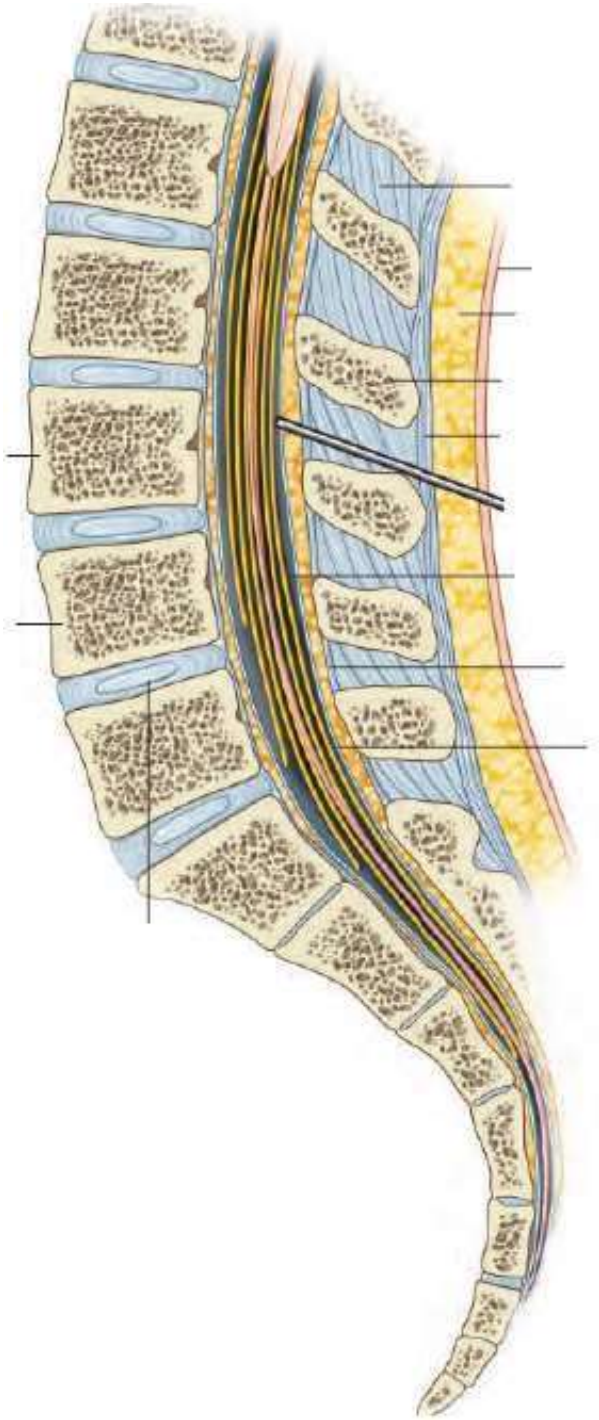
- When no spinal cord is exist !
- When the larger volume is the subarachnoid space !
- When vertebrae are flexed !



*Arrow is on filum terminale

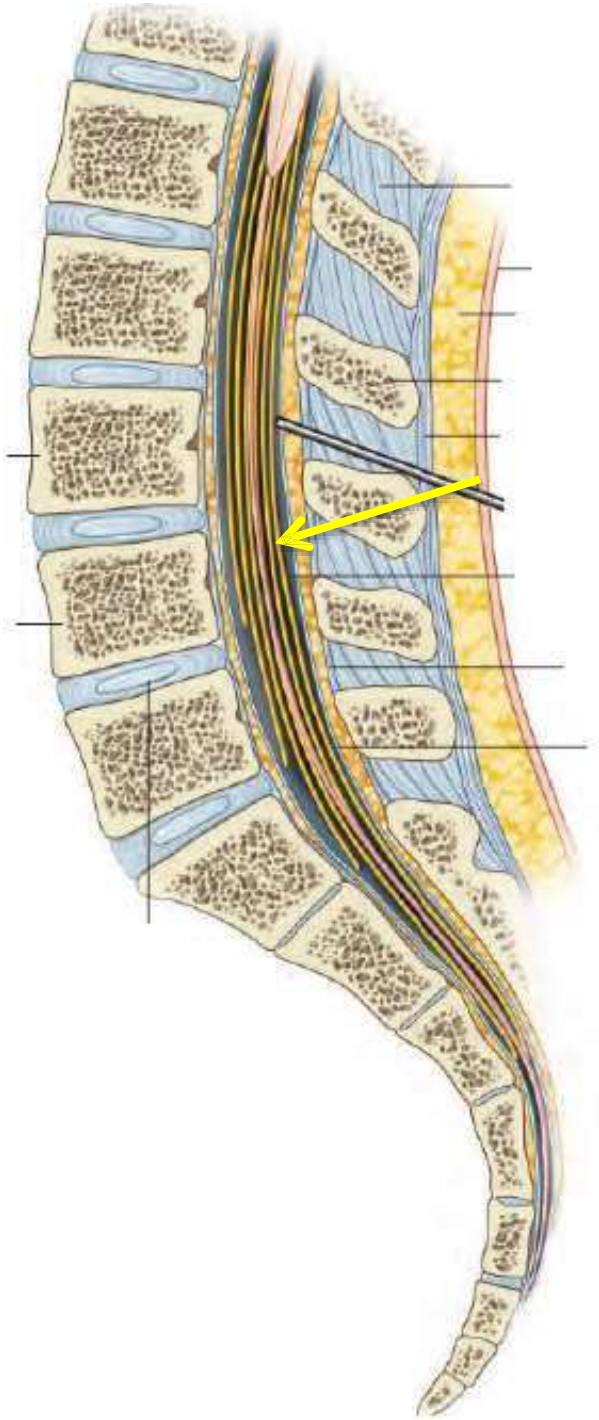
Lumbar puncture

- In lumbar puncture the needle is inserted between the spines of L3 and L4 or L4 and L5 vertebrae when the patient's back is flexed, usually when curled up lying on one side.
- The needle passes through the supraspinous and interspinous ligaments and through or between ligamenta flava before reaching the dura which is penetrated with a characteristic 'give'.
- Since the spinal cord ends at the level of LI vertebra, it is in no danger.
- Lumbar puncture do not



