Peripheral nervous system

Peripheral nervous system comprises:

A) Cranial nerves:

12 in number, arise mainly from brain stem.

B) Spinal nerves:

arise from spinal cord, varies in number according to species.

C) Autonomic nervous system :

1-Sympathetic (thoracolumbar) division.

2-Parasympathetic (craniosacral) division.

Cranial nerves

- They are 12 pairs
- **General features:**

– They are known by roman numbers from (rostral to caudal) .

– Some nerves take their names according to:

* Function as olfactory and abducent
* Distribution as facial and hypoglossal
* Shape as trigeminal.

- All cranial nerves have superficial origins on ventral aspect of brain except trochlear nerve originates from dorsal aspect of brain.

-All cranial nerves except first one originate from brain stem.

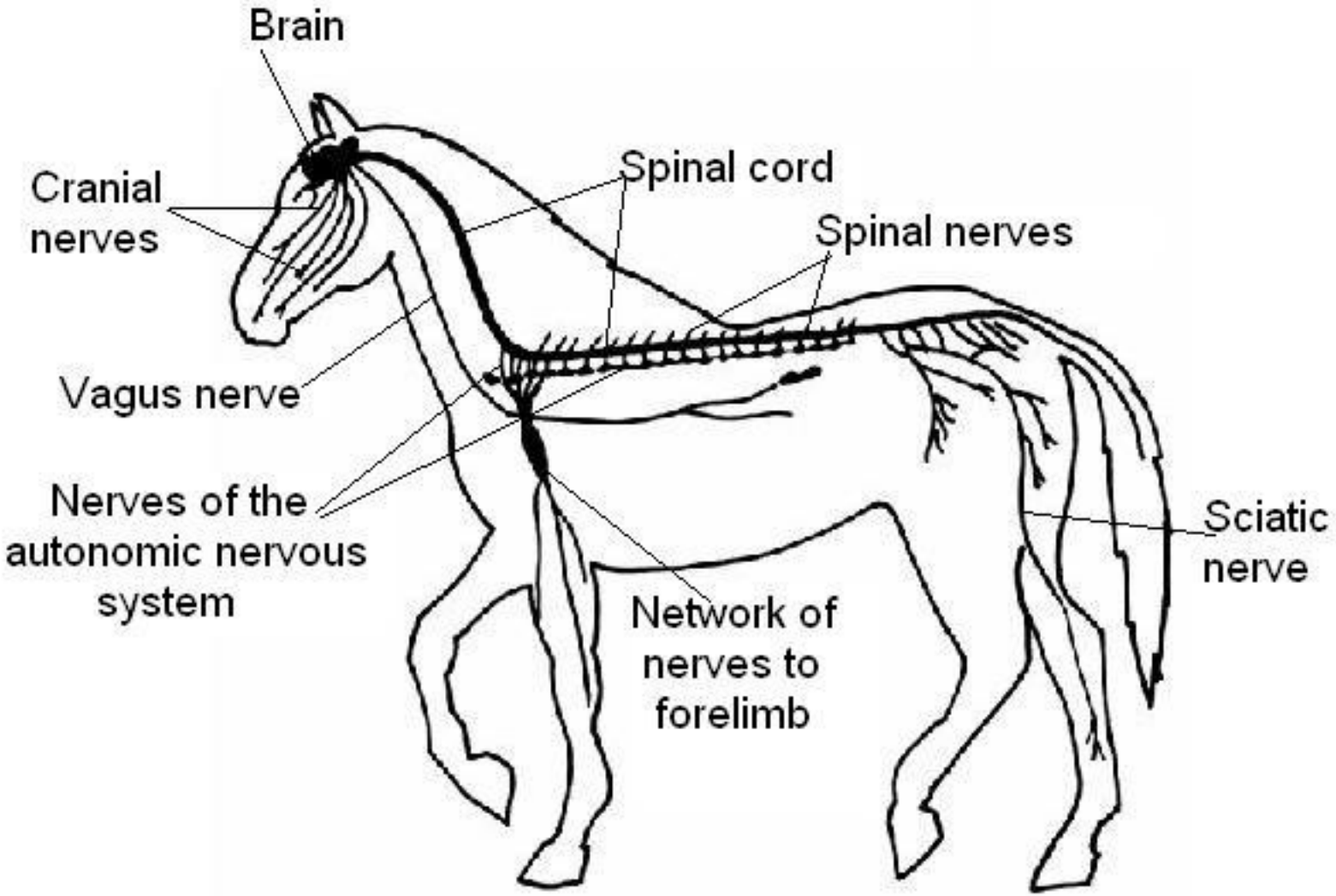
- Each nerve emerges from cranial cavity through a foramen.

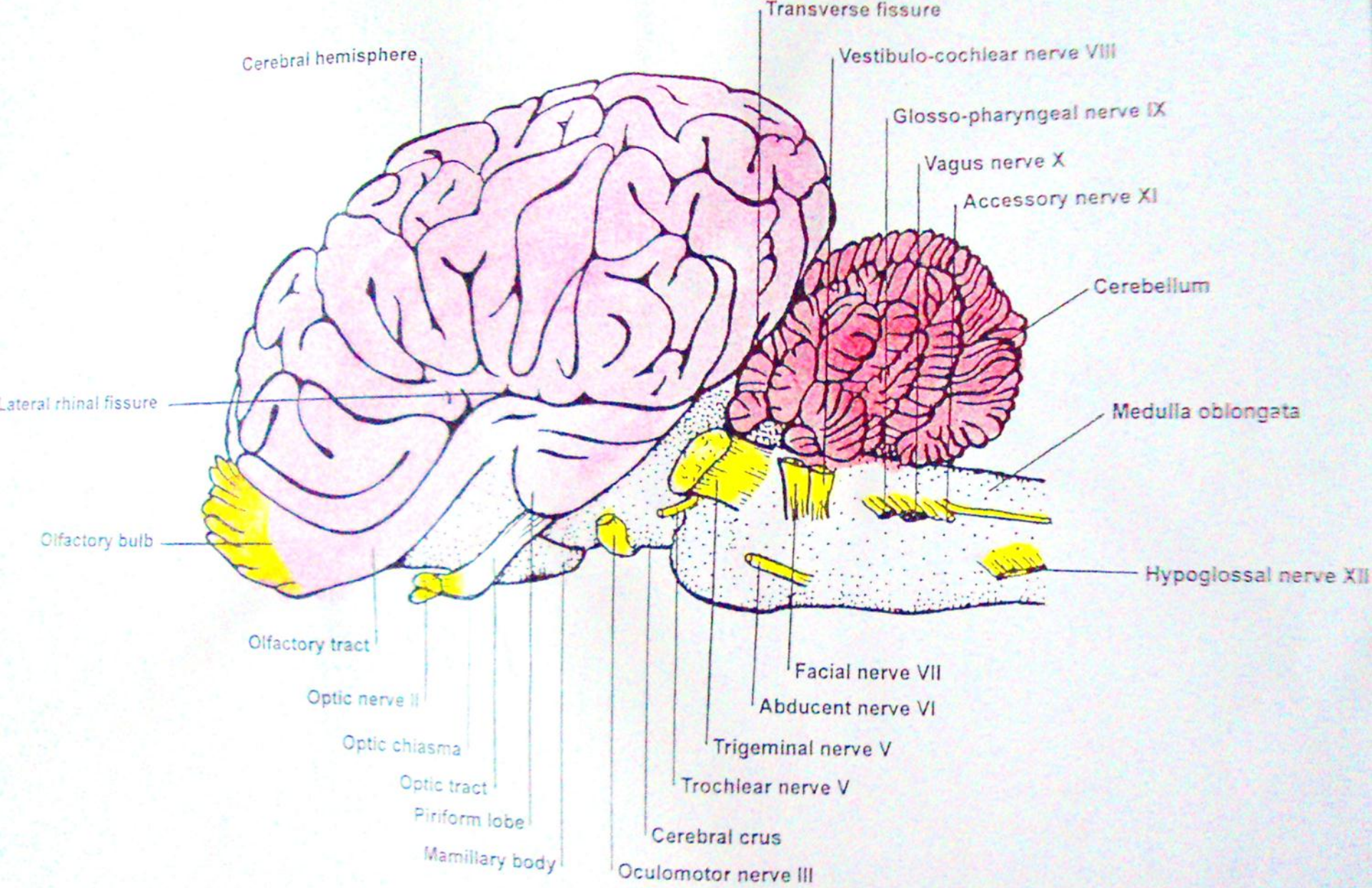
- The largest cranial nerve is **trigeminal N.**, while the smallest cranial nerve is **trochlear N.**

- All cranial nerves except vagus distributed generally in head region.

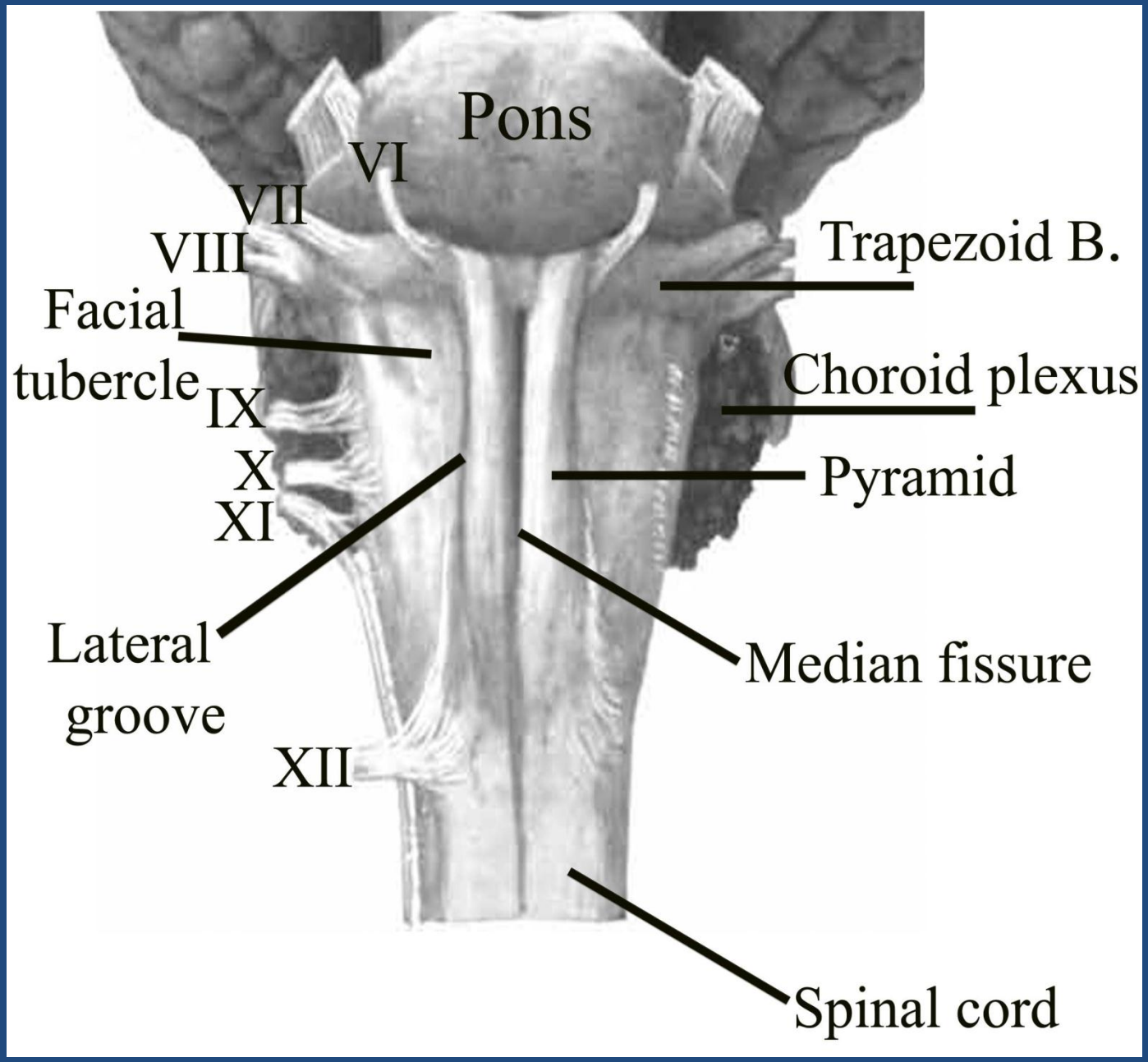
- 3,7,9,10 cranial nerves carry parasympathetic fibers.

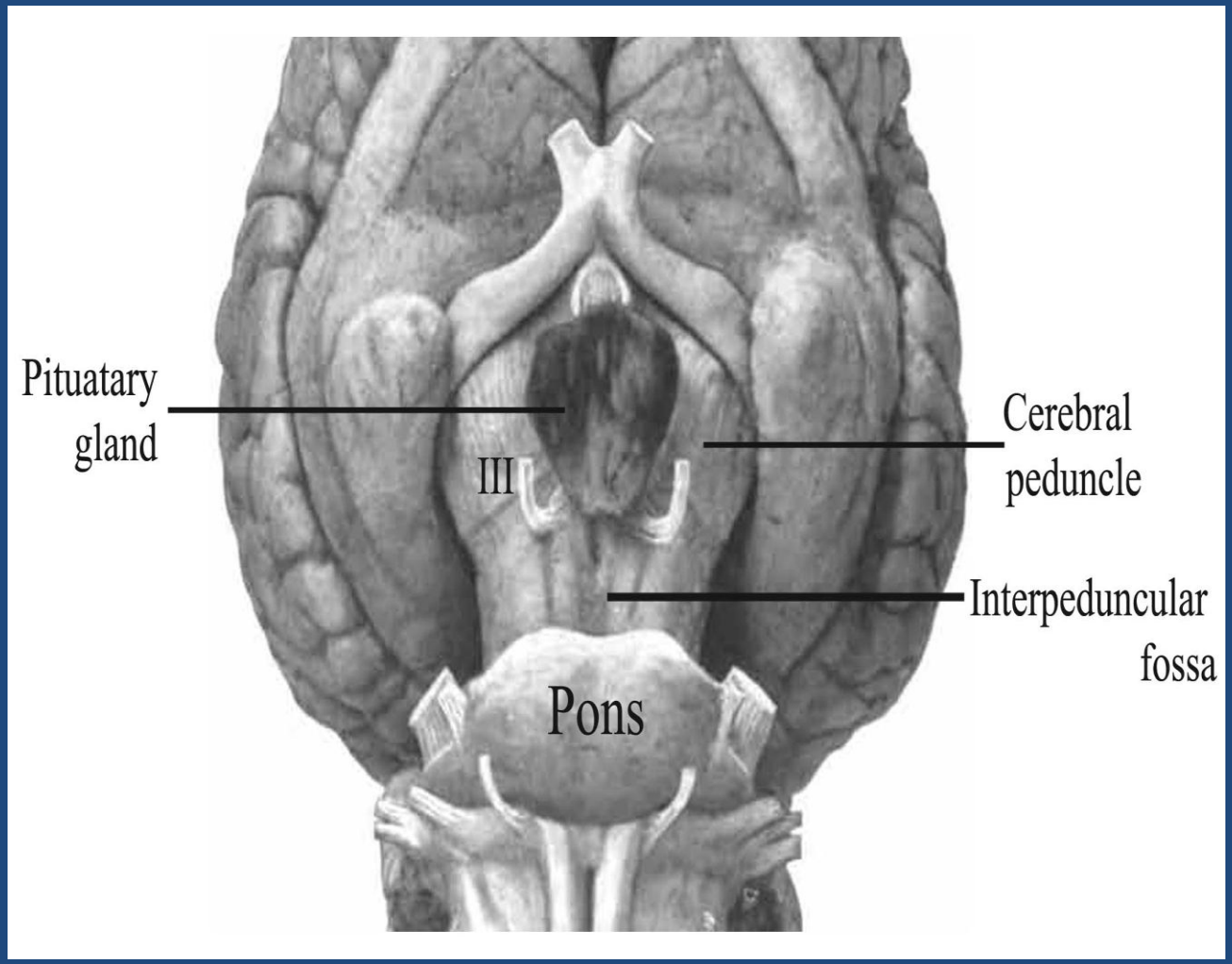
- Classification of cranial nerves:
- They are classified according to the function into:
  1-Sensory nerves: 1,2,8.
  2-Motor nerves: 3,4,6,11,12.
  3-Mixed nerves: 5,7,9,10.

