RF

Dopaminergic cell groups

Cerebral aqueduct and periaqueductal gray matter

Paramedian reticular formation

Raphe nuclei

Lateral reticular formation and nuclei

Medial reticular formation

Respiratory nuclei

Major noradrenergic and adrenergic cell groups

Raphe nuclei

Raphe nuclei
1. Obscurus, pallidus
2. Magnus
3. Pontis
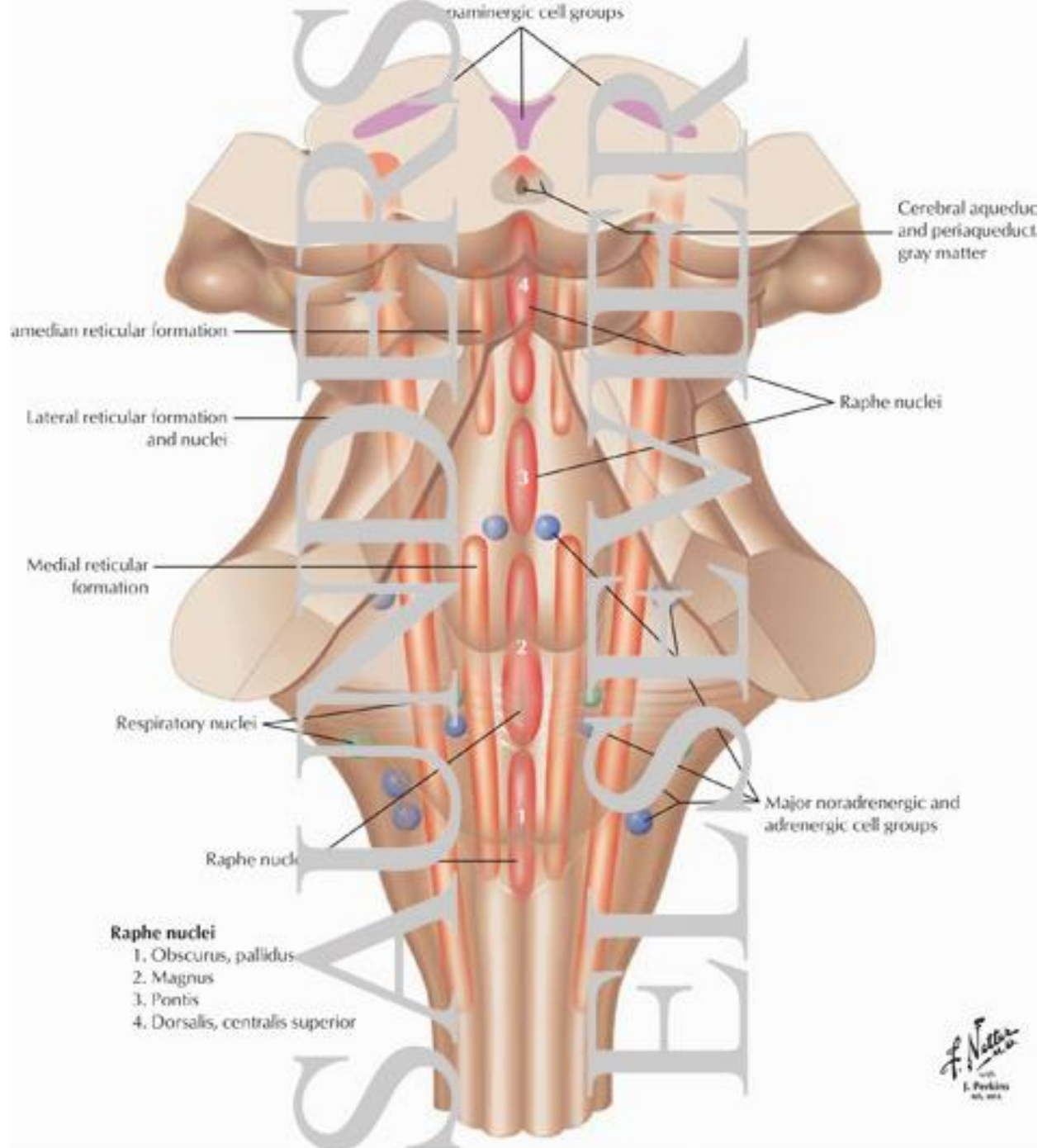4. Dorsalis, centralis superior

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Reticular formation = Formatio reticularis

- phyllogeneticaly old CNS structure
- manages basic stereotypes (gait, sleep)
- greatly influences vigilance, tiredness and motivation
- not well morphologically defined
- centrally and dorsally in brainstem (mainly pons)
- ***ascending activation system*** → thalamus, hypothalamus, cerebral cortex
- *descending activation system* → cerebellum, sensory nerves
- *ascending* + ***descending inhibitory*** *system*

RF – functions and centers

- control of muscle tone and reflex activity
  - tr. reticulospinalis → alfa + gama motoneurons
- control of facial muscle in emotions expression
- breathing:
  - inspiratory neurons
  - expiratory neurons
  - pneumotactic center
  - apneuistic center
- vasomotor center
- heart function
- vomiting center
- control of pain
  - tr. spinoreticularis
  - tr. raphespinalis