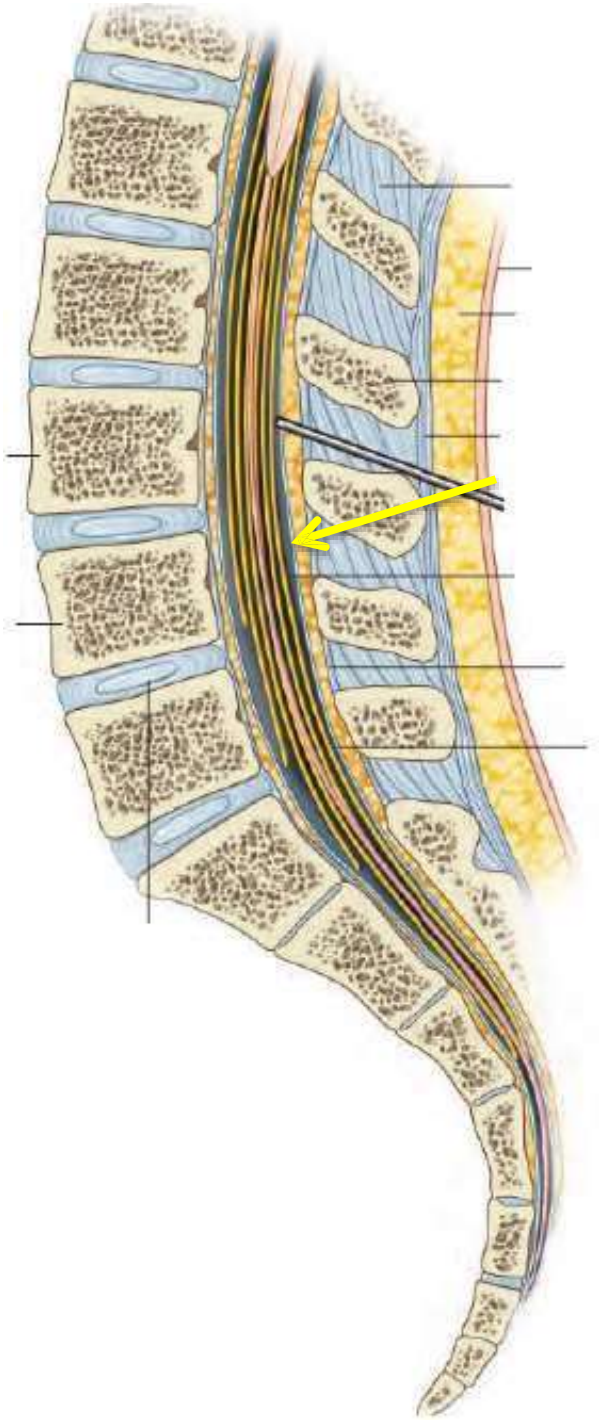
Spinal anesthesia

- **In spinal anaesthesia, the anaesthetic solution is injected into the subarachnoid space (with the needle in a similar position to that used for lumbar puncture), so mixing with the cerebrospinal fluid surrounding the nerve roots and percolating into them**



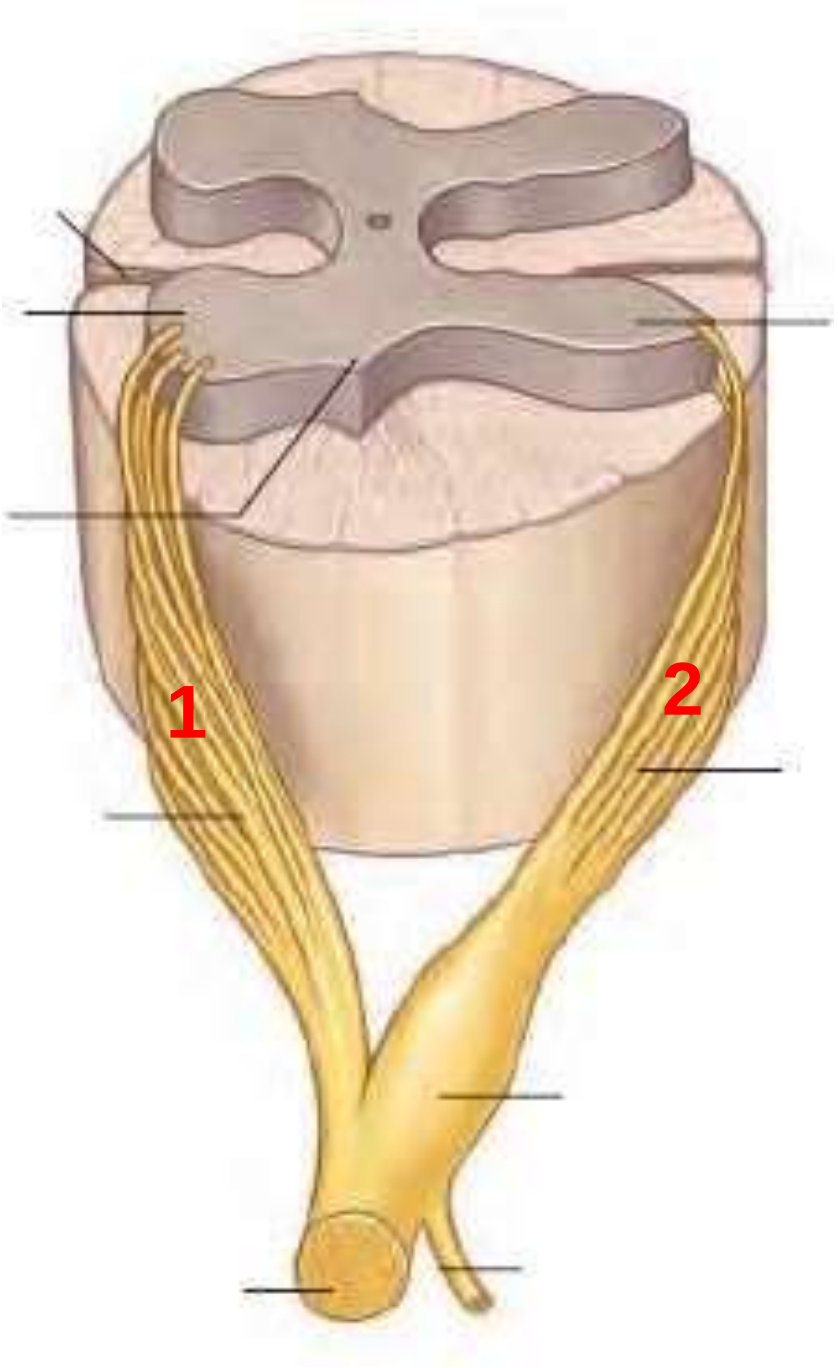
Epidural anesthesia

- In epidural anaesthesia (commonly used in child birth), the solution is injected into the epidural (extradural) space without penetrating as far as the dura, so that the solution can infiltrate through the meningeal sheaths containing the lumbar and sacral nerve roots.
- The approach is similar to that for formerly (though now) alternative approach an sacral canal through the sacral hiatus.