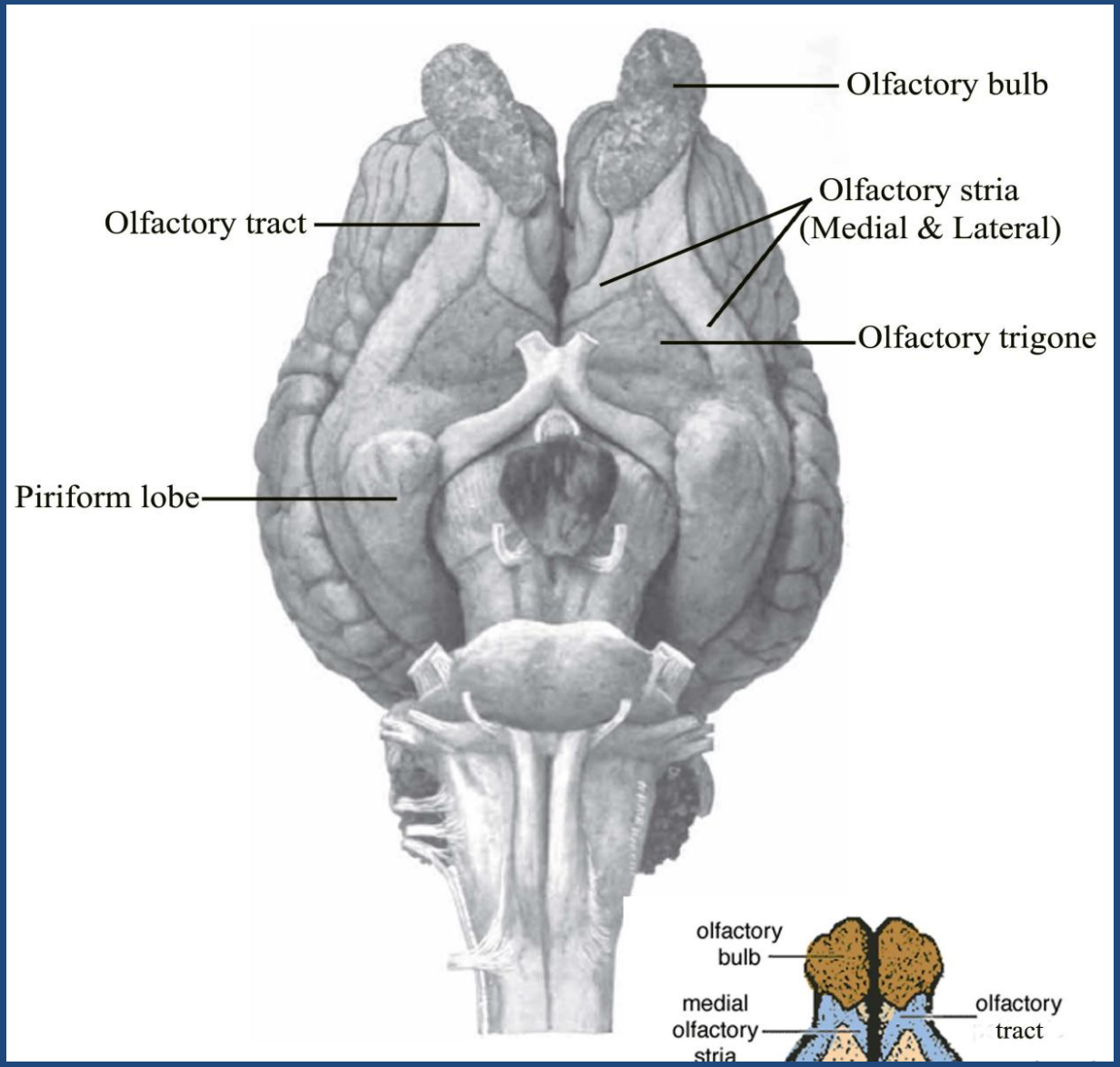

Brain
Cranial nerves
Spinal cord
Spinal nerves
Vagus nerve
Nerves of the autonomic nervous system
Network of nerves to forelimb
Sciatic nerve



Brain, lateral view


Pons
VI
VII
VIII
Facial
tubercle
IX
X
XI
Lateral
groove
XII
Trapezoid B.
Choroid plexus
Pyramid
Median fissure
Spinal cord


Pituatary gland
III
Cerebral peduncle
Interpeduncular fossa
Pons


Olfactory bulb
Olfactory stria
(Medial & Lateral)
Olfactory tract
Olfactory trigone
Piriform lobe
olfactory
bulb
medial
olfactory
stria
olfactory
tract

I- Olfactory nerves

Type:

- Sensory for smell.

Origin:

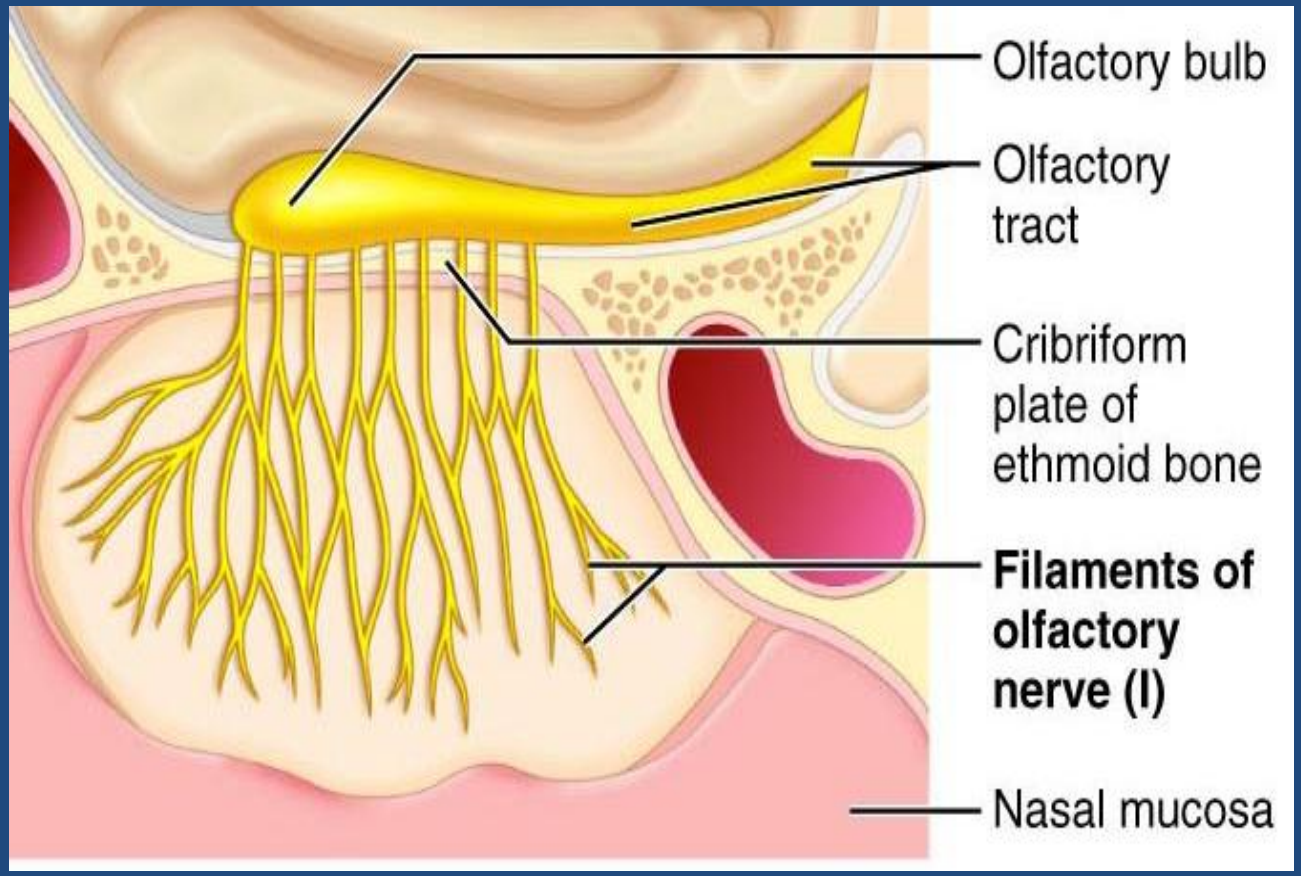
- Arises from the **olfactory epithelium** of olfactory region of nasal cavity.

Course:

- They pass though cribriform plate to join olfactory bulb.

➢ **Vomeronasal nerve:**

- It arises from vomeronasal organ ,passes through medial border of cribriform plate to terminate in olfactory bulb.


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

II- Optic nerve

Type:

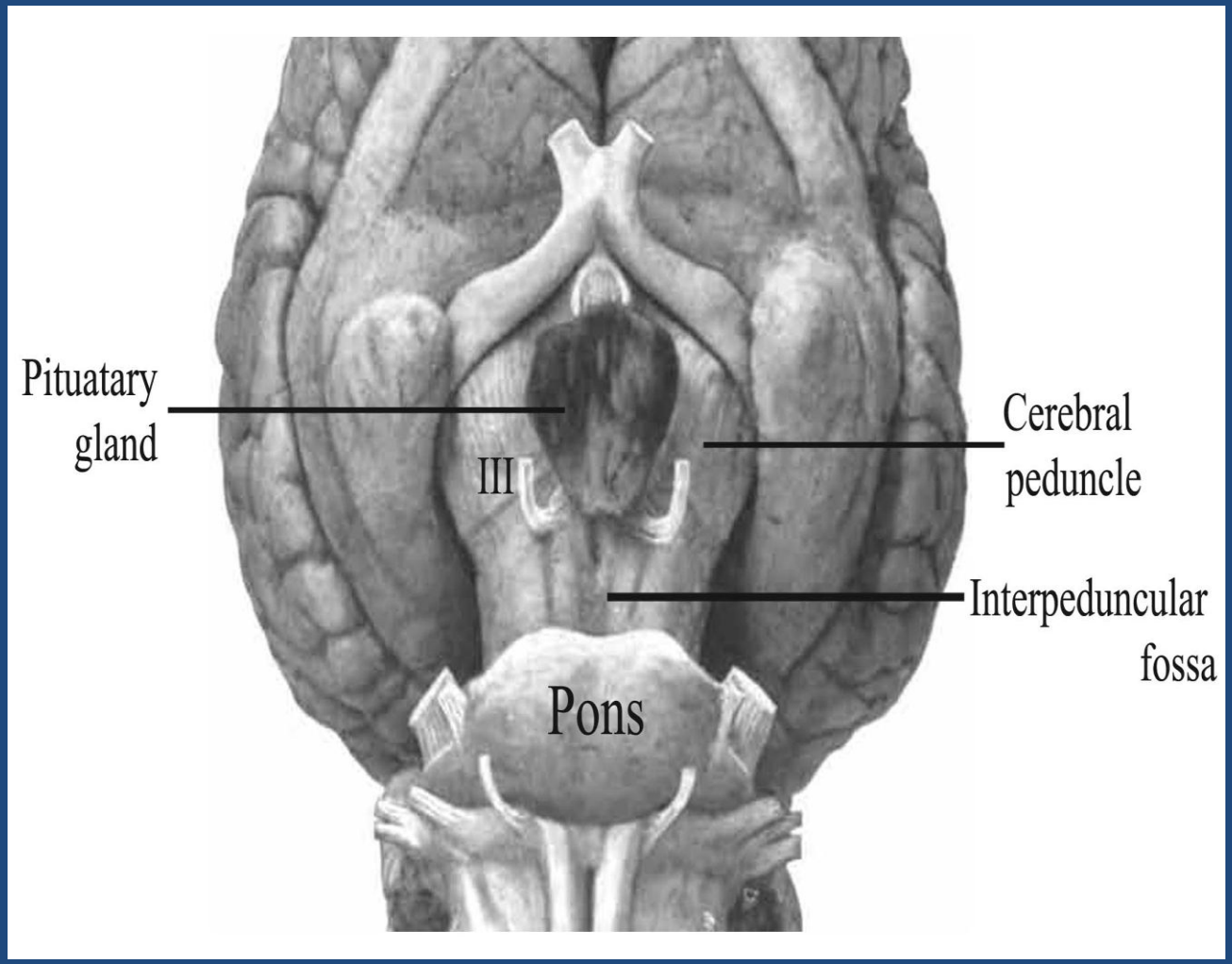
- Sensory for vision.

Origin:

- retinal ganglionic layer.

Course:

- Fibers converge toward optic papilla forming optic nerve, emerges from eyeball.
- Then passes through **optic foramen** and decussates with its fellow to form optic chiasma.


Pituatary gland
III
Cerebral peduncle
Interpeduncular fossa
Pons

III- Oculomotor Nerve

Type:

- motor nerve.
- It carries parasympathetic fibers.

Origin:

- Medial aspect of cerebral crus.

Course:

- It passes through **orbital foramen**
- It divides into dorsal and ventral branches.

Distribution:

1) Dorsal branch supplies:

-levator palpebrae superiori muscle.

-dorsal rectus muscle.

2) Ventral branch is longer:

It carries ciliary ganglion.

It supplies:

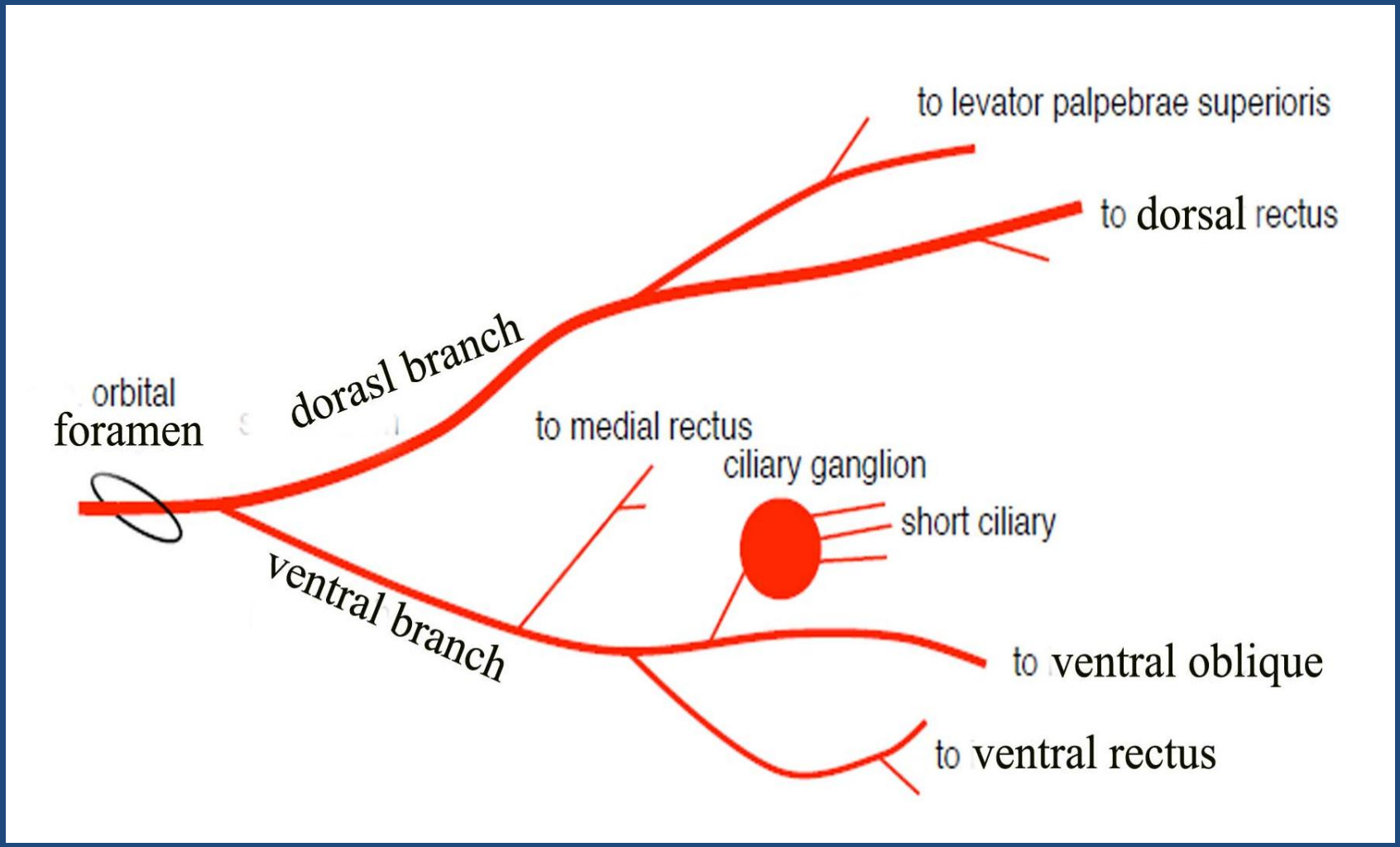
-Medial rectus muscle.

