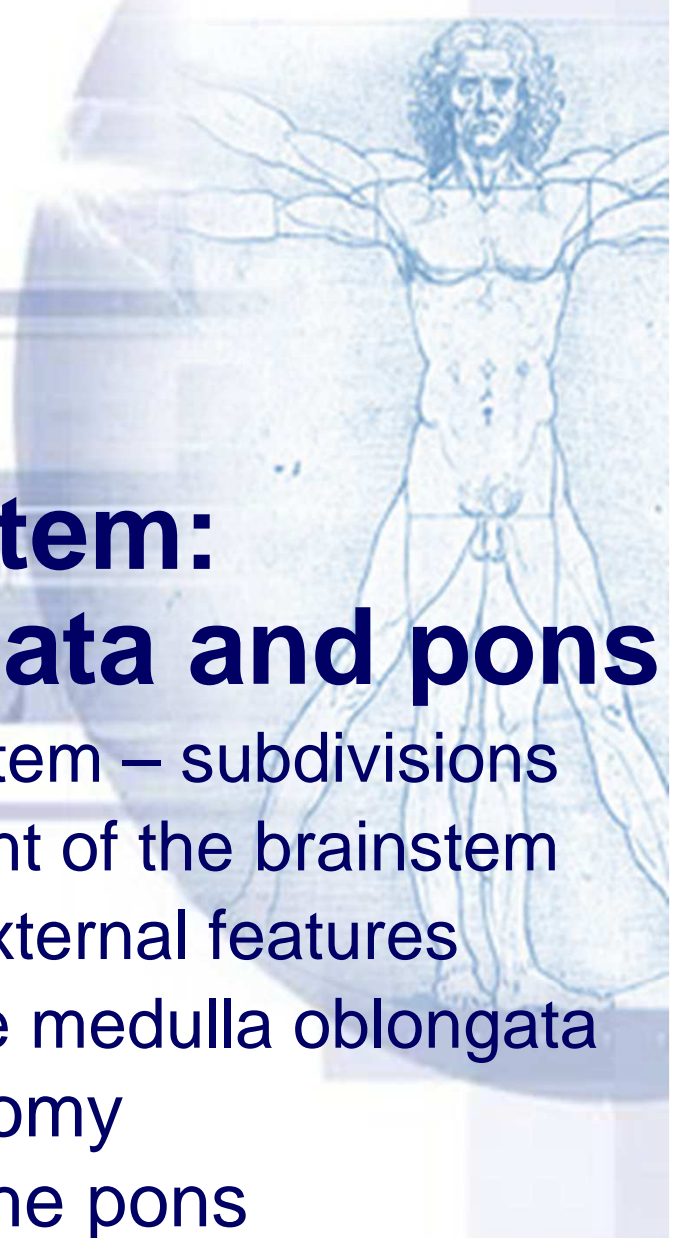


Brainstem: Medulla oblongata and pons

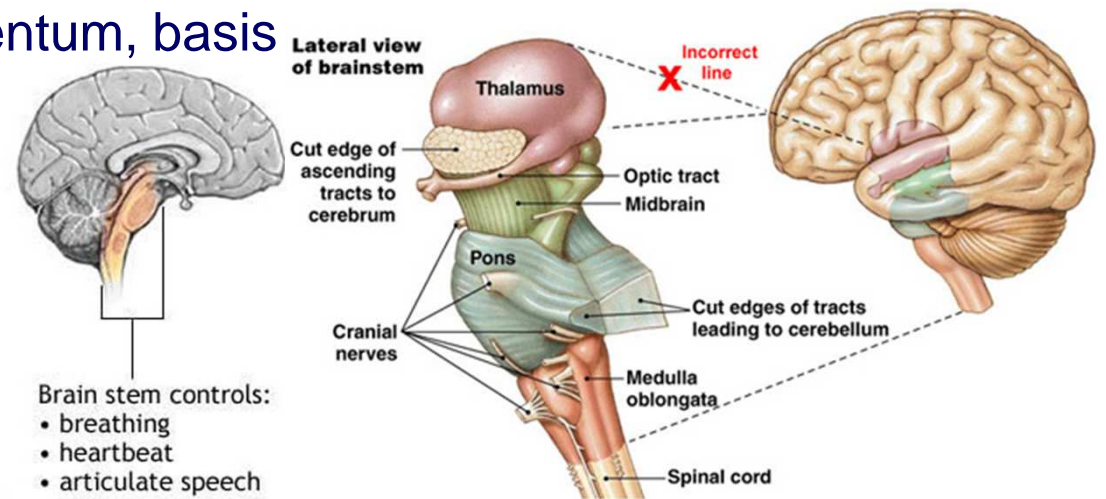
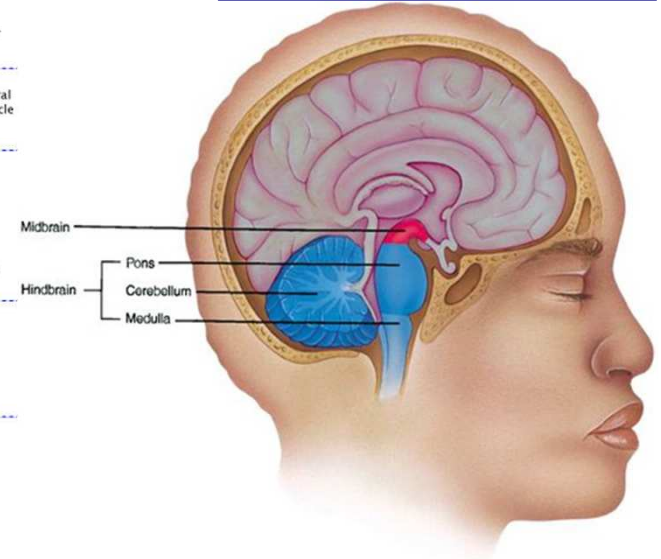
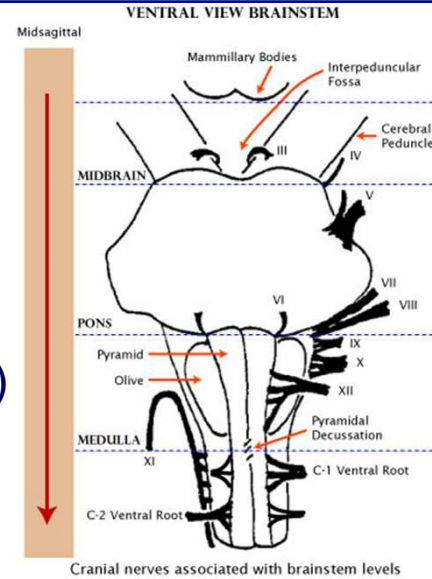
1. Overview of the brainstem – subdivisions
2. Embryonic development of the brainstem
3. Medulla oblongata – external features
4. Internal structure of the medulla oblongata
5. Pons – external anatomy
6. Internal structure of the pons
7. Fourth ventricle. Reticular formation





General organization

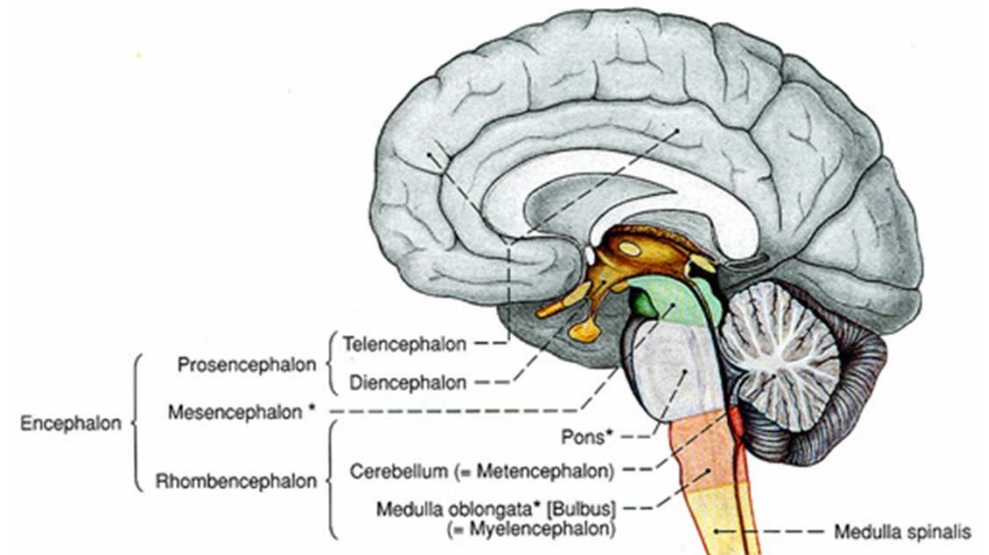
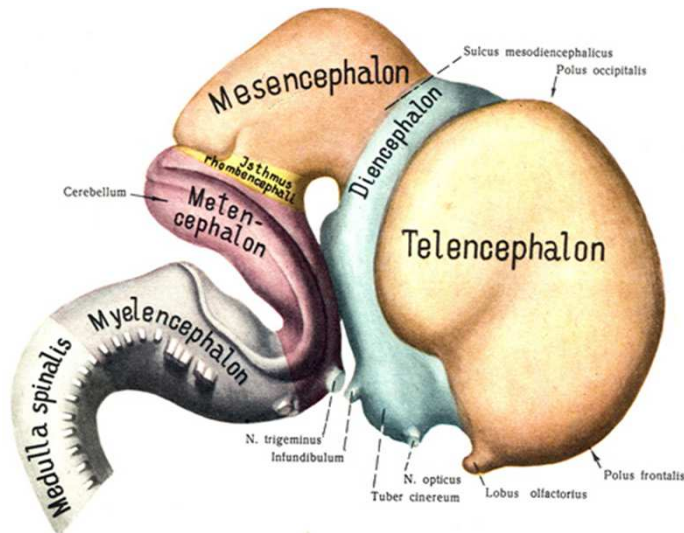
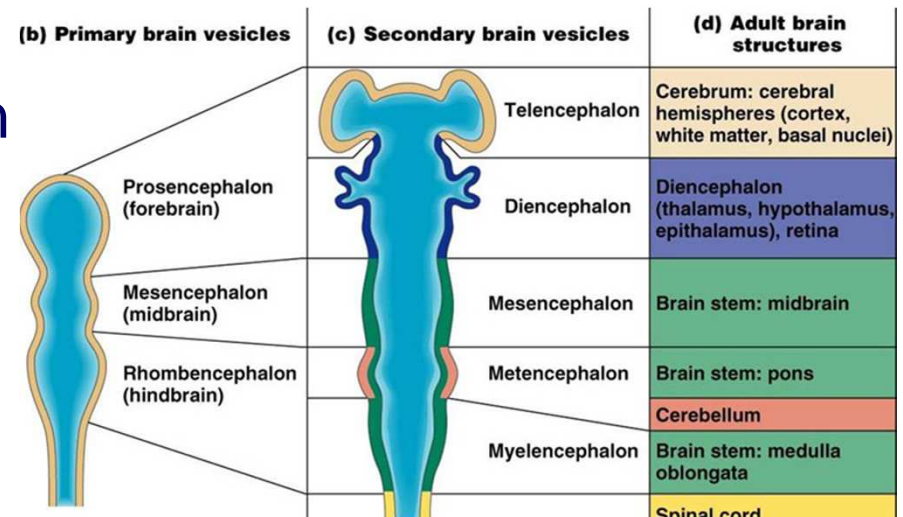
- 3 subdivisions:
 - ✓ medulla oblongata
 - ✓ pons
 - ✓ midbrain
- 10 cranial nerves attached (with the exception of nn. I and II)
 - ✓ motor and sensory innervation: face&neck
- pathway for:
 - ✓ all fiber tracts passing up and down
- 3 laminae: tectum, tegmentum, basis
- neurological functions:
 - ✓ survival
 - breathing
 - digestion
 - heart rate
 - blood pressure
 - ✓ arousal
 - being awake and alert