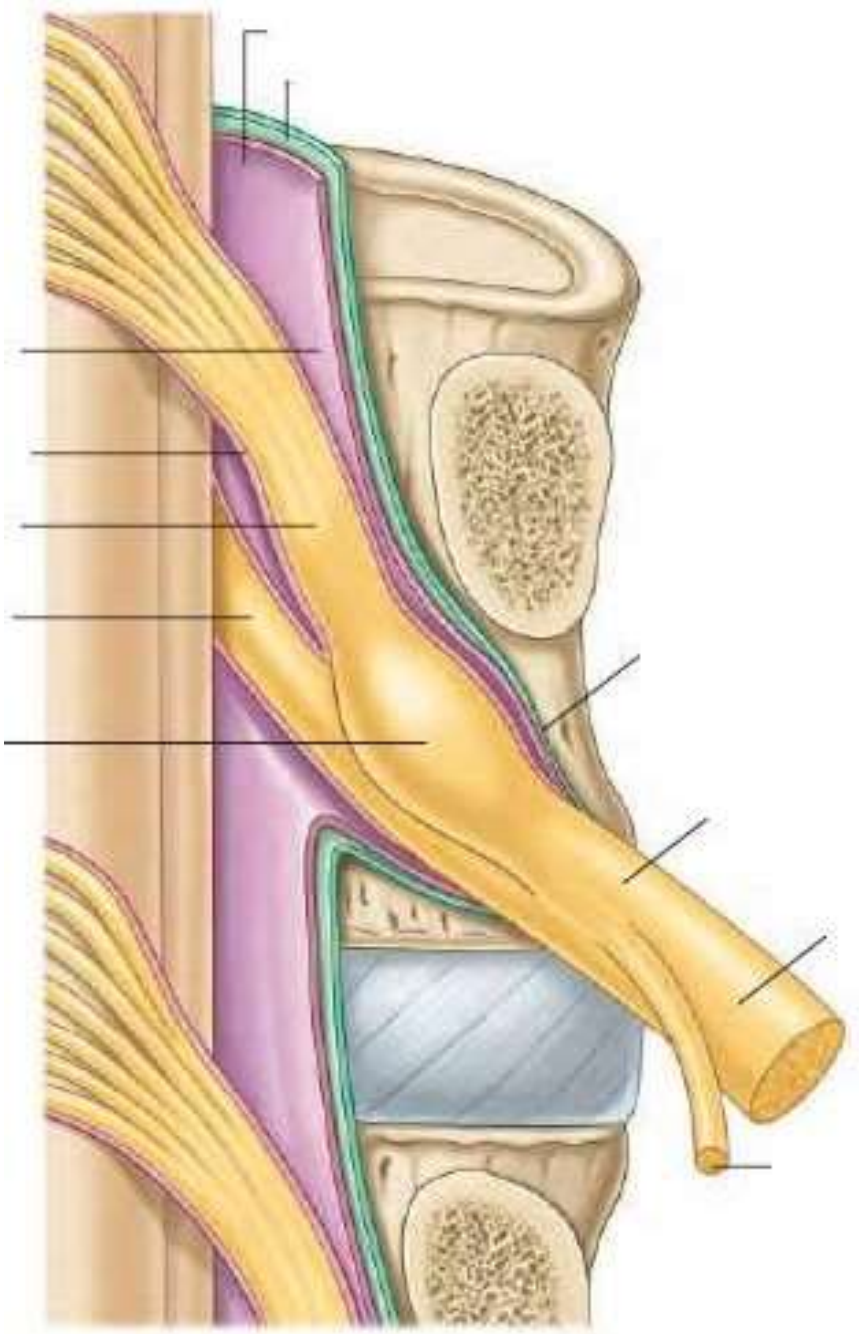
Spinal nerves roots

- No spinal nerves lie inside spinal theca (dura) ; indeed, no nerve lies, strictly speaking, within the vertebral canal.
- The anterior and posterior roots of the spinal nerves unite within the intervertebral foramina.
- Within the subarachnoid space the nerve roots are attached to the spinal cord each by a series of rootlets.
- Each anterior root is formed by 1 to 6 rootlets which emerge irregularly along the anterolateral surface of the spinal cord. (see 1)
- Each posterior root is formed by several rootlets, attached vertically to the posterolateral surface of the cord. (see 2)



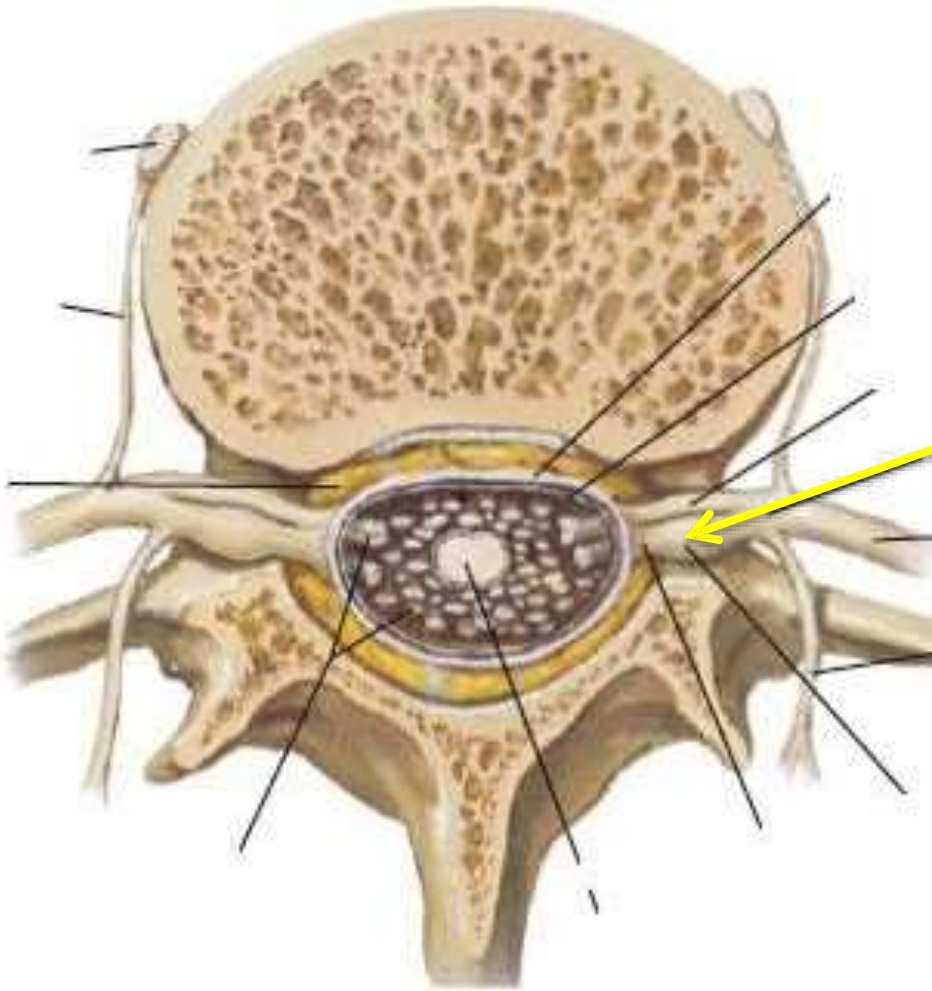
Spinal nerves roots

- The roots pass to their appropriate intervertebral foramina, before uniting to form the mixed spinal nerve.



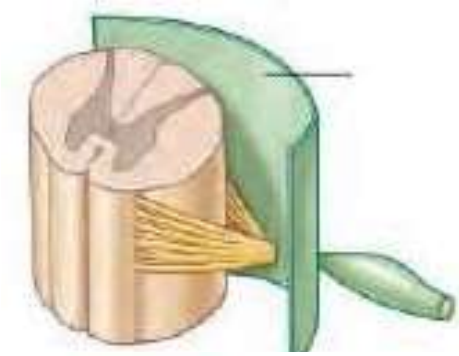
Posterior root ganglion

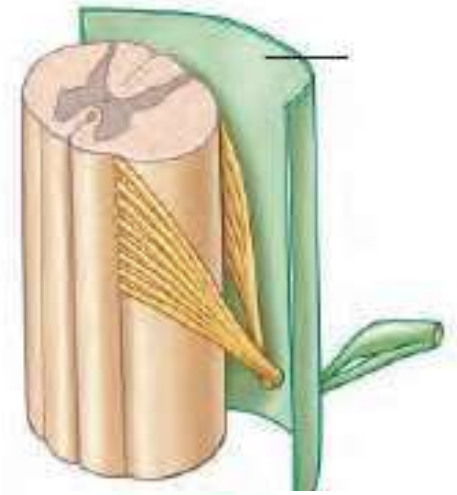
- The ganglion on the posterior nerve root lies in the intervertebral foramen, within the tubular evagination of dura and arachnoid immediately proximal to the point of union of anterior and posterior nerve roots.
- the posterior root ganglia of cervical nerves lie just in contact with vertebral artery,

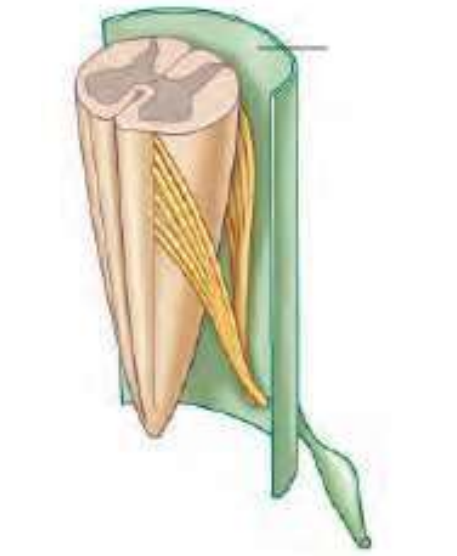


Spinal nerves roots

- all levels from C1 to L1 vertebrae the anterior and posterior nerve roots pass in front of and behind the denticulate ligament respectively and evaginate the dura mater between the denticulations
- In conformity with the shortness of the spinal cord, the lower the nerve root the more steeply it slopes down to the intervertebral foramen.
- The upper cervical roots are horizontal, the thoracic root first slope down c upper s of evagination to of pain inges the only to becom ner t kinked upwards at an angle to reach their foramen