-Ventral rectus muscle.

-Ventral oblique muscle.

- **Functions**:

All extraocular muscles of eyeball except lateral rectus and dorsal oblique muscle (**directing the eyeball**). Also, it supplies levator palpebrae superioris muscle (**raising the eyelid**), besides, it also supplies autonomic fibers to sphincter pupillae and cilliaris muscles (**constricting the iris**, and **controlling lens shape**).


to levator palpebrae superioris
to dorsal rectus
orbital foramen
dorasl branch
to medial rectus
ciliary ganglion
short ciliary
ventral branch
to ventral oblique
to ventral rectus

IV- Trochlear nerve

Type:

- motor nerve. Smallest cranial nerve.

Origin:

- dorsal midbrain just behind corpora quidrigemina.
- The only cranial nerve appears on dorsal surface of brain

Course:

- Passes through orbital foramen.

Distribution:

- Supplies dorsal oblique muscle of eyeball.

V- Trigeminal nerve

Type:

- Mixed nerve. largest cranial nerve

Origin:

- It arises from lateral part of pons by two roots:

A) large sensory root: carries semilunar or trigeminal ganglion from which arise ophthalmic, maxillary and mandibular nerves .

B) Small motor root: is incorporated with mandibular nerve.

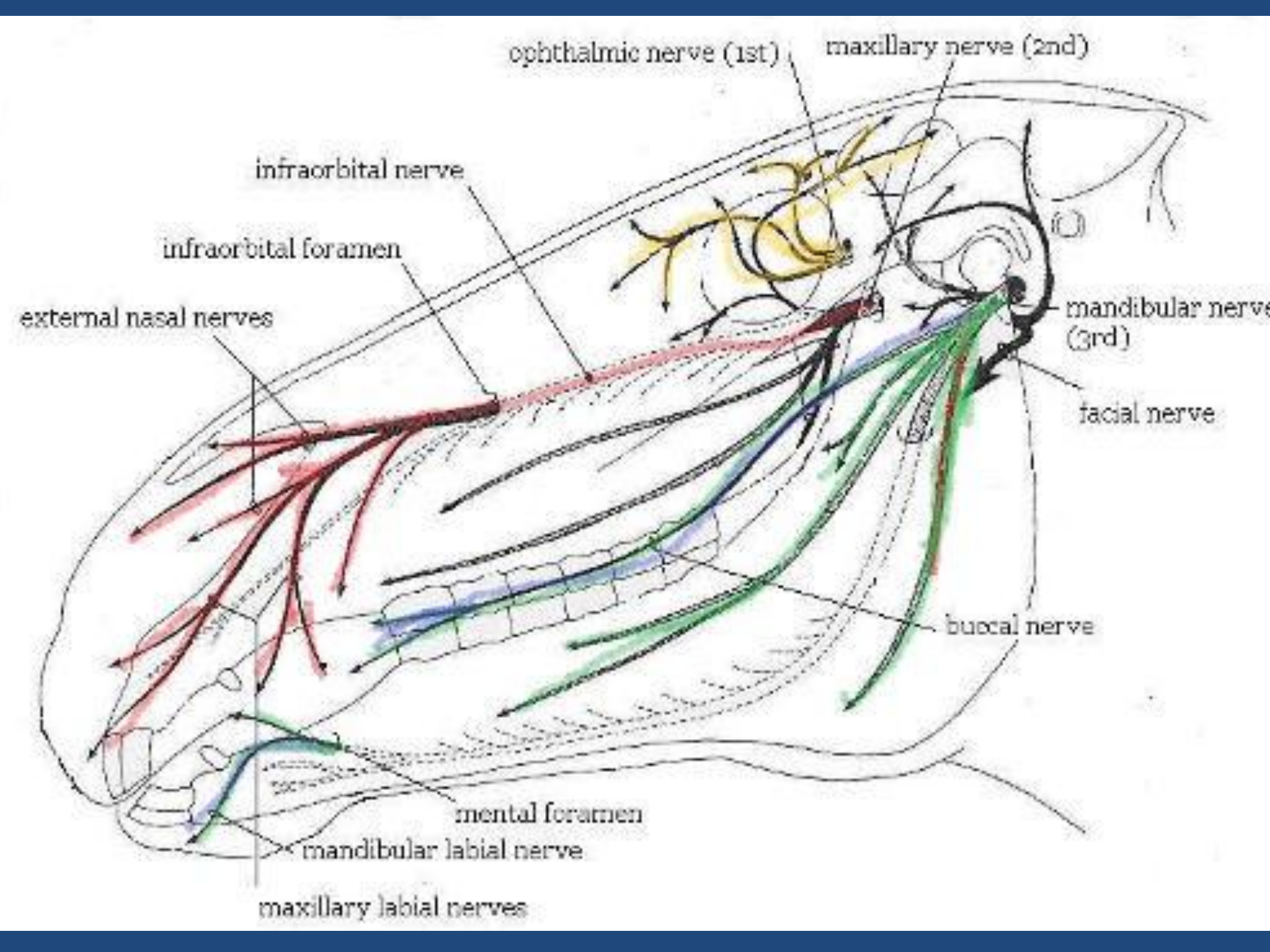
Course and distribution:

- It divides into :

    1-Ophthalmic nerve (sensory nerve)

    2-Maxillary nerve (sensory nerve)

    3-Mandibular nerve (mixed)


ophthalmic nerve (1st)
maxillary nerve (2nd)
infraorbital nerve
infraorbital foramen
external nasal nerves
mandibular nerve (3rd)
facial nerve
buccal nerve
mental foramen
mandibular labial nerve
maxillary labial nerves

A) Ophthalmic nerve

Type:

- Sensory nerve. Smallest branch of trigeminal nerve.

Course:

- It passes through orbital foramen to be in orbit where it divides into:
  1- Frontal N.
  2- Lacrimal N.
  3- Zygomaticotemporal N.
  4- Nasociliary N.

Distribution:

1. Frontal nerve:

- It emerges from supraorbital foramen as supraorbital nerve.
- Ramifies in skin of forehead and upper eyelid

2.Lacrimal nerve:

- Ramifies in lacrimal gland and upper eyelid.

3.Zygomaticotemporal branch:.

- Ramifies in skin of temporal region.

4.Nasociliary nerve:

It gives off:

A-Communicating branch to ciliary ganglion.

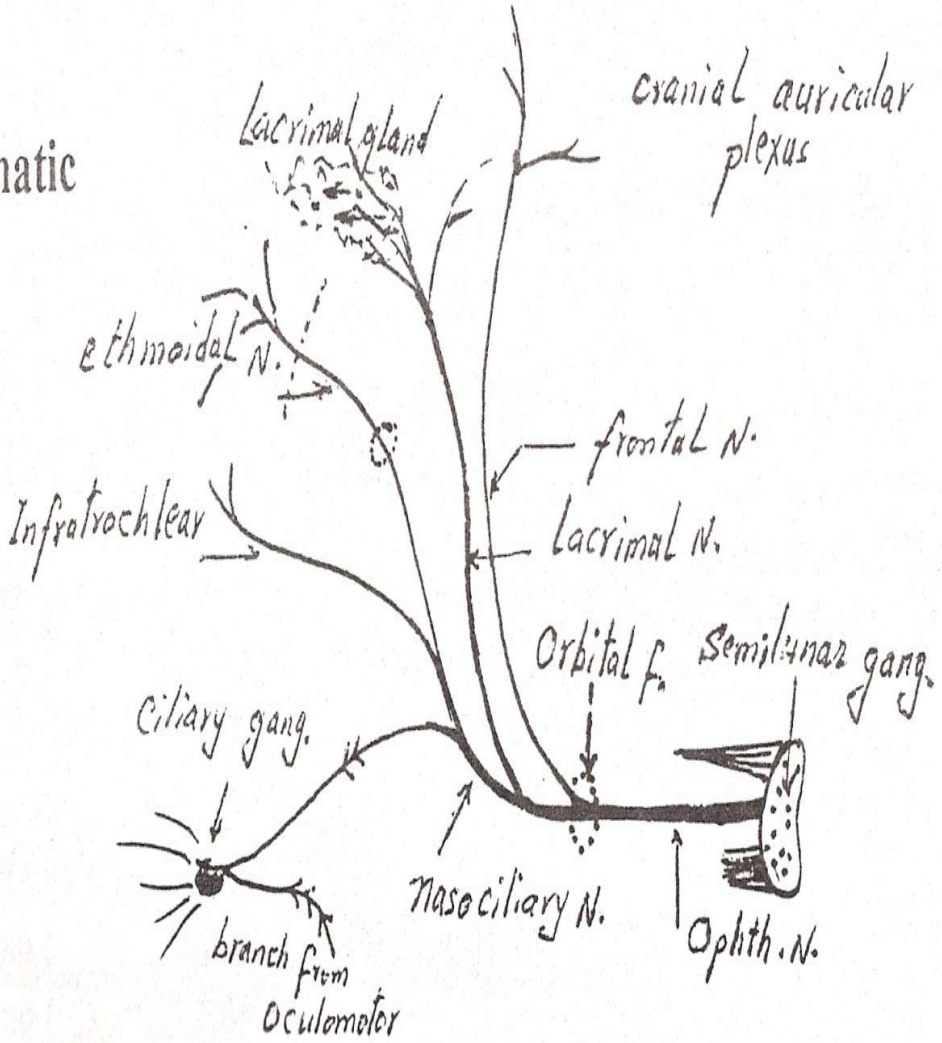
B-Long ciliary nerves: to pierce sclera.

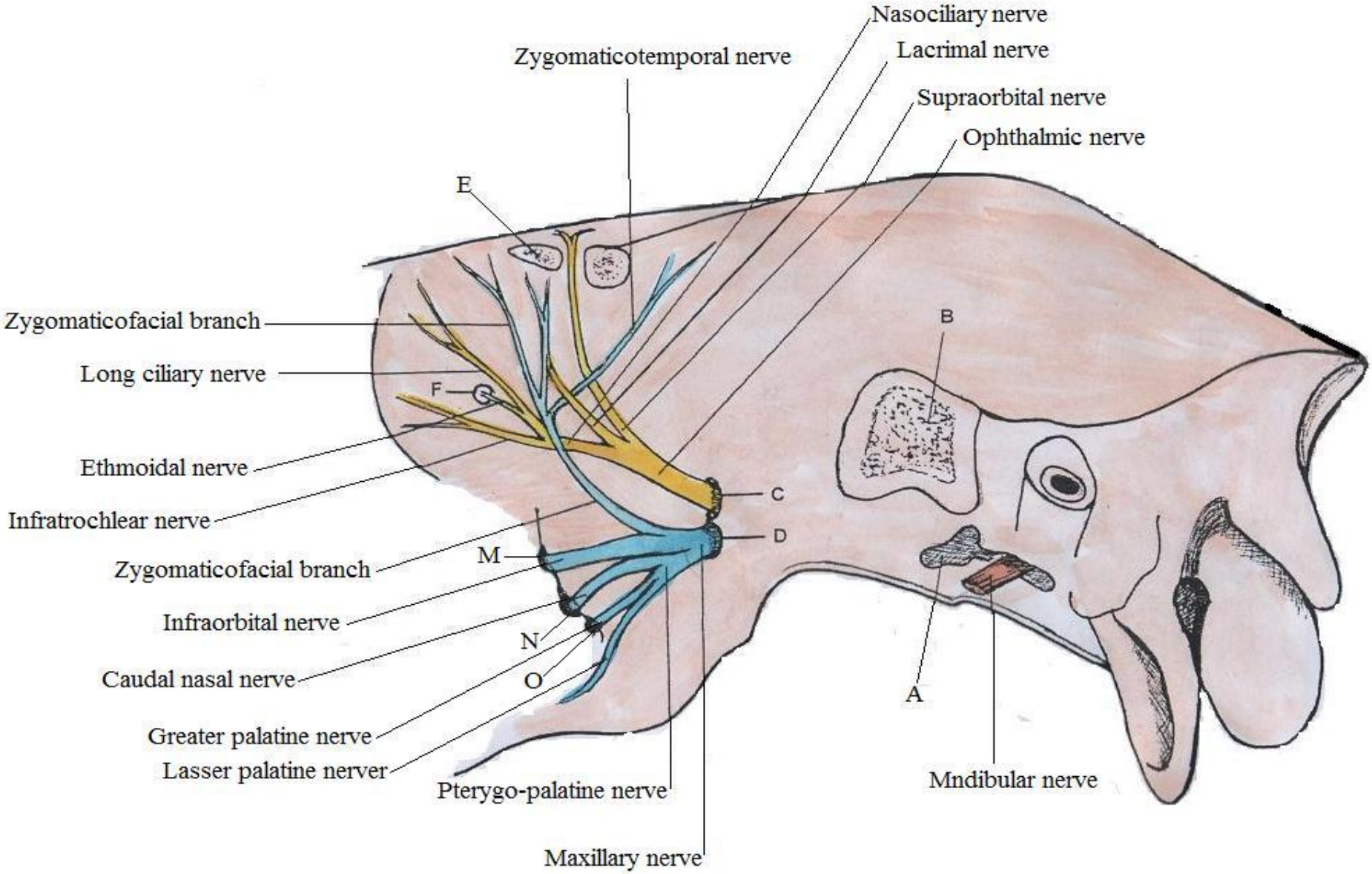
C-Ethmoidal nerve: enters nasal cavity .

D-Infratrochlear nerve: supplies skin of medial angle of eye.

Fig. 119.

Distribution of the ophthtalmic N.; diagramatic





Trigeminal nerve (Ophthalmic and maxillary nerves)

B) Maxillary nerve

Type:

- It is sensory nerve.

Course:

- It passes through foramen rotundum and it gives off:
    1- zygomaticofacial branch.
    2- pterygopalatine nerve
    3- infraorbital nerve.

Distribution:

1. Zygomaticofacial branch:

Ramifies in in skin of lateral angle and lower eyelid

2. pterygopalatine nerve:

a)Caudal nasal nerve:

Passes via sphenopalatine foramen to nasal cavity.

b) Greater palatine nerve:

Passes through palatine canal to supply hard palate, gums and soft palate .

c) Lesser palatine nerve:

Passes through palatine groove to supply in soft palate.

