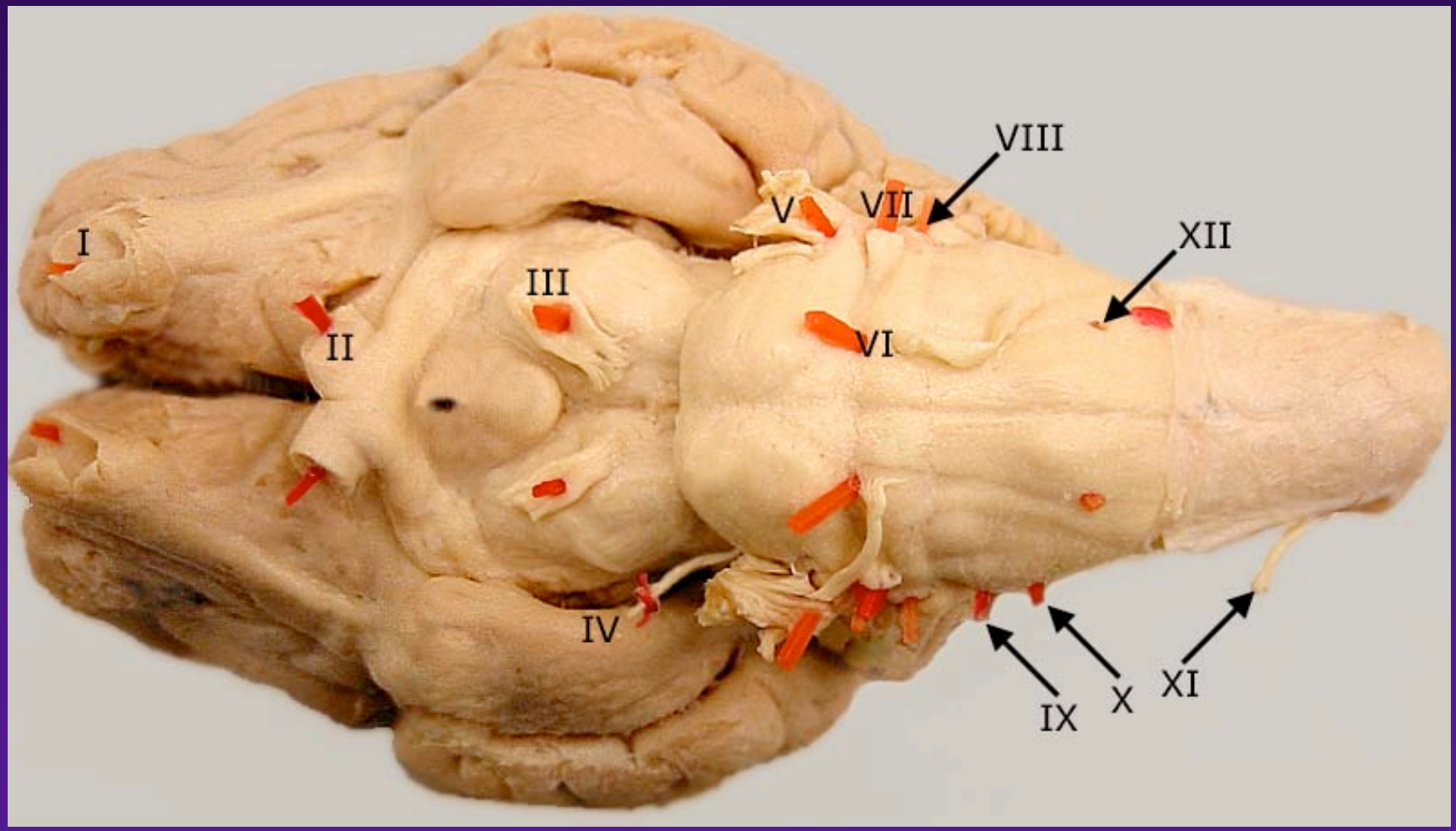
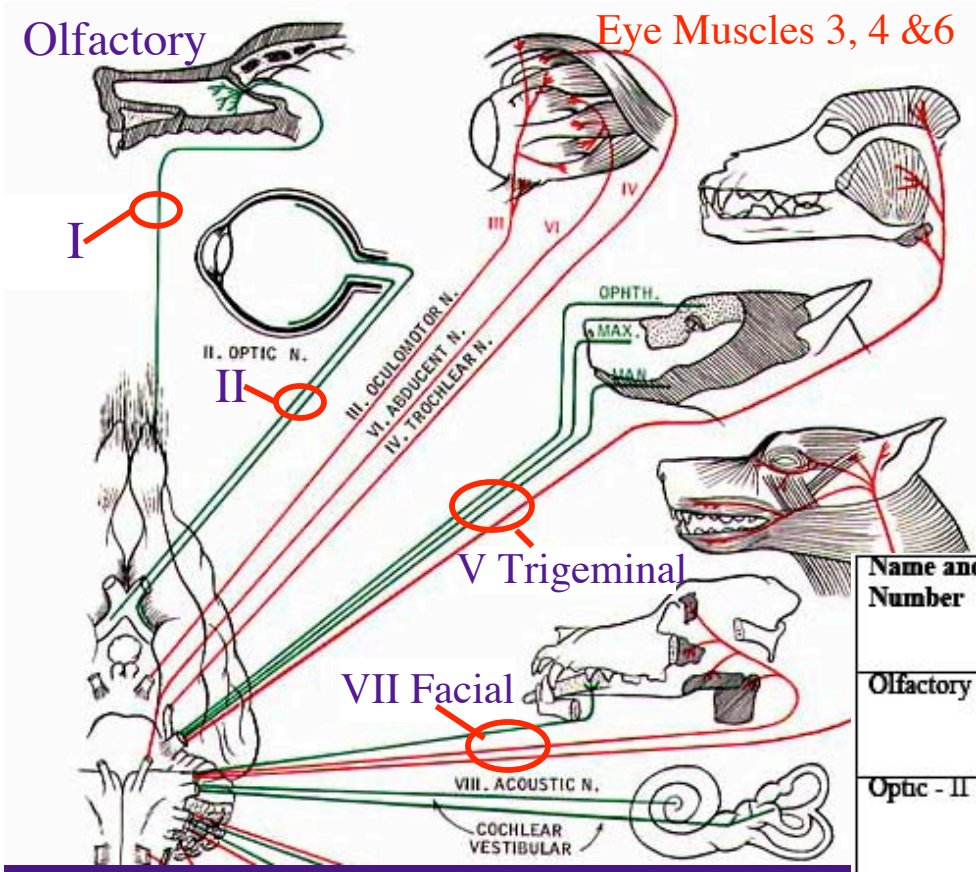
Lecture 6: Cranial Nerves

Objective: To understand the organization of cranial nerves with respect to their nuclei within the brain, their course through and exit from the brain, and their functional roles.





Cranial Nerves 1-7 overview

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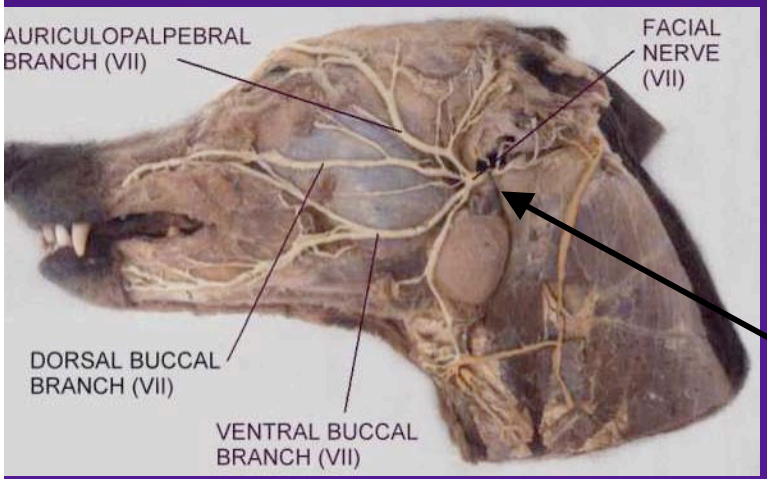
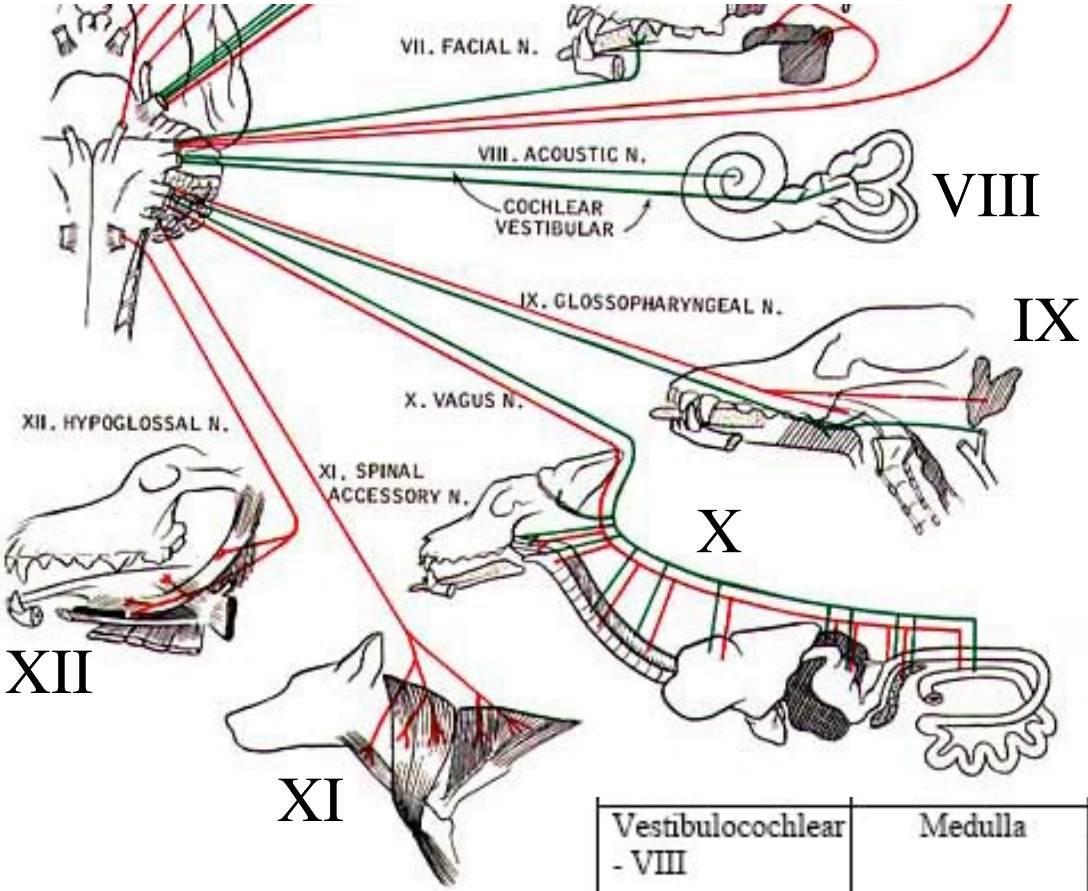
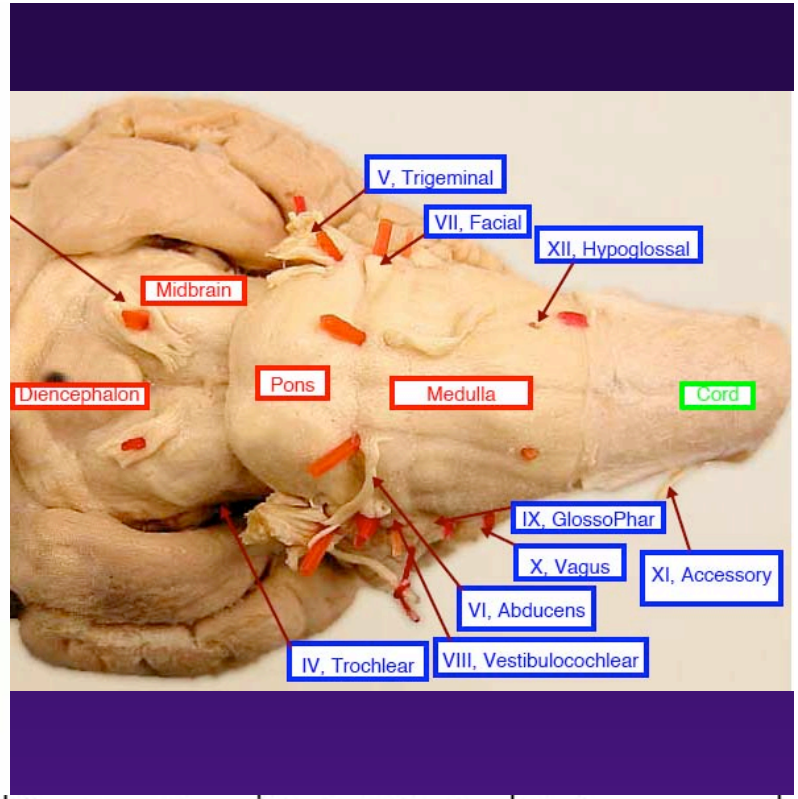
Lecture notes