Embryologic development

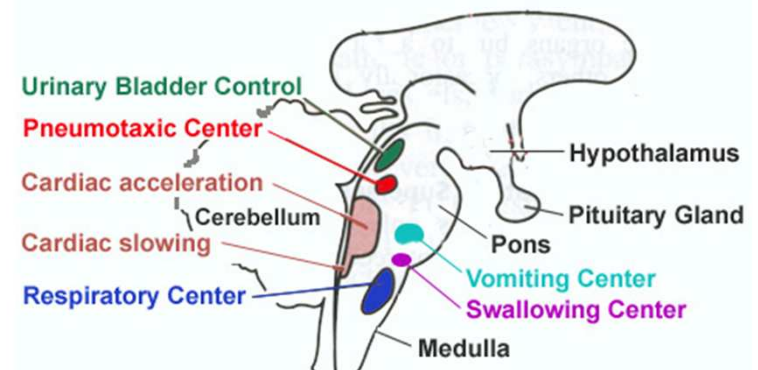
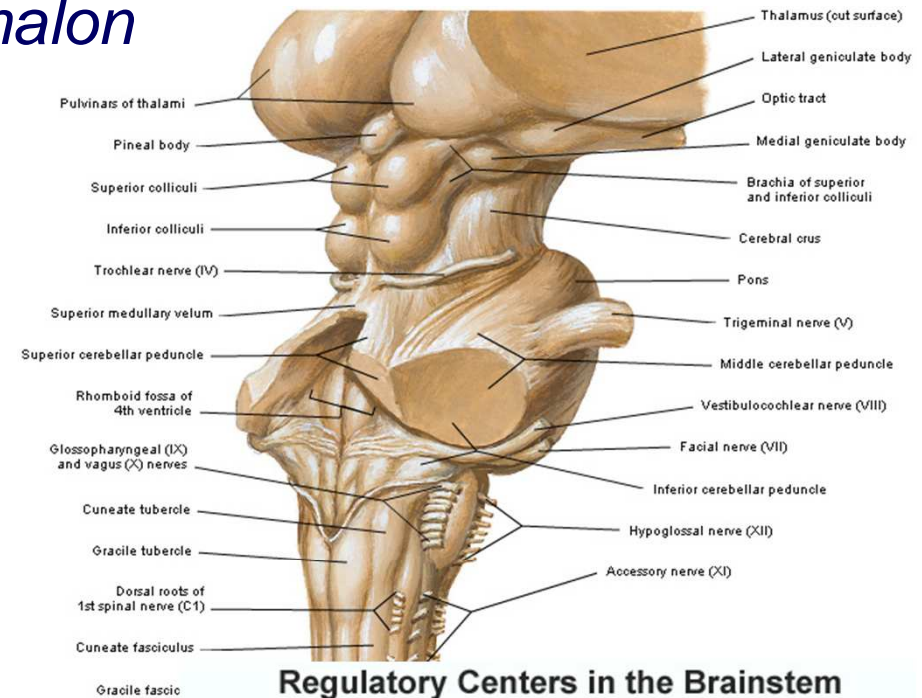
- Embryonic origin:
 - ✓ mesencephalon ⇒ midbrain
 - ✓ rhombencephalon:
 - metencephalon ⇒ pons & cerebellum
 - myelencephalon ⇒ medulla oblongata





Medulla oblongata – external features

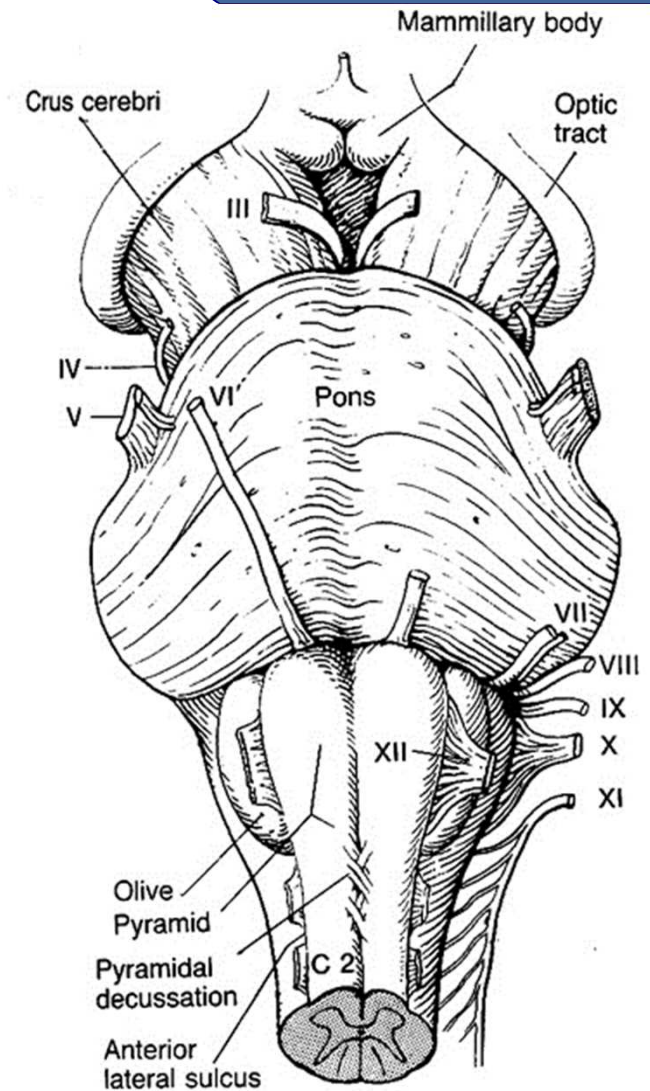
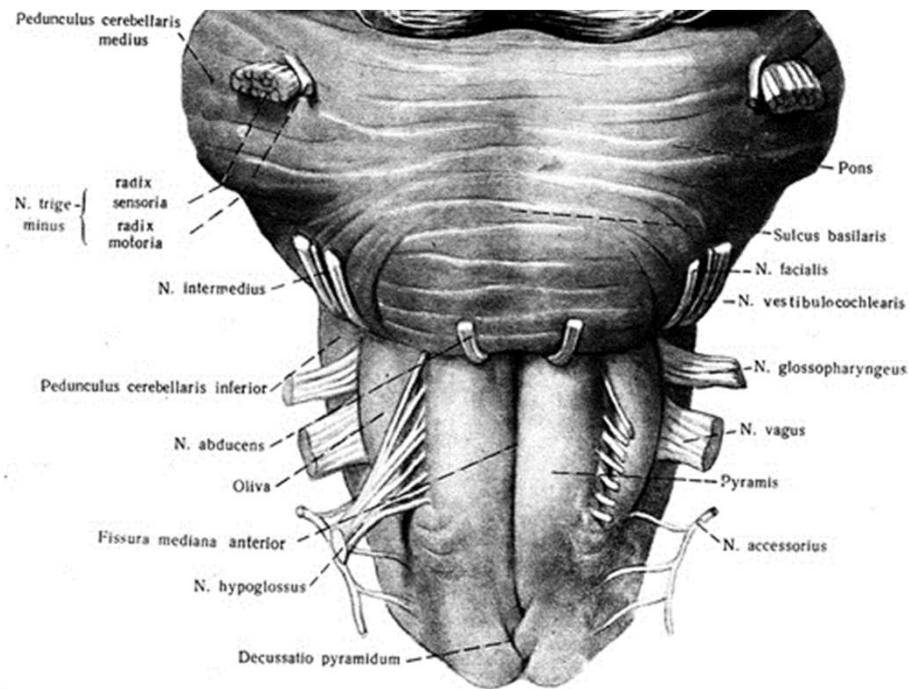
- synonyms: *bulbus*, *myelencephalon*
- shape – pyramidal or conical
- size:
 - ✓ 3 cm longitudinally
 - ✓ 2 cm transversally
 - ✓ 1.25 cm anteroposteriorly
- 2 parts:
 - ✓ lower, *closed part*
 - ✓ upper, *open part*
- functions:
 - ✓ relay station of motor tracts
 - ✓ contains respiratory, vasomotor and cardiac centers
 - ✓ controls reflex activities such as coughing, gagging, swallowing and vomiting





Medulla oblongata – anterior aspect

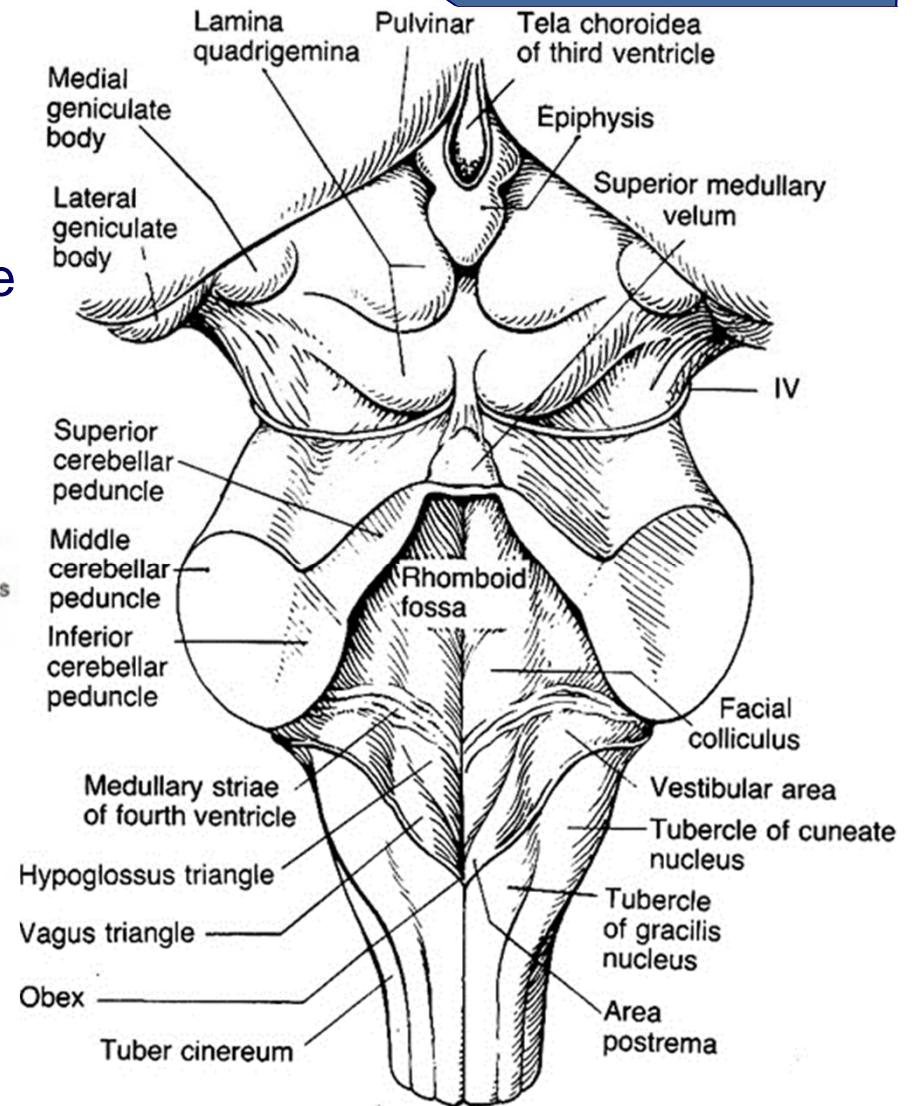
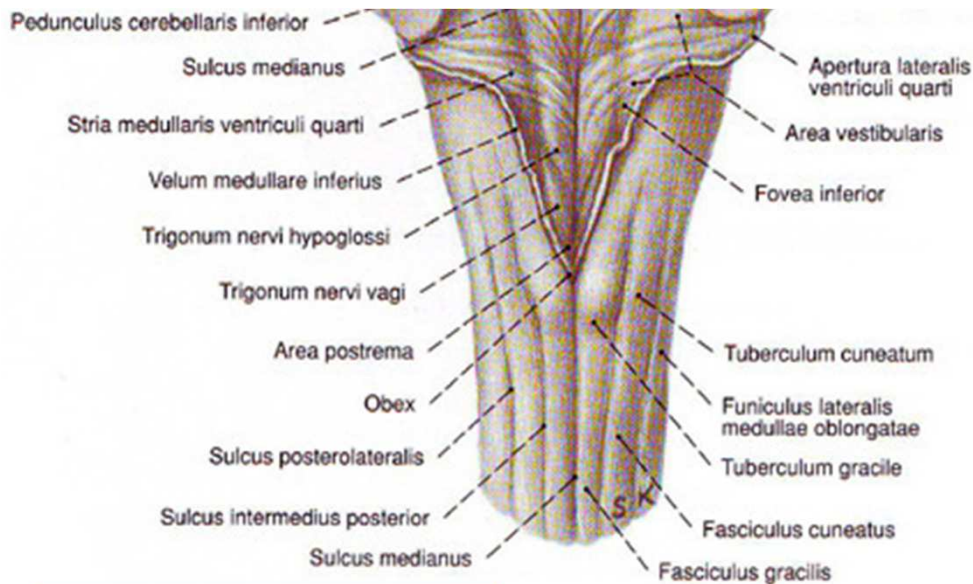
- anterior median fissure
- pyramid ⇒ pyramidal decussation
- olive
- anterolateral sulcus ⇒ hypoglossal nerve (XII)
- retroolivary sulcus ⇒ nn. IX, X and XI