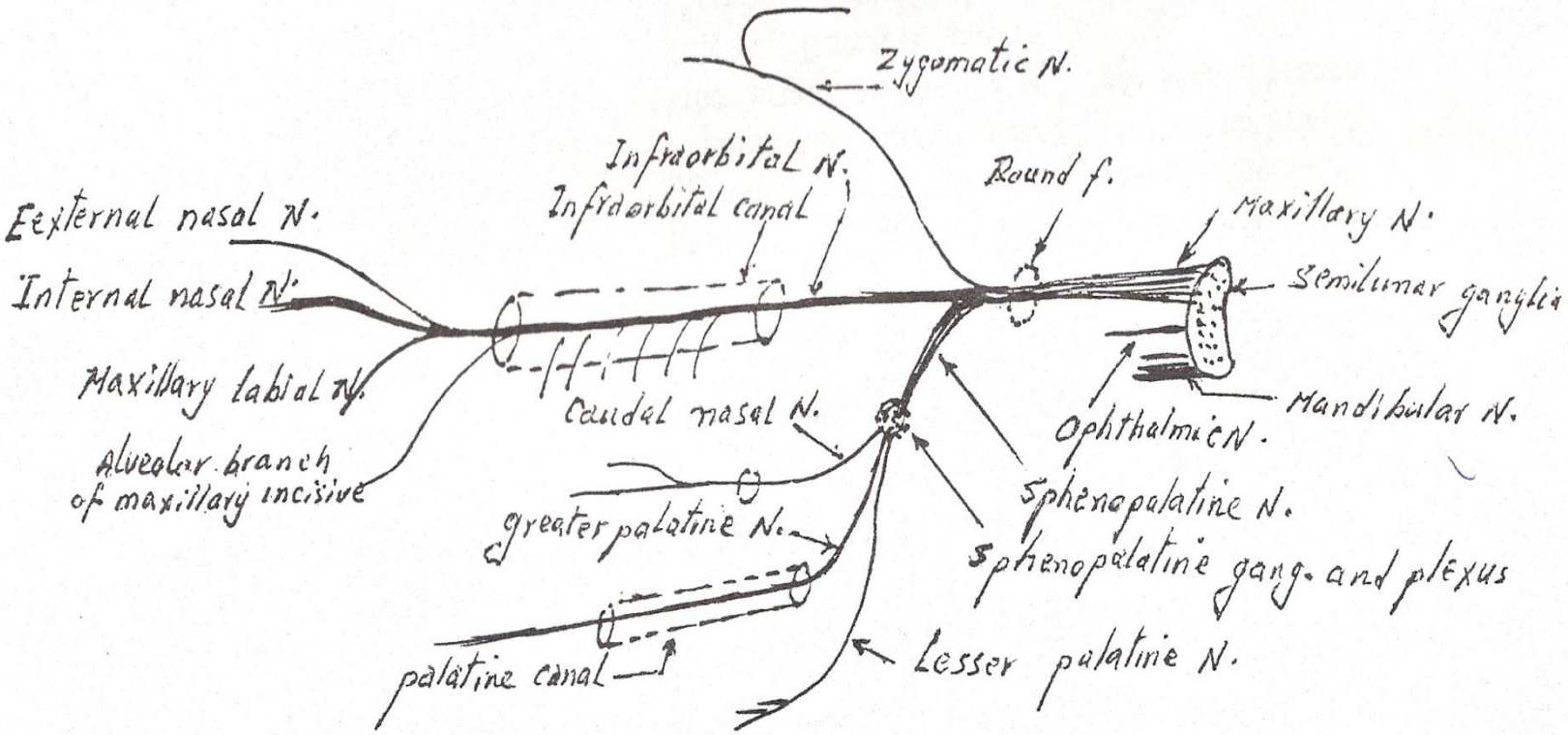


Fig. 119. Distribution of the maxillary N.; diagramatic

3. Infraorbital nerve:

- It passes through infraorbital canal where it gives alveolar branches to teeth, alveolar periosteum and gums.
- After leaving the canal it gives off:

a) External nasal branches:

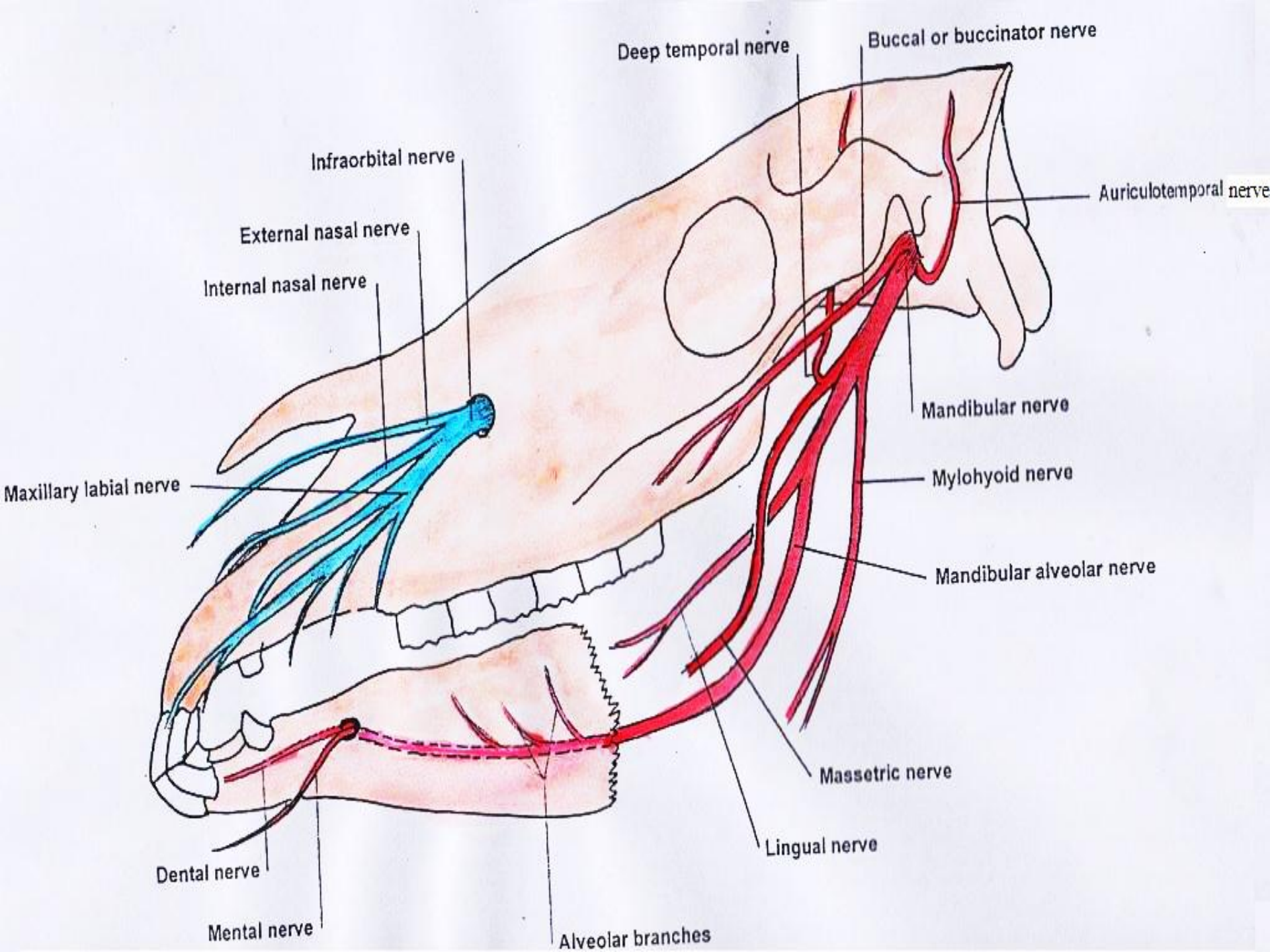
Supplies nasal region and nasal diverticulum.

b) Internal nasal branches:

Supplies upper lip, nostrils and nasal vestibule.

c) Maxillary labial branches:

Supplies cheek and upper lip.


Deep temporal nerve
Buccal or buccinator nerve
Infraorbital nerve
Auriculotemporal nerve
External nasal nerve
Internal nasal nerve
Mandibular nerve
Maxillary labial nerve
Mylohyoid nerve
Mandibular alveolar nerve
Massetric nerve
Lingual nerve
Dental nerve
Mental nerve
Alveolar branches

C) Mandibular nerve

Type:

- Mixed nerve.

Course:

- It passes through oval foramen.
- Supplies muscles of mastication.

Distribution:

1. **Masseteric nerve:**

   masseter M.

2. **Deep temporal nerves:**

   2-3 branches to temporal muscle.

3. Buccal nerve:

Supplies lateral pterygoid, cheeks and buccal glands.

4. Medial pterygoid nerve:

supplies medial pterygoid and and tensor veli palatini.

5. Auriculotemporal nerve: It divides :

a) Transverse facial branch:

ramifies in skin of cheek.

b) Ventral branch:

Unites with the ventral buccal branch of facial nerve.

6. Mandibular alveolar nerve:

It enters mandibular canal, emerges at mental foramen

.

It gives off:

a) Mylohyoid nerve:

It supplies mylohyoid, **rostral belly of digastric** and skin of intermandibular space rostrally.

b) Alveolar branches:

Supply lower alveoli, teeth and gums.

c) Mental nerve:

Ramifies in lower lip and chin.

7. Lingual nerve:

-It supplies m.m. of rostral 2/3 of tongue

-it joins chorda tympani of facial nerve.

.

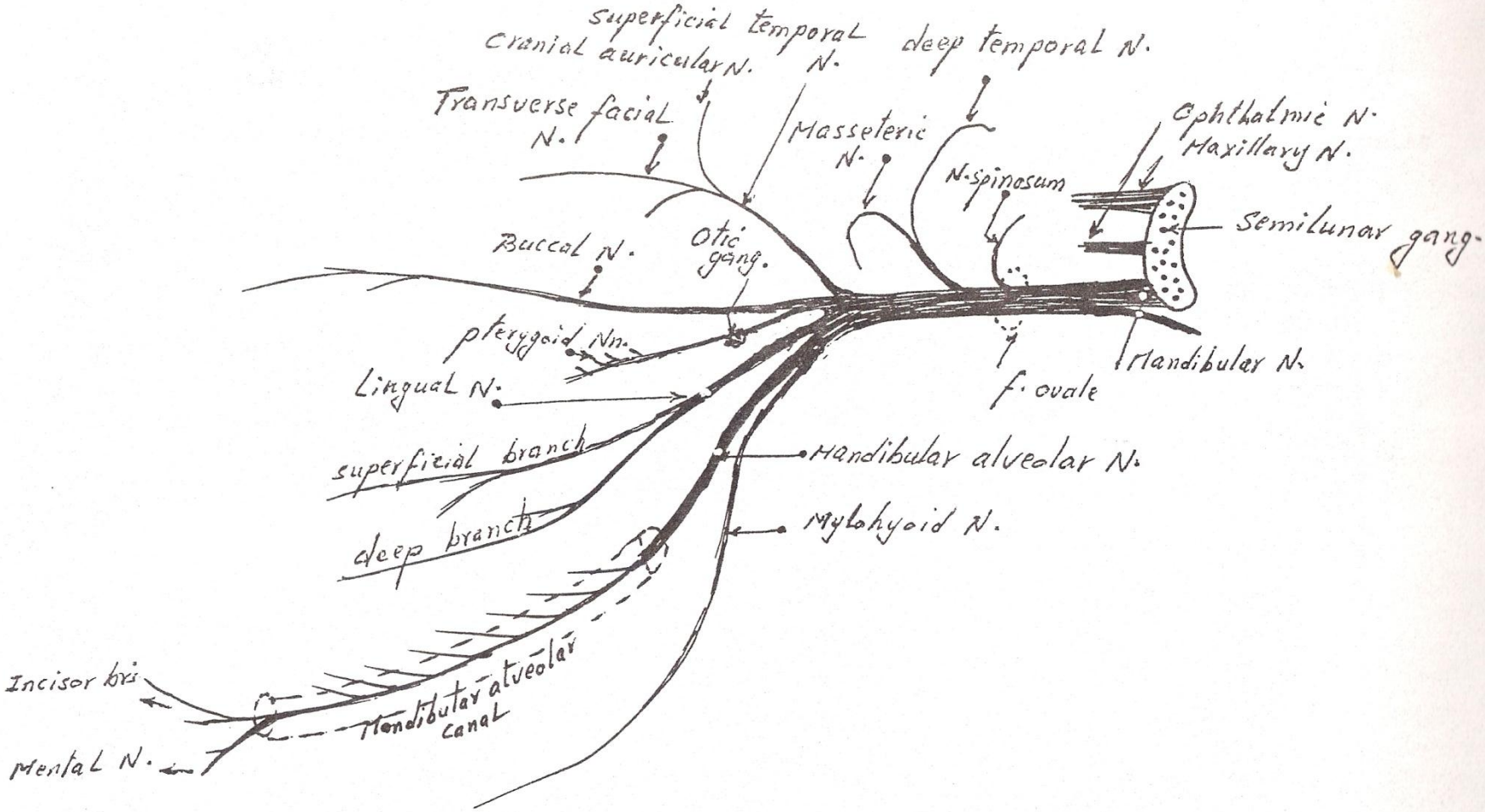


Fig. 120. Distribution of the mandibular N.; diagramatic

VI- Abducent nerve

Type:

- Motor nerve.

Origin:

- from medulla oblongata caudal to pons and just lateral to the pyramid.

Course:

- Passes through orbital foramen with oculomotor and ophthalmic nerves
- Divides into two branches.

Distribution:

It supplies:

1- Retractor oculi muscle. 2 -Lateral rectus muscle.

VII- The facial nerve

Type

- mixed nerve. It carries parasympathetic fibers.

Origin

- from lateral part of trapezoid body of medulla oblongata.

Course:

- It passes via internal acoustic meatus with 8th nerve to enter facial canal ,then leaves it at stylomastoid foramen.
- It bears geniculate ganglion.

Distribution:

A) Inside facial canal it gives off:

1. Greater petrosal nerve:

- it gives a filament to typmanic plexus.

2. A delicate branch:

- It unites with tympanic nerve of glosspharyngeal to form lesser petrosal nerve which ends in otic ganglion.

3. Chorda tympani:

- It joins lingual nerve of mandibular nerve and sends twigs to mandibular ganglia.
- It gives fibers to taste buds of rostral 2/3 of tongue.

B) After emergence from facial canal it gives:

1. Caudal auricular nerve:

- It innervates caudal and dorsal auricular muscles & skin of convex surface of external ear.

2. Internal auricular branch:

It supplies skin of concave surface of external ear.

3. Digastric branch:

- Innervates **caudal belly of digastric**, occipitomandibularis, stylohyoideus and occipitohyiodeus muscles.

4. Parotid branches:

- To parotid gland.

5. Auriculopalpebral nerve:

- It divides into :

a) Rostral auricular branches:

- It shares in formation in of auricular plexus which supplies auricularis rostralis, parotidoauricularis.

b) Zygomatic (Temporal) branch:

- It runs to medial angle of eye.
- It innervates orbicularis oculi, levator anguli oculi medialis, levator nasolabialis.

6. Cervial branch (ramus colli):

- Descends in neck.
- Anastomoses with cutaneous branches of 2-6 cervical nerves.

7. Dorsal buccal branch:

- Supplies muscles of upper lip and nostrils.
- Anastomoses with infraorbital nerve and ventral buccal branch.

8. Ventral buccal branch:

- Supplies depressor labii mandibularis, buccinator and cutaneous fasciei muscles.