Cranial Nerves and their Functions

Name and Number	Brain Region Associated With	Function (Functional Components)	Clinical Examination	Symptom Seen After Injury
Olfactory - I	Cerebrum	Smell (SVA)	Owner's Observations	Anosmia (Loss of Smell)
Optic - II	Diencephalon	Vision (SSA)	Menace Response	Anopsia (Loss of Vision)
Oculomotor - III	Midbrain	Eye Movement (SE, VE)	Horizontal Eye Movement; Pupillary Light Reflex	Strabismus: eye deviated down & out. Large Pupil
Trochlear - IV	Midbrain	Eye Movement (Dorsal Oblique Muscle: SE)	Extend head and look for dorso-lateral strabismus	Cat: dorsal aspect of vertical pupil deviated laterally
Trigeminal - V	Pons	Masticatory Movements, sensation from face (SE, GSA)	Jaw movement Eye blink reflex	Bilateral damage = Dropped jaw, Asymmetric chewing, atrophy
Abducens - VI	Medulla	Eye Movement (Lateral Rectus Muscle; SE)	Lateral Eye Movement	Double vision; Strabismus: eye deviated medially
Facial - VII	Medulla	Facial Movement; Taste, rostr. tongue (SE, SVA, VE)	Facial Movement	Facial paralysis, drooling







Cranial Nerves 8-12 Overview

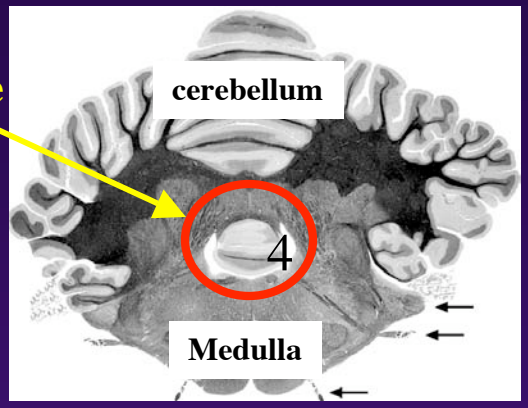
Vestibulocochlear - VIII	Medulla	Hearing and Balance (SSA)	Horizontal and Vertical Eye Movement	Deafness, Head tilt, nystagmus
Glossopharyngeal - IX	Medulla	Tongue and Pharynx (GVA, VE, SVA)	Pharyngeal gag reflexes	Choking, Swallowing Difficulty
Vagus - X	Medulla	Pharynx, Larynx, Heart, Viscera (SE, VE, GVA ...)	Gag reflexes, Blood Pressure, Heart Rate	Hoarseness, Inspiratory dyspnea
Spinal Accessory - XI	Medulla	Trapezius, + three neck mm. (SE) **sternocephalic**	Neck movement	Weakened turning of neck
Hypoglossal - XII	Medulla	Tongue Muscles (SE)	Tongue movement	Deviation of Tongue toward Side of lesion

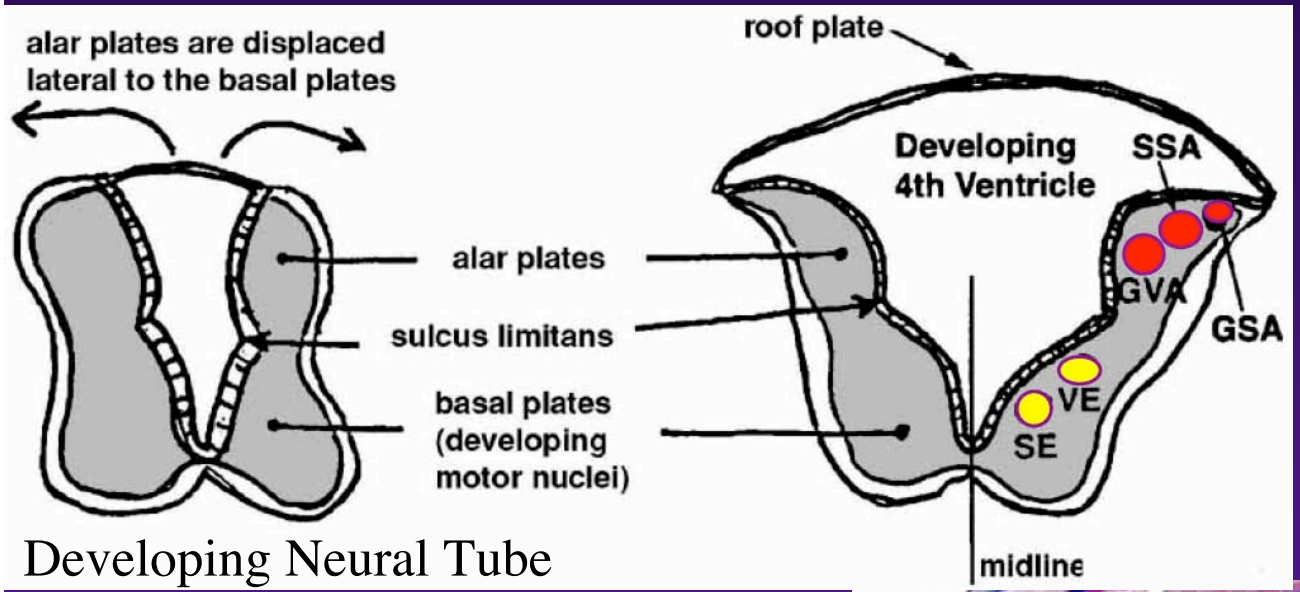
I. Factors Responsible for the Complex Internal Organization of the Brain Stem-> leads to altered location of cranial nerve nuclei in adult brain stem

1. Development of the Fourth Ventricle

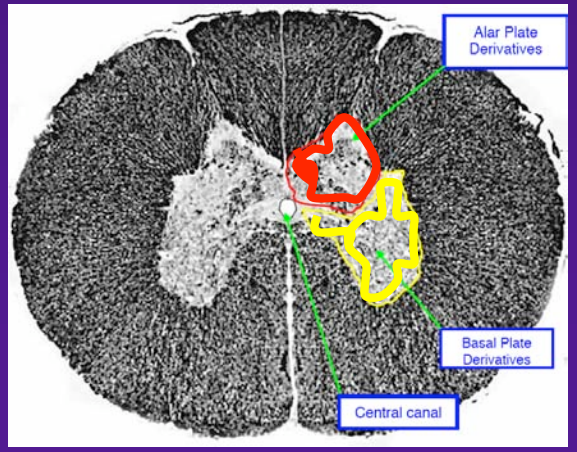
a. Medulla and Pons develop ventral to the 4th ventricle

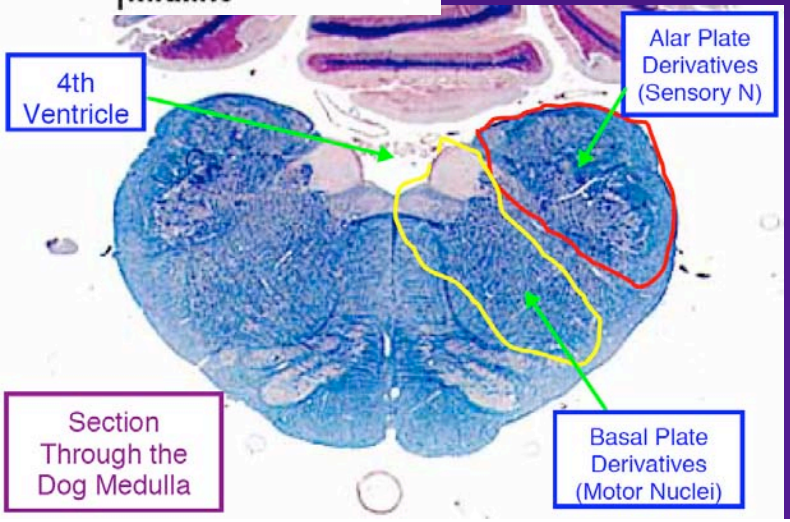
b. Alar plate is displaced lateral to basal plate