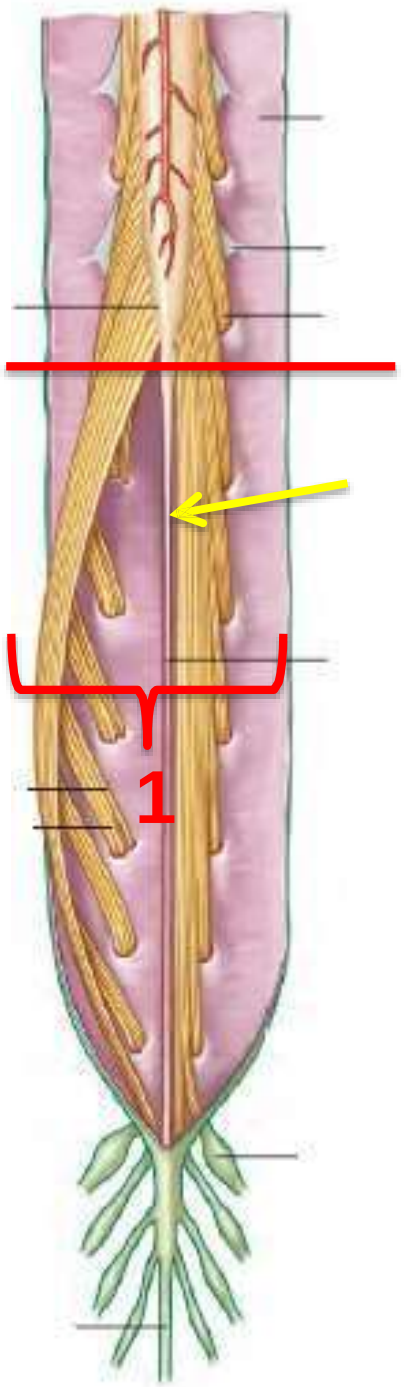




Spinal nerves

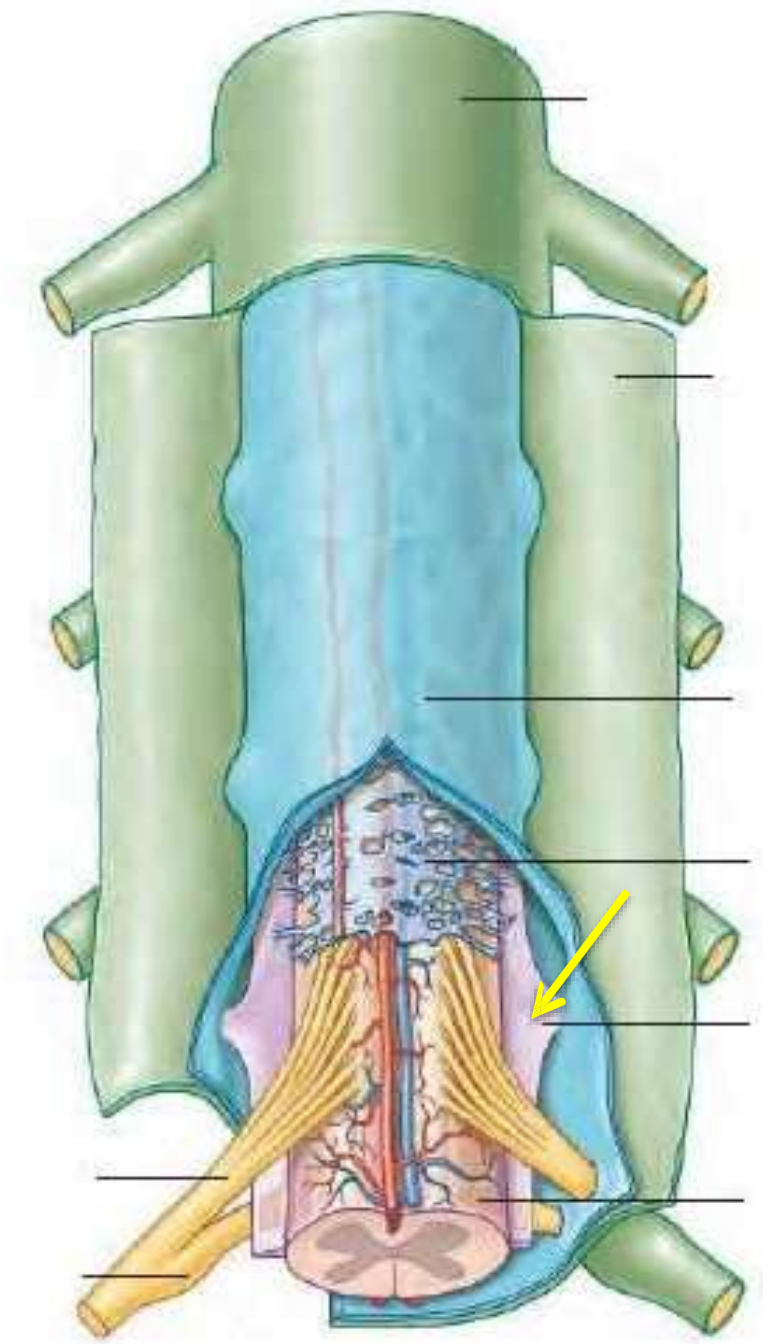
roots

- Below L1 vertebra the roots pass almost vertically through the subarachnoid space, forming the cauda equina (1)
- note that this consists NOT of spinal nerves but of nerve roots.
- The filum terminale (pia matter's derivatives) (arrow) extends down from the tip of the conus medullaris among the nerve roots of the cauda (but is not classified as part of the cauda).
- The roots of the spinal part of the accessory nerve emerge from the lateral surface of the upper five or six segments of the cord, behind the denticulate ligament. They form into a single trunk which passes upwards through the foramen magnum into the cranium to join the cranial root



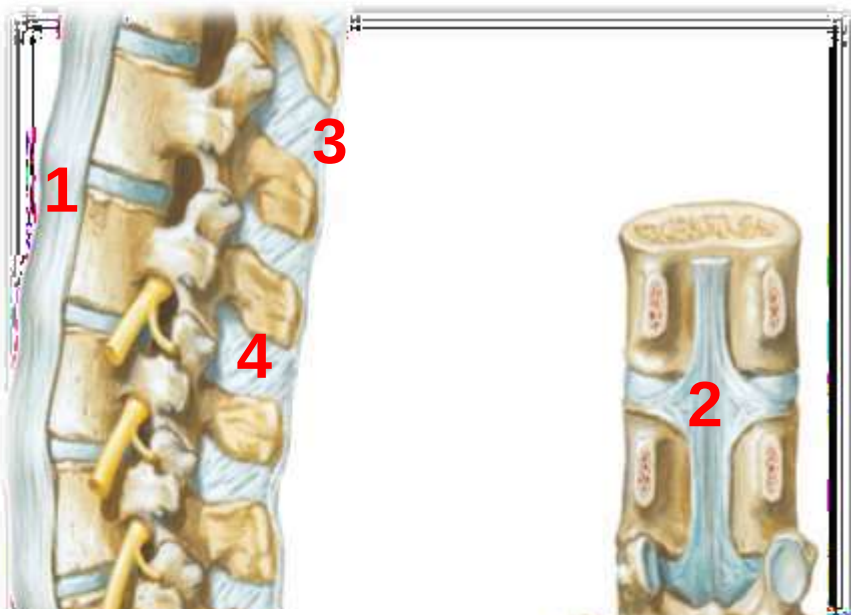
Rememb er!

