Respiratory physiology III.

Control

L.o.: 30-31.

Biology of the airways

L.o.: 32.

Prof. Gyula Sáry

What do these terms mean?

normoventilation

hypoventilation

hyperventilation

eupnoe

bradypnoe

tachypnoe

orthopnoe

dyspnoe

asphyxia

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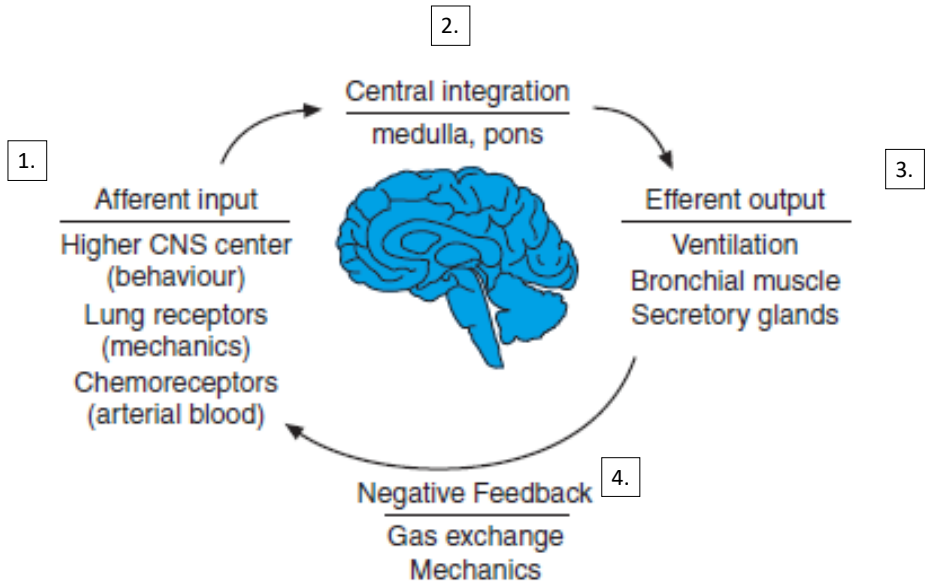
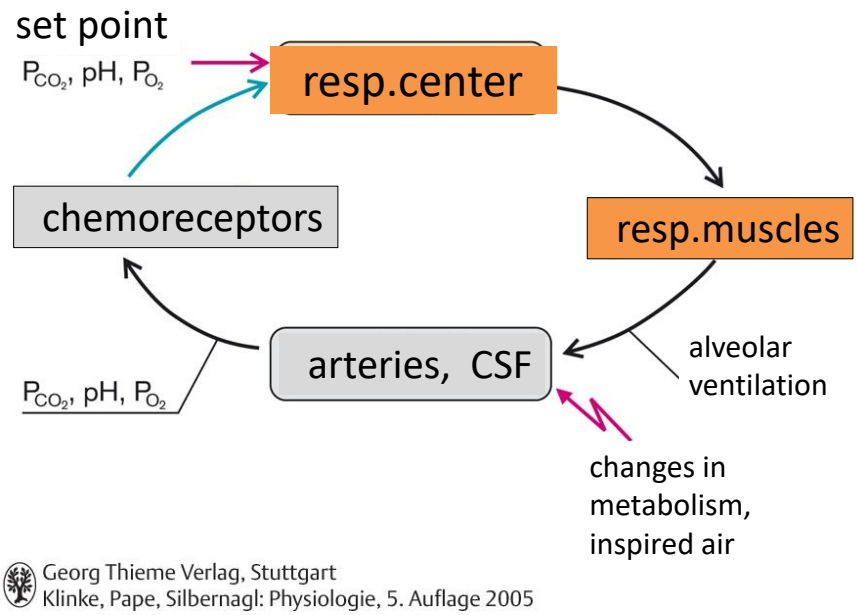
Reflexes and negative feedback





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Driving force of respiration

- Question:

  if metabolism in the body

  produces CO_2 (must be removed);

  and

  needs O_2 (must be taken up);

  which of the two is more important in respiratory control?