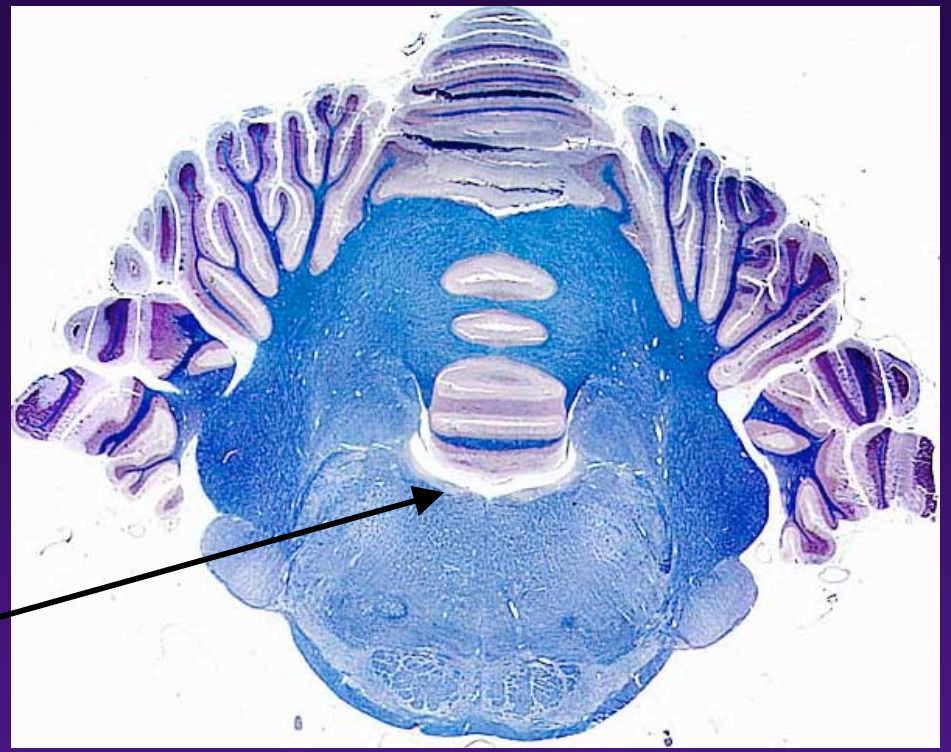


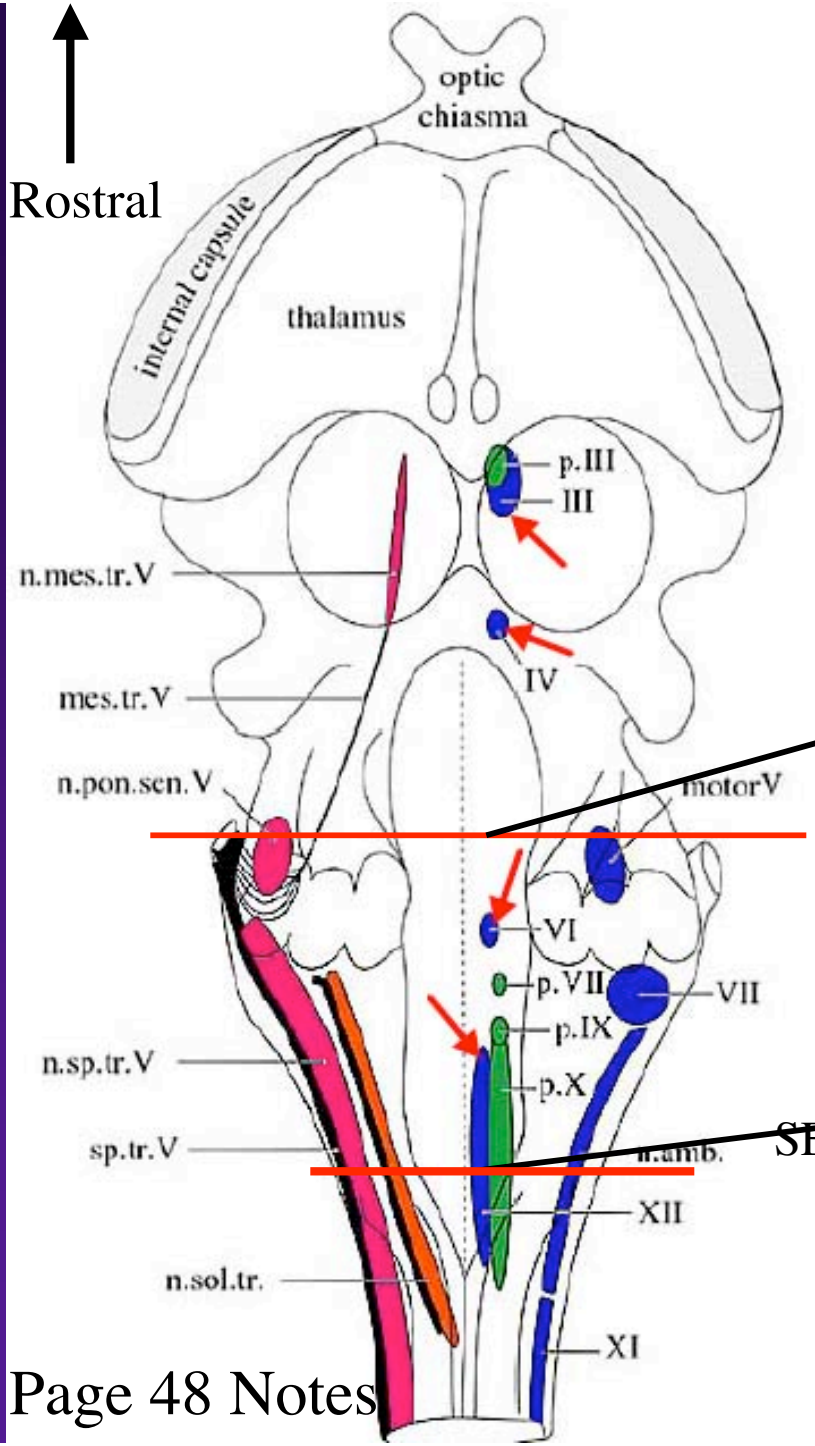
Developing Neural Tube

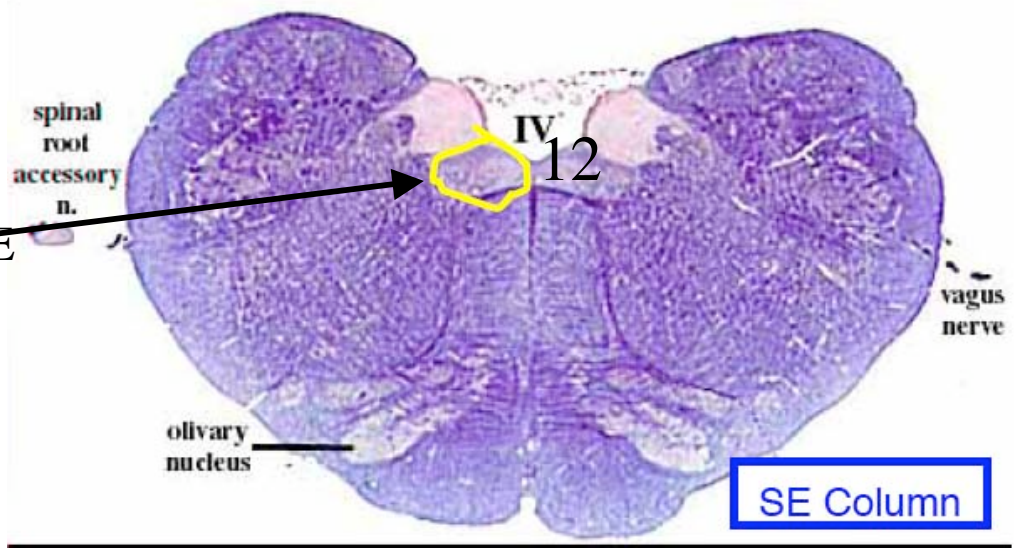




2. Cranial nerve nuclei form discontinuous columns







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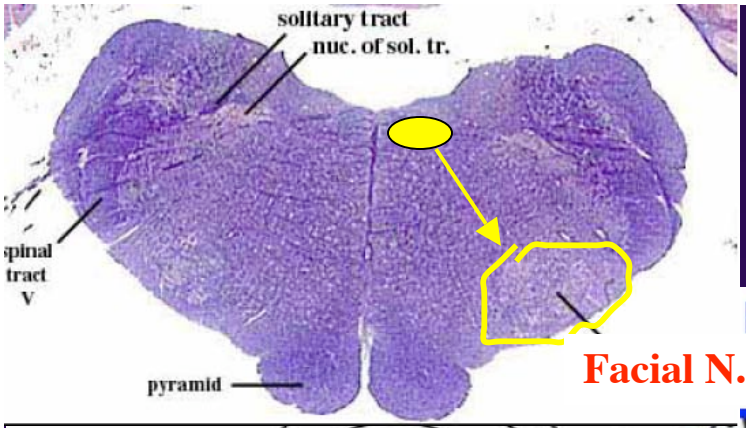


3. Some cranial nerve nuclei migrate from their primitive embryonic positions (e.g., nuclei of V and VII)

Embryonic Site of Origin

III

ventricle

genu VII

V

VI

VII

pons

facial nerve

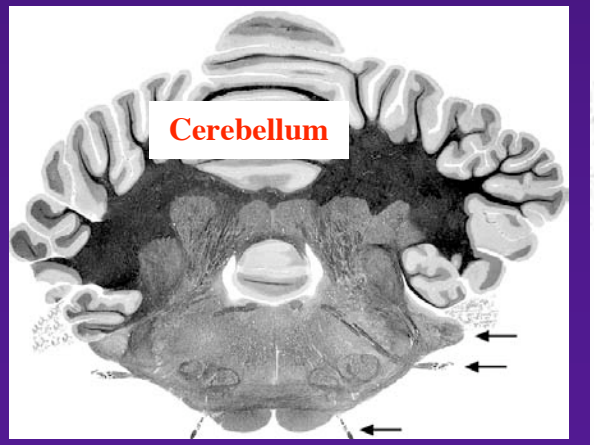
olivary nucl.

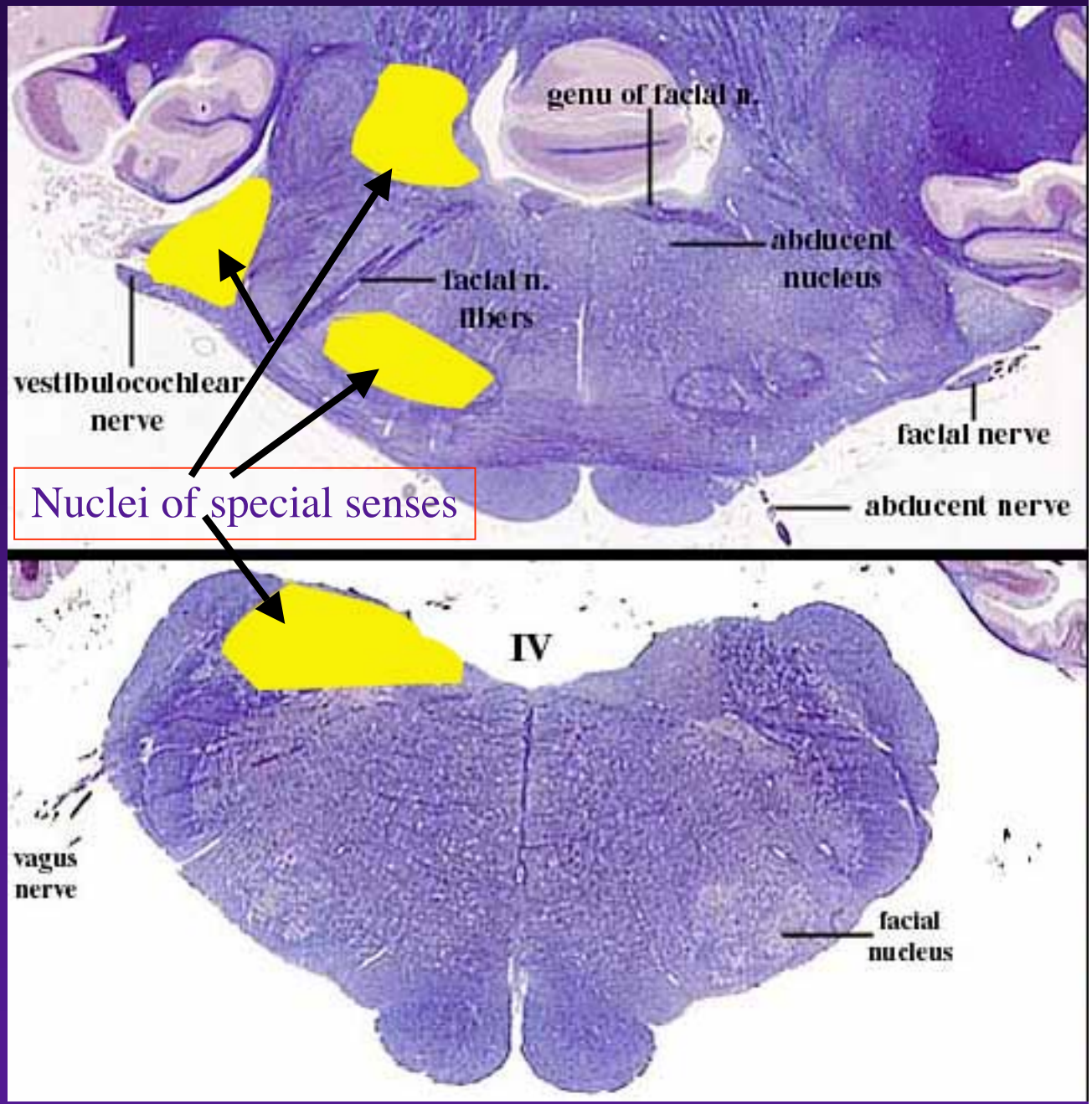
Facial Nucleus

Factors responsible for the complex internal organization of the brainstem:

4) Special senses develop in association with the brain stem.

5) Development of the cerebellum and its connections

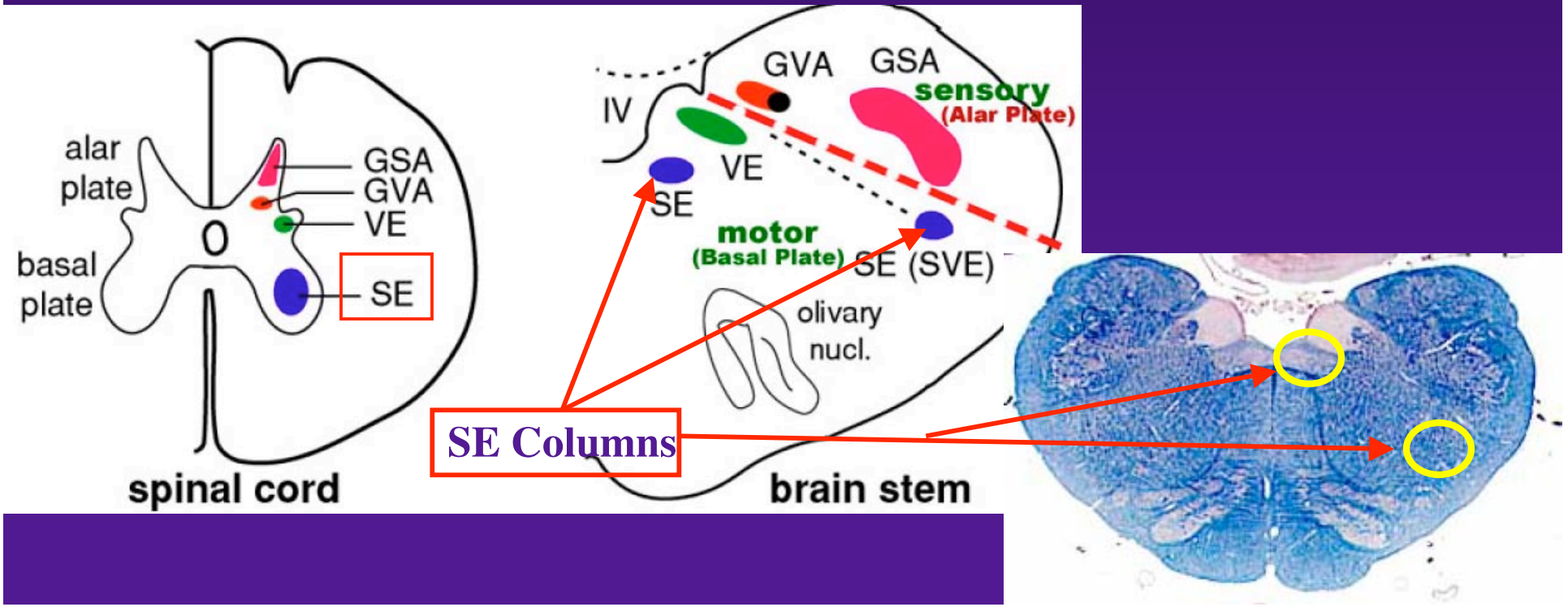




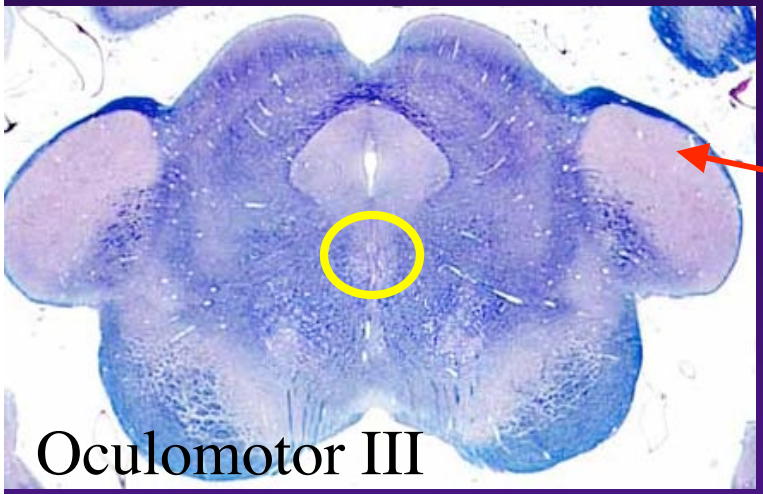
II. Cranial Nerve Nuclei: Nucleus = column of neuron cell bodies. Efferent nuclei are composed of cell bodies of alpha or gamma motor neurons (SE) or preganglionic parasympathetic neurons (VE).