RF – functions and centers

ARAS = ascending reticular activating system

- arousal and conciouseness
- sensory information → RF → cortex + hypothalamus → arousal
- Permanent impulses from RF maintain state of conciouseness
- **acetylcholine and noradrenaline**

DRIS = descending reticular inhibiting system

- ventrocaudal
- inhibition of pain
- **serotonine**

ARAS – clinical disorders*

- **narkolepsy**
  - disturbance of Ch5 and Ch6
  - daily somnolence and reduced quality of night sleep
  - sudden loss of wakefulness
  - loss of muscle tone (kataplexy), often during emotional impulse (laugh, fright)

- **disturbance of behavior in sleep**
  - degeneration of ARAS
  - in REM sleep: no physiological off of motorics
  - pacient reacts to dreams by motoric movements
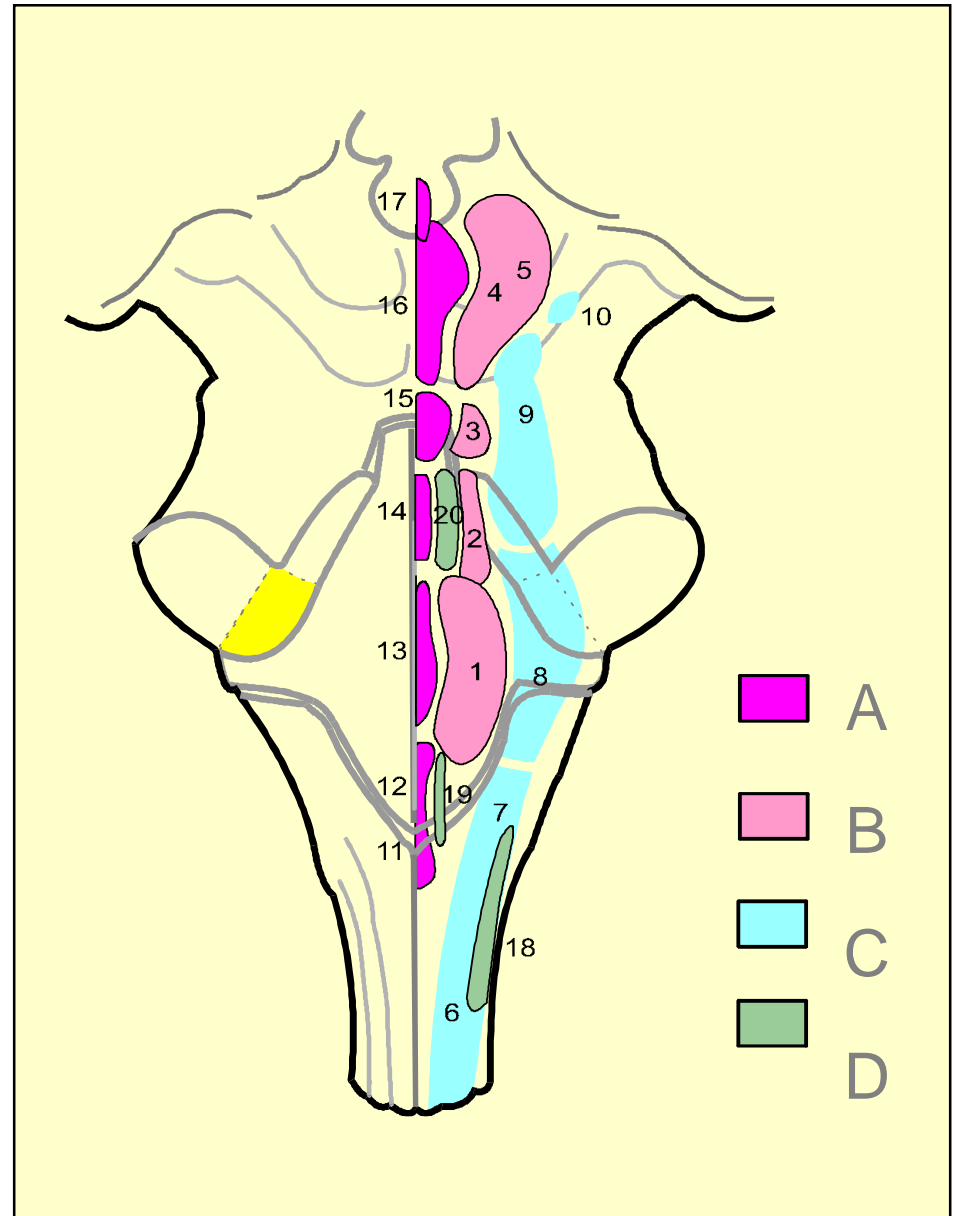
Reticular formation