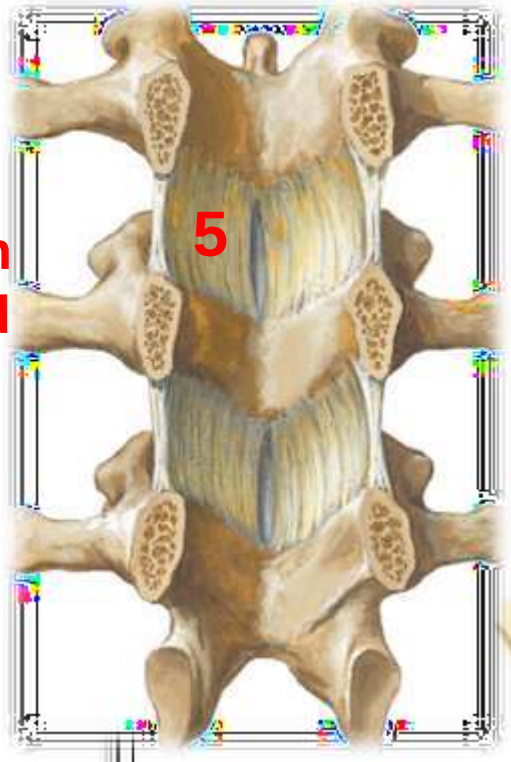
- all levels from C1 to L1 vertebrae the anterior and posterior nerve roots pass in front of and behind the denticulate ligament respectively, and evaginate the dura mater between the denticulations. The accessory nerve emerges from the lateral surface of the spinal cord, behind the denticulate ligament.
- Surface of the spinal part of the accessory nerve arises from five or six segments of the cord,

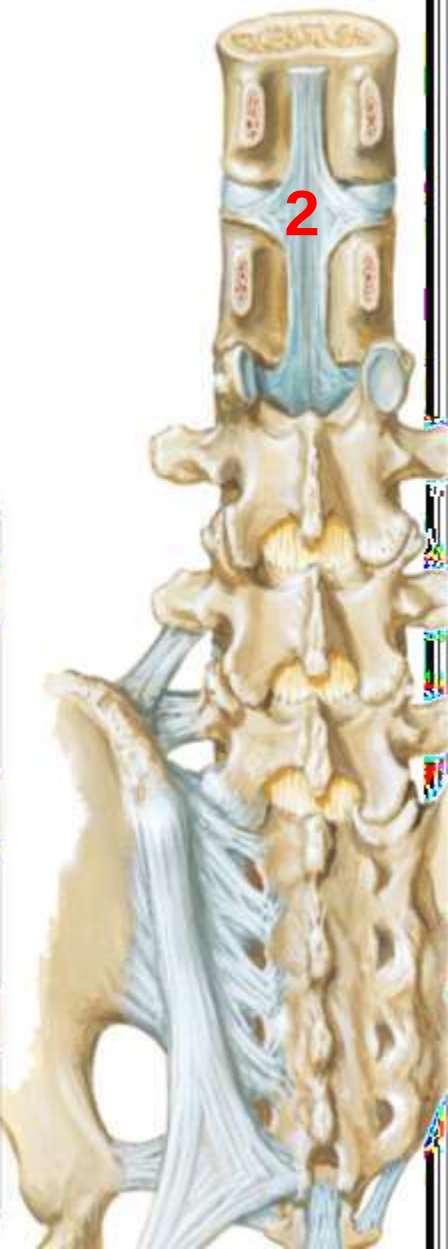


Important ligaments in the spine

1. Anterior longitudinal ligament (ALL)
2. Posterior longitudinal ligament (PLL)
3. Supraspinous ligament
4. Intraspinous ligament
5. Ligamentum flav (between pedicles - between spinous and transverse processes)

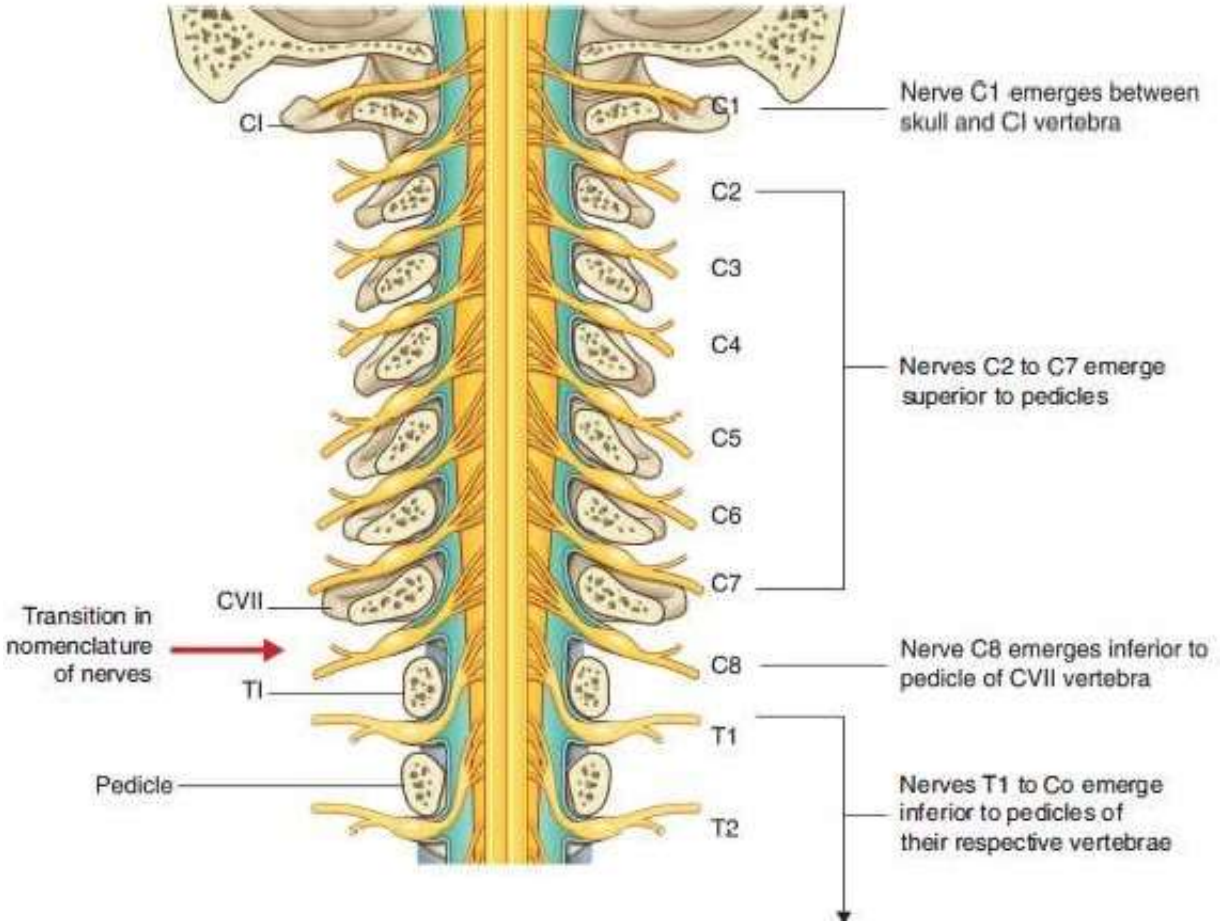






Nomenclature of spinal nerves

- **Notice this C1 nerve root exit above C1 vertebra**
- **C8 nerve root exit below C7 vertebra**
- **Also, T1 nerve root exit below T1 vertebra**