III. Motor Efferent Nuclei (Basal Plate Derivatives):

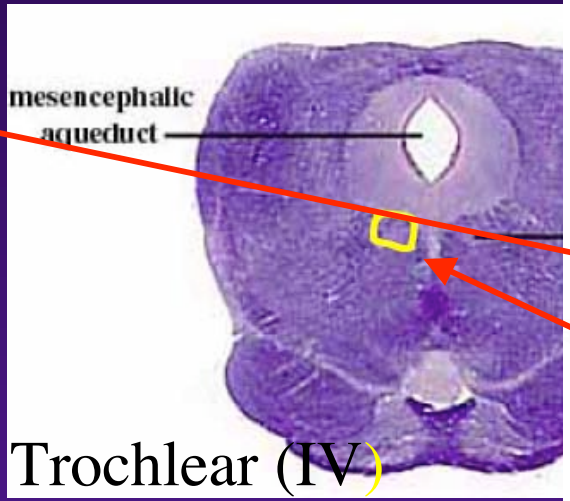
1. SE (Somatic Efferent) Nuclei: SE neurons form two longitudinally oriented but discontinuous columns of cell bodies in the brain stem. Neurons that comprise these columns are responsible for innervating all of the skeletal musculature of the head.



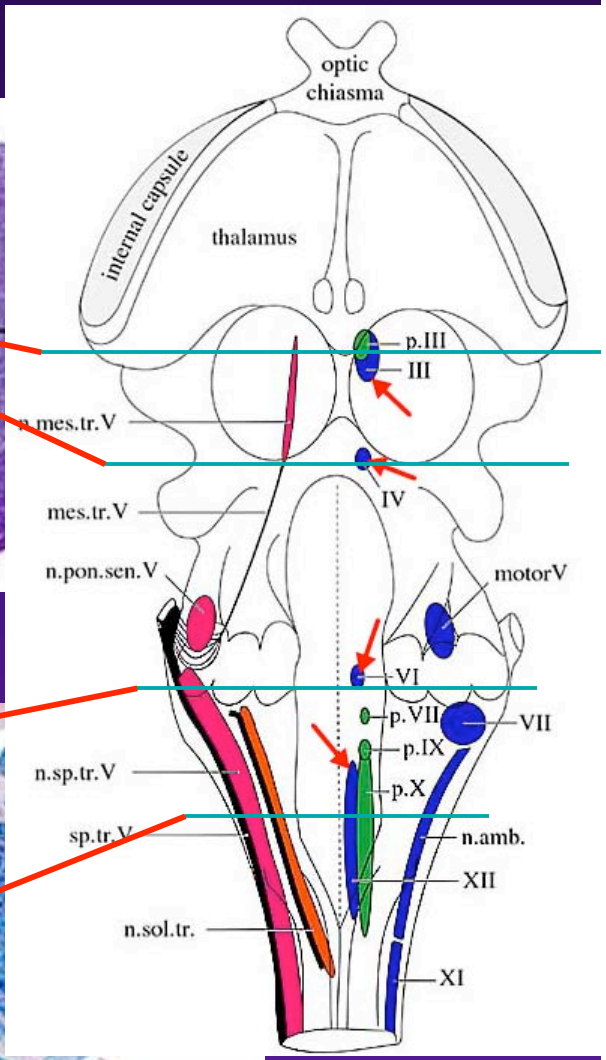
A) Oculomotor, Trochlear, Abducent and Hypoglossal Nuclei- Are formed by a column of cells located near the dorsal midline of the brainstem. The nuclei innervate muscles of the tongue (12) and eye (3, 4 and 6) which are derived from somites.

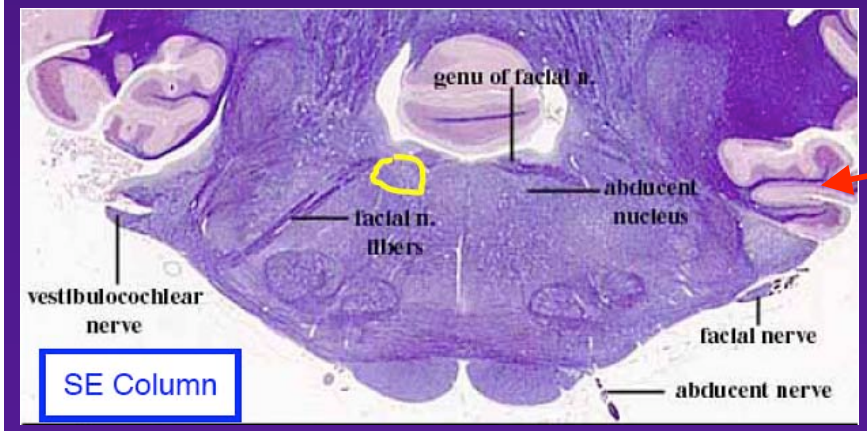


Oculomotor III

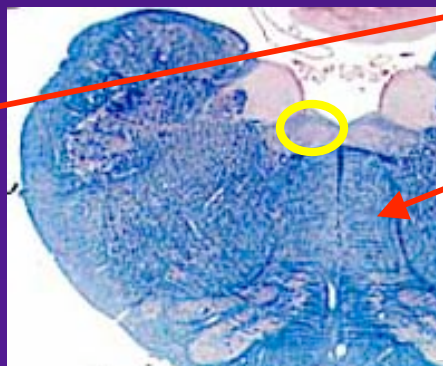


Trochlear (IV)





Abducens (VI)



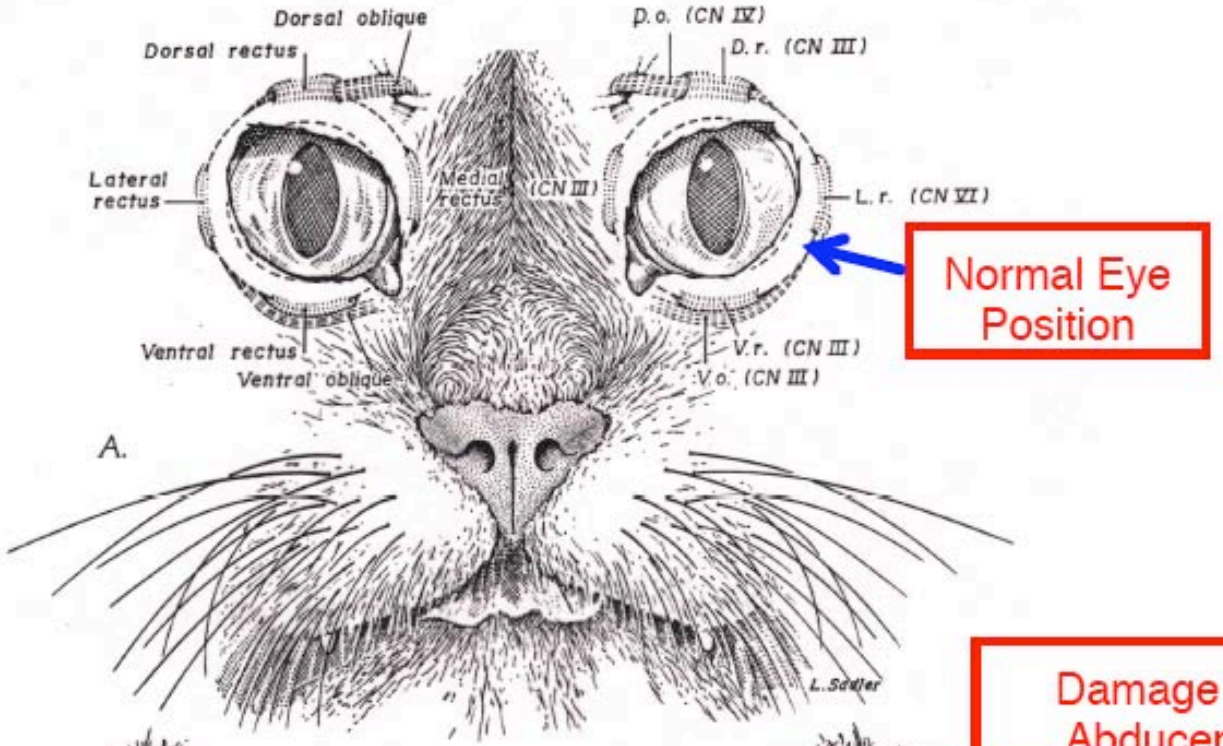
Hypoglossal (XII)

Damage or lesion to these nuclei or their nerves (III, IV, VI and XII) result in the following clinical signs:

1) **Oculomotor, trochlear or abducent nuclei** (or nerves): abnormalities in eye movement, deviation of the eyes (known as **strabismus**).

2) **Hypoglossal (XII):** paralysis or atrophy of tongue muscles; deviation of the tongue toward the side of damage; problems chewing and swallowing.

Damage (lesions) of the 3rd, 4th or 6th cranial nerves or their nuclei of origin cause the following symptoms that can be observed clinically:



Normal Eye Position

CN III Oculomotor nerve
CN IV Trochlear nerve
CN VI Abducent nerve

Damage to Abducens

Ventrolateral Strabismus

Medial Strabismus

Damage to Oculomotor

Damage to the Trochlear N.

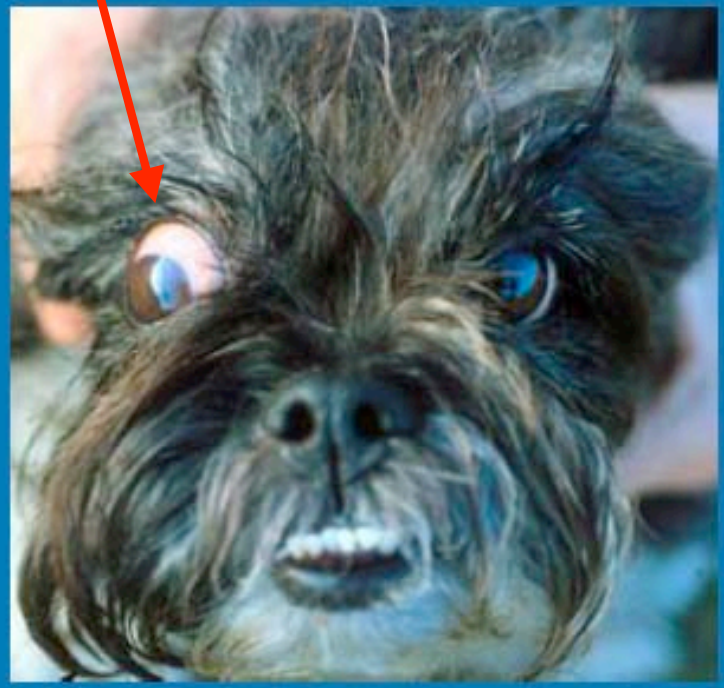
Rotational Strabismus

Strabismus: deviation of the alignment of one eye in relation to the other

Strabismus

- Oculomotor nerve
  - Peripheral
    - Trauma
    - Retrobulbar masses
    - Neurofibroma
    - Lymphosarcoma
  - Central
    - Infection
    - Inflammatory disease
    - Neoplasia