A. Nuclei raphes

B. Medial group of nuclei

C. Lateral group of nuclei

D. Precerebellar reticular nuclei
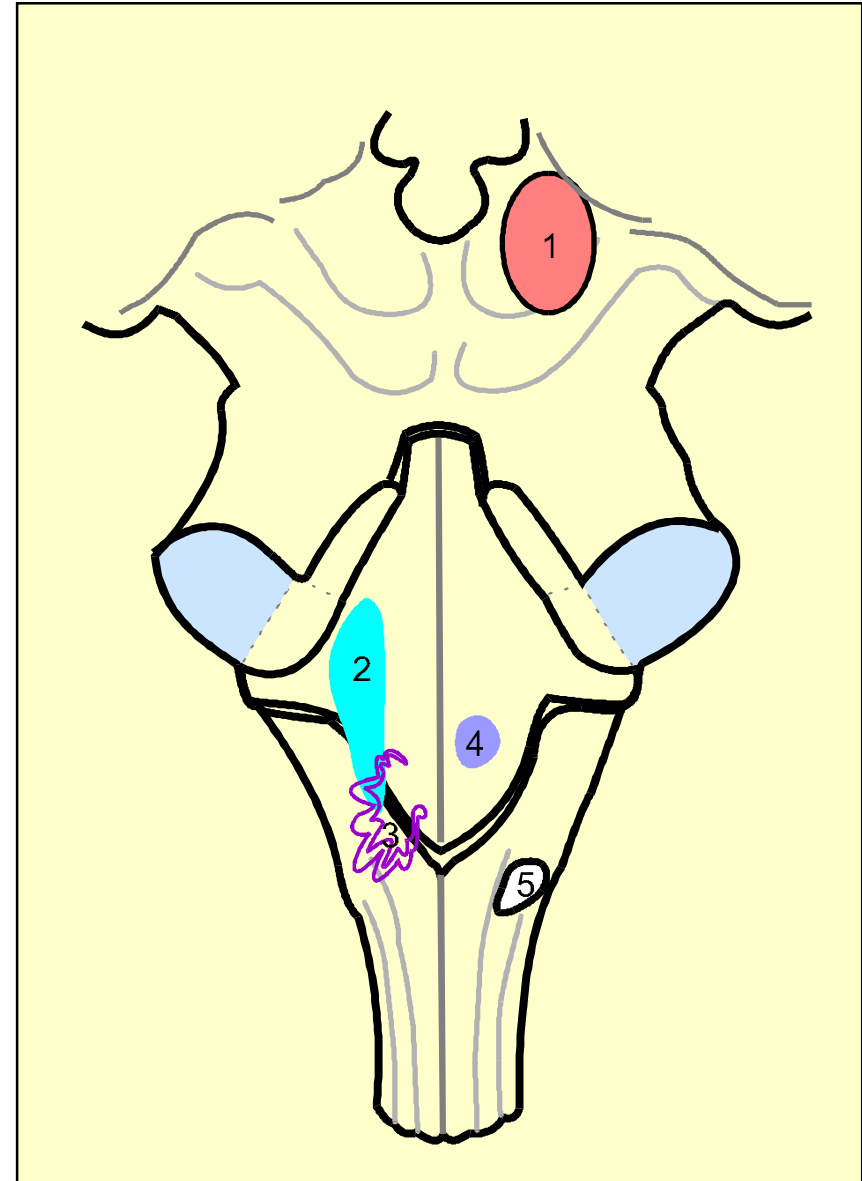
E. Chemical nuclei

RF – nuclei

- **nuclei raphes**
  - unpaired, along whole length of RF in midline, connections to medial nuclei and limbic circuits

- **medial** group of nuclei
  - along whole length of RF, largest nuclei with long connections

- **lateral** group of nuclei
  - mainly in medulla oblongata and pons, connections to medial nuclei
    - <u>nuclei parabrachiales</u> (breathing, taste, pain)

- precerebellar reticular nuclei
  - nucleus reticularis lateralis, paramedianus, reticularis tegmentalis Bechterewi

- chemical nuclei
  - catecholaminergic, serotonergic, cholinergic

Precerebellar nuclei **outside RF**

1. nucleus ruber

2. nuclei vestibulares

3. complexus olivaris inferior

4. nuclei perihypoglossales

5. nucleus cuneatus accessorius

(6. in RF)

RF – chemical nuclei

- <u>serotonerg</u>:
  - nuclei raphes (B1-B7)

- <u>noradrenergic</u>:
  - nucleus caeruleus (A6)

- <u>dopaminergic</u>:
  - nucleus retrorubralis (A8)
  - nuclei tegmentales ventrales *Tsai* (A10)
  - pars compacta substantiae nigrae (A9)

- <u>cholinergic</u>:
  - nucleus pedunculopontinus (Ch 5)
  - nucleus tegmentalis dorsolateralis (Ch 6) (part of ARAS)

RF – connections

- **tractus tegmentalis centralis**

afferent:

- tractus spinoreticularis
- tractus corticoreticularis
- fibrae corticonucleares tractus pyramidalis
- tractus cerebelloreticulares
- connections from pallidum, substantia nigra, tectum, hypothalamus
- collaterals from tractus spinothalamicus

efferent:

- tractus reticulospinalis
- tractus reticulothalamicus (ARAS)
- tractus reticulonucleares (cranial nerves)
- tractus reticulo-reticulares
- tractus reticulocerebellares