Medulla oblongata – posterior aspect

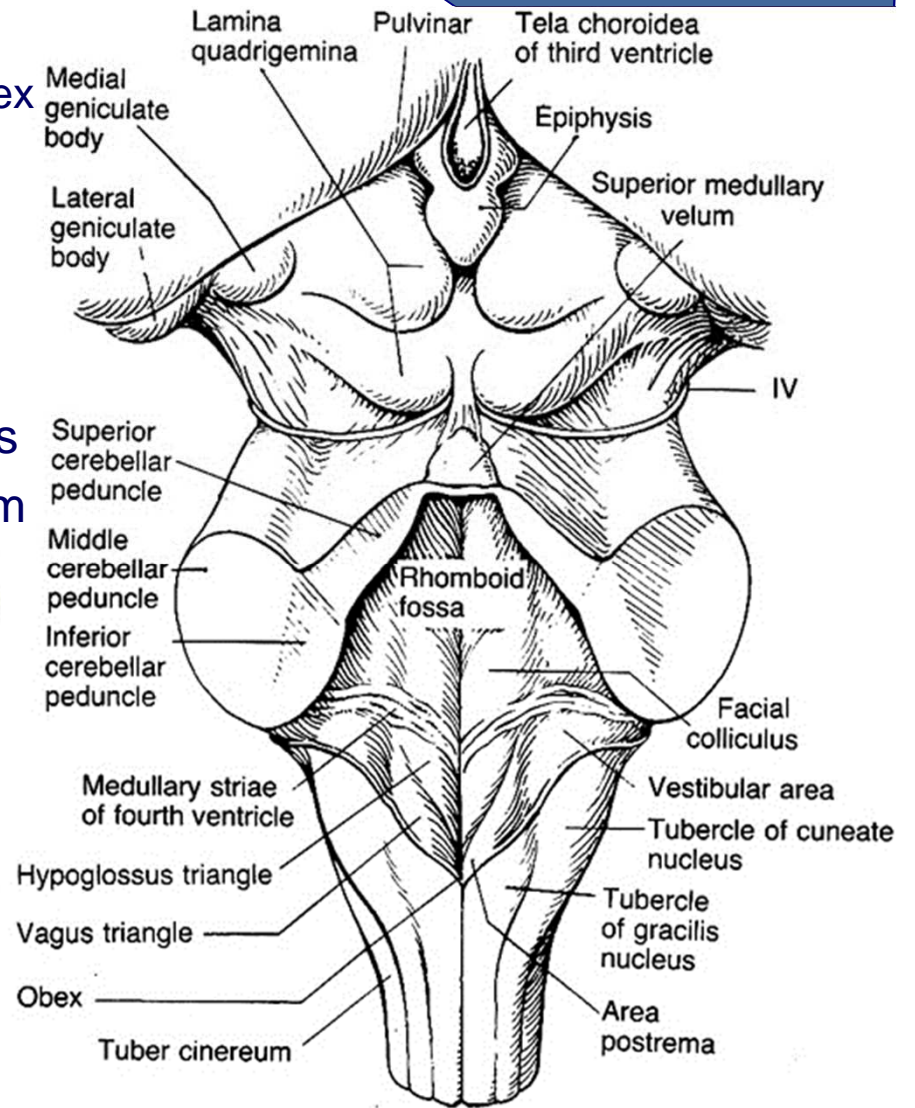
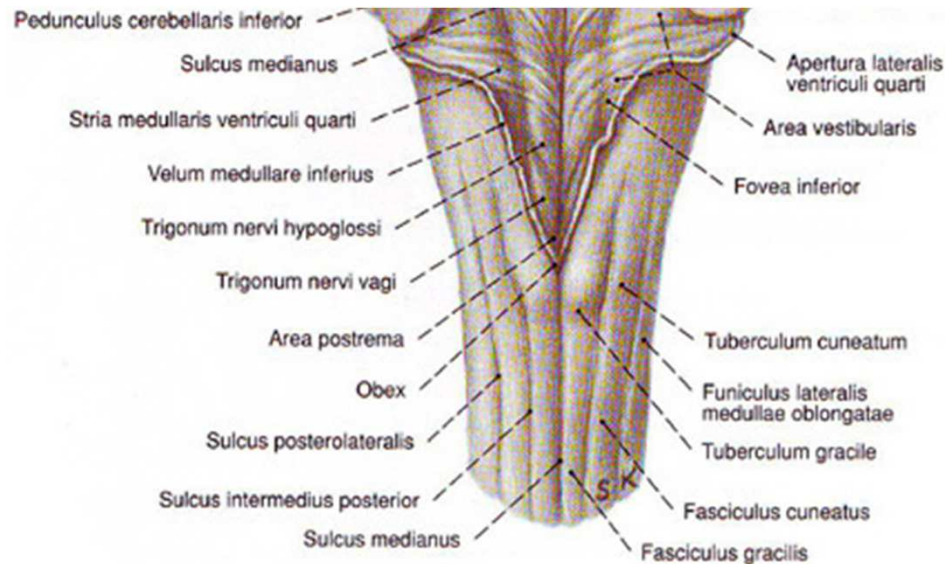
- posterior median sulcus
- caudal, *closed part* – obex:
 - ✓ gracile fascicle ⇒ gracile tubercle
 - ✓ cuneate fascicle ⇒ cuneate tubercle
 - ✓ posterior intermediate sulcus
 - ✓ posterolateral sulcus
 - ✓ *tuberculum cinereum*





Medulla oblongata – posterior aspect

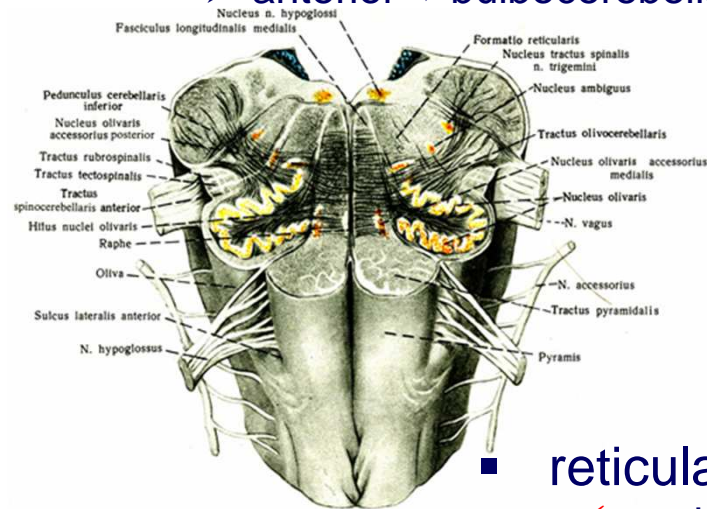
- cranial, *open part* – rhomboid fossa:
 - ✓ medullary striae of fourth ventricle ⇔ obex
 - ✓ *sulcus limitans*
 - ✓ hypoglossus triangle
 - ✓ vagus triangle
 - ✓ area postrema
 - ✓ vestibular area, acoustic tubercle ⇒ pons
 - ✓ inferior cerebellar peduncle ⇒ cerebellum





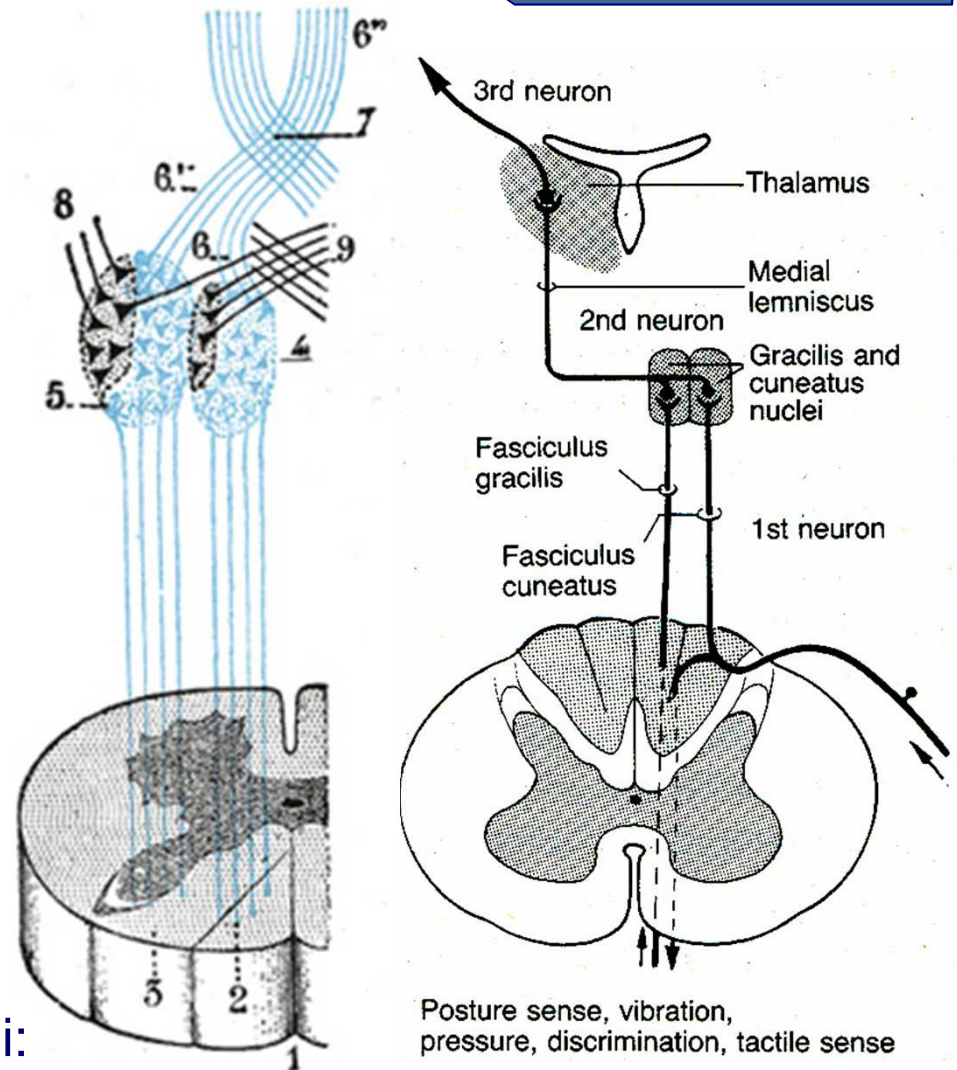
Medulla oblongata – internal structure

- white and grey matter
- olive:
 - ✓ inferior olivary nuclear complex
- posterior column nuclei:
 - ✓ *nucleus gracilis*
 - ✓ *nucleus cuneatus*
 - ✓ internal arcuate fibers ⇒ sensory decussation ⇒ medial lemniscus ⇒ bulbothalamic tract
 - ✓ external arcuate fibers
 - posterior ⇒ cuneocerebellar tract
 - anterior ⇒ bulboocerebellar tract



- reticular nuclei:

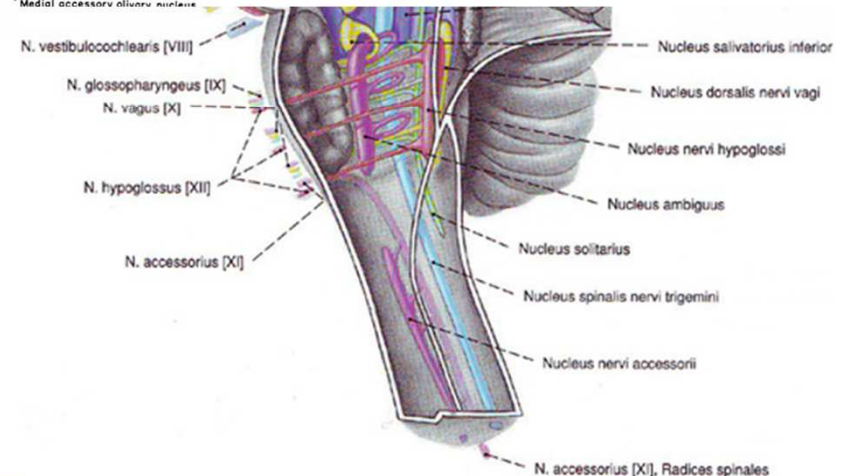
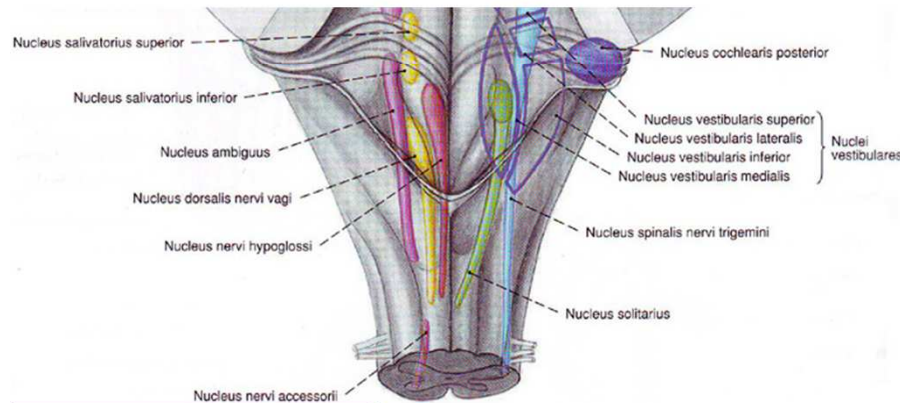
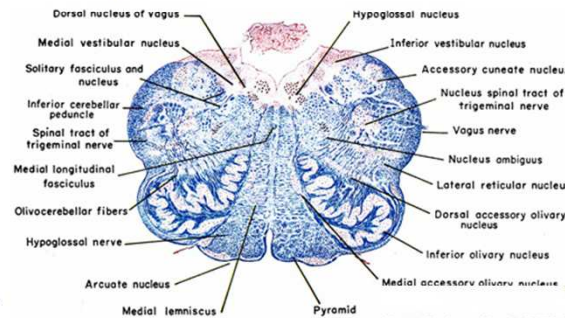
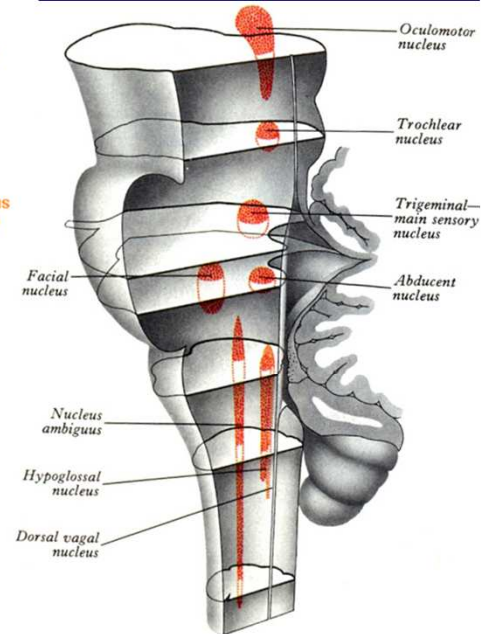
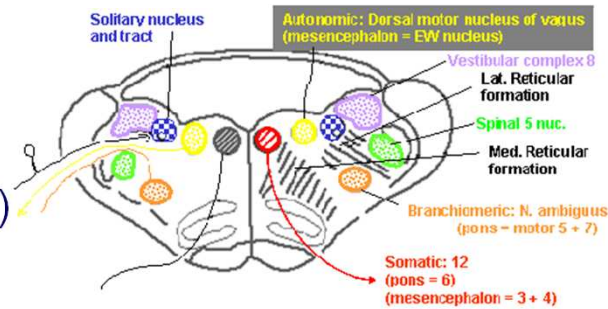
- ✓ raphe nuclei, pallidus, obscurus & magnus – SERgic (B1-B3)