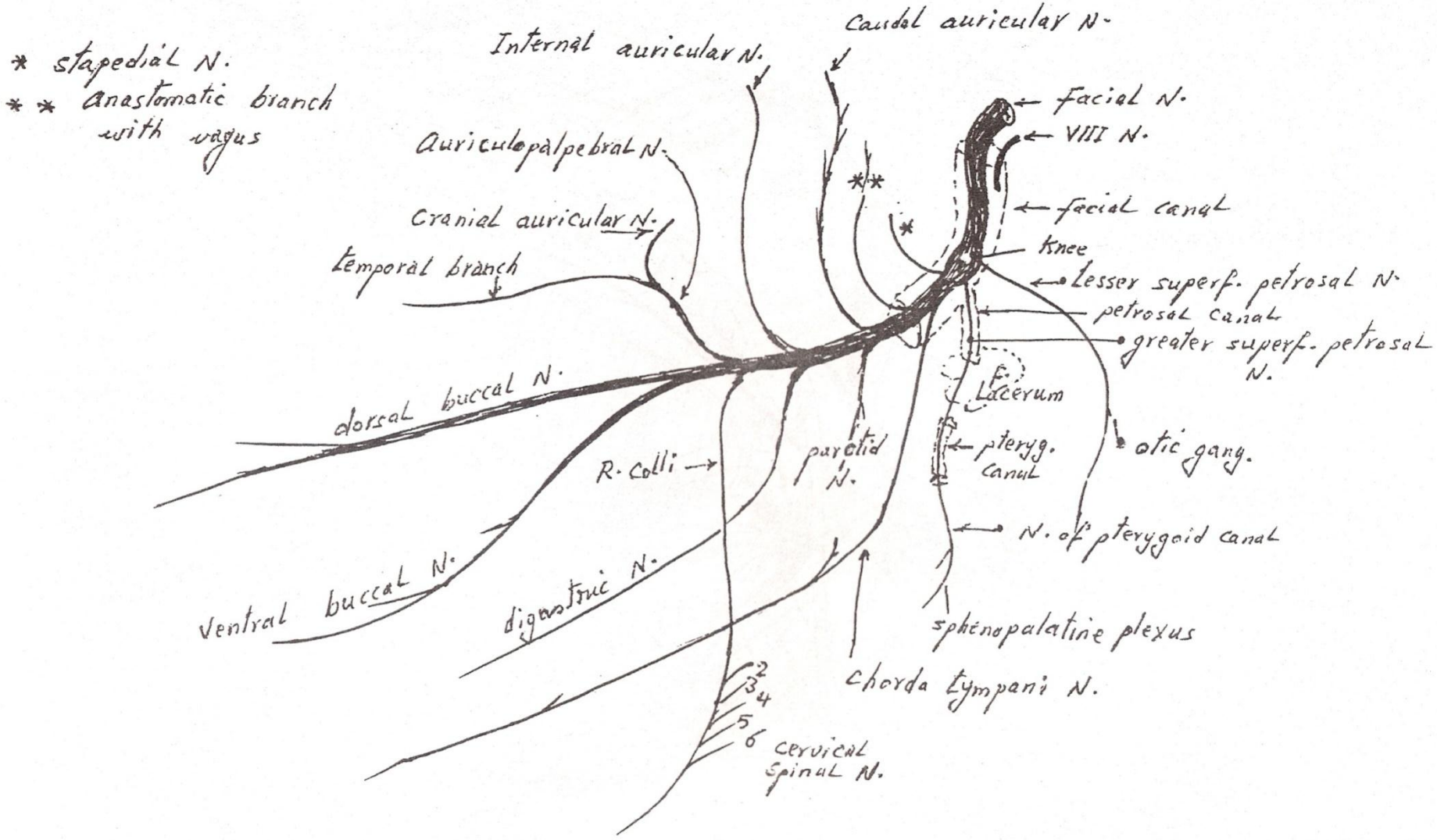
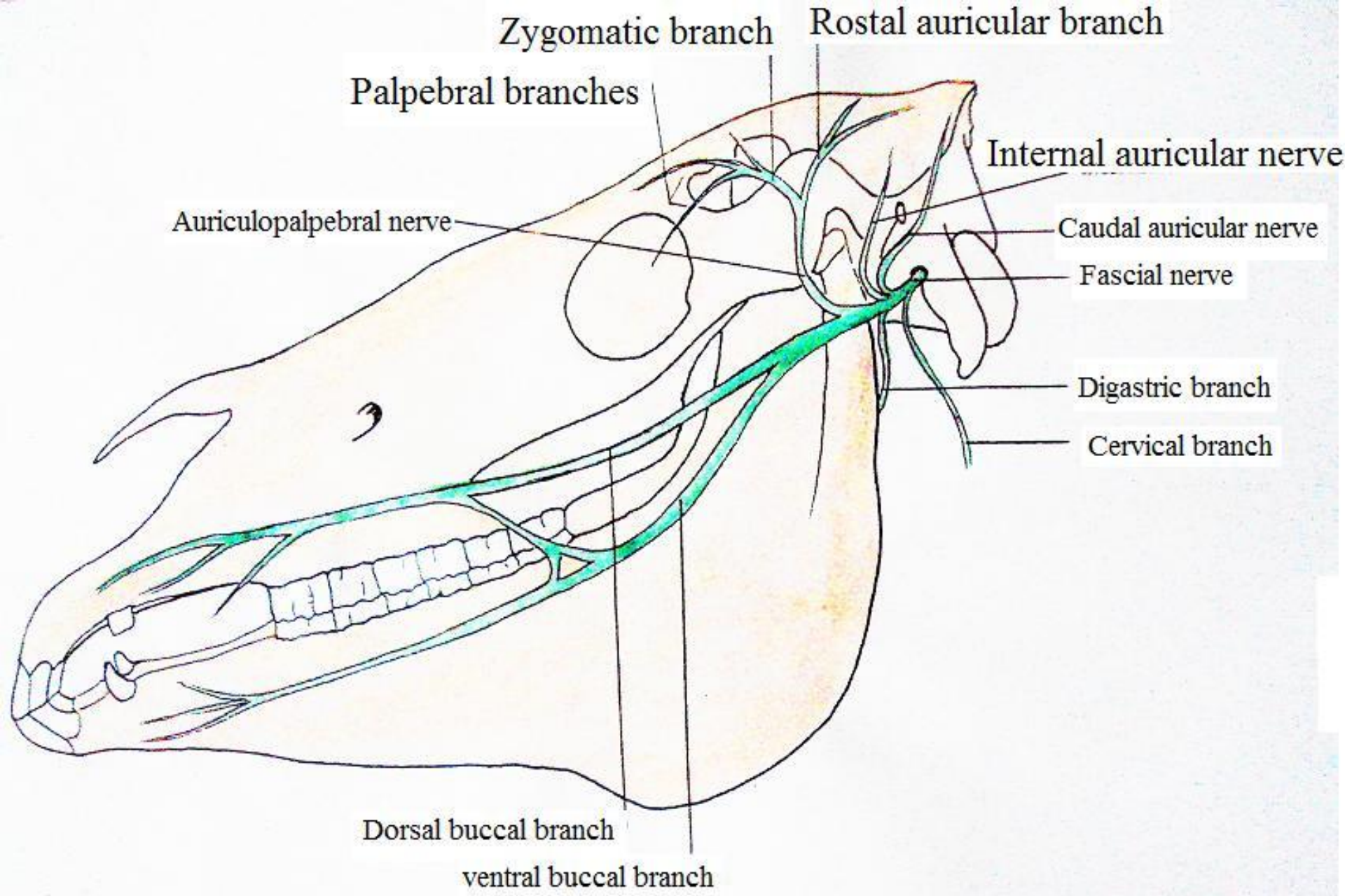


Fig. 122. Distribution of the facial N.; diagramatic



Facial nerve (extracanalicular part)

VIII- Vestibulocochlear (acoustic) nerve

Type

- Sensory nerve.

Origin:

- From lateral aspect of medulla oblongata caudal to origin of facial nerve.

Course:

- Enters internal acoustic meatus where it divides into, vestibular and cochlear parts.

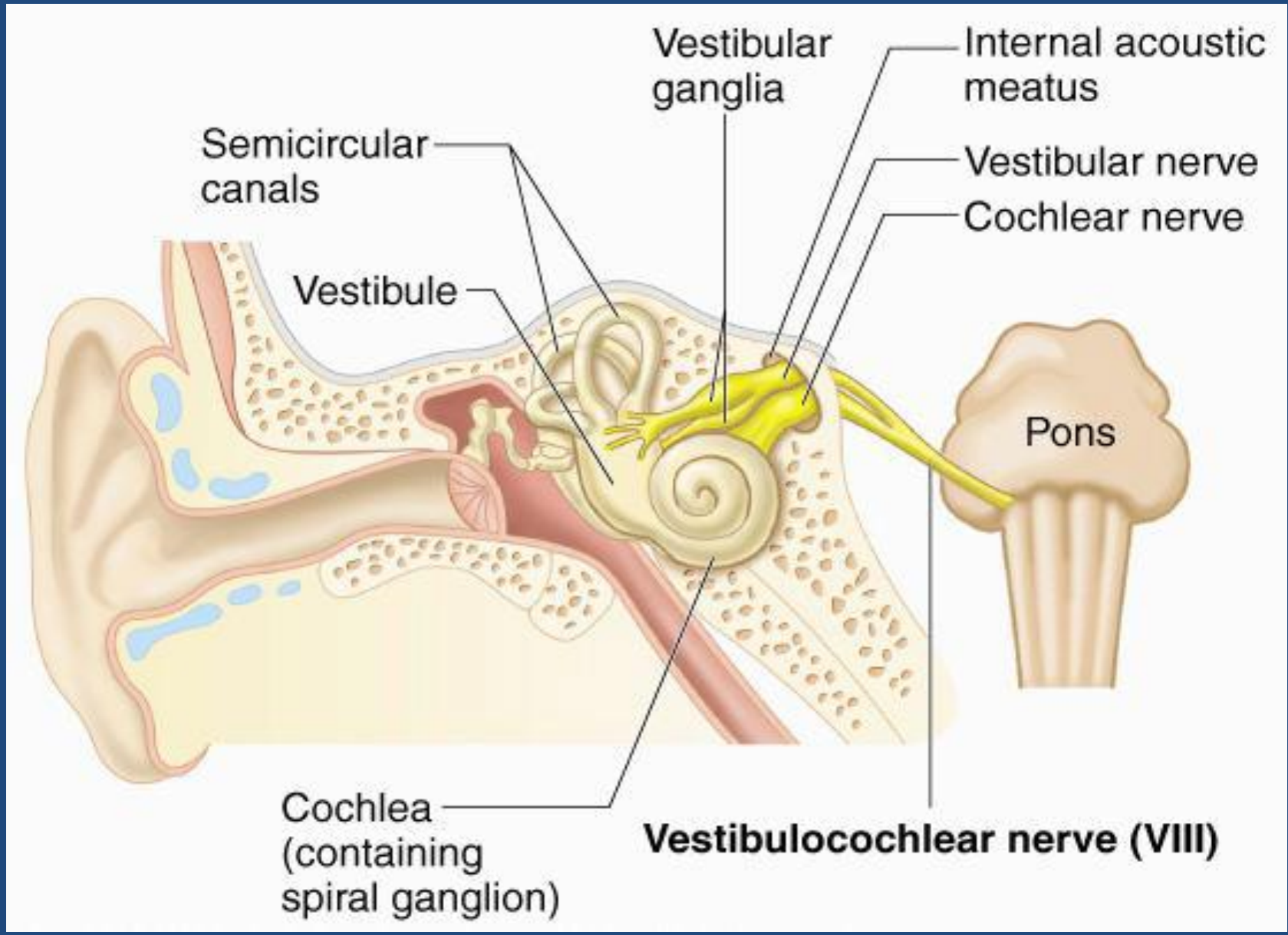
Distribution:

1. Vestibular part:

- Distributed in vestibule of internal ear.
- Responsible for position and equilibrium of body

2. Cochlear part:

- Distributed in cochlea of internal ear.
- Responsible for hearing.


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

IX- Glosspharyngeal nerve

Type:

- mixed nerve. carries parasympathetic fibers.

Origin:

lateral aspect of medulla oblongata with 10,11 nerves.

Course:

- It emerges from foramen lacerum caudalis (jugular foramen) with 10,11 nerves.
- It bears jugular and petrous ganglia (often fused).
- It terminates by dividing into pharyngeal and lingual branches.

Distribution:

1. Tympanic nerve:

- It shares in formation of tympanic plexus which supply m.m.of tympanum and auditory tube.

2. Considerable branch to carotid sinus:

- Shares in formation of carotid plexus on termination of carotid artery.

3. Branch to aboral stylopharyngeal muscle :

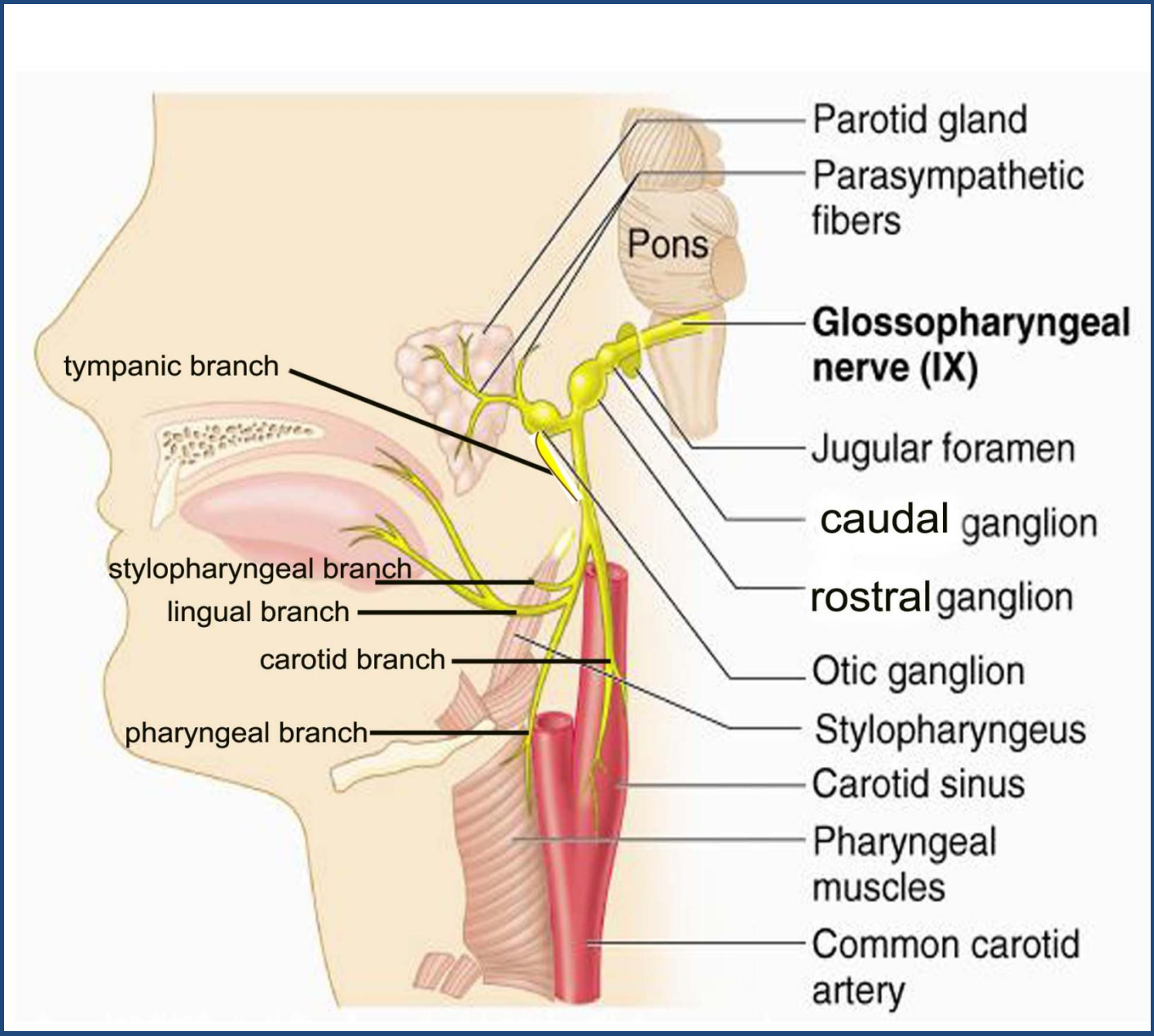
4. Terminal branches:

a) Pharyngeal branch:

- Smaller, it shares in pharyngeal plexus, which supplies muscles and m.m. of pharynx.

b) Lingual branch:

-It supplies sensory fibers to m.m. and taste buds of caudal 1/3 of tongue.


Parotid gland
Parasympathetic fibers
Pons
Glossopharyngeal nerve (IX)
tympanic branch
Jugular foramen
caudal ganglion
stylopharyngeal branch
rostral ganglion
lingual branch
carotid branch
Otic ganglion
Stylopharyngeus
pharyngeal branch
Carotid sinus
Pharyngeal muscles
Common carotid artery

X- Vagus nerve

Type:

- mixed, longest cranial nerve.
- Carries parasympathetic fibers.

Origin:

lateral aspect of medulla oblongata.

Course:

extends in head, cervical, thoracic and abdominal regions.

A) In head and cervical region:

- passes through jugular foramen where it bears **jugular ganglion** . Here it gives meningeal and auricular branches .
- In neck, it joins sympathetic trunk forming vagosympathetic trunk.

B) In thoracic region:

- Each vagus divides into dorsal and ventral branches.
- Both right and left dorsal as well as ventral branches unite forming dorsal and ventral vagal trunks.
- These run caudally with esophagus to enter abdomen through esophageal hiatus.

C) In abdominal region:

Dorsal trunk :

forming caudal gastric plexus, celiacomesenteric ganglion and intermesenteric plexus.

Ventral trunk :

forming cranial gastric plexus

Distribution:

It gives collateral branches as:

1-Pharyngeal branch:

- It shares in **formation of pharyngeal plexus** with 9,11 cranial and sympathetic nerves
- The plexus supplies muscles of pharynx and soft palate (except tensor veli palatini supplied by mandibular nerve). And cervical part of esophagus

2. Cranial laryngeal nerve:

- It passes through thyroid foramen of thyroid cartilage.
- It supplies m.m. of larynx, floor of pharynx and entrance of esophagus.
- It supplies cricothyroid and cricopharyngeus muscles.

.

3. Recurrent laryngeal nerve:

a) ***Right nerve:*** turns around costocervical trunk, runs cranial in neck on ventral face of trachea .

b) ***b) left nerve:*** turns around aortic arch, continues in neck like right one.

- It terminates as caudal laryngeal N.
- It supplies all intrinsic muscles of larynx except cricothyroid. It gives branches to trachea, esophagus and cardiac plexus.

4. Cardiac branches:

- Form **cardiac plexus** with sympathetic and recurrent laryngeal nerves.