RF – descending inhibition of pain

substantia grisea centralis mesencephali = (PAG)

enkefalins

⬇

ncll. raphes (ncl. raphe magnus, dorsalis) medullae oblongatae

serotonin
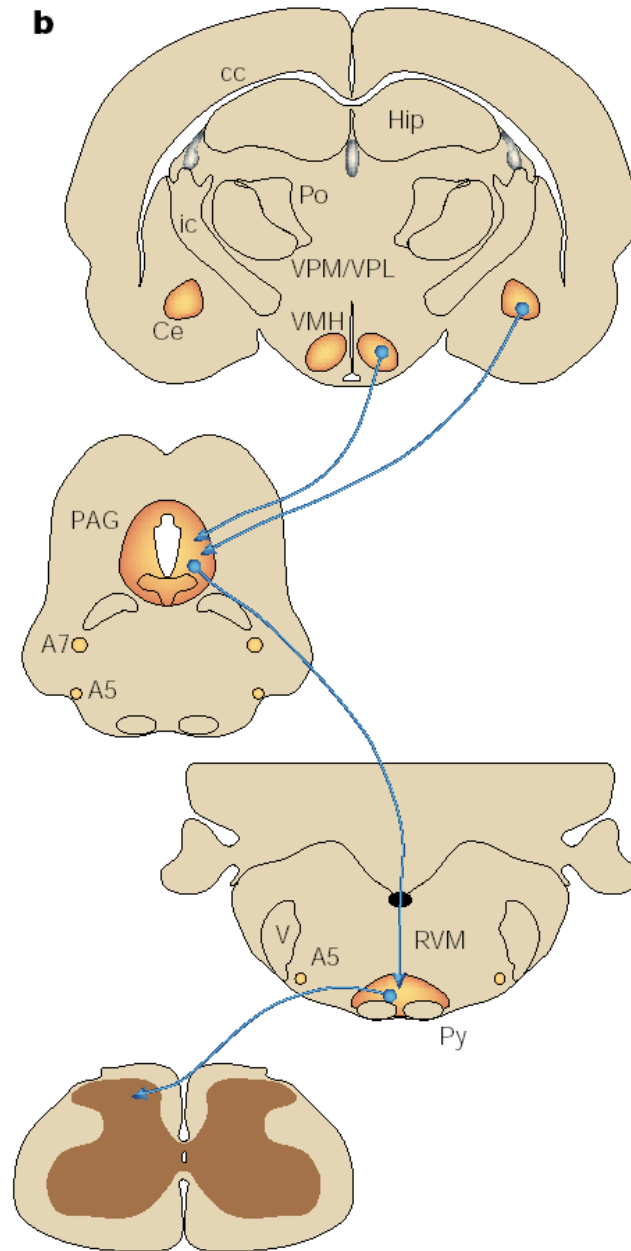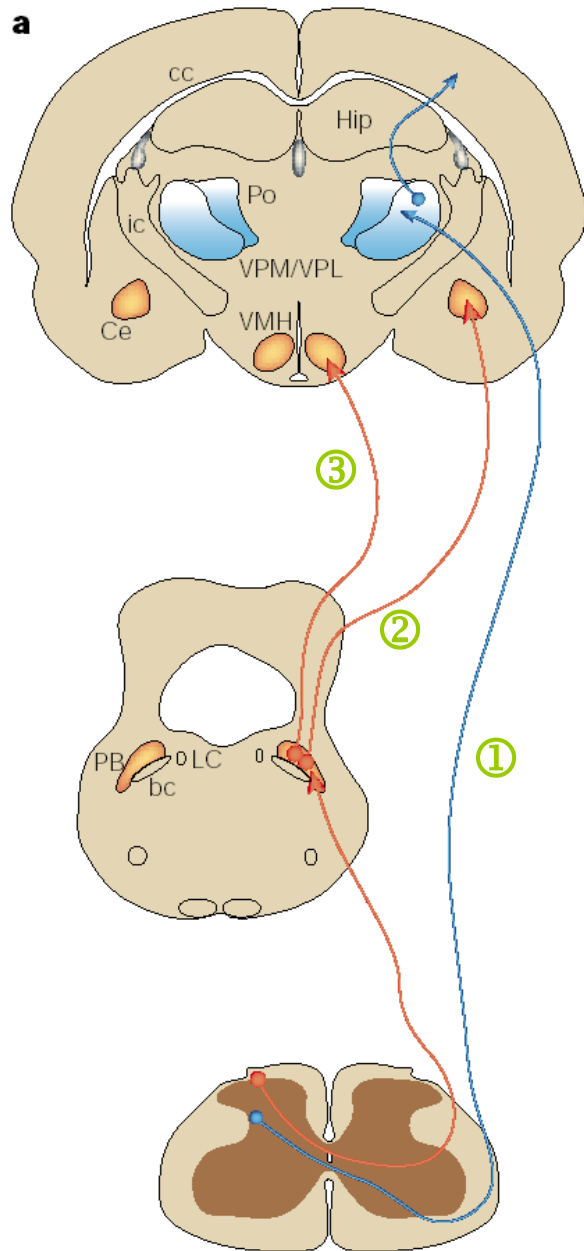
⬇

fasciculus posterolateralis (Lissaueri)