  – Experiment by Haldene and Priestley

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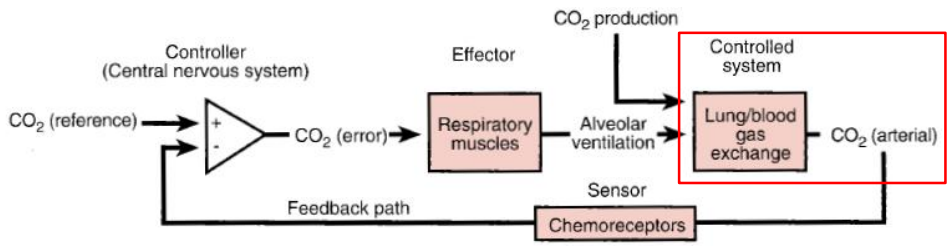
Reflexes and negative feedback



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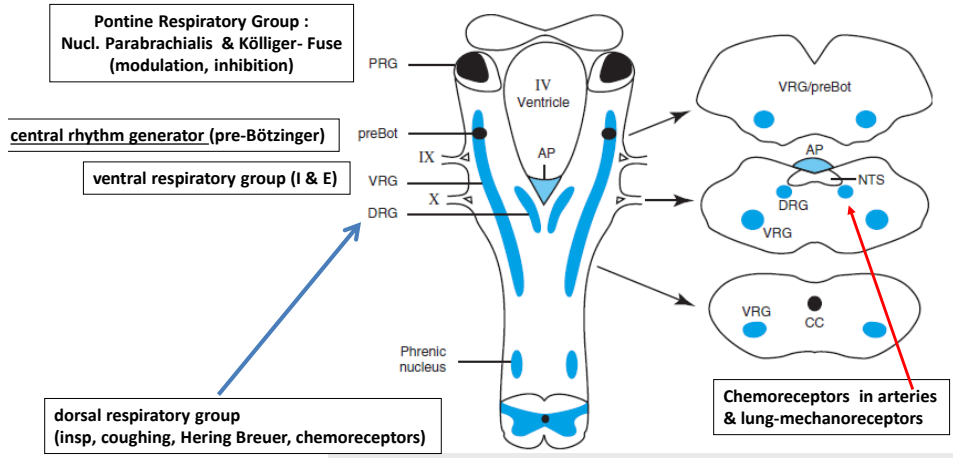
Respiratory centers in the medulla



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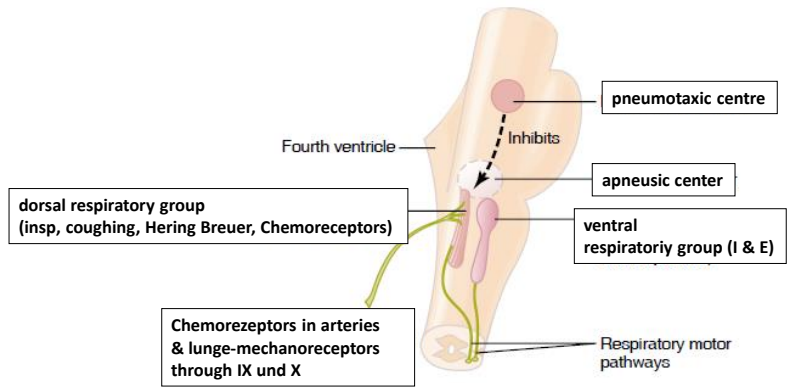
A „simpler view”