Grey matter: nuclei of the cranial nerves

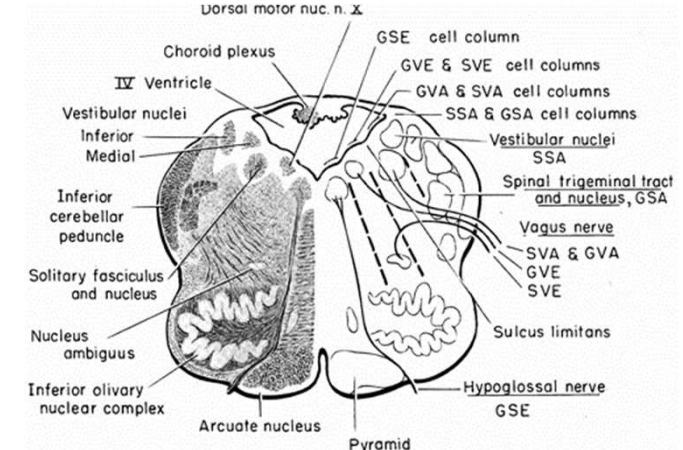
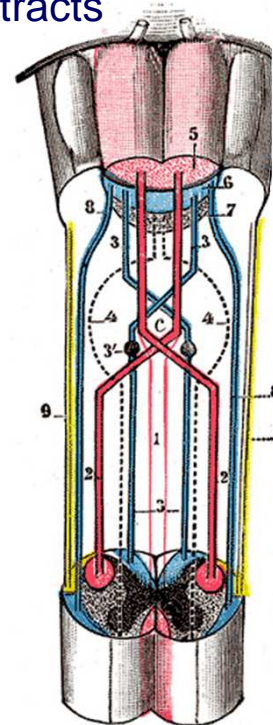
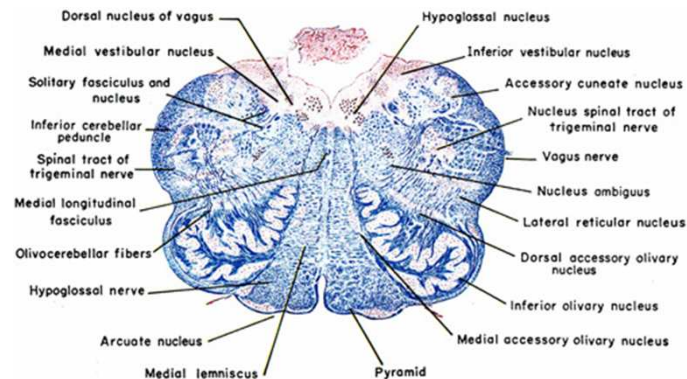
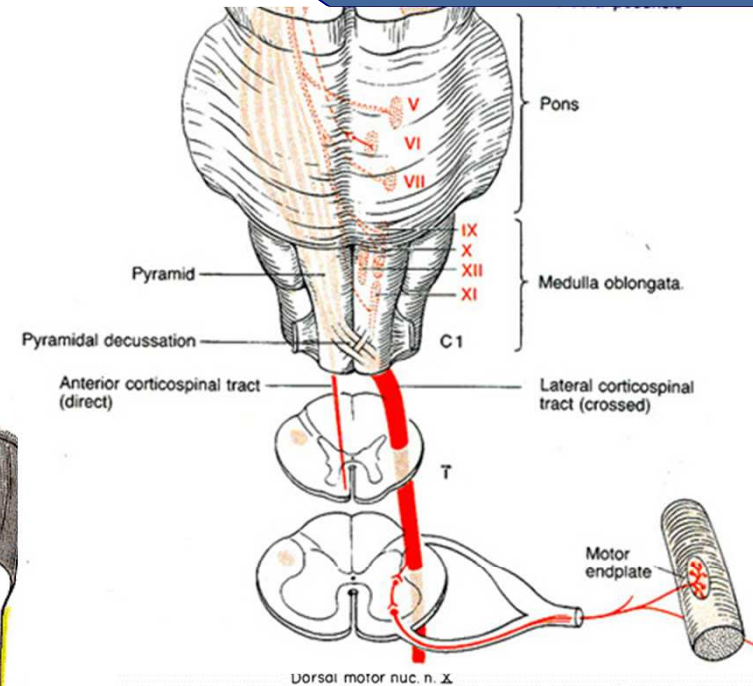
- glossopharyngeal nerve (IX):
 - ✓ inferior salivatory nucleus
 - ✓ nucleus ambiguus (IX, X, XI)
 - ✓ solitary tract nucleus (VII, IX, X)
- vagus nerve (X):
 - ✓ dorsal motor nucleus of the vagus
- accessorius nerve (XI)
- hypoglossal nerve (XII):
 - ✓ hypoglossal nucleus
- trigeminal nerve (V):
 - ✓ spinal trigeminal nucleus





White matter: ascending and descending tracts

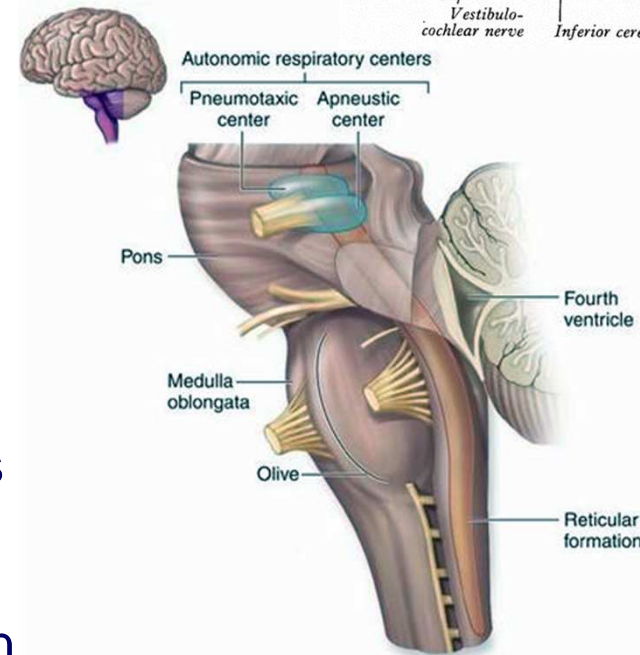
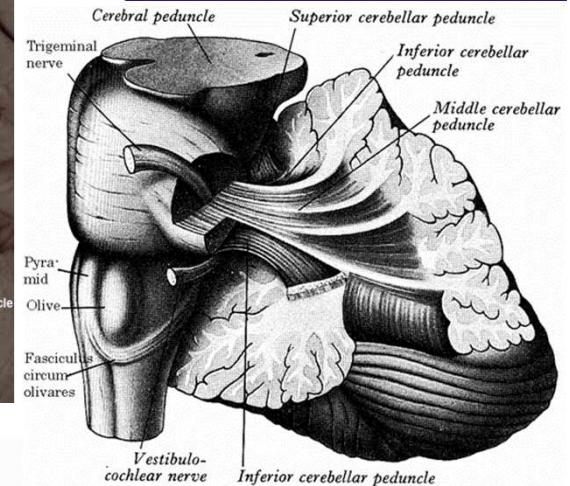
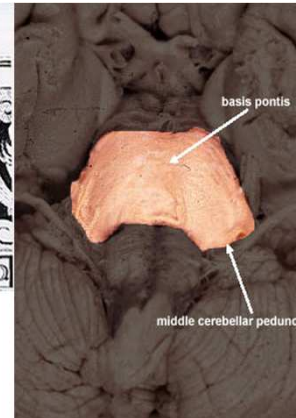
- descending (corticobulbar) tracts:
 - ✓ corticospinal tract ⇒ pyramidal decussation
 - ✓ reticulospinal tract
- ascending tracts:
 - ✓ cuneocerebellar tract
 - ✓ anterior and posterior spinocerebellar tracts
 - ✓ anterior and lateral spinothalamic tracts
 - ✓ spinotectal tract
- mixed tracts:
 - ✓ dorsal longitudinal fasciculus:
 - descending hypothalamic axons
 - ascending visceral sensory axons





Pons – external features

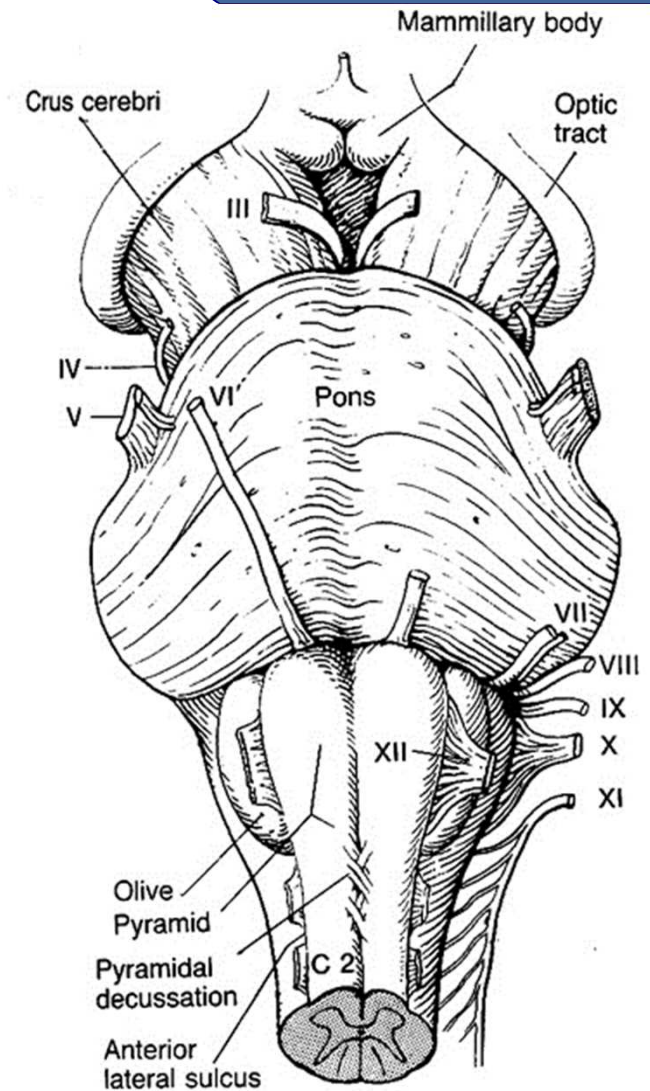
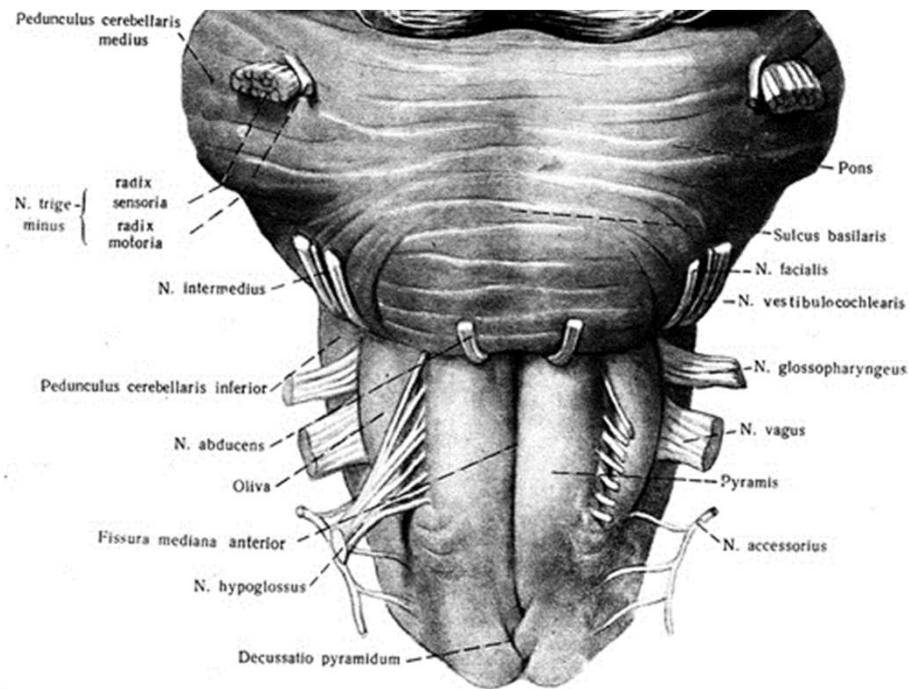
- synonym: *pons Varolii*
- rostral part of hindbrain
- basal pons:
 - ✓ shape – "knob-like"
 - ✓ size: 2 cm long
 - ✓ composition – transverse fibers
- dorsal pons:
 - ✓ covered by cerebellum
 - ✓ upper half of fourth ventricle
- middle cerebellar peduncle
- functions:
 - ✓ relay station from medulla to higher cortical structures
 - ✓ assists in the control of movements
 - ✓ control of sleep and arousal
 - ✓ contains respiratory center and regulates respiration