Ventrolateral strabismus

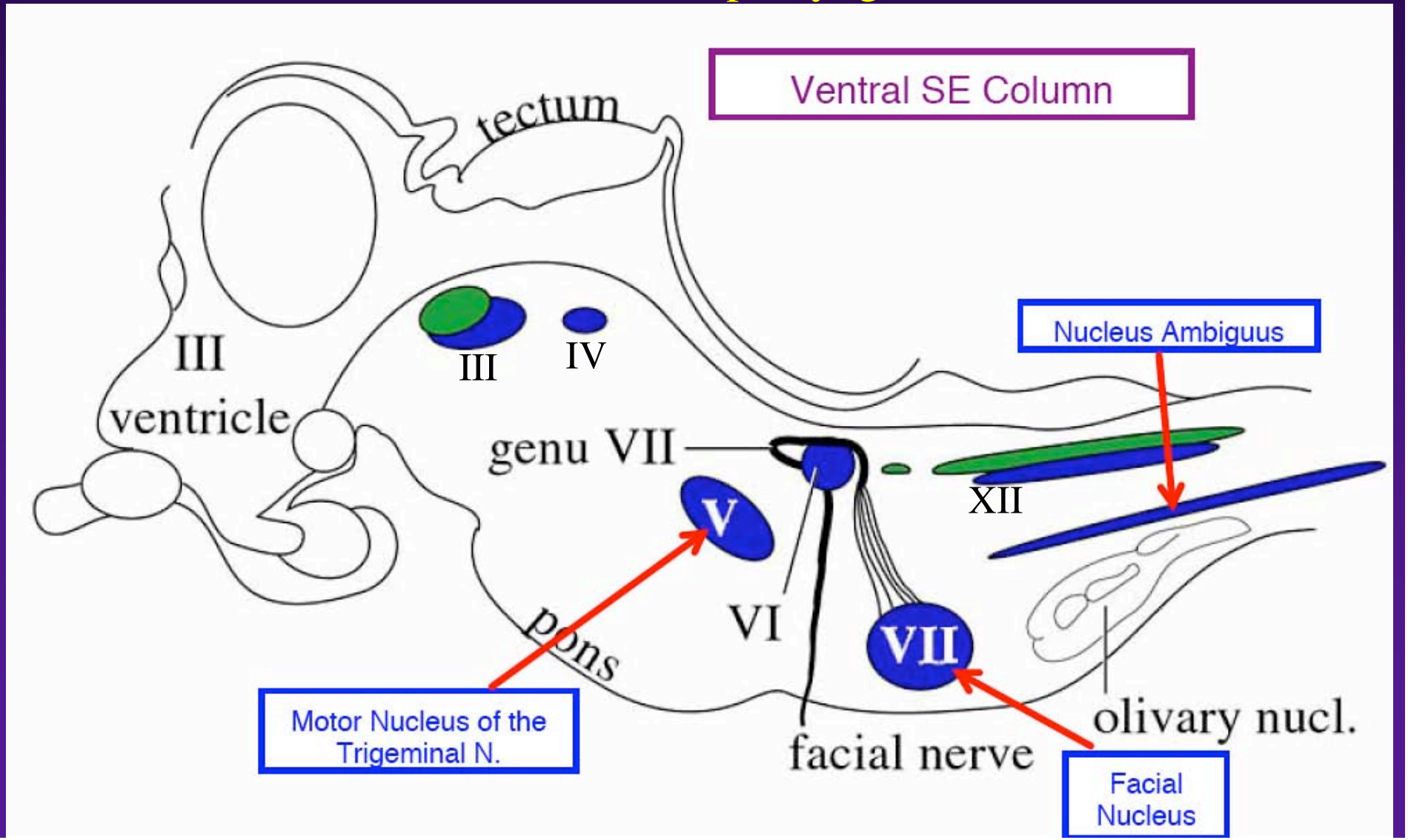


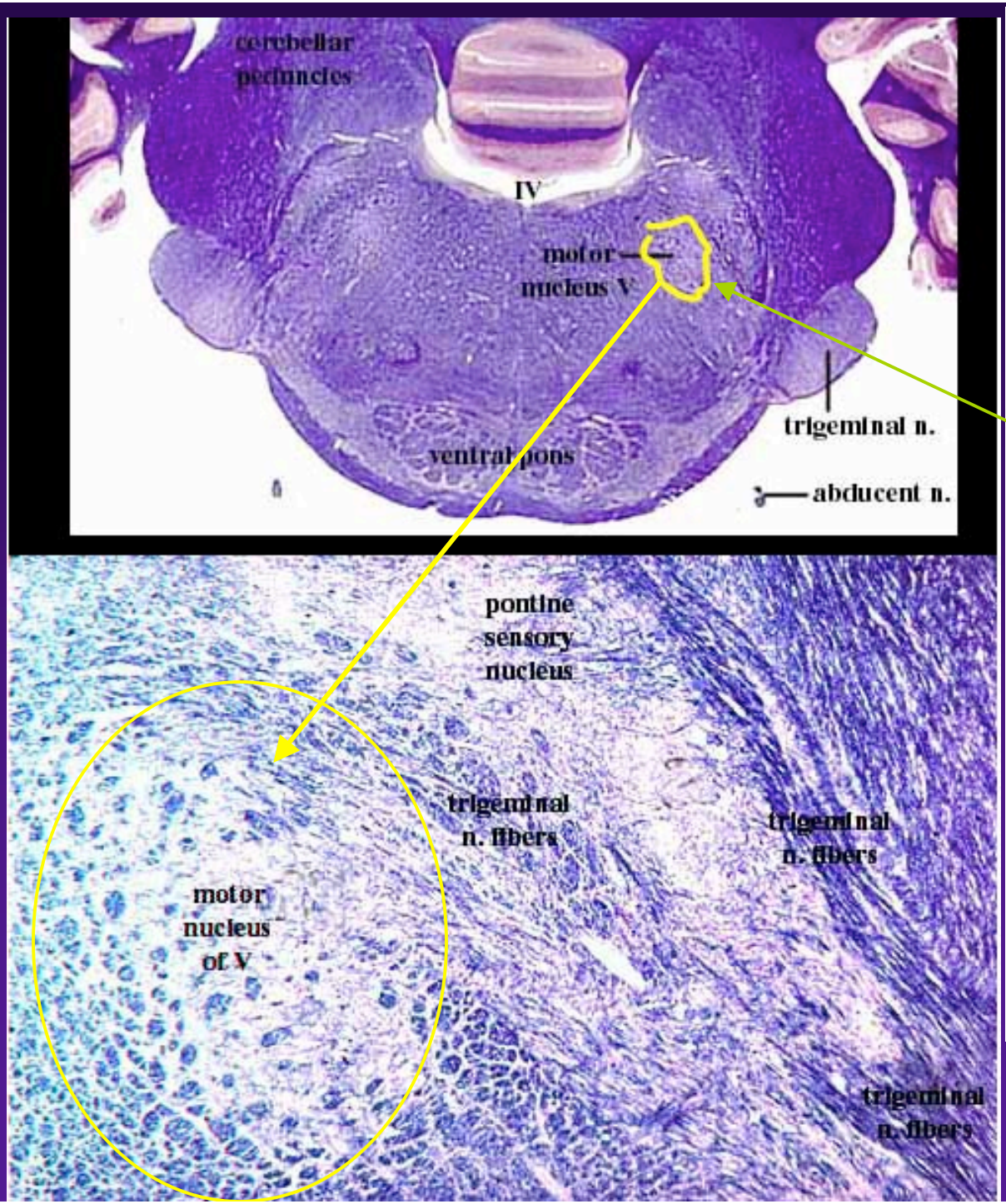
Hypoglossal nucleus (XII Nerve):

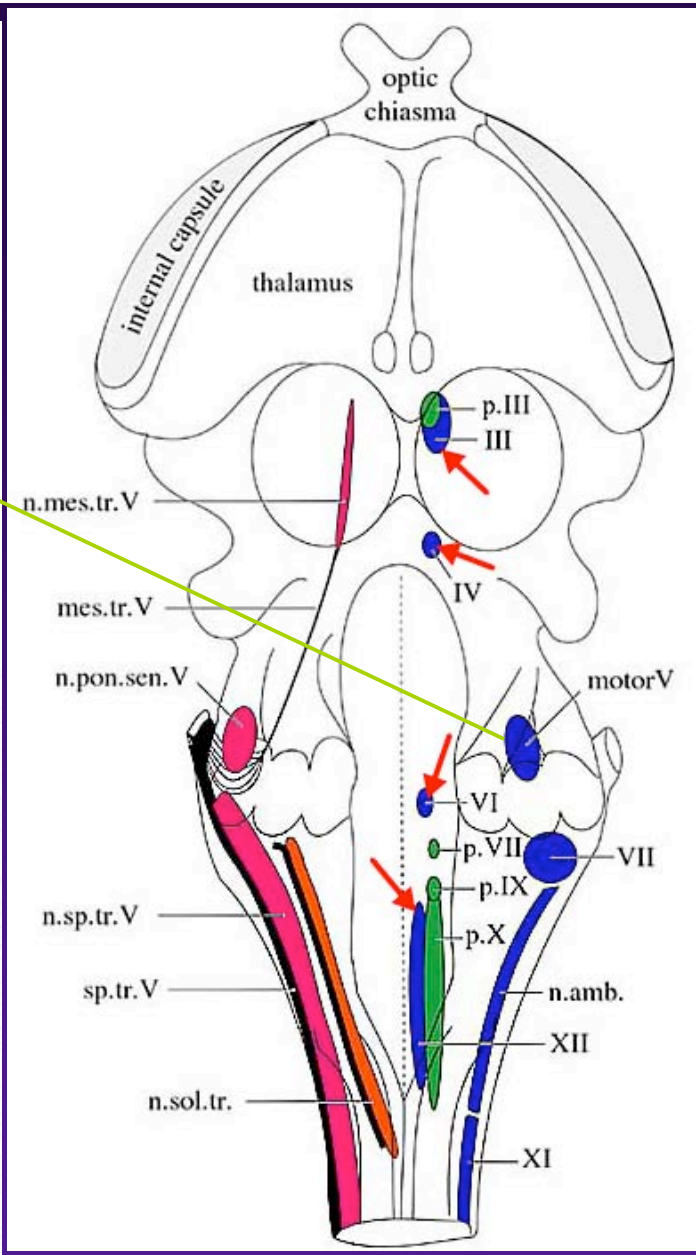
Normal Function: Tongue movement;

Damage-->paralysis or atrophy of tongue muscles

B) **Motor Nucleus of the Trigeminal N. (cranial n. V), Facial Nucleus (nerve VII) and Nucleus Ambiguus (IX & X)** - are formed by a column of cells located in the ventrolateral brainstem-->innervate muscle derived from somitomeres in pharyngeal arches