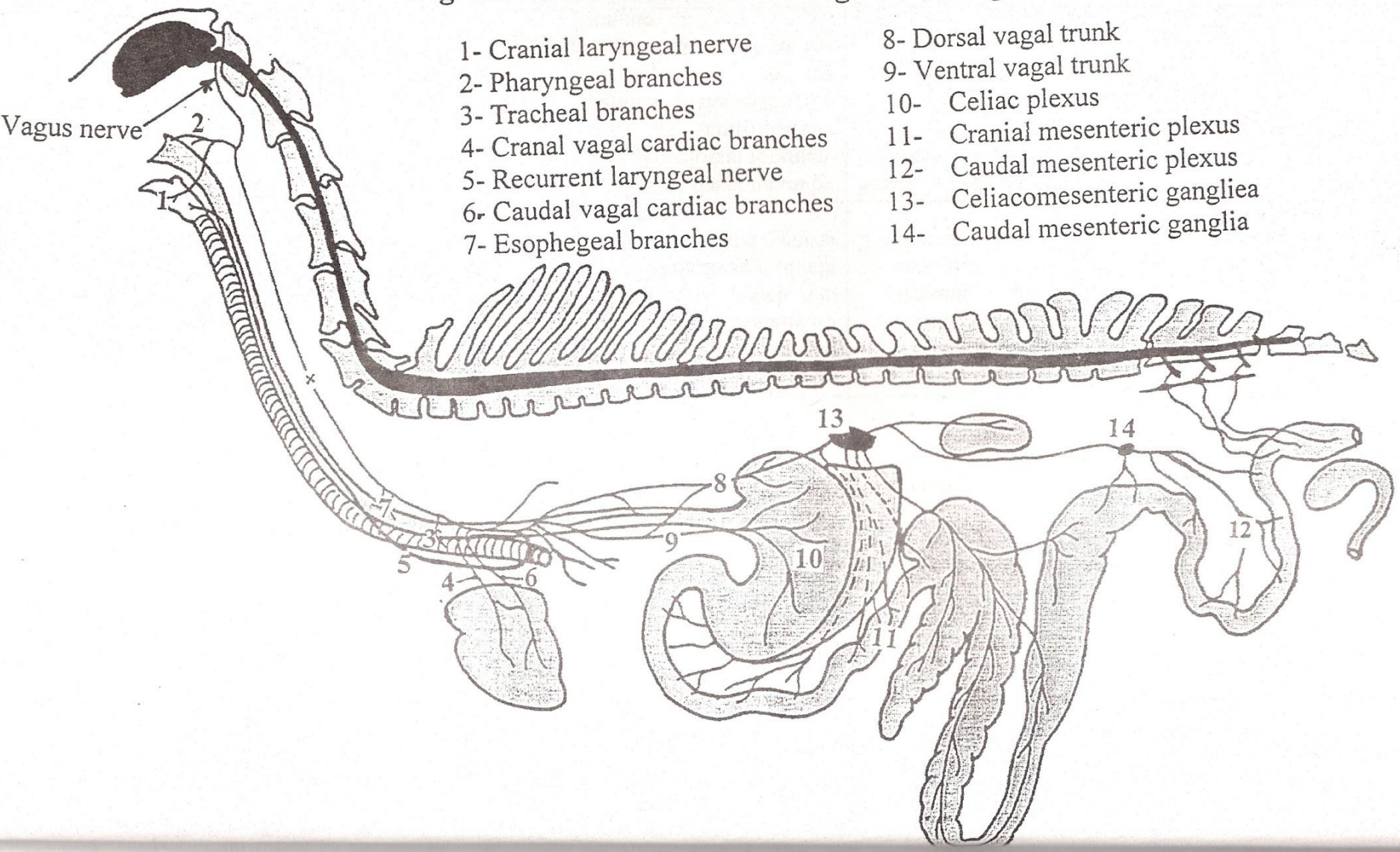
5. Tracheal and esophageal branches:

- Form caudal tracheal and esophageal plexuses with recurrent laryngeal, vertebral and cervicothoracic ganglion of sympathetic.

6. Bronchial branches:

- Form pulmonary plexus with sympathetic.

Fig. 125. Distribution of the vagus N.; diagramatic



1- Cranial laryngeal nerve
2- Pharyngeal branches
3- Tracheal branches
4- Cranal vagal cardiac branches
5- Recurrent laryngeal nerve
6- Caudal vagal cardiac branches
7- Esophegeal branches
8- Dorsal vagal trunk
9- Ventral vagal trunk
10- Celiac plexus
11- Cranial mesenteric plexus
12- Caudal mesenteric plexus
13- Celiacomesenteric gangliea
14- Caudal mesenteric ganglia

XI- Accessory nerve

Type: motor nerve.

Origin: from two parts :

Cranial part: lateral aspect of medulla oblongata.

Spinal part: from cervical part of spinal cord.

It enters foramen magnum and joins cranial part

.**Course:**

It passes through foramen lacerum caudalis and

divides into; internal and external branches.

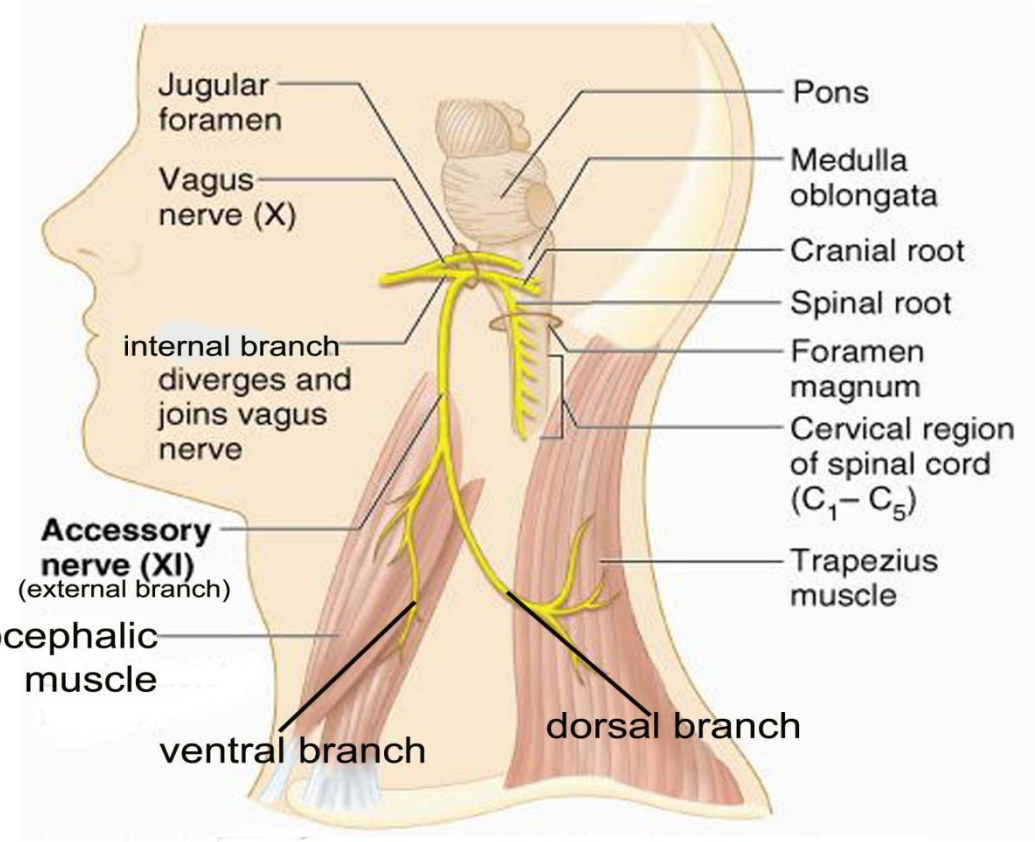
Distribution:

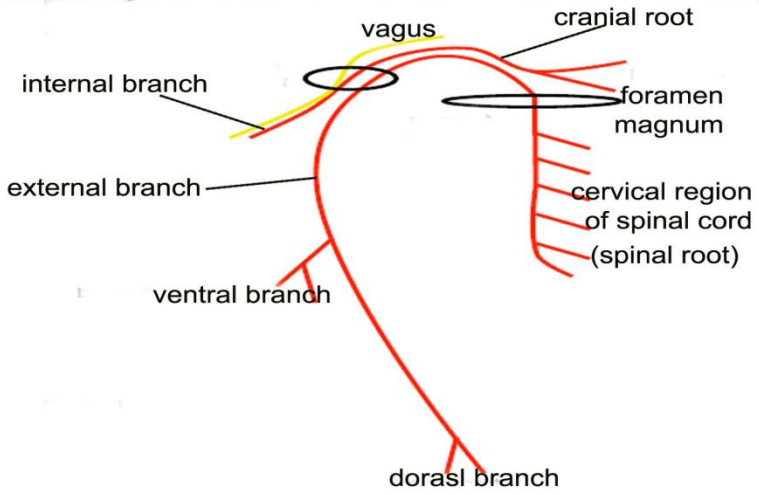
A) Internal branch:

from cranial root, runs with vagus to share in **formation of pharyngeal plexus** .

B) External branch: divides into:

- Dorsal branch: extends along brachiocephalic muscle (in flexuous manner) and ends in trapezius muscle.
- Ventral branch: enters sternocephalic muscle.


Jugular foramen
Vagus nerve (X)
internal branch diverges and joins vagus nerve
Accessory nerve (XI)
(external branch)
Sternocephalic muscle
ventral branch
dorsal branch
Pons
Medulla oblongata
Cranial root
Spinal root
Foramen magnum
Cervical region of spinal cord (C_1– C_5)
Trapezius muscle


vagus
cranial root
internal branch
foramen magnum
external branch
cervical region of spinal cord
(spinal root)
ventral branch
dorasl branch

XII- Hypoglossal nerve

Type:

motor nerve.

Origin:

ventral face of medulla oblongata lateral to pyramid.

Course:

- It passes through hypoglossal foramen, runs to reach tongue.

Distribution:

It supplies muscles of tongue and geniohyoideus.

Spinal nerves

General consideration:

- Arranged **in pairs**.
- With exception of **cervical and caudal** nerves, spinal nerve emerges **behind** vertebra of same number.
- 1st and 2nd cervical nerves emerge through **LVF of atlas**, and **axis**. Therefore, there are 8 cervical nerves.
- There are **fewer** pairs of caudal nerves.

Formation of typical spinal nerve:

- Each spinal nerve has two roots:

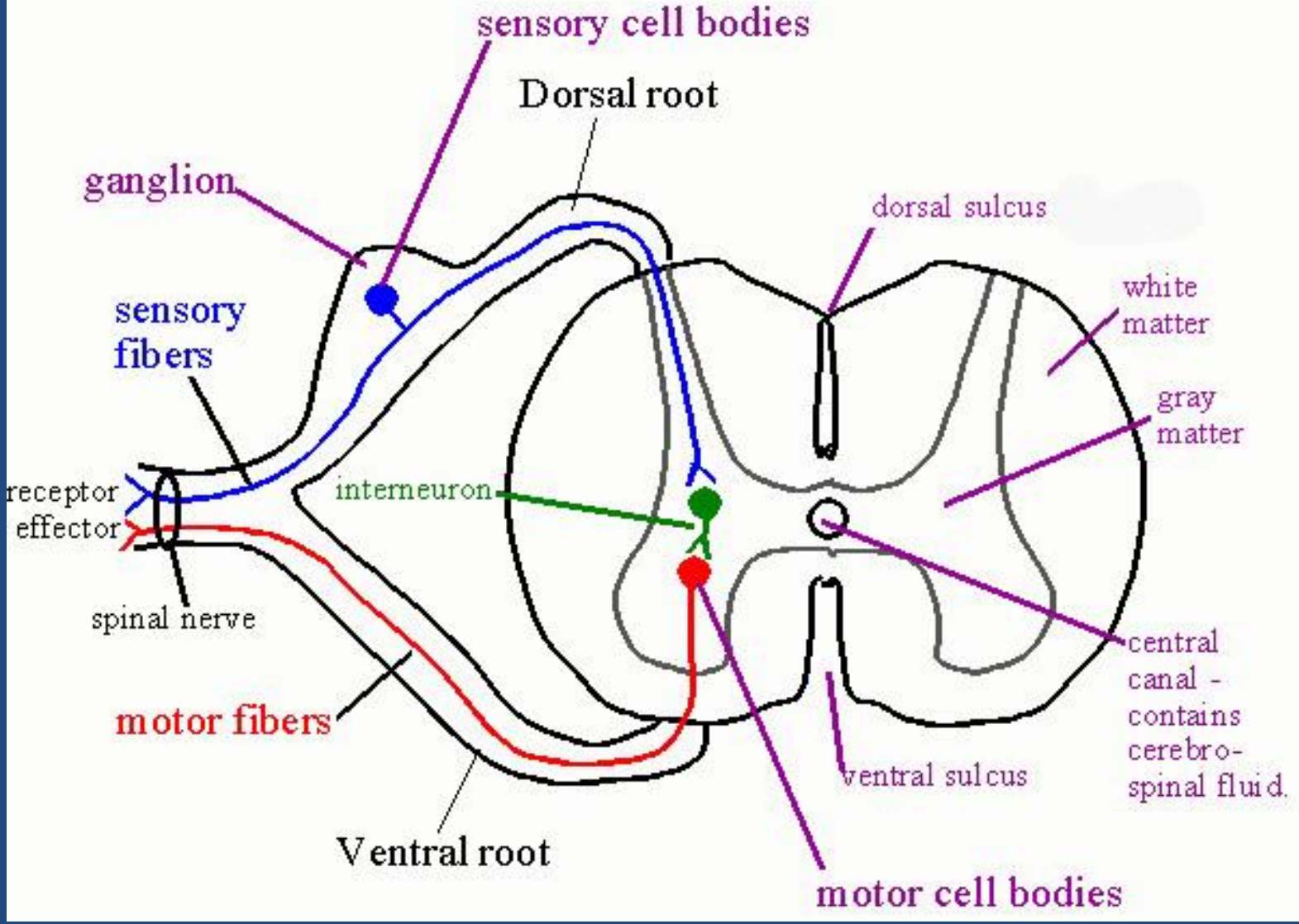
1. Dorsal root:

- Sensory root.
- Larger than ventral one.
- Afferent as conveys impulses from organ towards CNS.
- Carries dorsal root (spinal) ganglion.
- It is axons of neurons lie in dorsal root ganglion.

2. Ventral root:

- It is motor root.
- Is smaller than dorsal root
- No ganglion on ventral root.
- It is efferent , conveys impulses from CNS to organ.