⬇

Rexed's lamina II – presynaptic inhibition

block of Ca^{2+} channels ➔ block of substance P

subnucleus caudalis ncl. spinalis n. V

Ascending and **descending** pain pathways

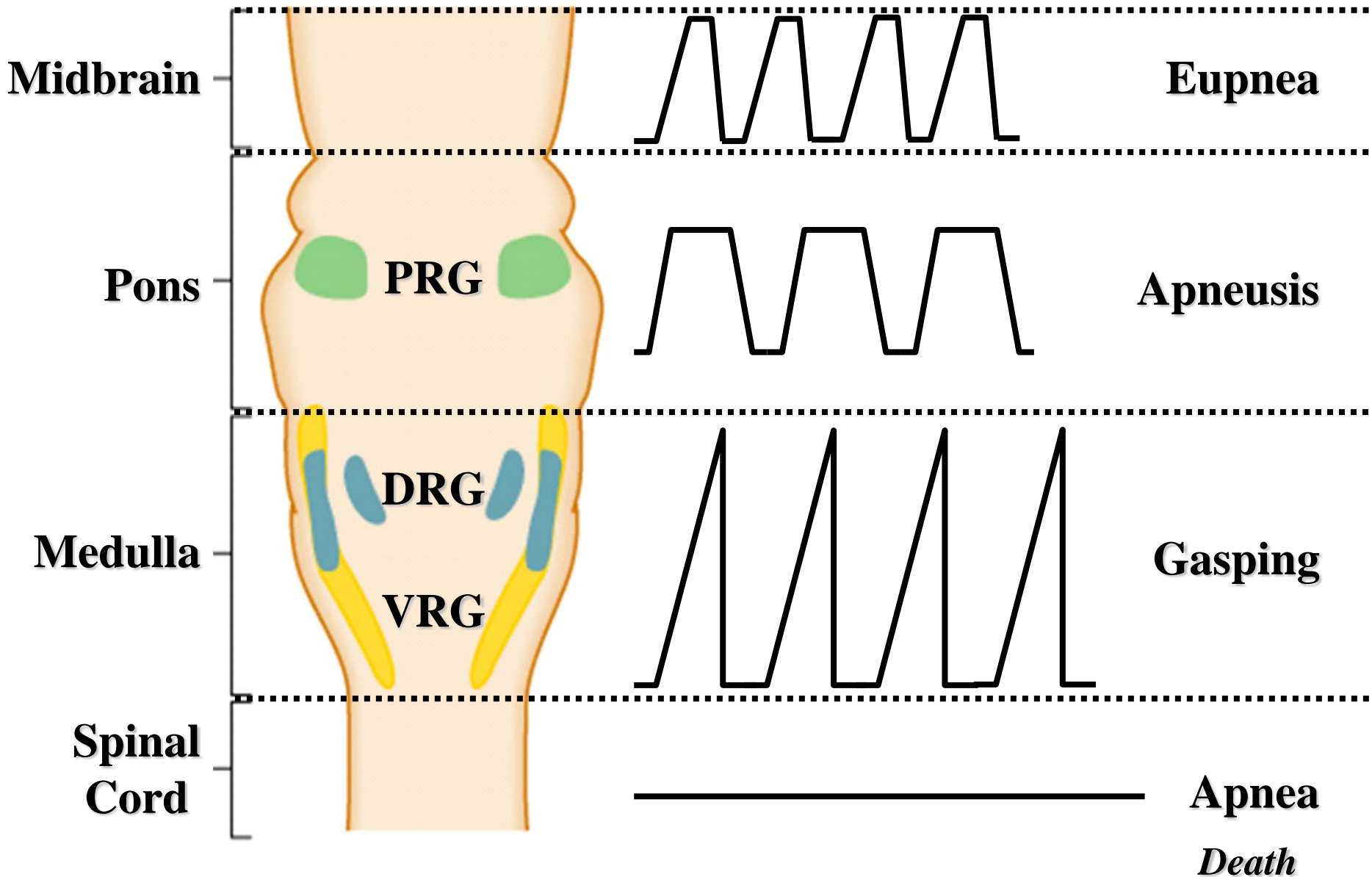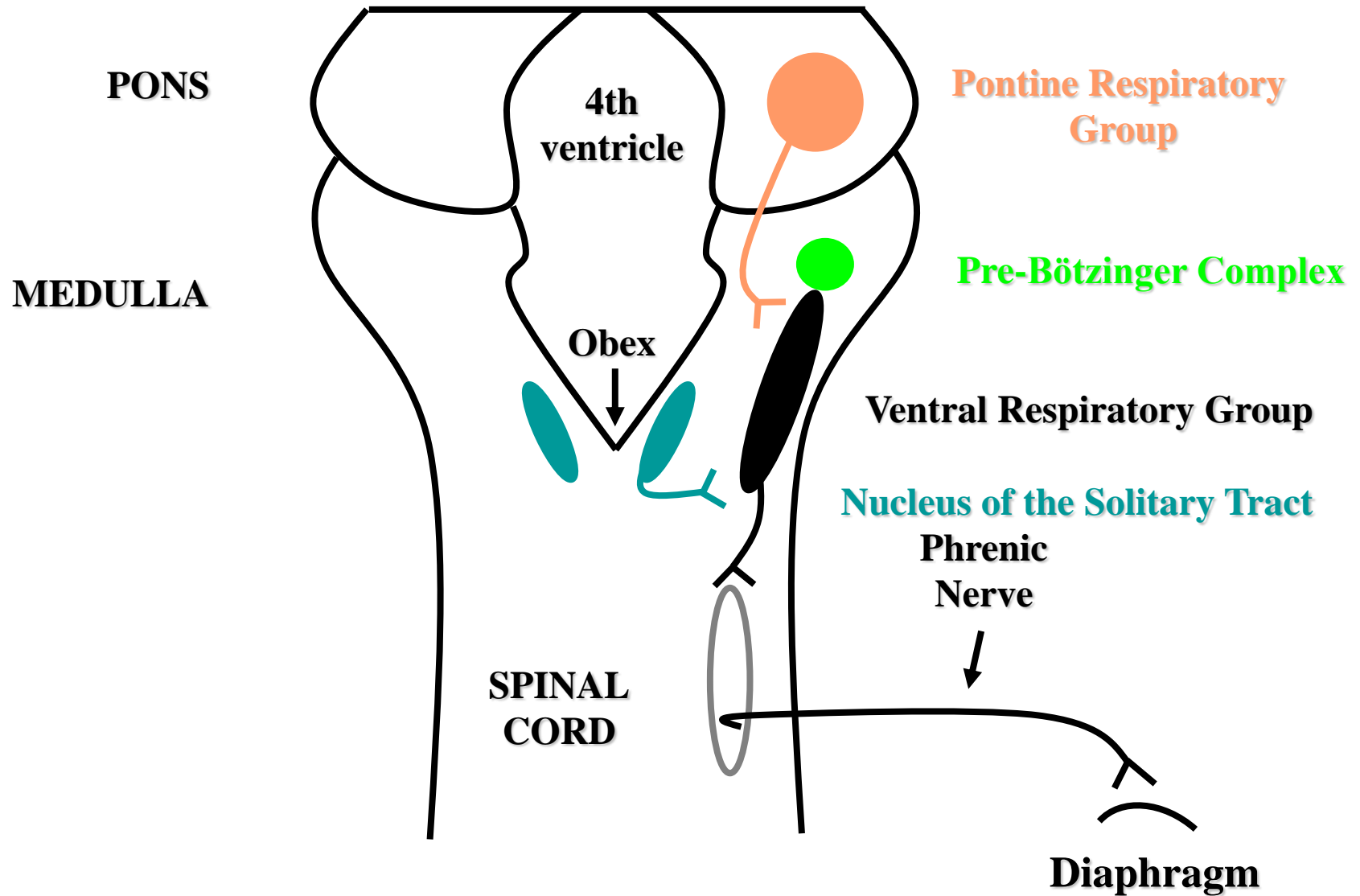① tr. spinothalamicus