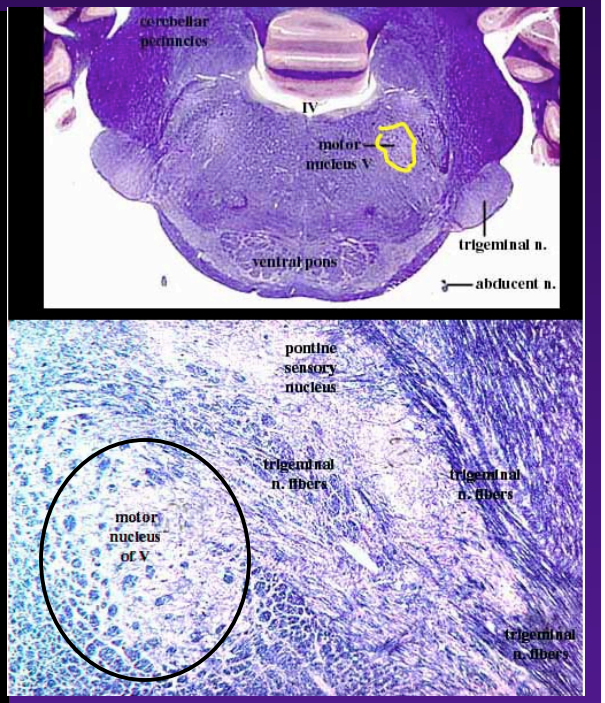






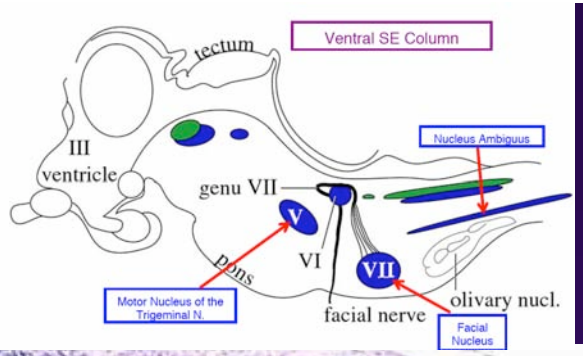
Motor Nucleus of the Trigeminal Nerve

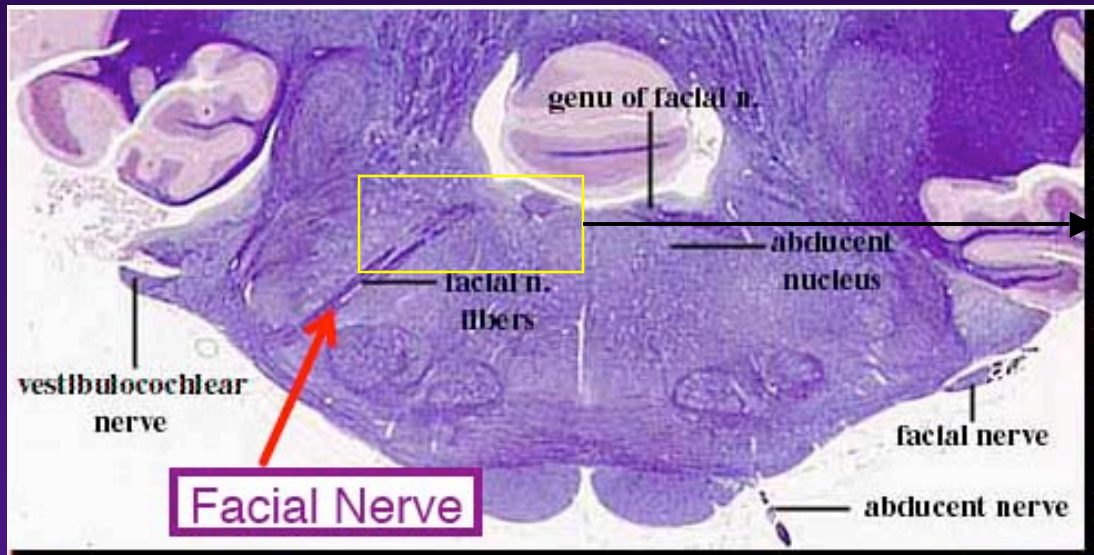
Damage to the motor nucleus of the Trigeminal Nerve or to the motor Root--> animal can't close mouth (drop-jaw).

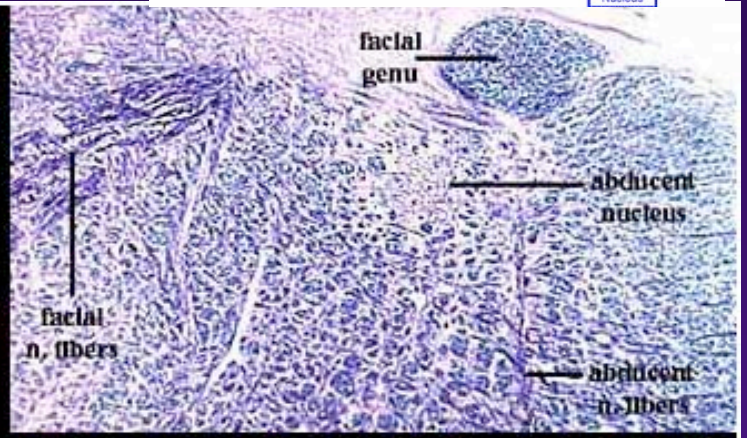


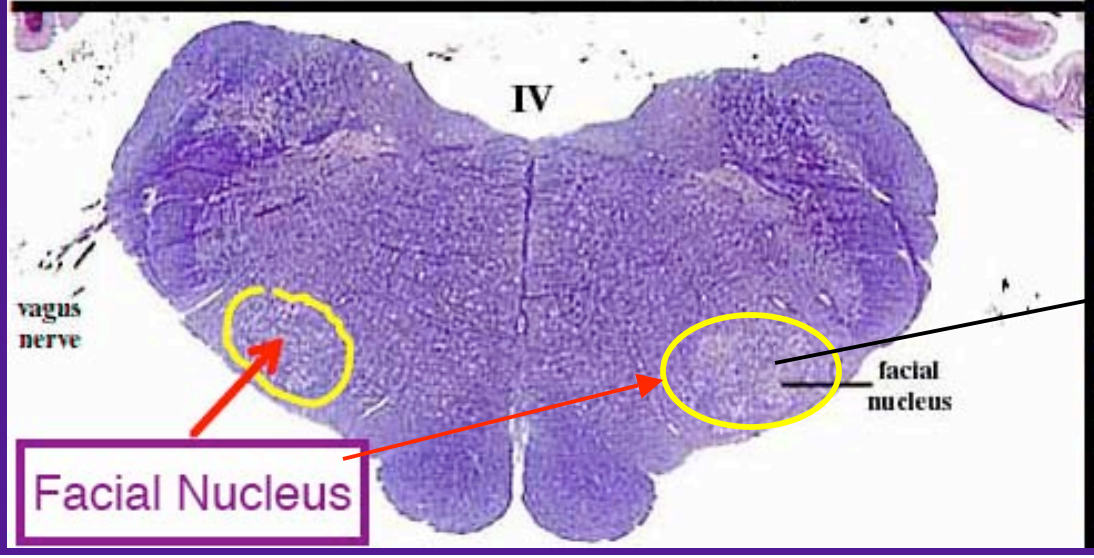
Location of Facial Nucleus and Nerve

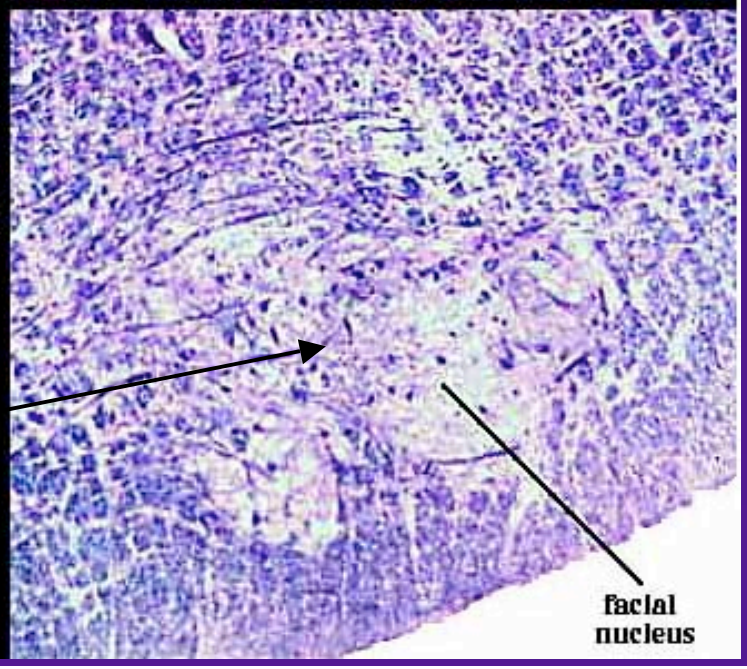
--> innervates muscles of facial expression







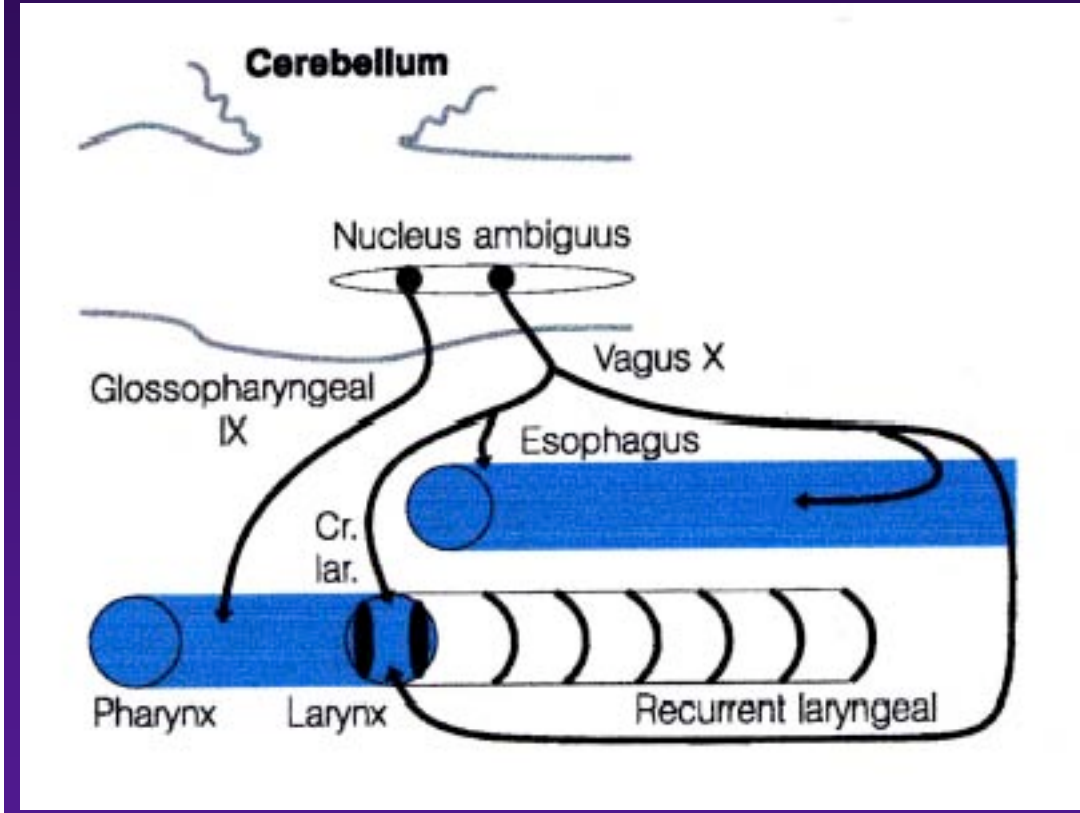


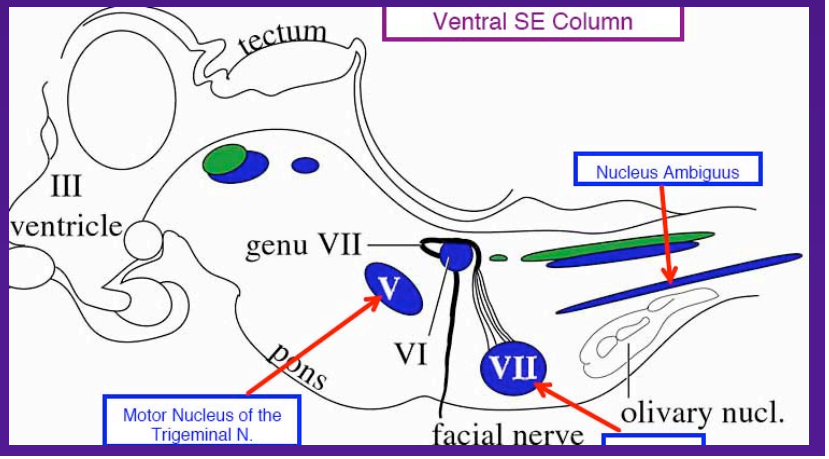


Damage to Facial Nucleus or Facial Nerve -->

Facial paralysis

Nucleus ambiguus innervates muscles of the soft palate, larynx and pharynx (involved with speech, coughing, swallowing and gag reflexes; damage -->swallowing and vocalization difficulties