Spinal Cord - Neuron Relationships

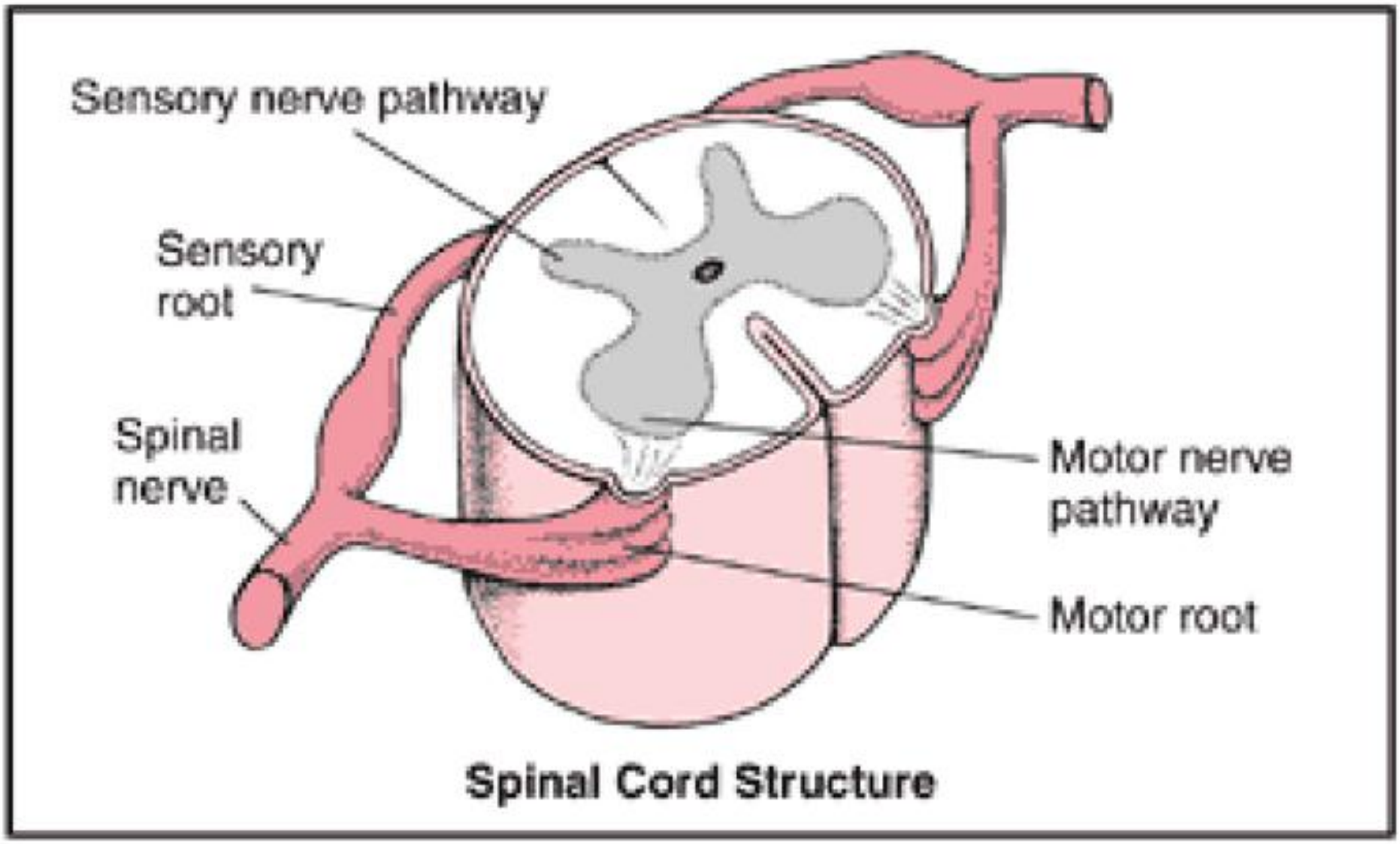


Basic distribution of spinal nerve:

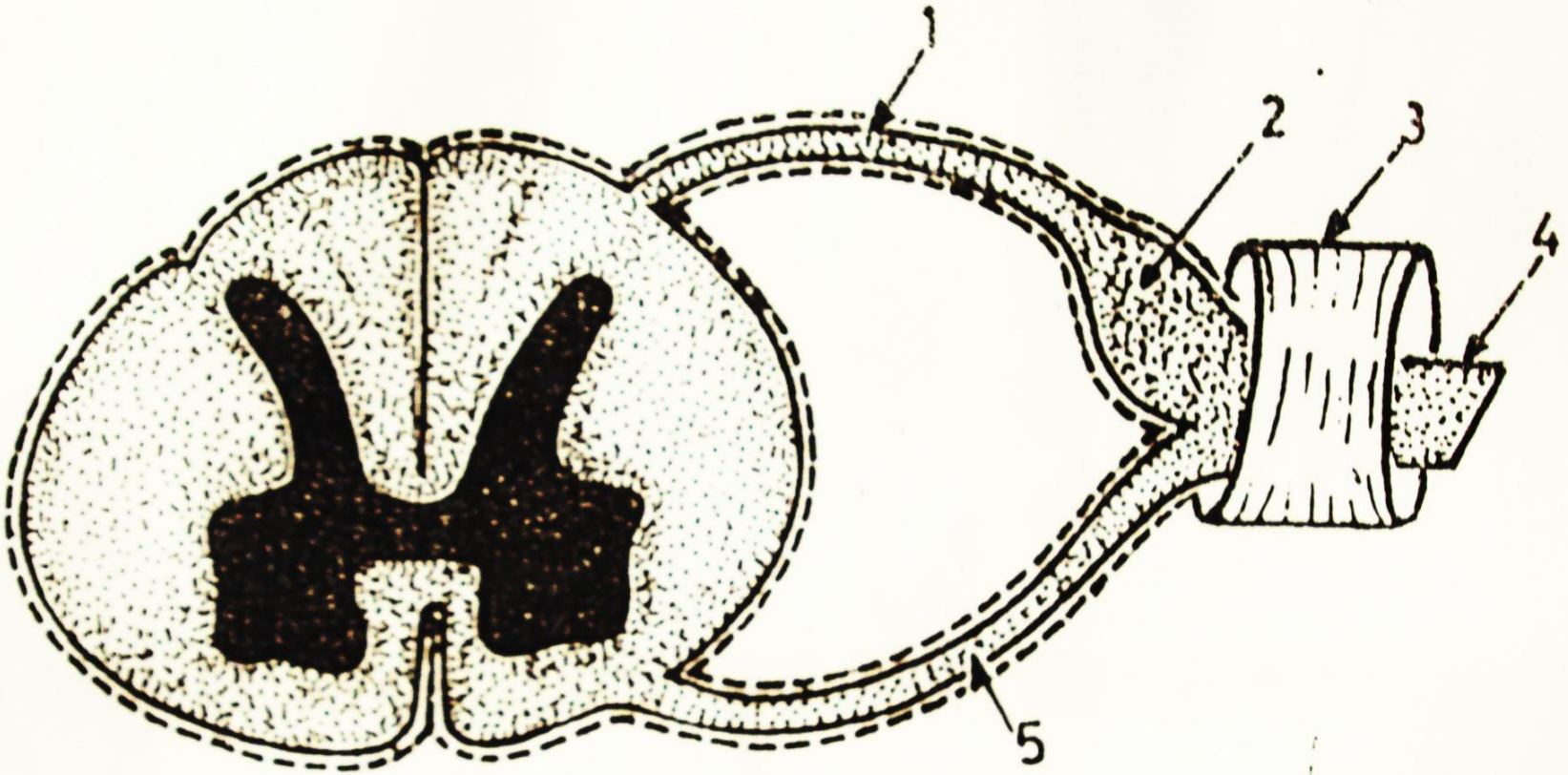
- The two roots unite to form typical spinal nerve, emerges through intervertebral foramen.
- Each nerve gives small meningeal branch then divides into :

1. Dorsal primary branch:

- Smaller one except in cervical regions.
- Distributed, in muscles and skin of dorsal part of body (epaxial region).

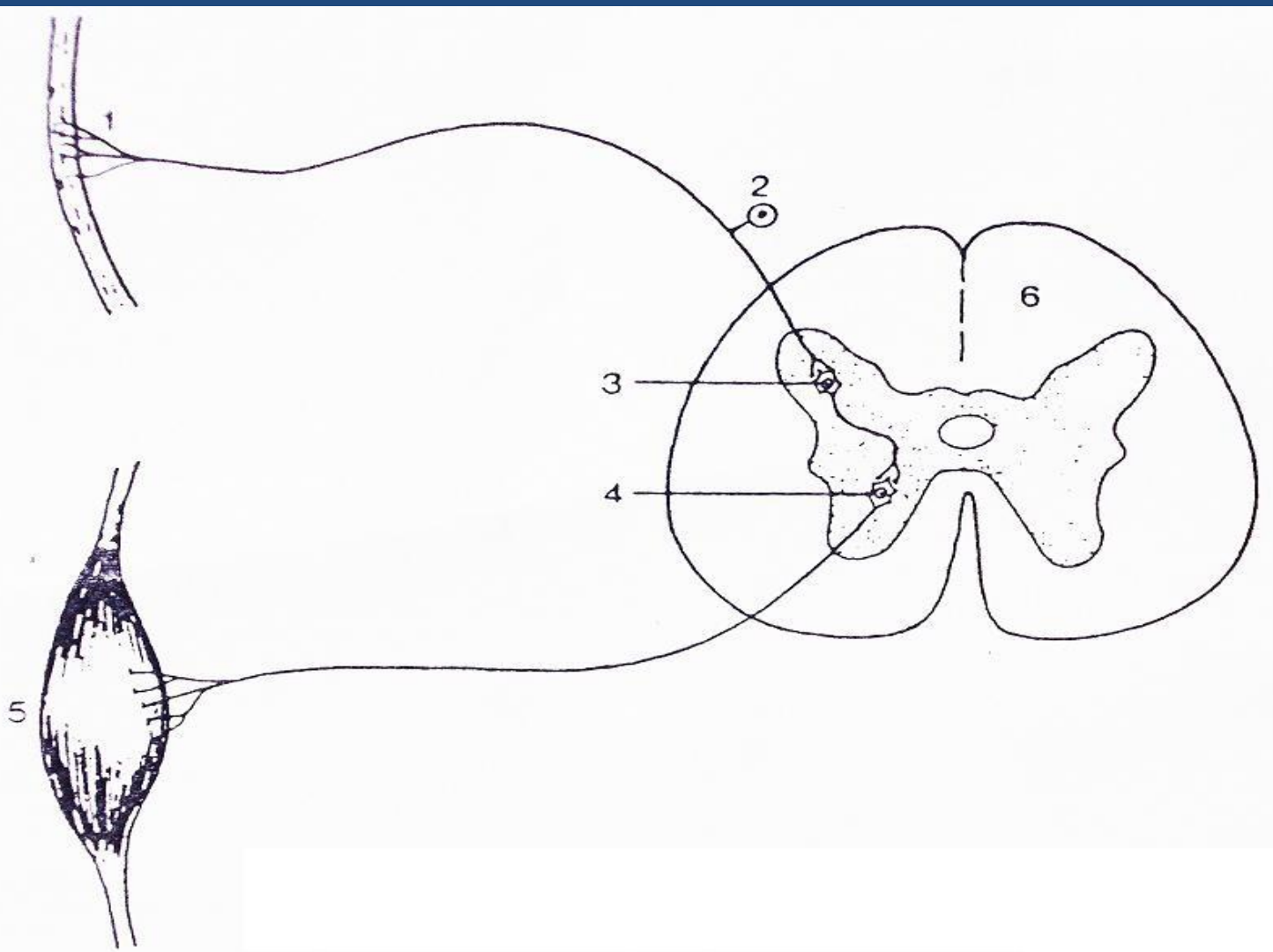


Spinal Cord Structure



POSITION OF THE TRUNK OF THE SPINAL NERVE

1. dorsal root.
2. dorsal root ganglion.
3. intervertebral foramen.
4. trunk of spinal nerve.
5. ventral root.



Schematic representation of a reflex chain in which an interneuron is interposed

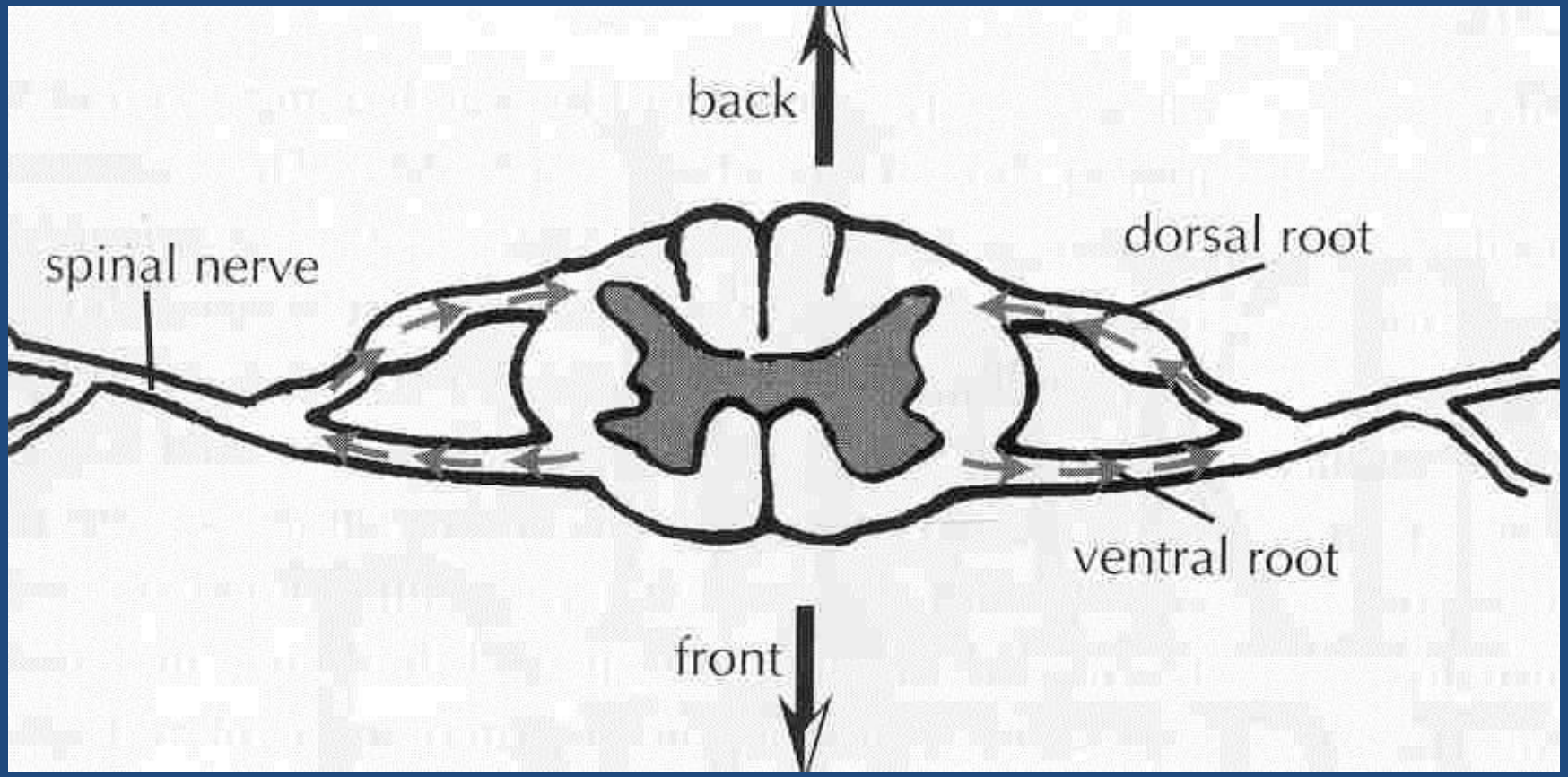
1. skin receptor 2. afferent neuron 3. synapse at interneuron 4.synapse at efferent neuron 5. muscle 6. spinal cord

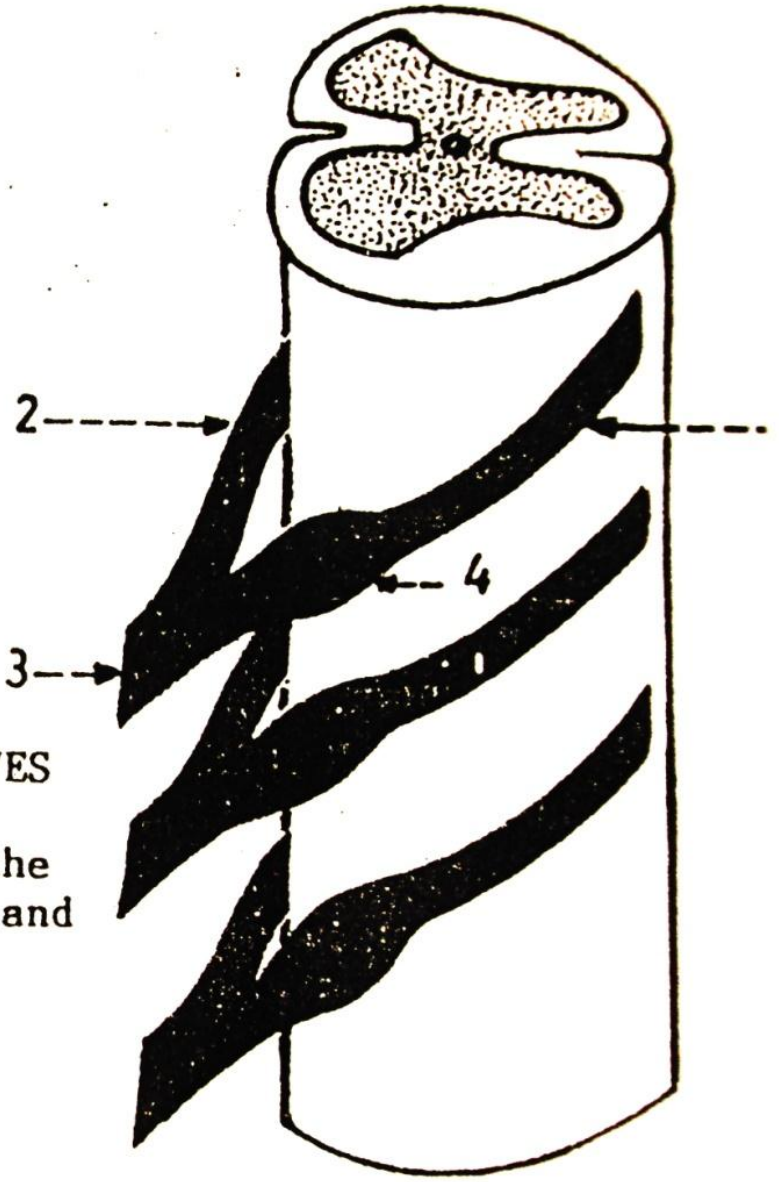
2. The ventral primary branch:

- larger one except in cervical region.
- It distributes in muscles and skin of lower part of body (hypoaxial region) including limbs.
- Each spinal nerve or its ventral branch connected by ramus communicans to adjacent sympathetic ganglion.