Pons – anterior aspect

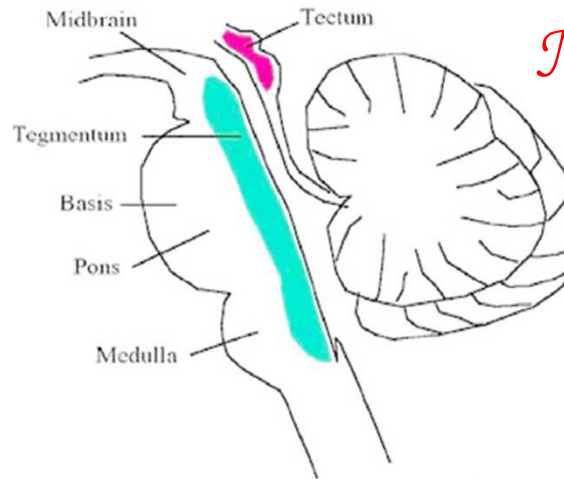
- *sulcus basilaris* ⇒ basilar artery
- median eminence ⇒ corticospinal fibers, 'pyramidal tract'
- middle cerebellar peduncle
- trigeminal nerve exit



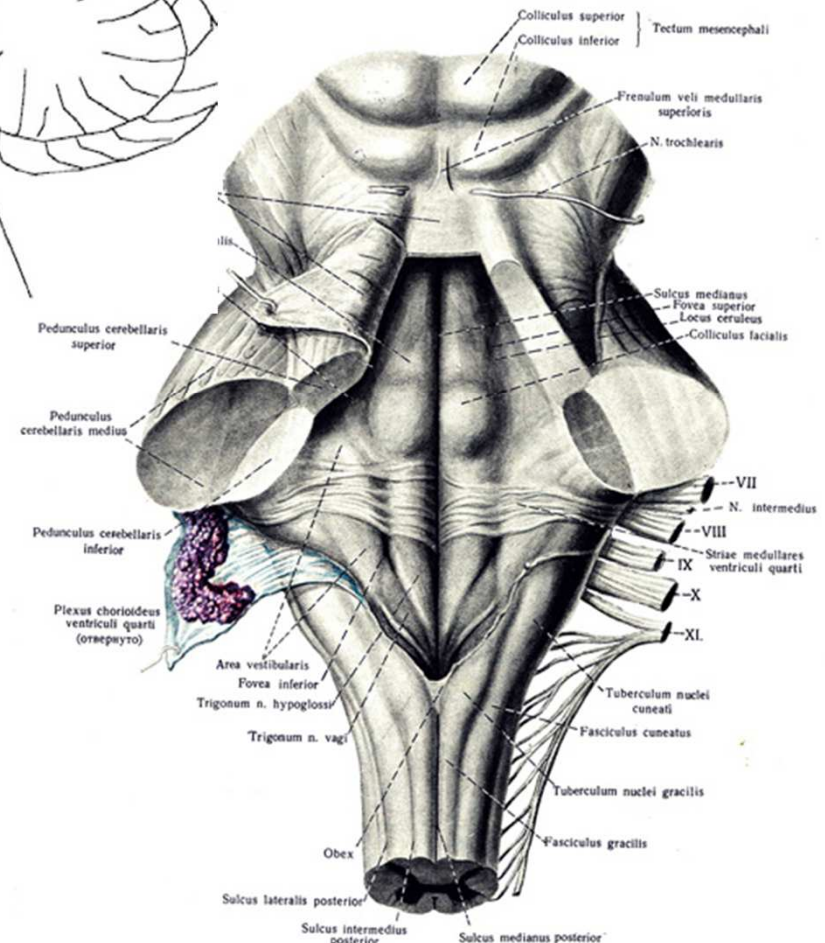


Pons – dorsal view and tectum

- *tectum* = superior medullary velum
- *tegmentum* = dorsal part of the pons
 - ✓ median sulcus
 - ✓ medial eminence
 - ✓ sulcus limitans
 - ✓ facial colliculus
 - ✓ superior fovea
 - ✓ locus coeruleus "the blue spot"
 - ✓ vestibular area
 - ✓ auditory tubercle
 - ✓ striae medullares



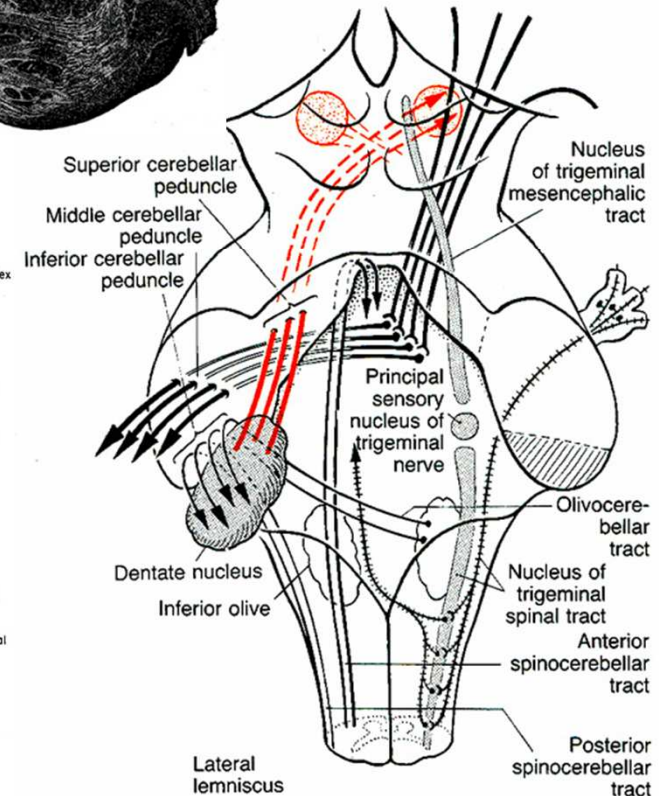
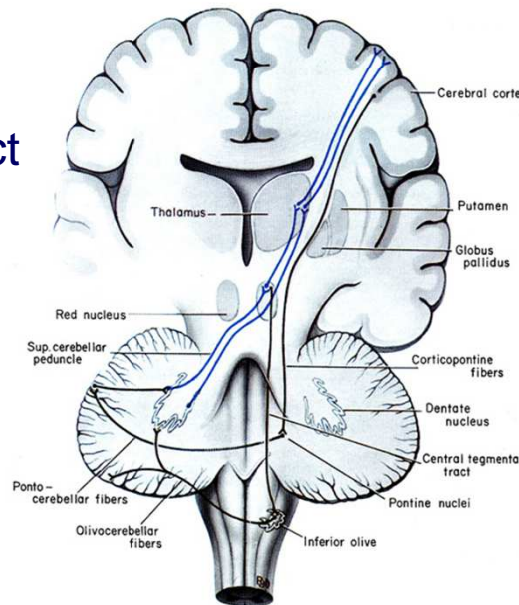
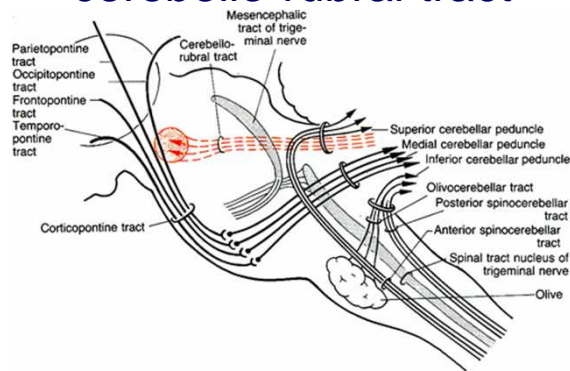
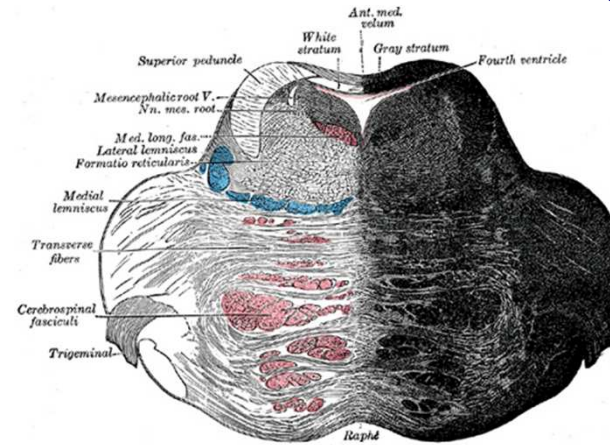
NB: *tectum* is Latin for *roof*, *tegmentum* for *covering*