② tr. spino-
parabrachio-
amygdalaris

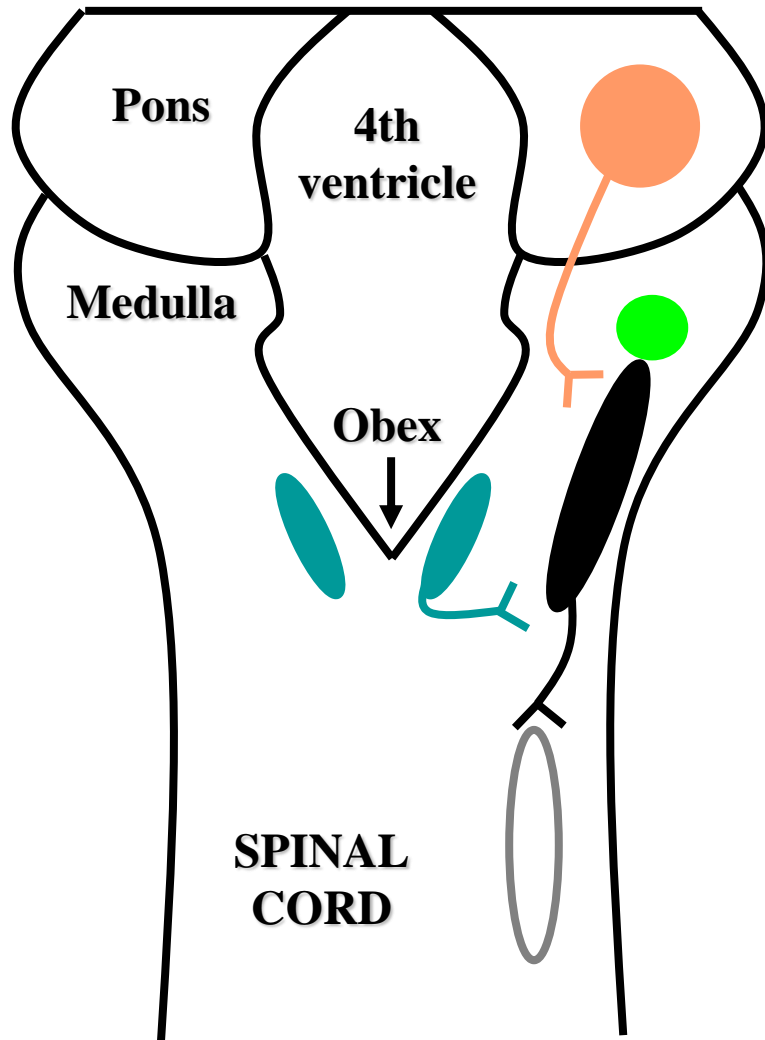③ tr. spino-
parabrachio-
hypothalamicus

RF – central control of breathing

Midbrain

Pons — PRG

Medulla — DRG / VRG

Spinal Cord

Eupnea

Apneusis

Gasping

Apnea

Death

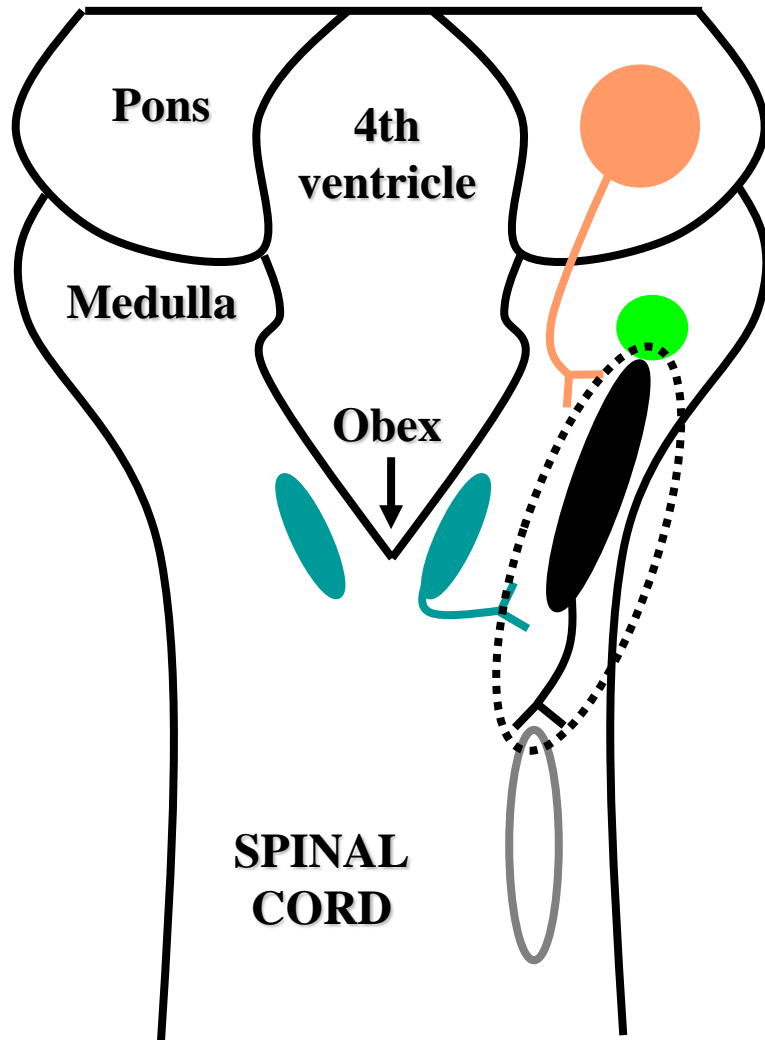# Important Respiratory Control Sites in the Mammalian Brainstem

Pre-Bötzinger Complex

Pre-Bötzinger Complex