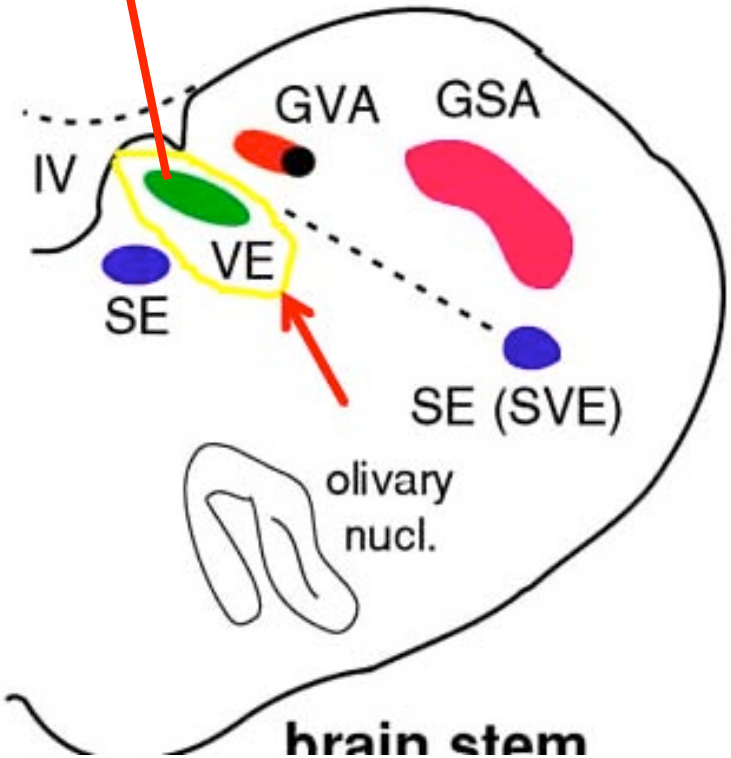




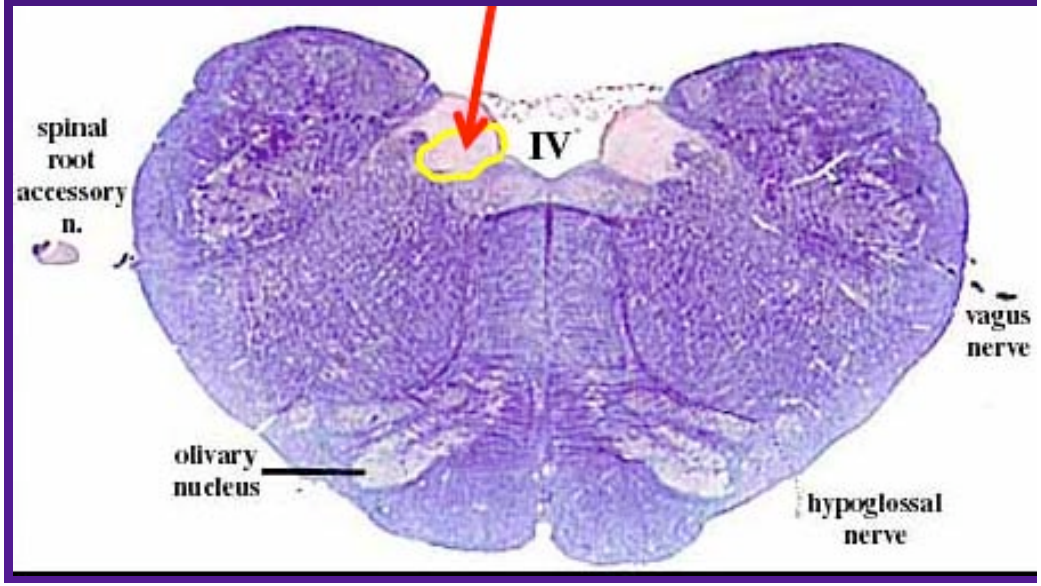
2. **VE (Visceral Efferent) Nuclei**: represent the **cranial** portion of the parasympathetic division of the autonomic nervous system (contain preganglionic parasympathetic neurons). Two important nuclei:

1) **Parasympathetic nucleus of III**: innervates the pupillary constrictor muscle & the ciliary body muscle of the eye

2) **Parasympathetic nucleus of the Vagus**: innervates cervical, thoracic and abdominal viscera; damage results in accelerated heart rate, increased blood pressure & GI disturbances

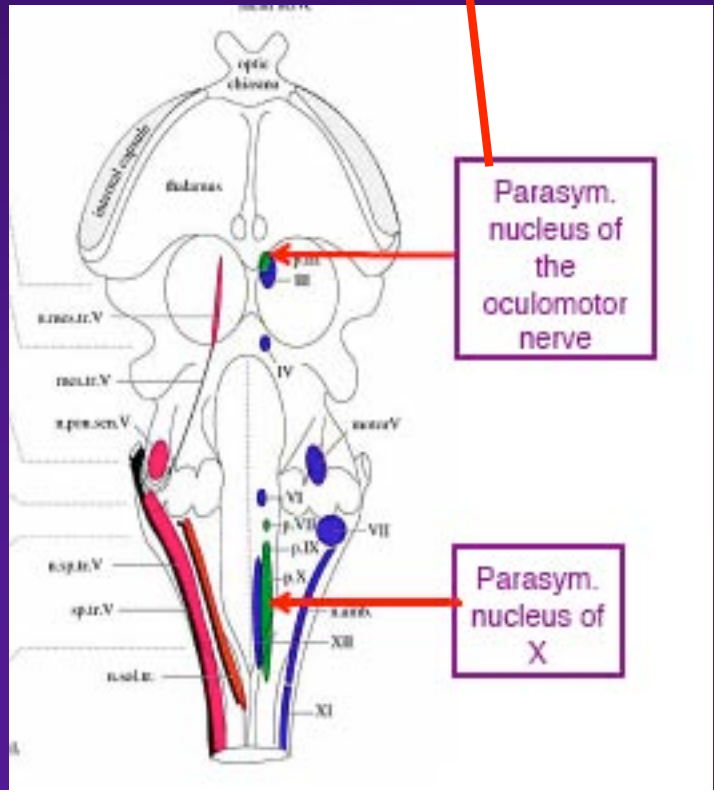


Parasymp. N. of Vagus



Parasympathetic nucleus of III--damage causes loss of pupillary constriction in response to light in the eye on the side of the lesion.

You examine the Parasympathetic Nucleus of III and its nerve fibers by testing the pupillary light reflex



Basal plate Nuclei

Alar plate derived nuclei

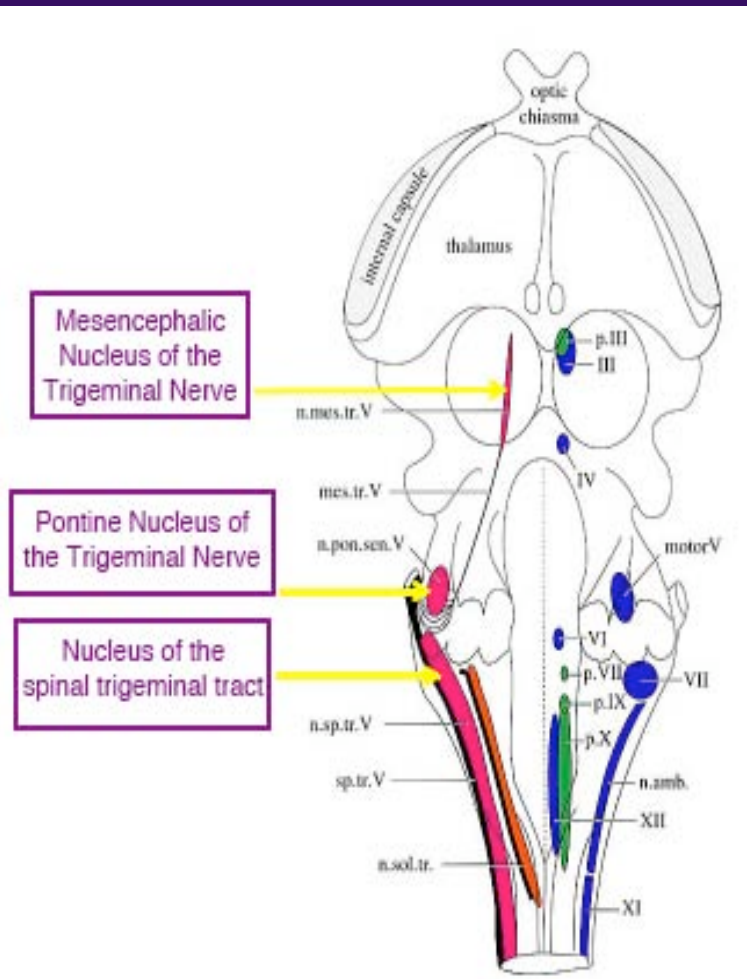
IV. Sensory Afferent Nuclei (Alar Plate derivatives):

1. **GSA (General Somatic Afferent) Nuclei**: Represented by the sensory trigeminal complex which is located laterally in the brain stem.

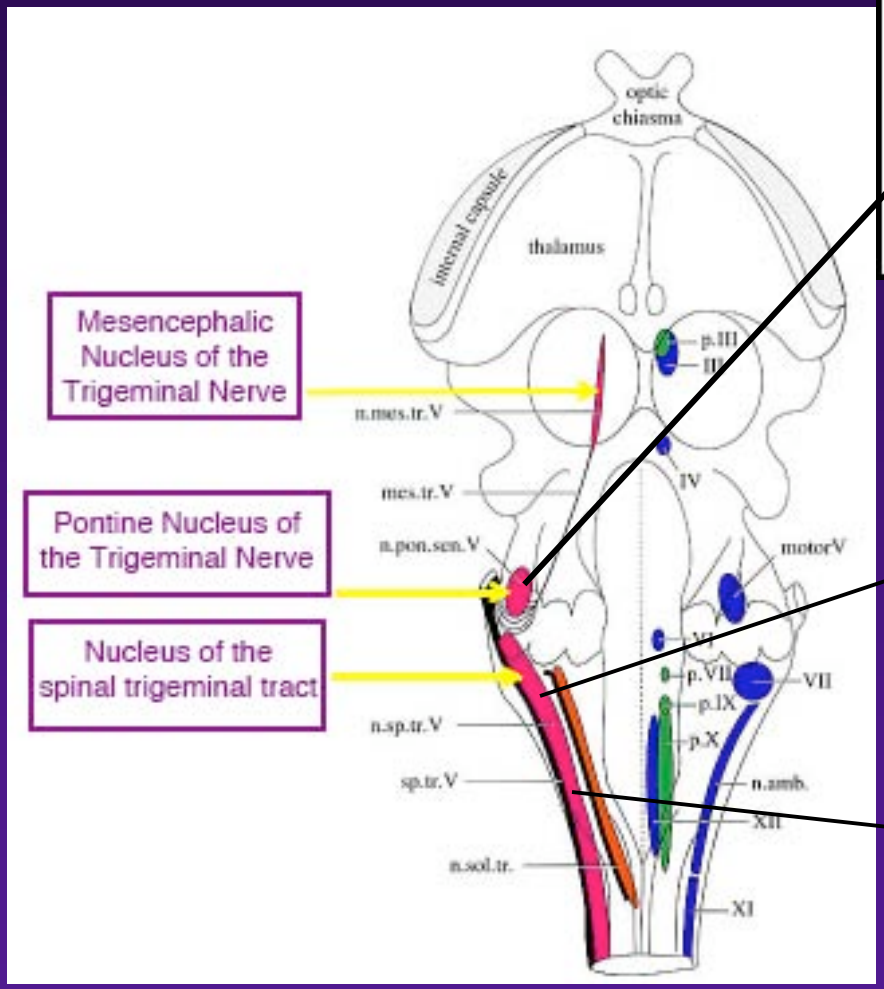
a) **Nucleus of the spinal trigeminal tract** (spinal trigeminal nucleus)- located in the medulla-relays **pain and temperature** sensation from the face & mouth

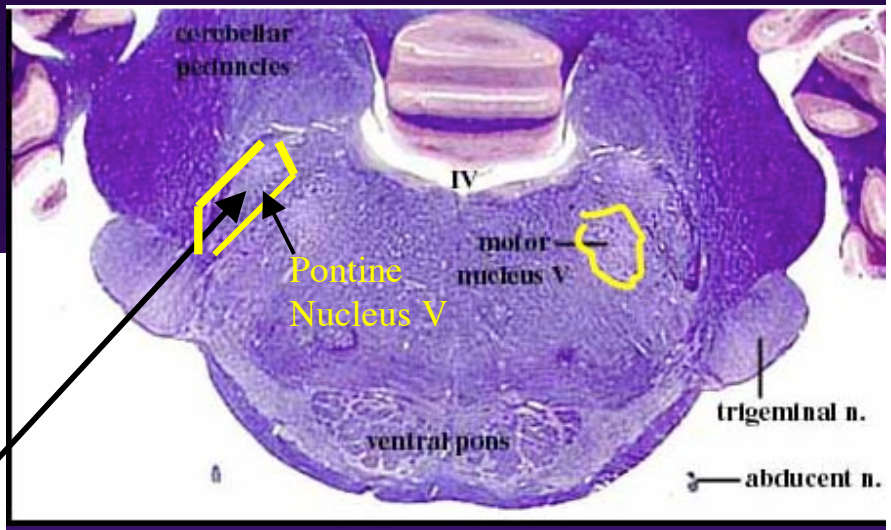
b) **Pontine nucleus of the trigeminal nerve**: located in the pons, relays **touch and pressure** sensation from the face and oral cavity

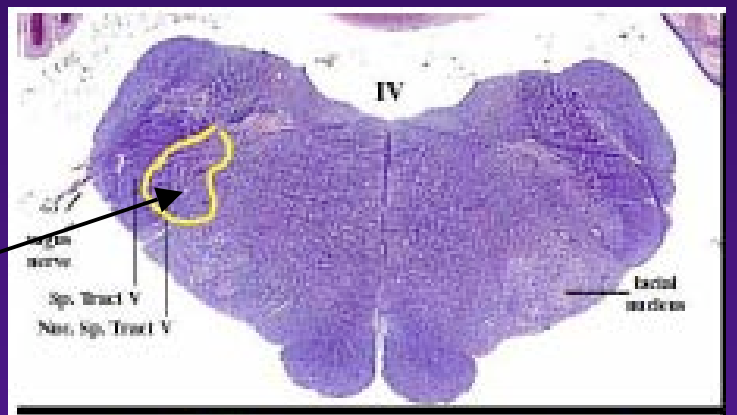
c) **Mesencephalic Nucleus of trigeminal nerve-** unipolar neurons located in the midbrain, relay **proprioceptive** information to motor nucleus of V- ->control force of animals bite.