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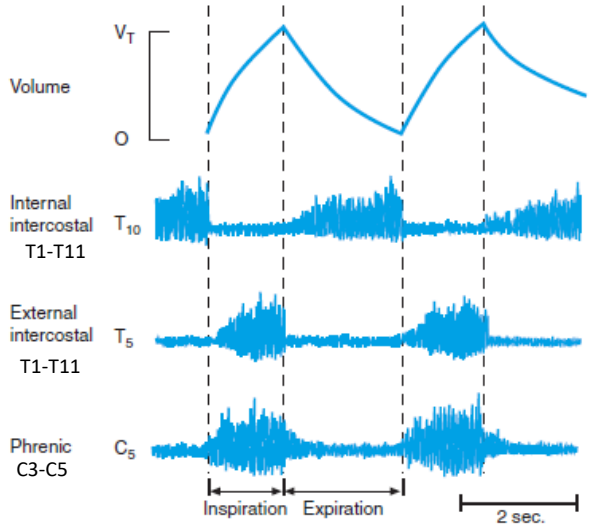
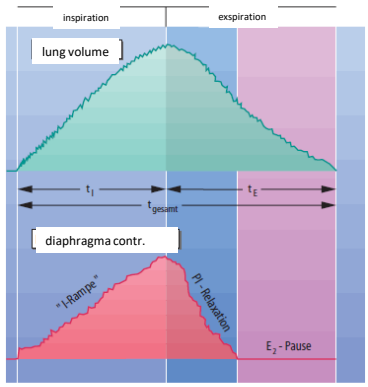
Volume changes and <u>efferent</u> nerve activity



Expiration

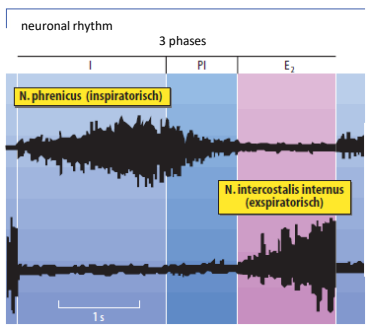
Inspiration

9



Respiratory rhythm

I= inspiratory phase (active)
PI= postinspiratory phase (passive)
E_2= expiratory phase (active)



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Reactions of the ventilation on arterial PO_2, PCO_2 and pH

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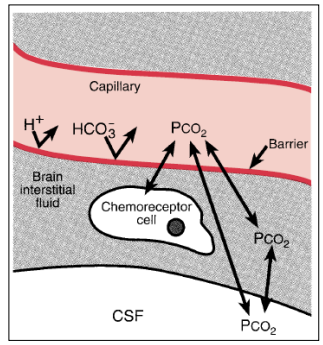
Central chemoreceptors



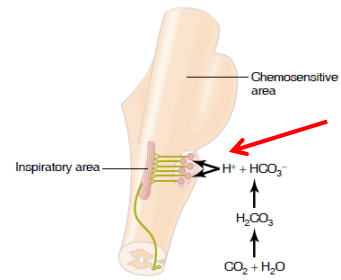
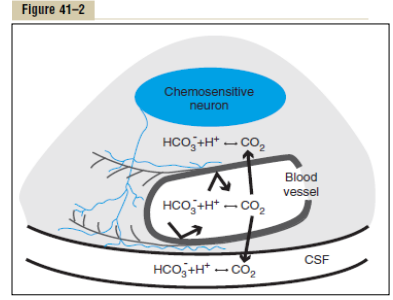


Figure 41–2



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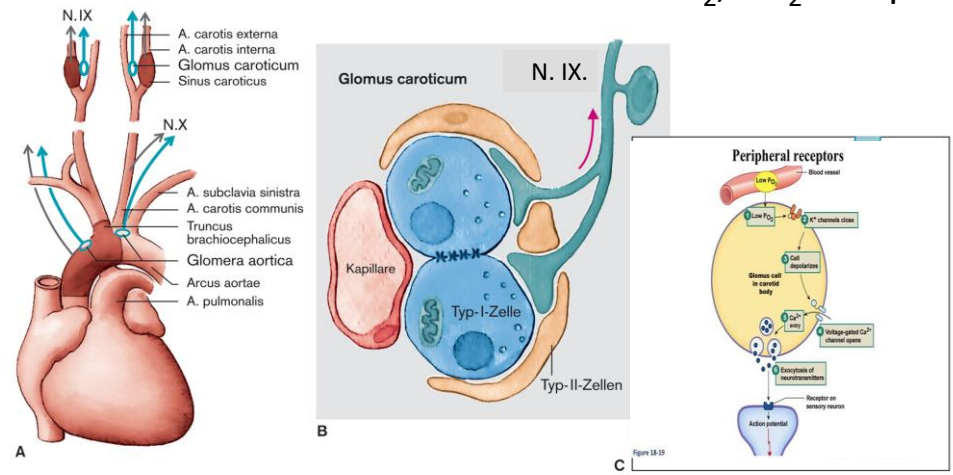
Arterial peripheral chemoreceptors