**The central rhythm generator for breathing??**

Ventral Respiratory Group

- **Bötzinger Complex**
- **Nucleus ambiguus**
- **Nucleus retroambiguus**

- **Inspiratory neurons that project to the respiratory motor neurons**

- **Inspiratory neurons that project within the VRG**

- **Expiratory neurons that fire only during active expiration (i.e., exercise)**
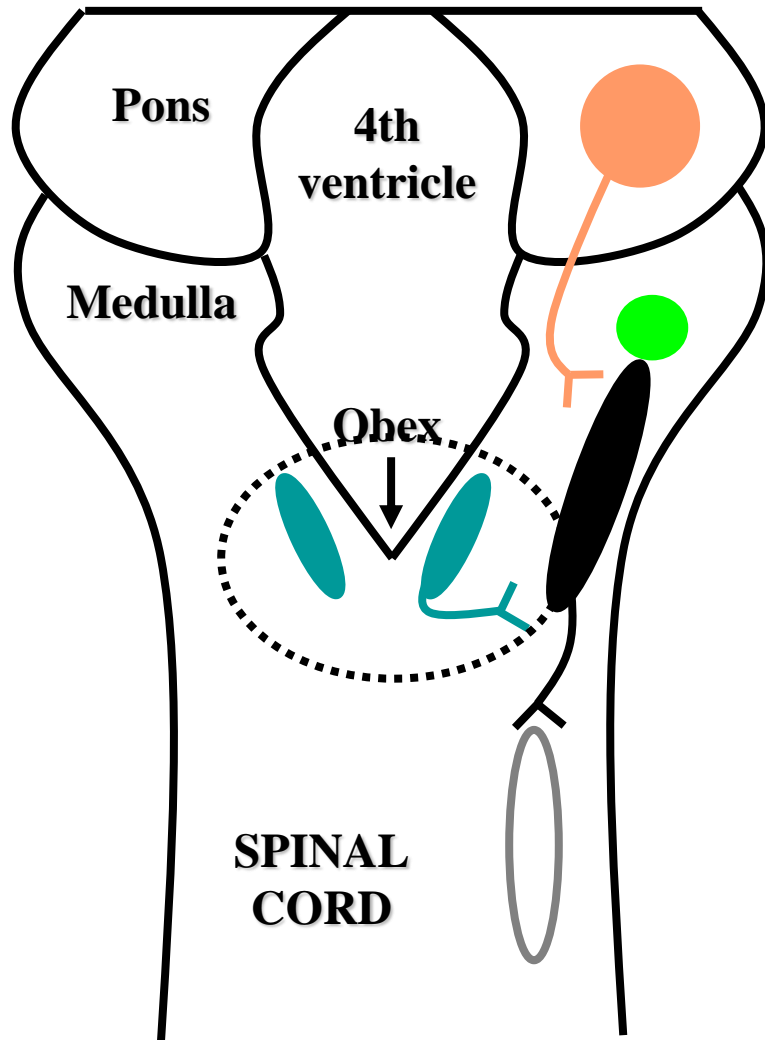
Labels on figure: Pons, 4th ventricle, Medulla, Obex, SPINAL CORD