Pontine basis: fiber bundles

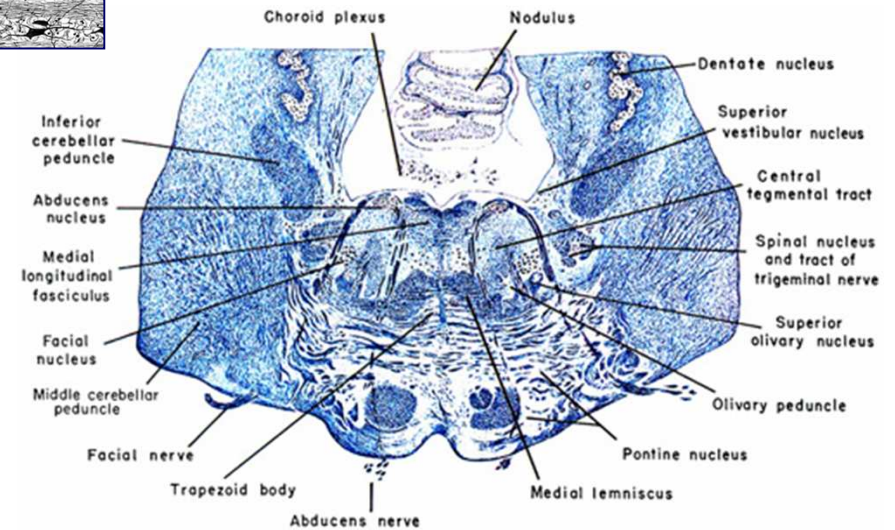
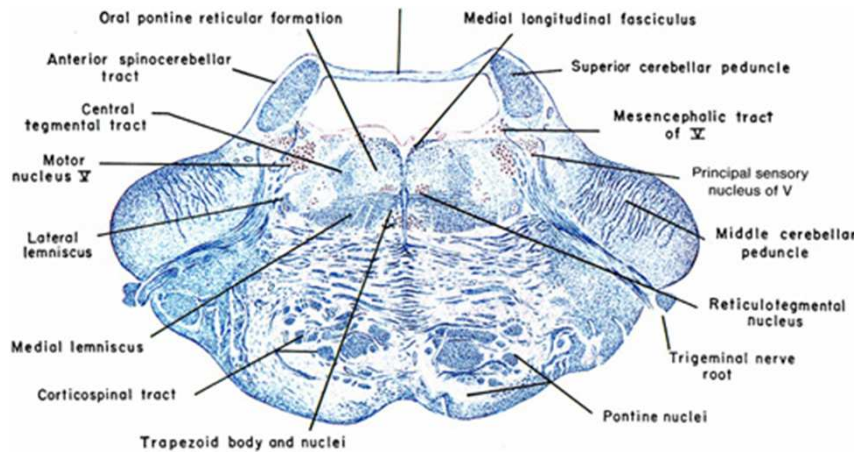
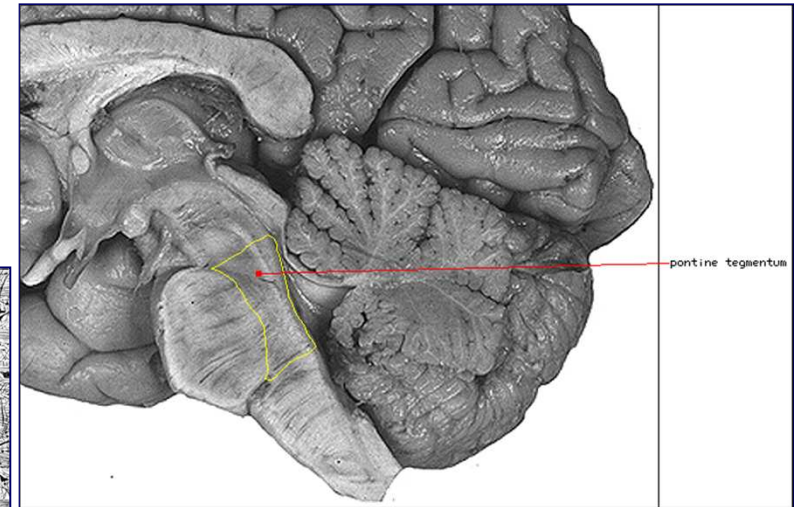
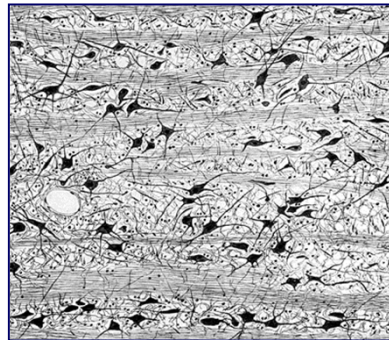
- composition:
 - ✓ longitudinal and transverse fibers
 - ✓ nuclear masses – pontine nuclei
- descending longitudinal bundles:
 - ✓ corticopontine fibers
 - ✓ corticonuclear fibers
 - ✓ corticospinal fibers
- ascending longitudinal bundles:
 - ✓ anterior spinocerebellar tract
 - ✓ olivocerebellar tract
- transverse pontine fibers
 - ✓ pontocerebellar fibers
- cortico-ponto-cerebellar tract
- cerebello-rubral tract





Pontine basis: *nuclei pontis*

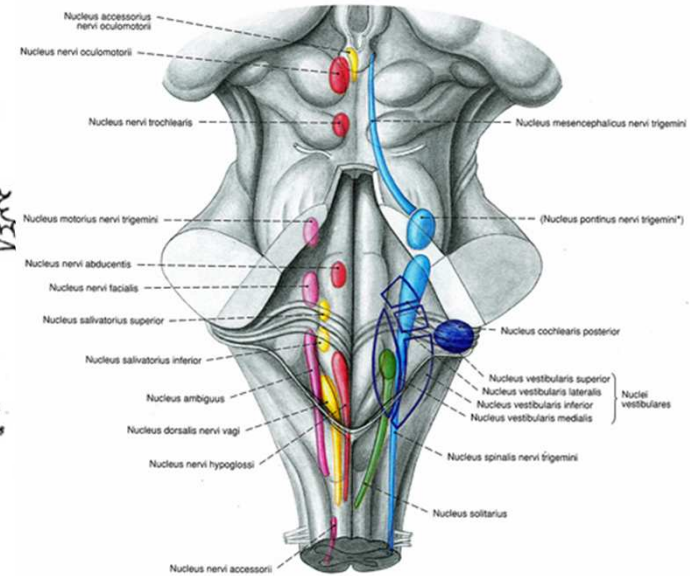
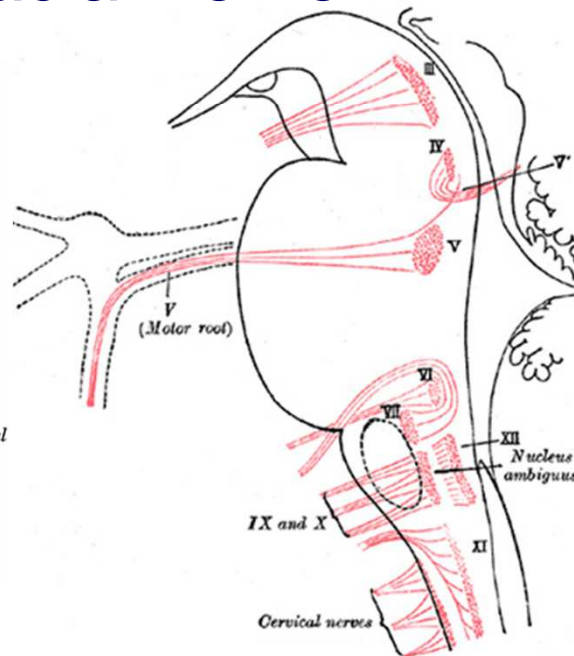
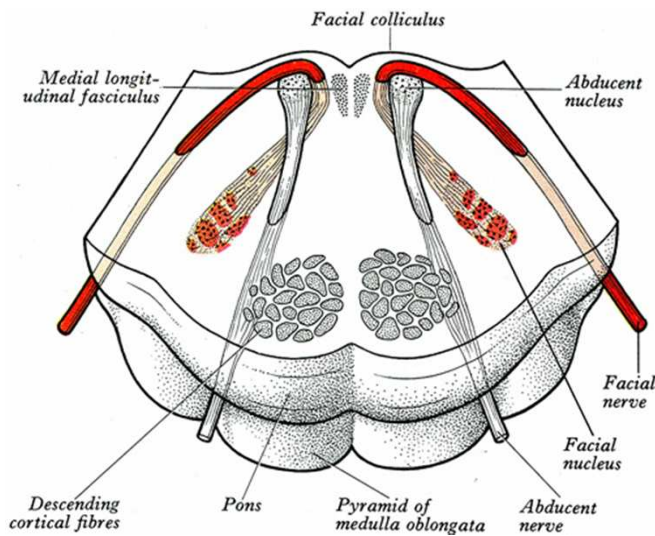
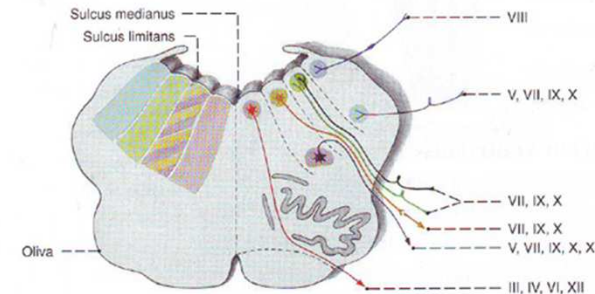
- pontine nuclei – ~20 million neurons:
 - ✓ excitatory glutamatergic neurons
 - ✓ inhibitory GABAergic (5%) neurons
- noradrenergic nuclei – in upper pontine tegmentum:
 - ✓ nucleus coeruleus (A6)
 - ✓ parabrachial nuclei, lateral and medial





Pontine tegmentum: motor cranial nerve triad

- motor nuclei:
 - ✓ trigeminal motor nucleus (V)
 - ✓ abducens nucleus (VI)
 - ✓ facial nucleus (VII)
- internal loop of facial nerve

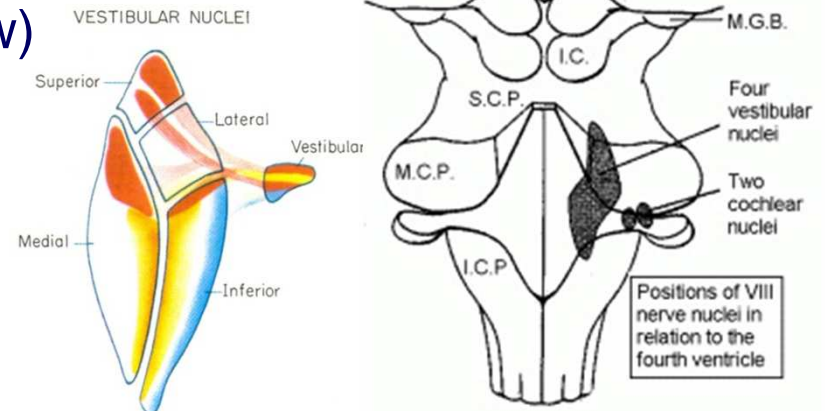
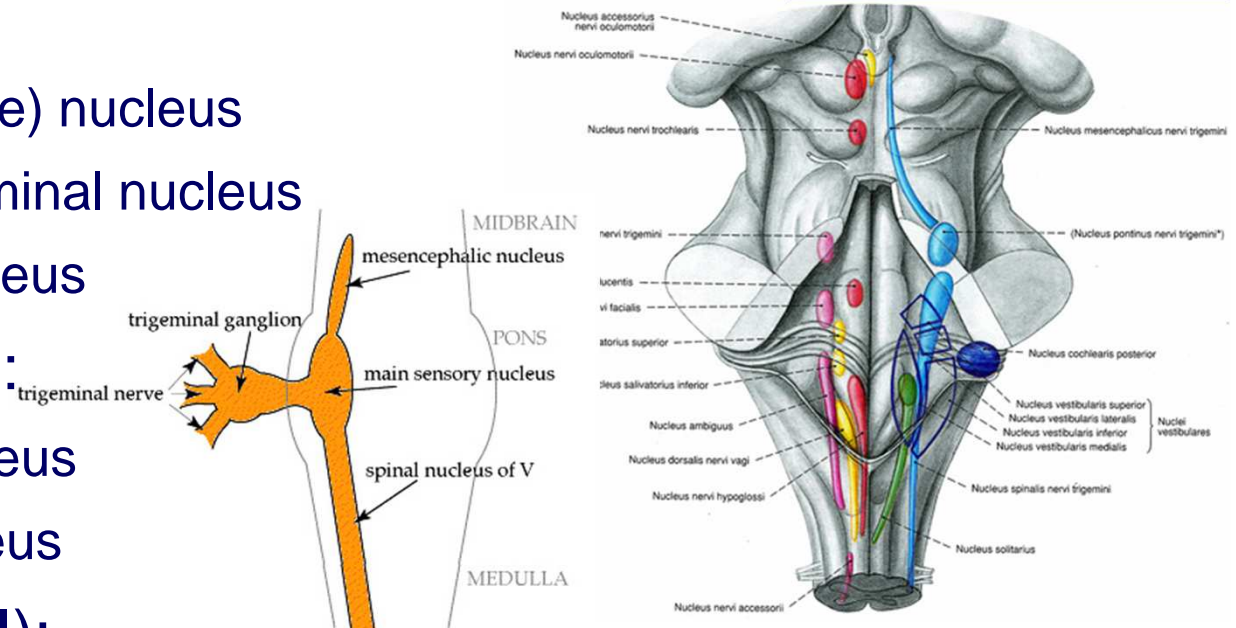




Pontine tegmentum: sensory cranial nerve nuclei

- trigeminal nuclei (V):
 - ✓ main sensory (pontine) nucleus
 - ✓ mesencephalic trigeminal nucleus
 - ✓ spinal trigeminal nucleus
- cochlear nuclei (VIII):
 - ✓ ventral cochlear nucleus
 - ✓ dorsal cochlear nucleus
- vestibular nuclei (VIII):
 - ✓ superior vestibular nucleus (Bechterew)
 - ✓ inferior vestibular nucleus (Roller)
 - ✓ medial vestibular nucleus (Schwalbe)
 - ✓ lateral vestibular nucleus (Deiters)