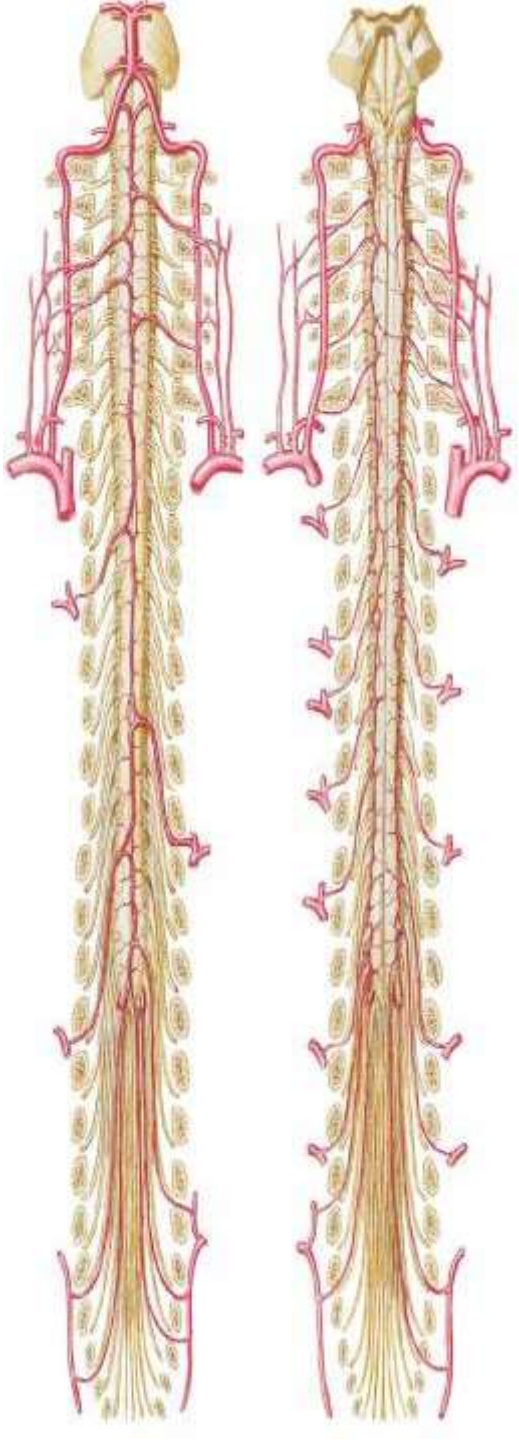
Quiz

- If there is herniation for nucleus pulposus in the level showed by the arrow , which nerve root will be affected ?!

- Answer is L3

Blood supply

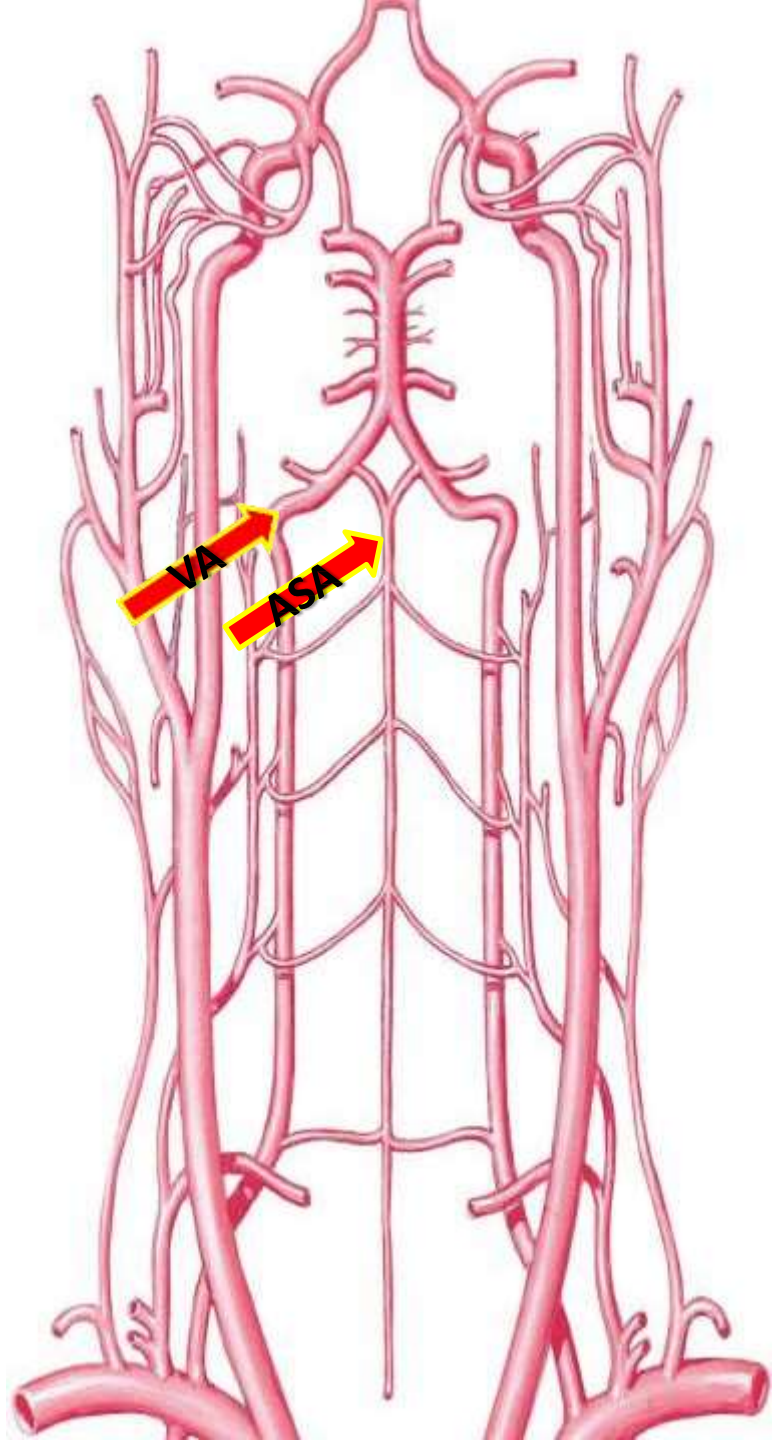
- The spinal cord is supplied by the (single) anterior and (right and left) posterior spinal arteries which descend from the level of the foramen magnum and form three longitudinal channels from which branches enter the cord.
- They are supplemented at variable levels by anastomoses with a variable number of radicular arteries.
- The main arteries supply the spinal cord lies on pia mater whereas their small branches evaginate it.