Pontine Respiratory Group
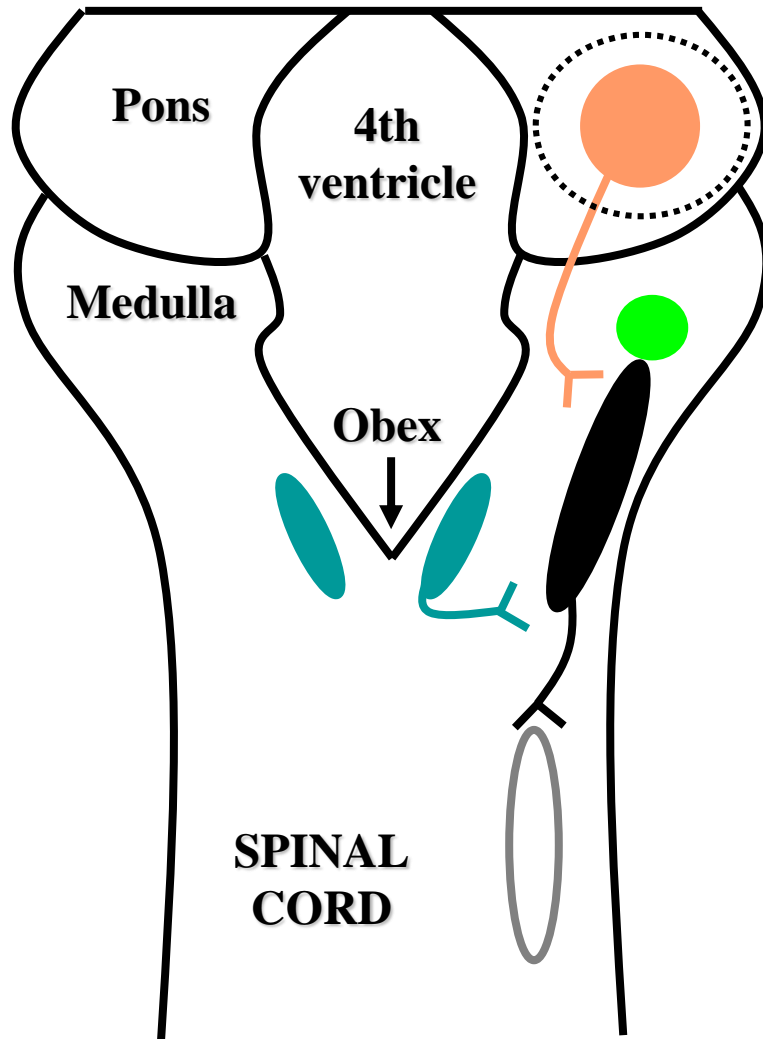
- **Located in the upper pons**

- **Nucleus parabrachialis**

- *Kölliker-Fuse*

- **Inspiratory termination**

- **Correct switching from inspiration to expiration**

- **Apneustic Centre**

Nucleus of the Solitary Tract

Pons

4th ventricle

Medulla

Obex

SPINAL CORD

Site of first synapse (within the CNS) of:
1) **Carotid sinus baroreceptors**
2) **Aortic arch baroreceptors**
3) **Carotid body O_2 chemoreceptors**
4) **Pulmonary Stretch Receptors**
5) **Taste buds**

Important Relay Centre

Breathing centers – 4

- inspiration + expiration
  - centrum respiratorium ventrale
  - Bötzinger's complex (centrum expiratorium ventrale)
  - close to nucleus ambiguus, retroambiguus
  - medulla oblongata
- preBötzinger's complex (centrum generans motuum respiratorium)
  - generator of central breathing rythm ?
- pneumotactic center (*Lumsdeni*) = ncl. *Kölliker-Fuse* (lateral pontine RF) = ncl. subparabrachialis
  - pons
- apneuistic center (?)
  - pons

RF – overal function

- seat of reflexes
  - vital
  - defensive
- respiratory (breathing) center
- vasomotor center
- cardiac center
- vomiting center
- slow (chronic) pain
- body temperature maintenance

RF – overall importance

- provides complex interconnection of cranial nerves themselves and with other centers → vital reflex from birth (blinking, lacrimation, coughing, sucking, salivary, vomiting, swallowing, secretory for glands..)

- its <u>activating system</u> influences cerebral cortex ascendently and spinal cord descendently

- its <u>inhibitory system</u> located mainly in caudal and ventral parts of RF and in serotonergic nuclei – influences cerebral cortex ascendently and spinal cord descendently

- *pain*