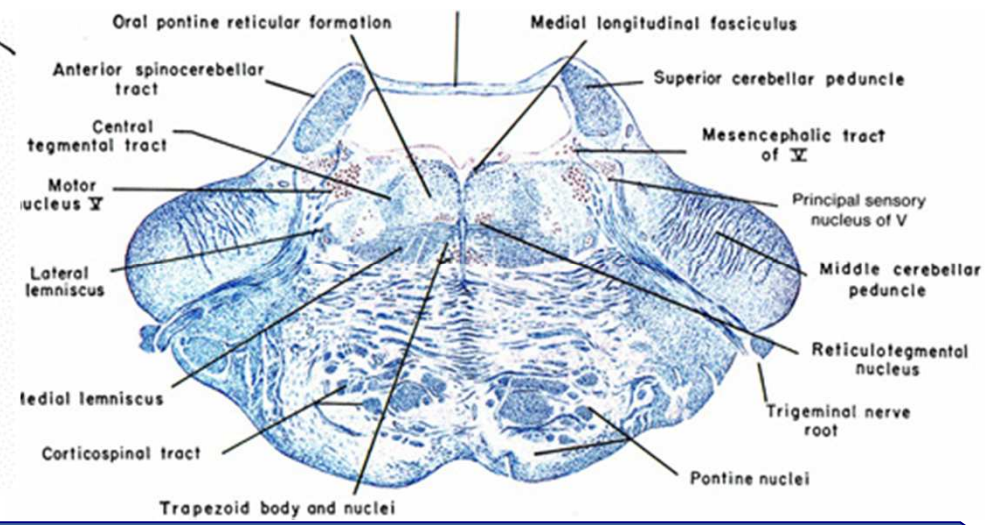
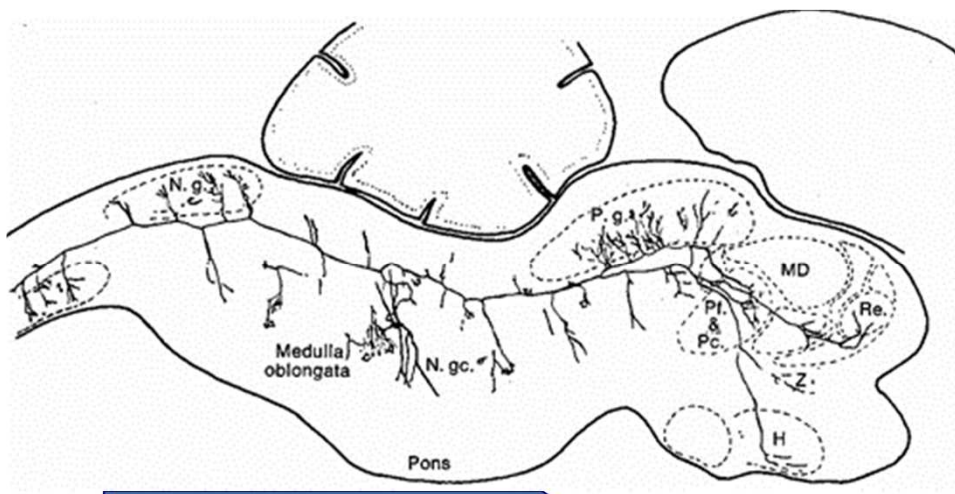
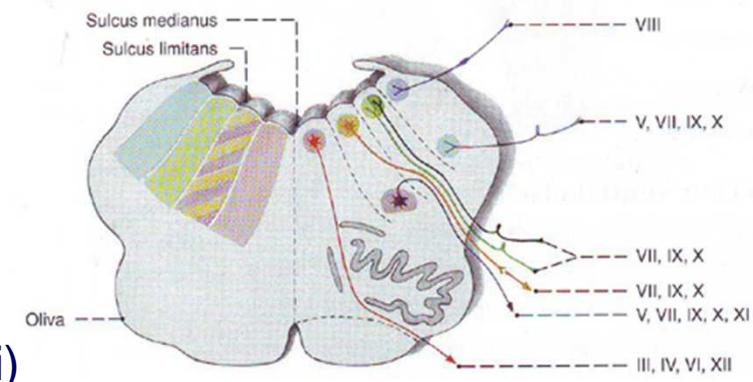
⇒ posterior spinocerebellar tract





Pontine tegmentum: pathways

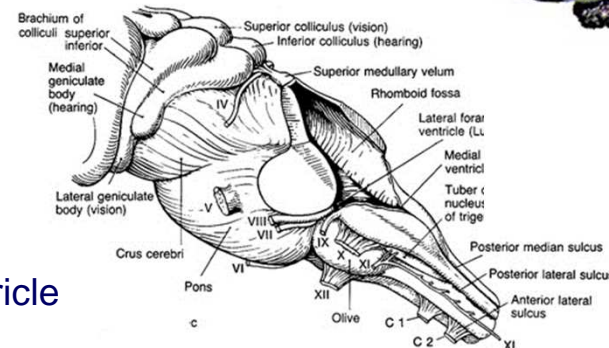
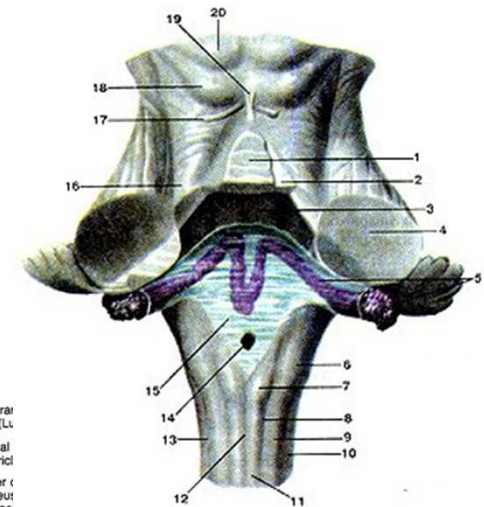
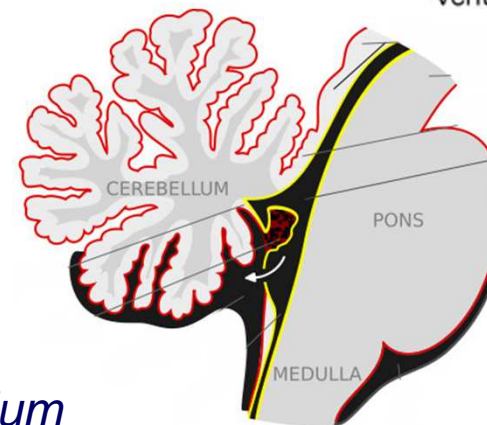
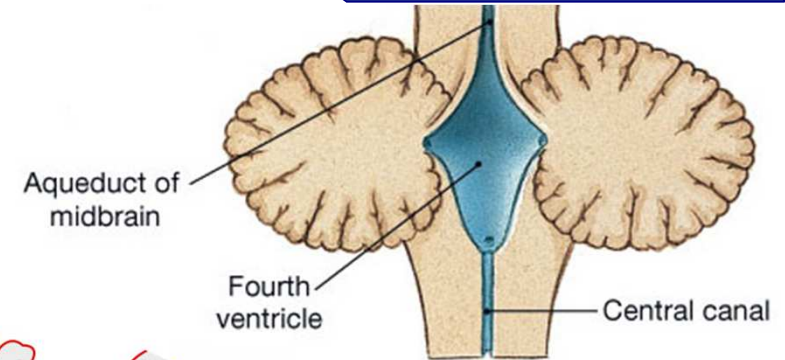
- descending tracts:
 - ✓ corticospinal tract
 - ✓ rubrospinal tract
 - ✓ tectospinal tract
- ascending tracts:
 - ✓ medial lemniscus
 - ✓ spinotectal tract
 - ✓ anterior spinocerebellar tract
- pontine reticular formation:
 - ✓ *nuclei reticularis pontis* (raphe nuclei)

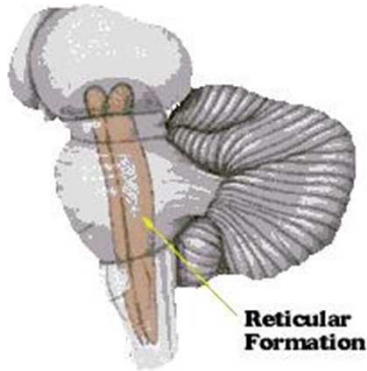




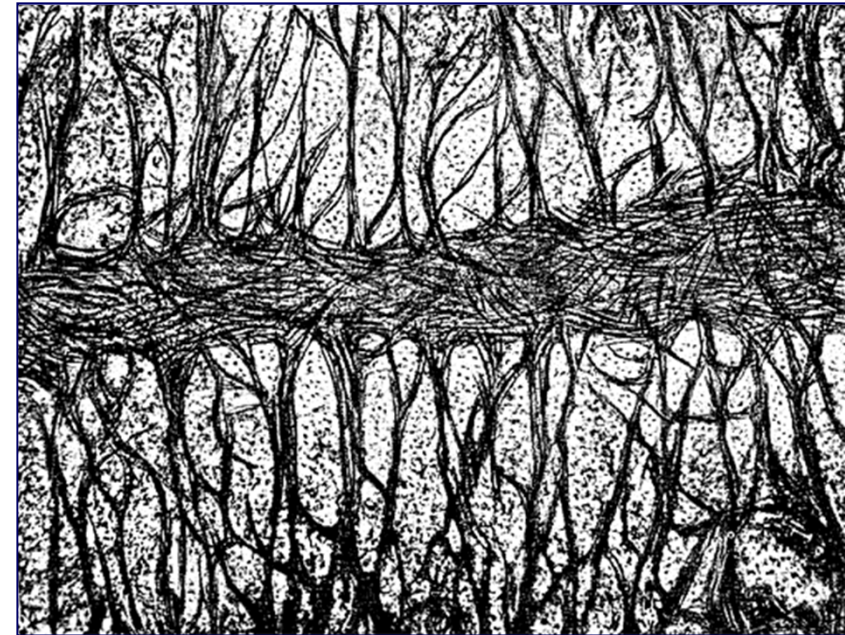
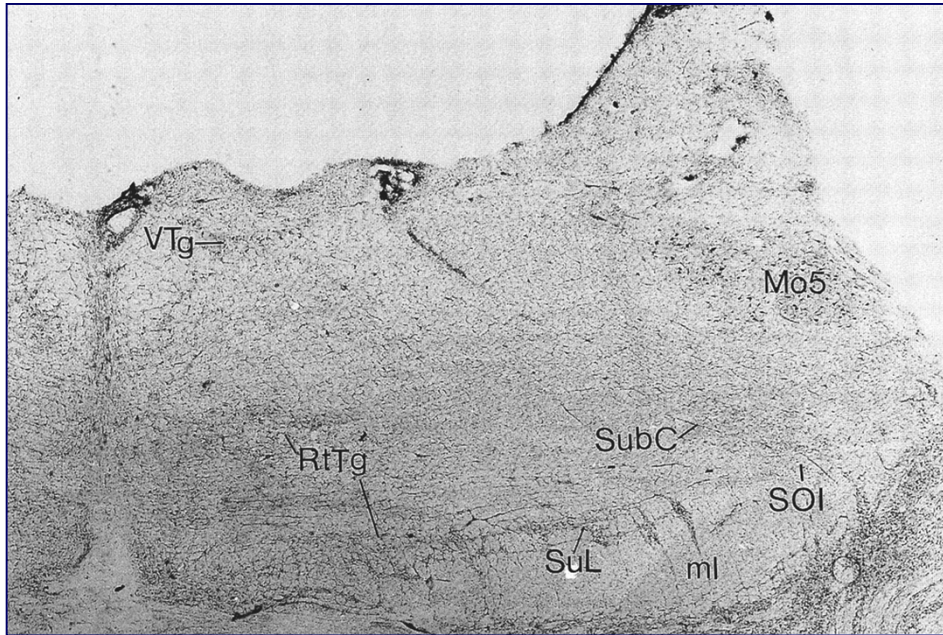
Fourth ventricle

- embryonic origin – *rhombencephalon*
- formation – tentorial space between:
 - ✓ dorsal pons & upper medulla oblongata
 - ✓ cerebellum
- lateral boundaries:
 - ✓ caudal part:
 - gracile & cuneate tubercles
 - fasciculus cuneatus
 - inferior cerebellar peduncle
 - ✓ cranial part:
 - superior cerebellar peduncle
- roof (dorsal wall):
 - ✓ cranial portion:
 - superior cerebellar peduncle
 - superior medullary velum
 - ✓ caudal portion:
 - inferior medullary velum
 - tela choroidea ⇒ choroid plexuses
- ventral floor – rhomboid fossa
- communication openings:
 - ✓ median aperture (of Magendie) ⇒ central canal
 - ✓ lateral apertures (of Luschka)
 - ✓ cerebral aqueduct (of Sylvius) ⇒ IIIrd ventricle





Reticular formation – terminology



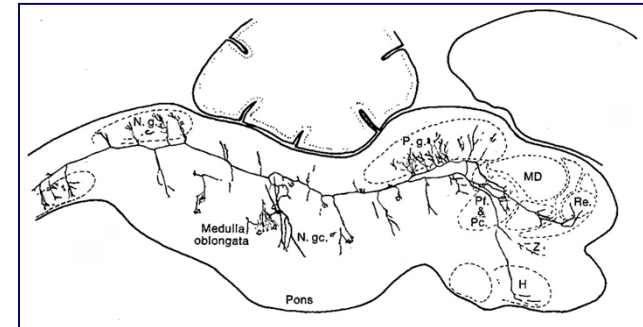
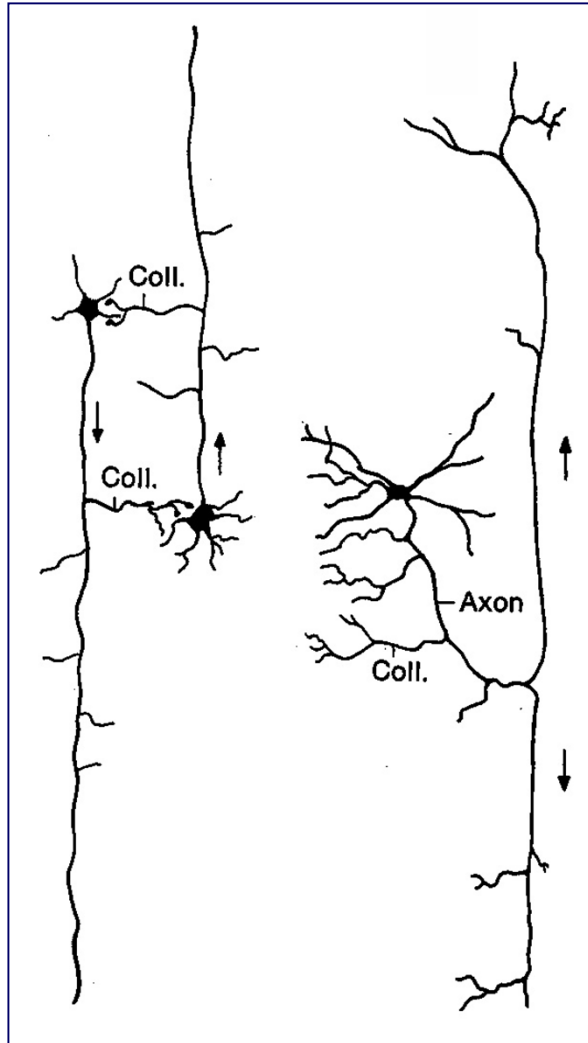
NB: reticulum means *netlike structure*

Why is the reticular formation a reticular formation? Because their fibers indeed build a net.