Anterior spinal artery

- **Origion :** union of the two anterior spinal branches, each given off by a vertebral artery above the foramen magnum.
- **Supply : (4 areas) It supplies the whole cord anterior to the posterior grey columns, i.e. the lateral grey and white columns and the anterior grey and white columns of both sides.**
- **The anterior spinal artery is a midline vessel that lies on the anterior median fissure.**

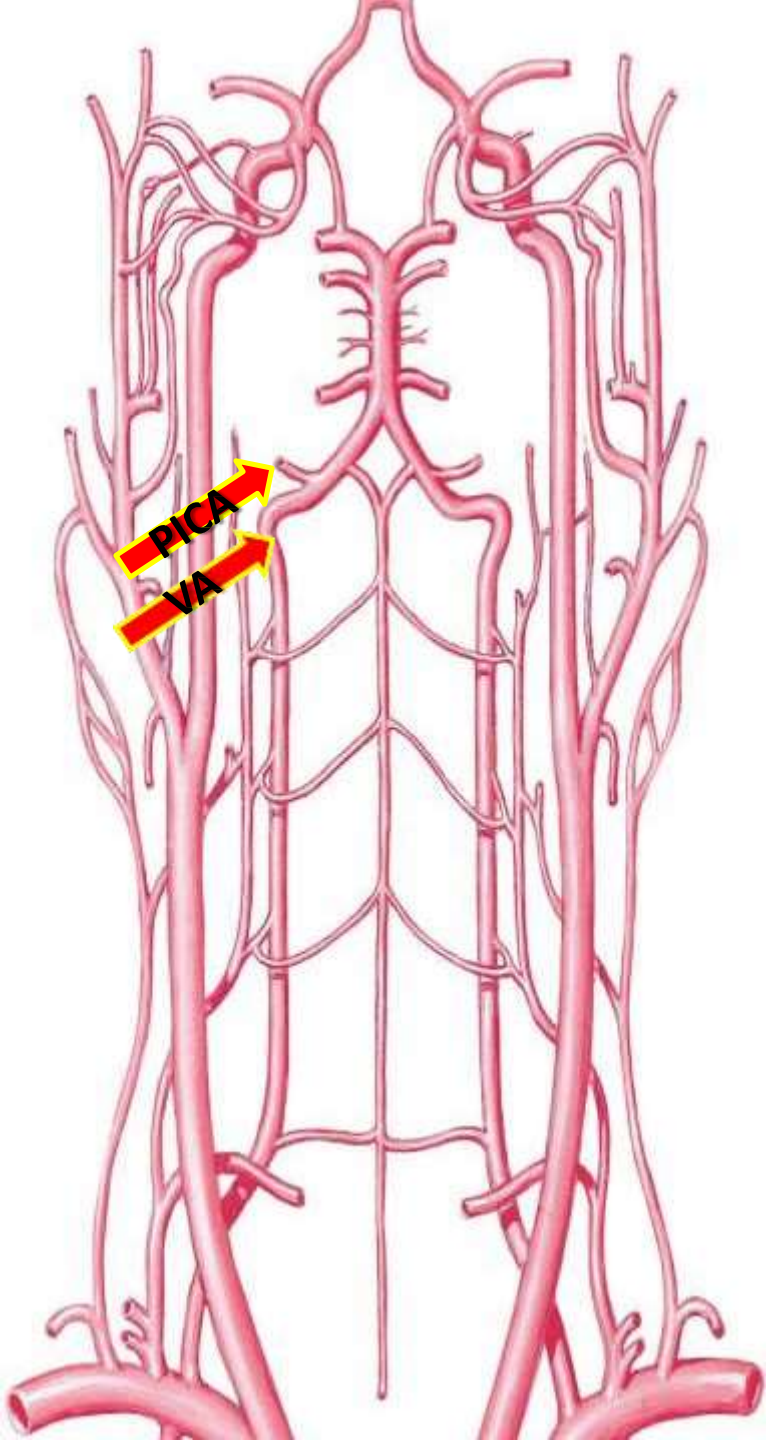
** ASA = Anterior Spinal Artery VA = Vertebral Artery



Posterior spinal artery

- **Origion :** The posterior spinal artery on each side arises from the posterior inferior cerebellar or vertebral artery above the foramen magnum.
- **Supply :** The posterior spinal artery supplies the grey and white posterior columns of its own side.
- Posterior spinal a. is NOT shown.
- PSA is forming longitudinal trunks that run through and behind the posterior nerve rootlets for the whole length of the cord.
- There is some anastomosis between the vessels of the two sides, with rather scanty connections with the anterior spinal artery, **except at the lower end of the cord where there are often good anastomoses.**

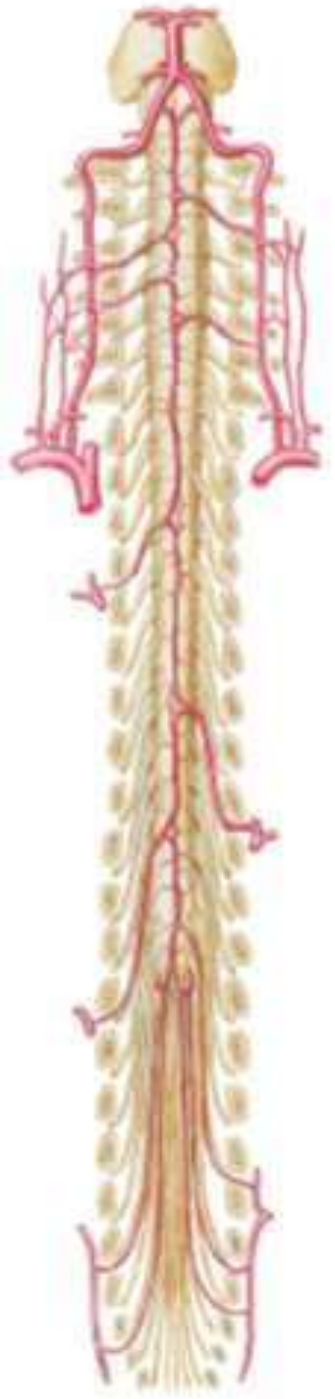
** PICA = Posterior Inferior



Radicular arteries

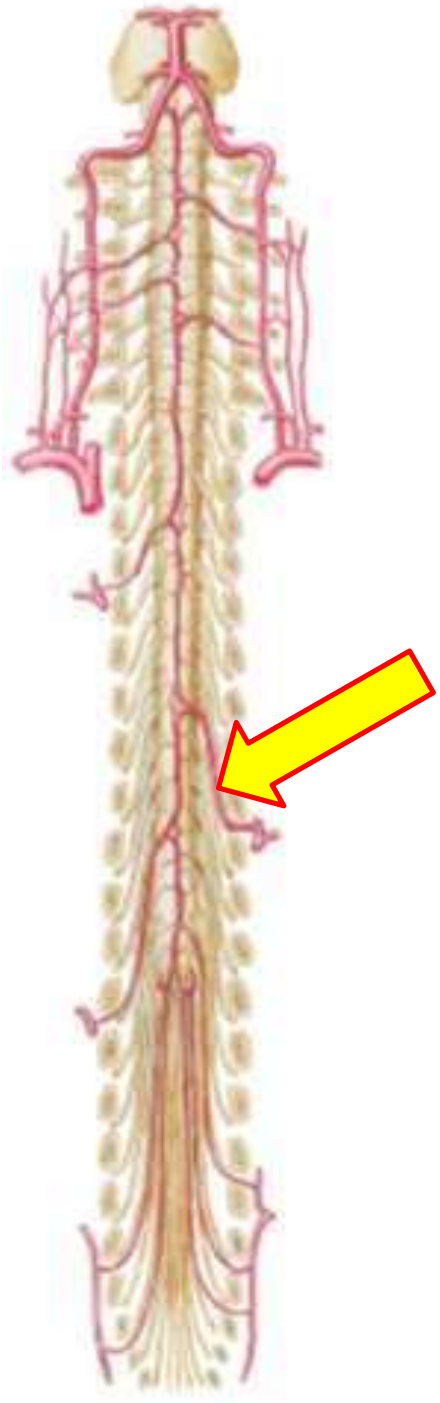
- At one stag during embryonic development every segment of the cord receives a radicular vessel on both sides; they enter through the intervertebral foramina as spinal arteries to penetrate the meninges and run along the nerve roots.
- They are derived from various parietal vessels depending on the level, s, sacral.
- As fetal growth proceeds, most of the radicular arteries disappear.
- Their most characteristic feature is