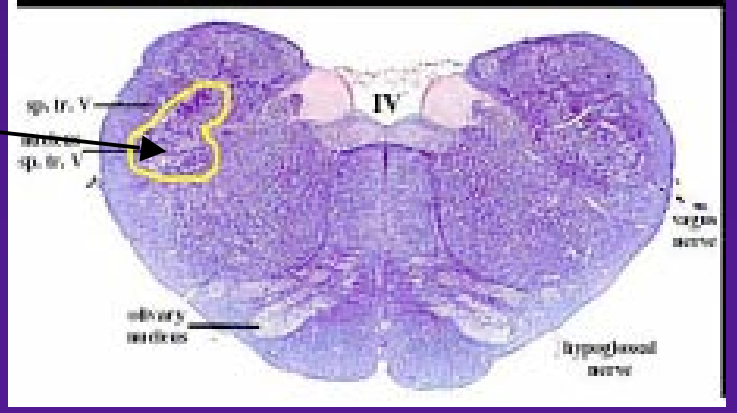


Location of the Trigeminal Nuclei in the brain stem



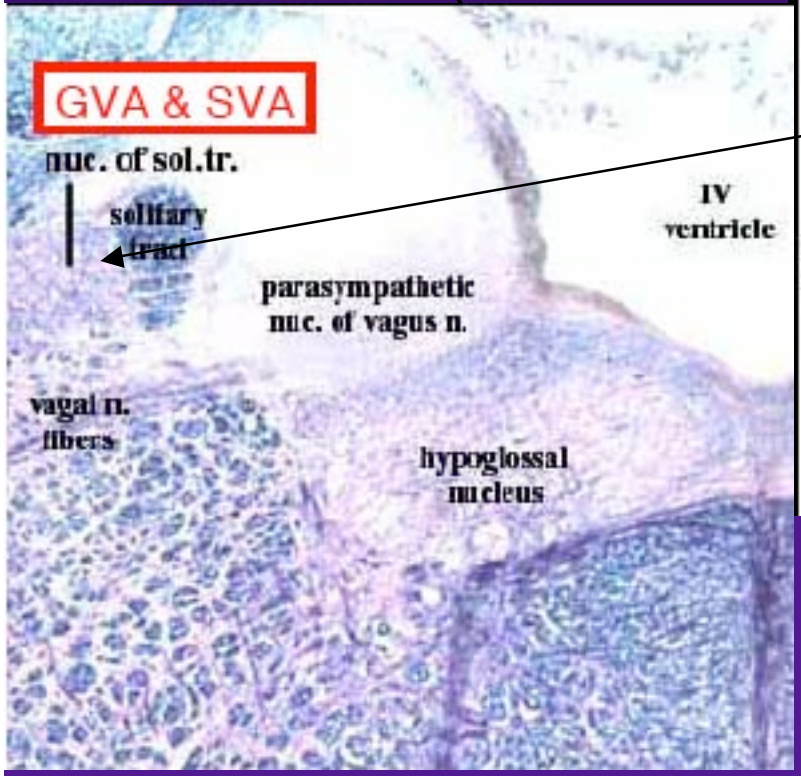


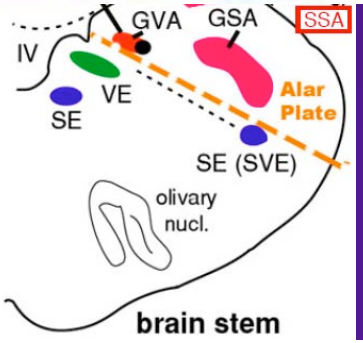




Damage can result in loss of sensation from the face and oral cavity

2. **GVA: General Visceral Afferent Nucleus**: Located lateral to the GVE column and comprised of a single nucleus termed the nucleus of the solitary tract (Nucleus solitarius). GVA portion of this nucleus is associated with cranial nerves IX and X. It mediates visceral sensation from the pharynx, larynx and part of the esophagus.

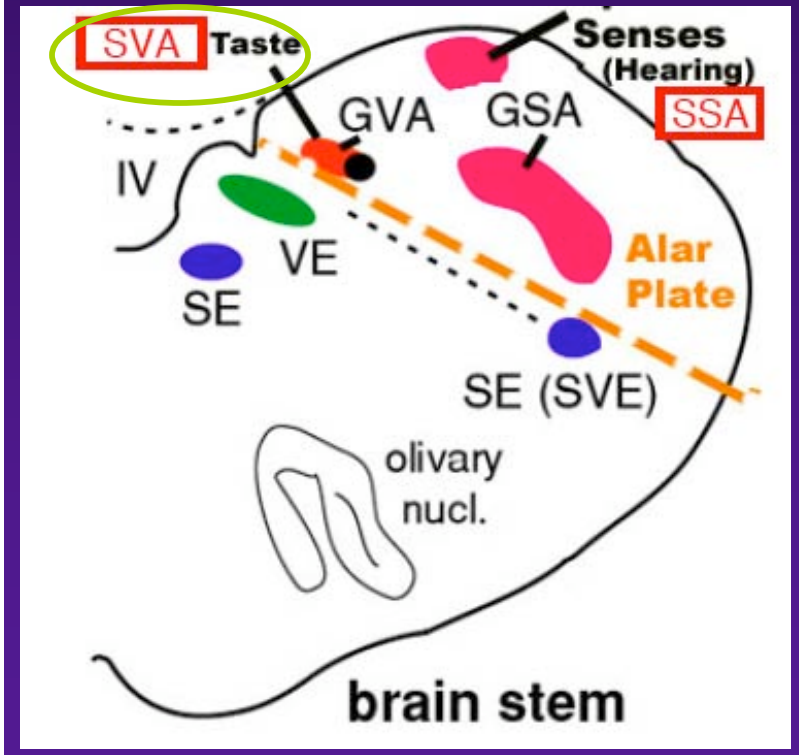




3. SVA (Special Visceral Afferent) Nuclei; Taste & Olfaction

A. There is a **taste** SVA component in the nucleus of the solitary tract. Taste is associated with cranial nerves 7, 9 & 10 which convey taste from the tongue and pharynx. Lesions to nucleus solitarius disrupt taste sensation.

B. The olfactory nerve is associated with **olfactory** SVA sensation (smell). Lesions or damage to nerve will interrupt olfaction.

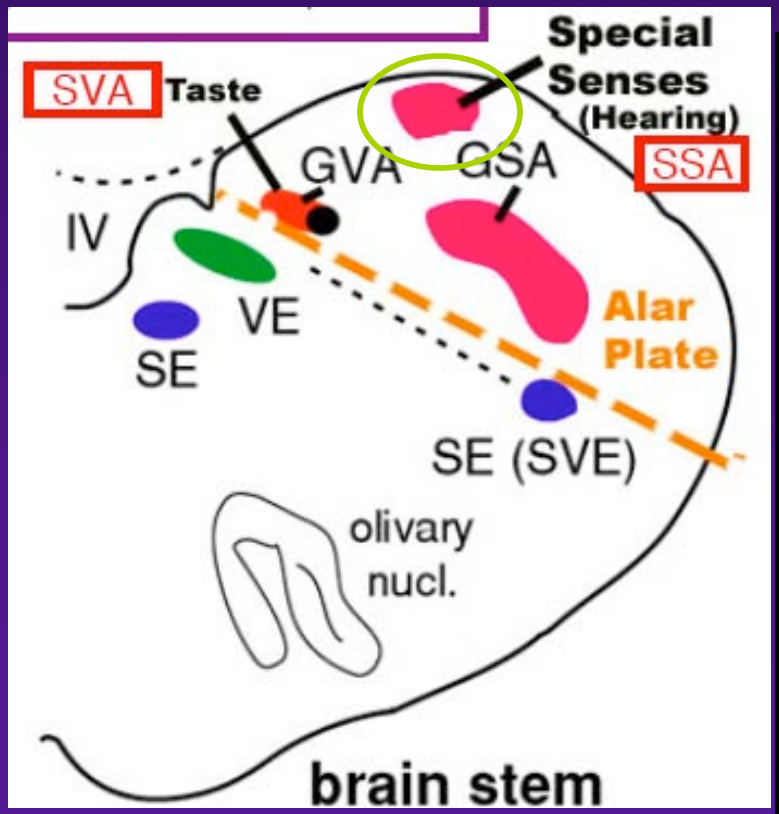


Olfactory- -CNI

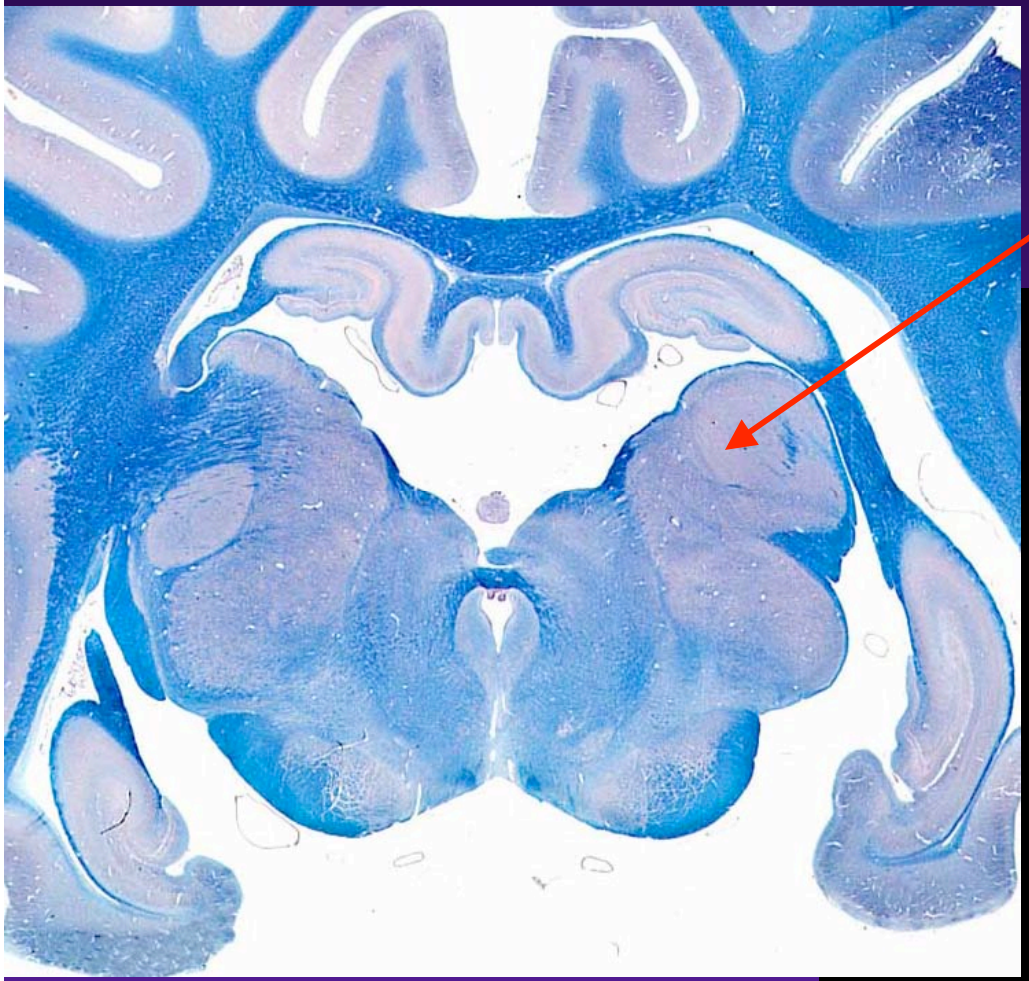
- Food Presentation
  - CNI / complex behavior
- If a cat can't smell, it won't eat

4. **SSA (Special Somatic Afferent Nuclei**: These brain stem nuclei relate to the sense of **vision** (lateral geniculate nucleus), the sense of **hearing** (cochlear nuclei) and the ability to maintain **balance** (vestibular nuclei).

The medullary SSA column related to hearing and balance is located dorsally and laterally in the brain stem and is related to cranial nerve VIII.



Vision: The SSA nucleus related to vision is located in the thalamus and is associated with the optic nerve/tract input. Damage to cranial nerves II or VIII or their associated nuclei will have profound effects on the animals ability to see or hear, respectively.



Test cranial nerve II using the Menace Response

And you thought you were tired!