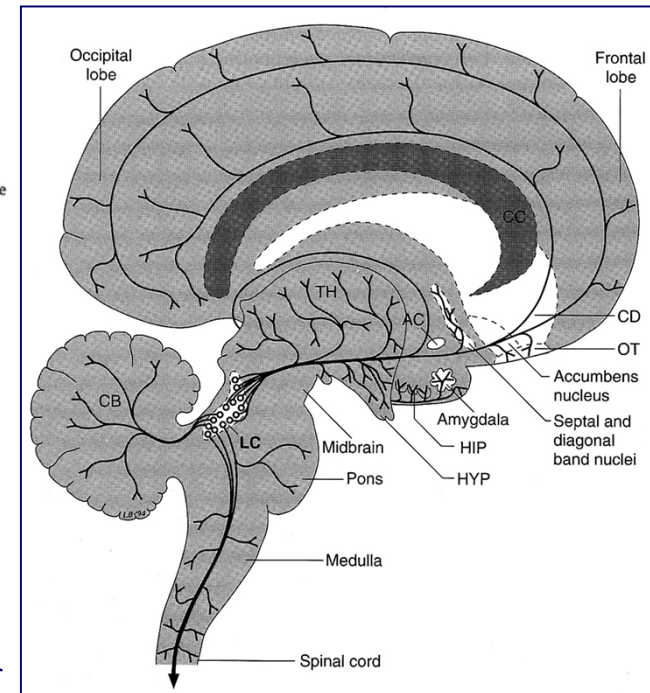
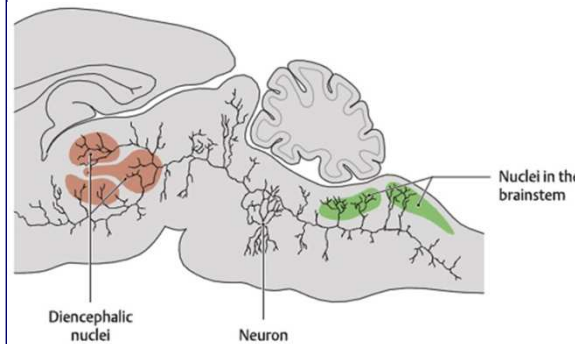


Reticular formation – general considerations

**Extensive collateralization
of the axon of
a reticular neuron**



Widespread distribution of reticular axons



Typical neurons of the reticular formation



Reticular formation – nuclei

- Median column of reticular nuclei – **raphe nuclei** (serotonergic):

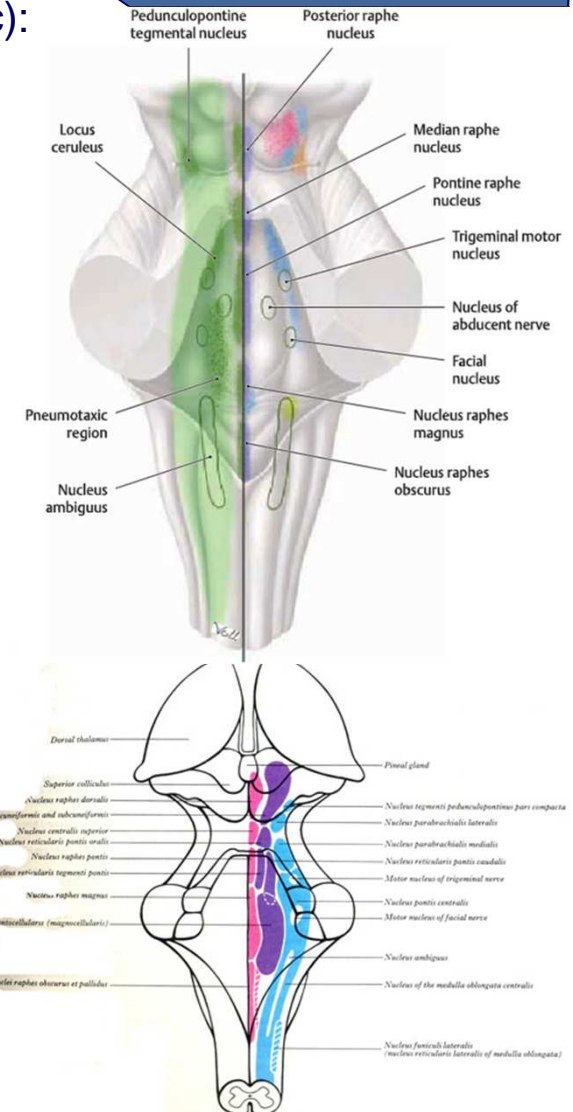
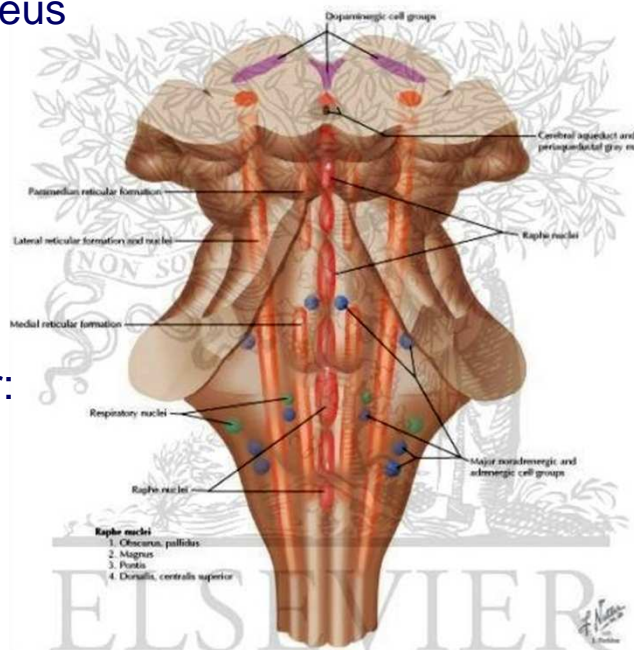
- ✓ *nucleus raphes obscurus et pallidus* in medulla
- ✓ *nucleus raphes magnus* in pons
- ✓ *nucleus raphes centralis superior* and
- ✓ *nucleus raphes dorsalis* in midbrain

- Medial column:

- ✓ medullary gigantocellular (magnocellular) nucleus
- ✓ pontine gigantocellular nucleus
- ✓ *nucleus tegmenti pontis*
- ✓ *nucleus pontis caudalis*
- ✓ *nucleus pontis oralis*
- ✓ *nucleus cuneiformis*
- ✓ *nucleus subcuneiformis*

- Lateral column – parvocellular:

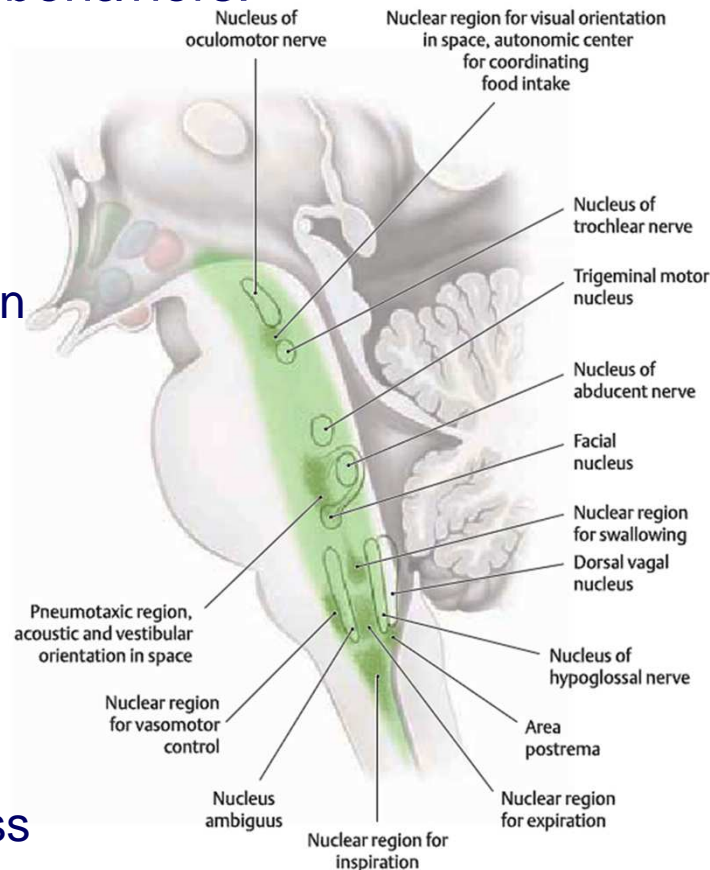
- ✓ *nucleus pontis centralis*
- ✓ *nuclei parabrachiales*
- ✓ *nucleus tegmentalis pedunculo pontinus*



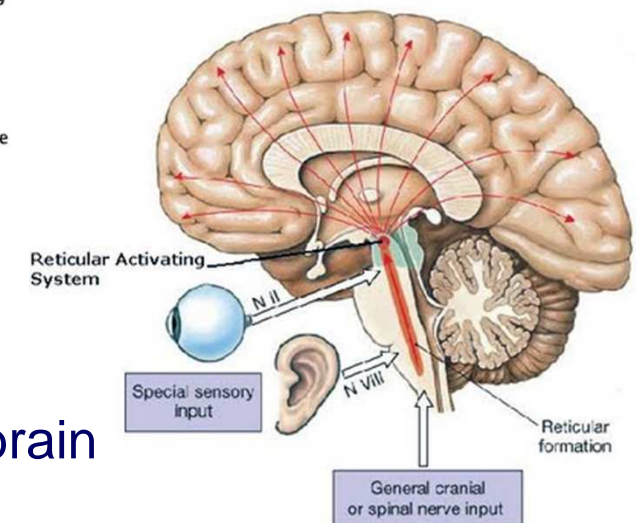
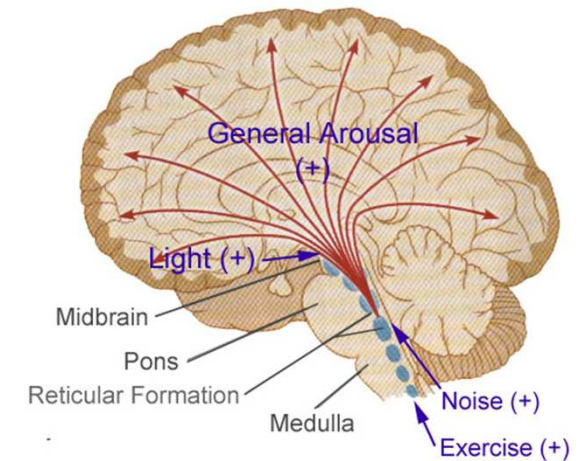


Reticular formation – functions

- controls ~25 specific behaviors:
 - ✓ sleep
 - ✓ walking
 - ✓ eating
 - ✓ urination&defecation
 - ✓ sexual activity
- additional functions:
 - ✓ arousal
 - ✓ attention
 - ✓ cardiac reflexes
 - ✓ motor functions
 - ✓ regulates awareness
 - ✓ relays nerve signals to the cerebral cortex
- one of the phylogenetically oldest portions of the brain



Reticular Activating System (RAS) determines the level of alertness





Thank you...