1. their variability in number and position.
2. blood from them may flow



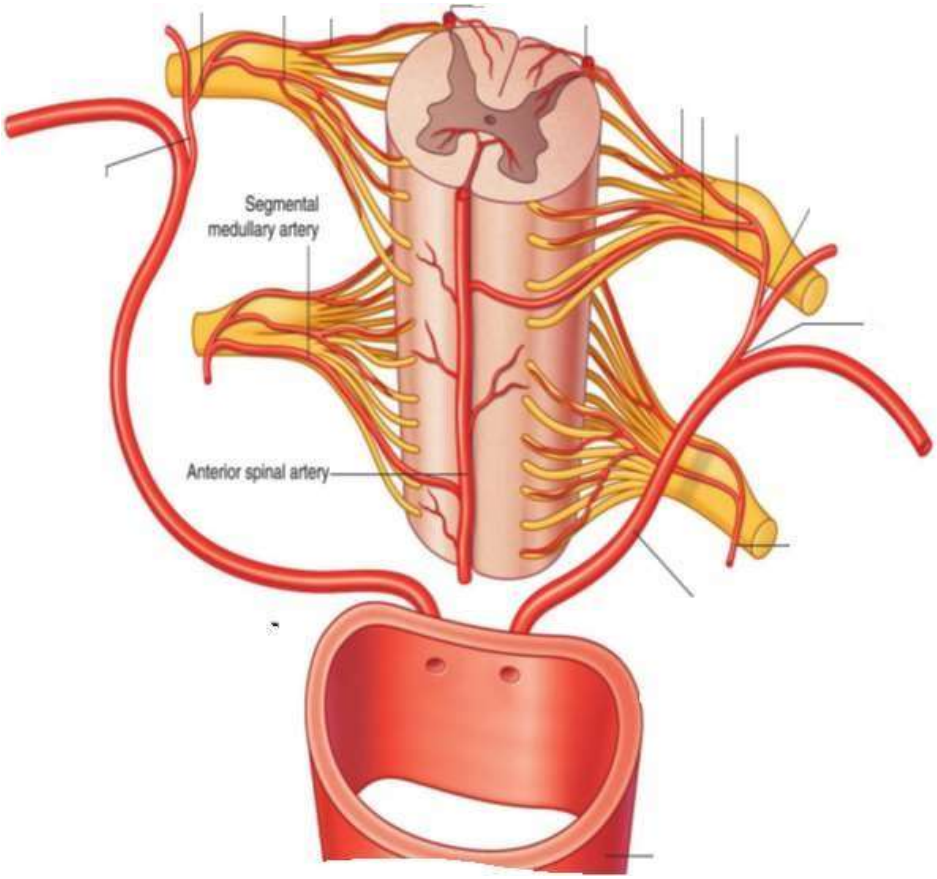
Adamkiewicz artery

- arteri radicularismagna (a Adamkiewicz), usually arises from a lowe intercostal or upper lumbar branch of the aorta on the left side.
- Operations on the vertebral column or adjacen structures (such as aortic aneurysms) that interfere with the parent stem of a major radicular vessel may seriously impair the blood supply to the cord.



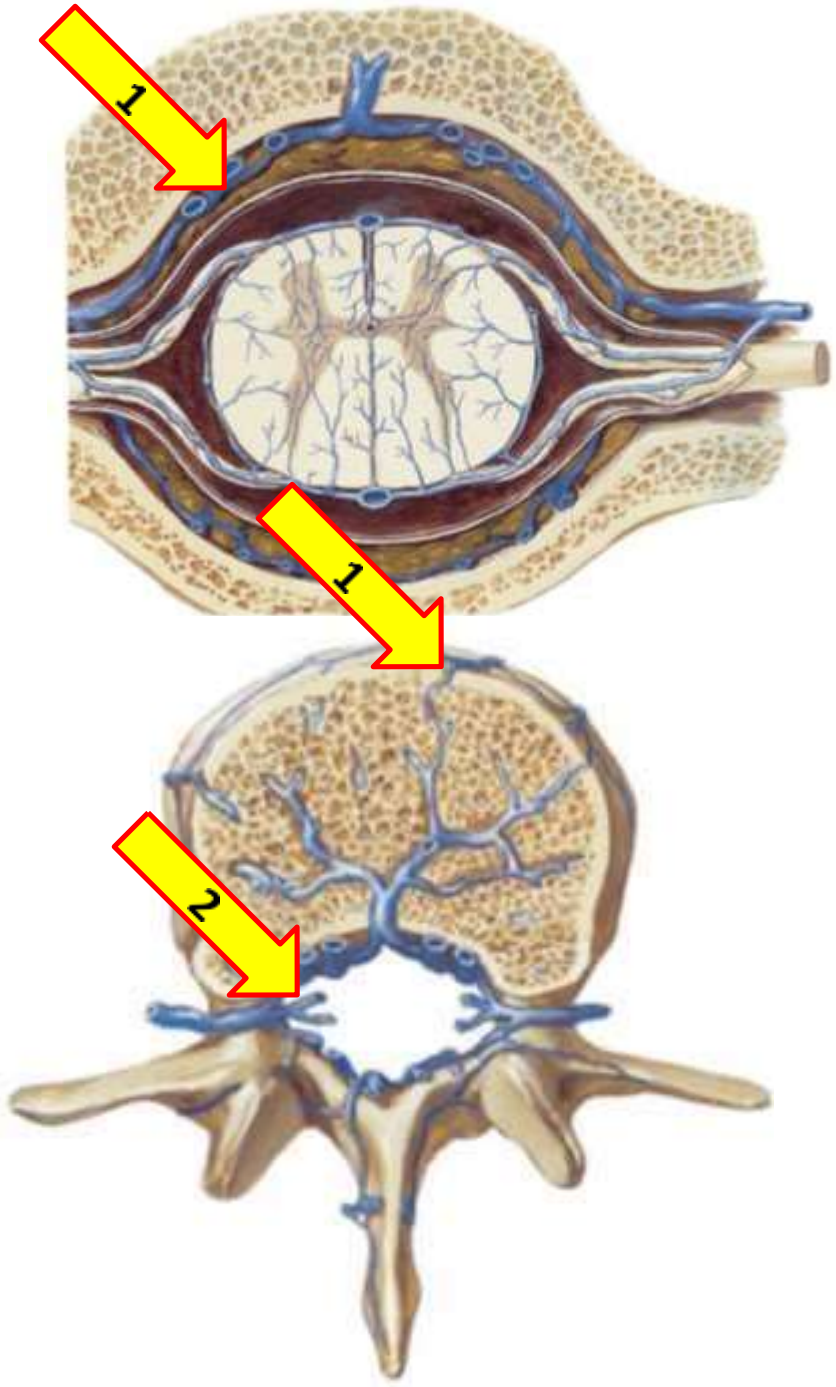
Anastomosis

- The anastomotic connections on the surface of the cord (deep to the pia mater) between the anterior and posterior spinal and radicular vessels provide very small pial arteries that are capable of supplying peripheral areas of the cord.
- This is important with respect to the lateral corticospinal and anterolateral tracts whose fibres are laminated, with sacral fibres lying nearest to the surface.
- Interference with the anterior spinal supply may eliminate the function of these tracts, except for the sacral fibres which remain supplied by the pial vessels (‘sacral sparing’).



Venous drainage

- The spinal veins form loose-plexuses in which there are anterior and a midline longitudinal vein, and one on each side a pair of longitudinal veins posterior to
- the anterior and posterior nerve roots.
- These veins drain to the internal vertebral venous plexuses (1) between (2) dura and bony canal, and through the intervertebral foramina to the veins of the neck; azygos in the thorax; lumbar in the lumbar region; and lateral sacral in the sacral region.
- At the foramen magnum they communicate with the veins of the medulla.



THANK YOU