Spinal nerves in horse are 42 pairs :

- Cervical spinal Nn.	8 pairs
- Thoracic spinal Nn.	18 pairs
- Lumbar spinal Nn.	6 pairs
- Sacral spinal Nn.	5 pairs
- Caudal spinal Nn.	5 pairs

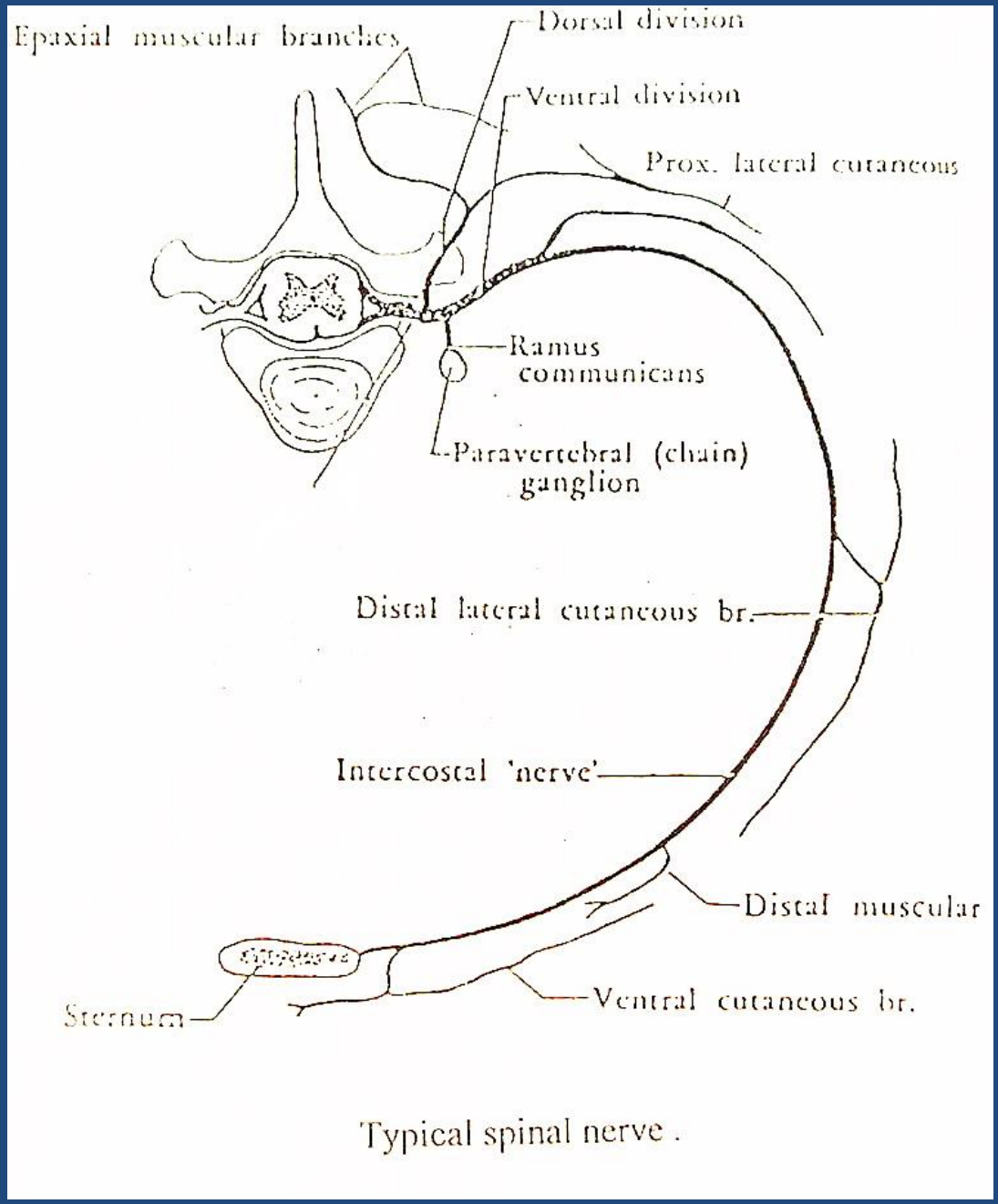

back
spinal nerve
dorsal root
ventral root
front



ATTACHMENTS OF SPINAL NERVES

The spinal nerves are attached to the sides of the spinal cord by dorsal and ventral roots.

1. dorsal root of spinal nerve.
2. ventral root of spinal nerve.
3. trunk of spinal nerve.
4. dorsal root ganglion.



Typical spinal nerve .

Cervical spinal nerves

- 8 pairs in horse.

Distribution:

- Dorsal branches of 3-6 nerves form dorsal cervical plexus, supply muscles above level of vertebrae.
- Ventral branches of 5,6 and 7 form phrenic nerve.
- Ventral branches of last three cervical (6,7 and 8) and first two thoracic (1,2) form brachial plexus.

Phrenic nerve

- Motor nerve to diaphragm.

Formation:

- Ventral branches of 5,6 and 7 cervical spinal nerves.

Course:

- It enters thoracic cavity.

Distribution:

-Terminates in tendinous center of diaphragm

Brachial plexus

Formation:

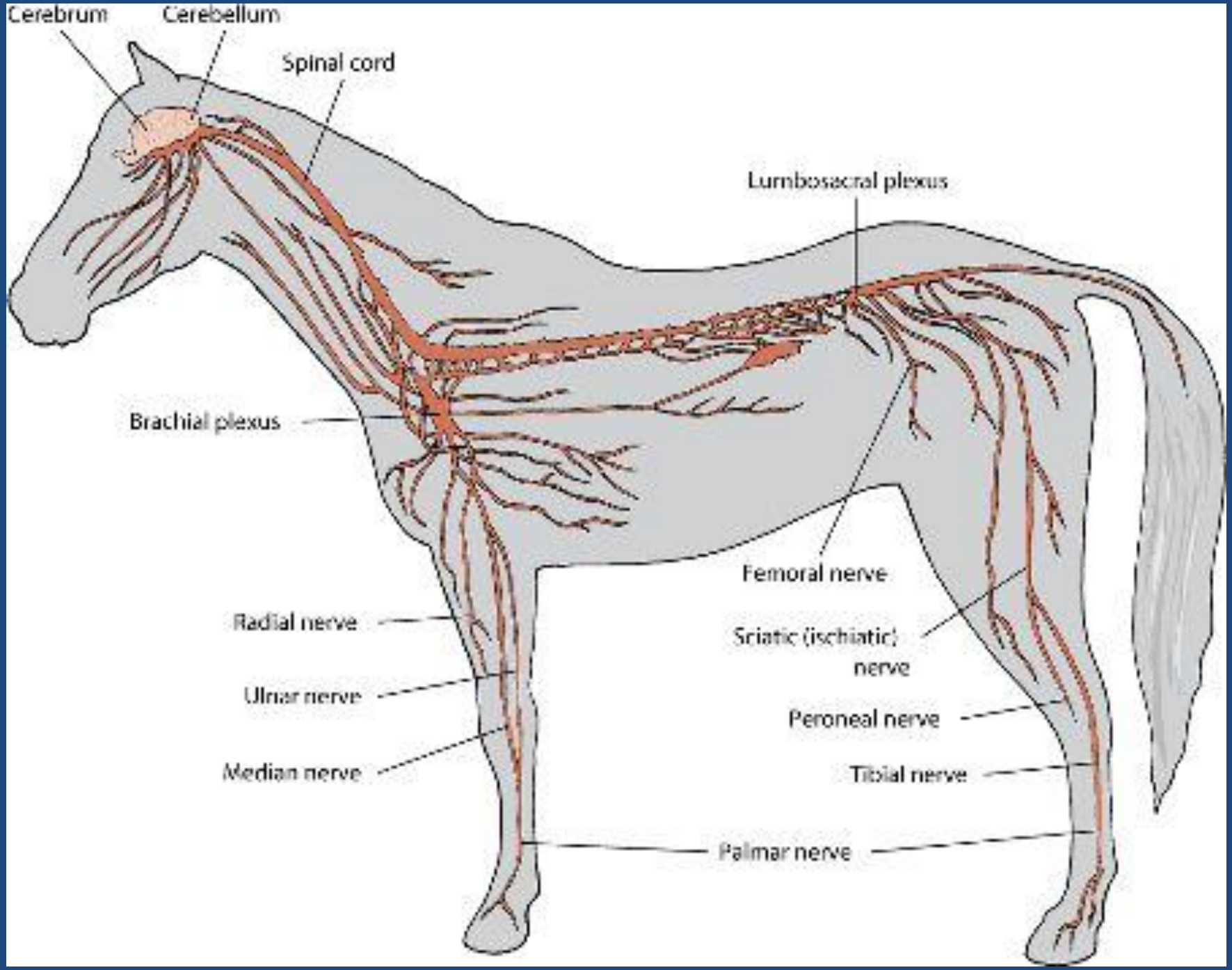
- Ventral branches of last three cervical (6,7 and 8) and first two thoracic (1,2) spinal nerves.

Position:

- It appears as thick band which pierces Scalenus medius muscle.

Distribution:

- distribute on thoracic limb and lateral thoracic wall.


Cerebrum
Cerebellum
Spinal cord
Lumbosacral plexus
Brachial plexus
Femoral nerve
Radial nerve
Sciatic (ischiatic) nerve
Ulnar nerve
Peroneal nerve
Median nerve
Tibial nerve
Palmar nerve

No.	Nerves	Origin
1	Suprascapular n.	C6 & C7
2	Subscapular nn.	C7
3	Axillary n.	C7 & C8
4	Musculocutaneous n.	C7 & C8
5	Pectoral nn.	C7 & C8
6	Long thoracic n.	C7 & C8
7	Thoracodorsal n.	C8
8	Radial n.	C8 & Th1
9	Median n.	C8 & Th1, Th2
10	Ulnar n.	Th1 & Th2
11	Lateral thoracic n.	Th1 & Th2

Thoracic nerves

- 18 pairs in horse.
- They have similar distribution so they are explained under typical thoracic nerve.

Typical thoracic nerve:

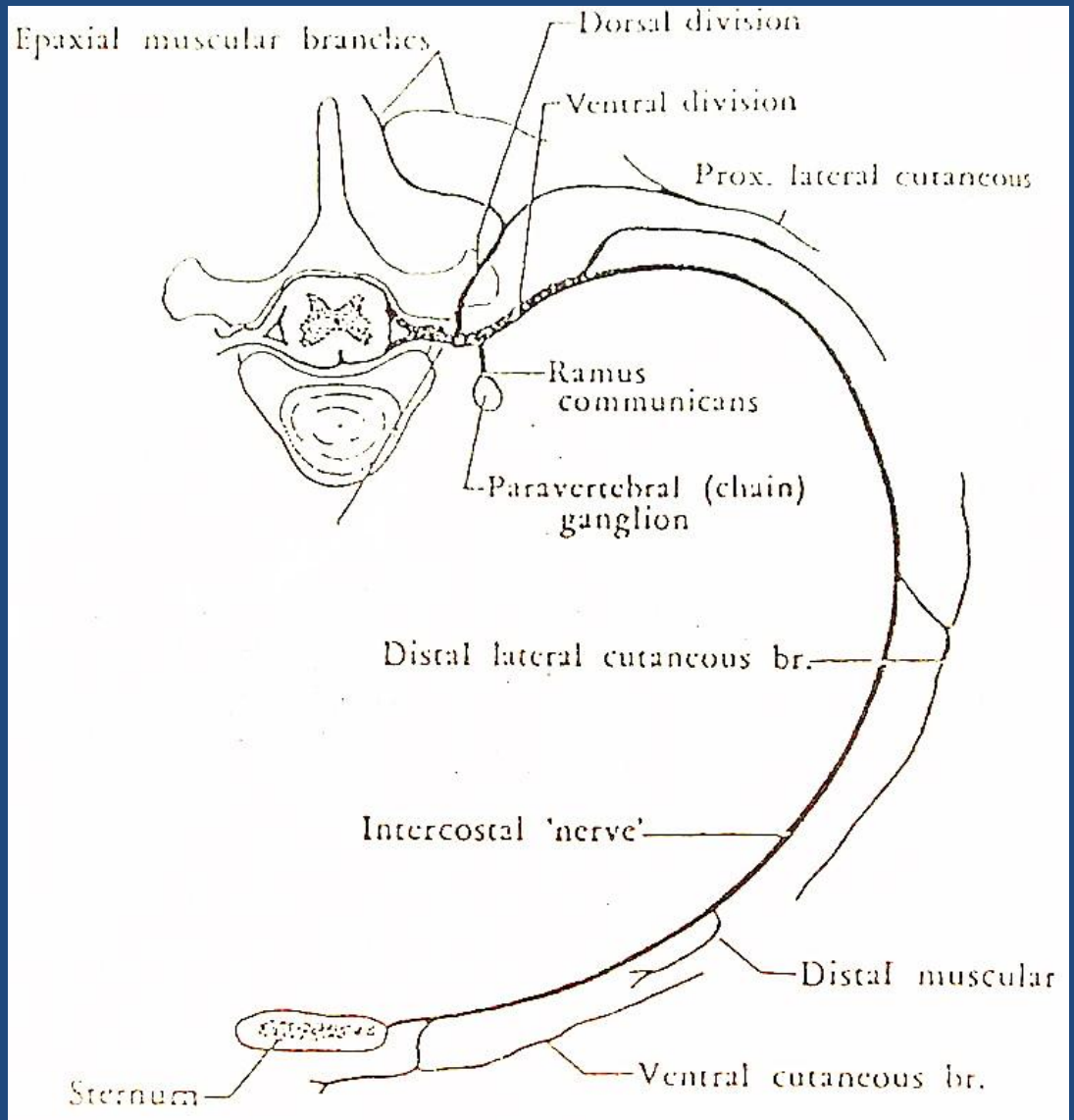
- It divides into small dorsal and large ventral branches

A) Dorsal branches:

- supply muscles and skin of epaxial region.

B) Ventral branches:

- Called intercostal nerves.
- That of 1 and 2 share in formation of brachial plexus, in addition to their intercostal distribution..
- Ventral branch of the last (18th) is known as costoabdominal nerve passes caudal to last rib. It supplies skin of flank region and abdominal muscles.



Typical spinal nerve .

III-Lumbar nerves

- 6 pairs in horse:
- Last one emerges between caudal lumbar (6th) vertebra and sacrum.
- They give dorsal and ventral branches.

1. The dorsal branches:

- supply muscles and skin of epaxial region .

2-Ventral branches:

- Gives branches to sublumbar muscles.
- Ventral branch of 1st lumbar nerve called iliohypogastric nerve, of 2nd called ilioinguinal nerve of 3rd branch called **genitofemoral nerve**
- Ventral branches of 4th,5th and 6th lumbar nerves share in formation of **lumbosacral plexus.**

Lumbosacral plexus:

- Formed by ventral branches of last three lumbar nerves (4^{th} ,5^{th}&6^{th}) and first two sacral nerves .
- It supplies pelvic limb.
- It gives off:

1-Femoral nerve. 2-Obturator nerve.

3-Cranial gluteal nerve. 4-Caudal gluteal nerve.

5-Ischiatic nerve.

Sacral nerves

- 5 pairs in horse.

A) Dorsal branches:

- Pass through dorsal sacral foramina to supply muscles and skin of epaxial region.

B) Ventral branches:

- Pass through pelvic sacral foramina .
- Contribute branches to pelvic plexus.

- 1st& 2nd share in formation of lumbosacral plexus.
- 3rd & 4th forming pudendal and caudal rectal nerves.
- Small fifth sacral nerve supplies muscle and skin of root of tail.

Caudal Nerves

- 5 pairs in horse
- Dorsal branches connect to form dorsal plexus.
- Ventral branches connect to form ventral plexus.
- The two plexuses supply muscles and skin of tail.


ThankYou