O_2, CO_2 *and* pH



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Glomus caroticum chemoreceptor reaction

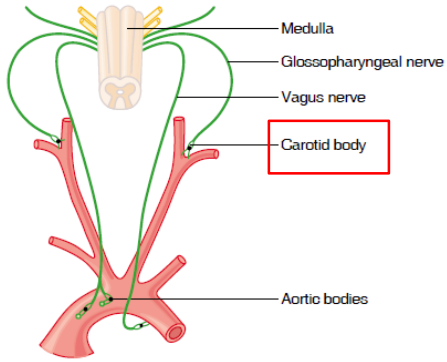

Figure 41–4

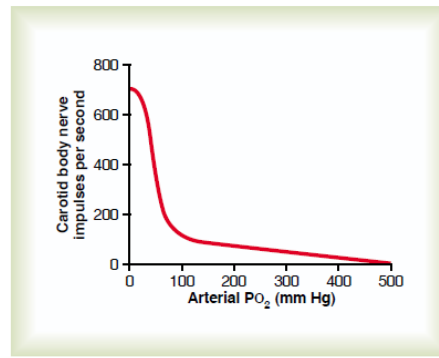

Figure 41–5

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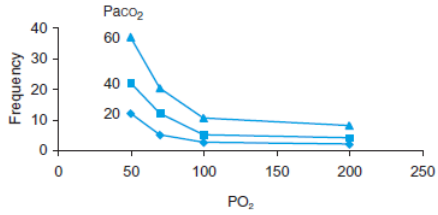
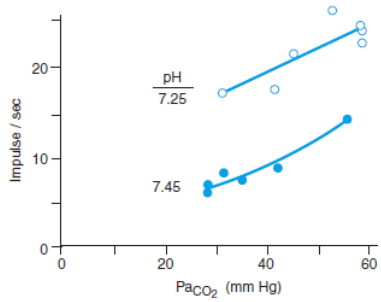
Glomus caroticum chemoreceptor reaction



PaO_2 and $PaCO_2$
have synergic effect



pHa and $PaCO_2$ both act on die
Glomus caroticum receptors
(Glomus aorticum does not react on pH)

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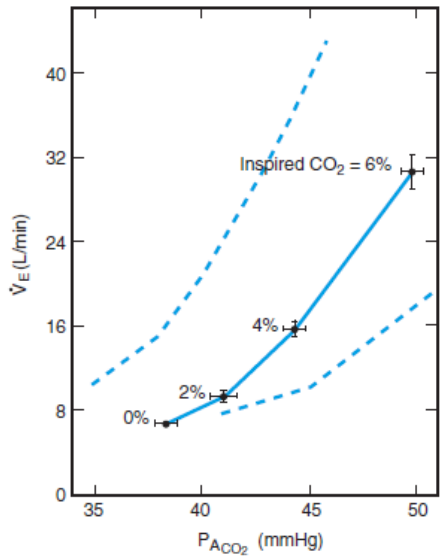
Ventilation and P_{ACO2}
(hyperkapnic respiratory reaction)



Test: „Re-breathing”
Methode

effect originates from the
central chemoreceptors

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CO_2 narcosis (CO_2 in the air)

CO_2 content in the air is normally very low (0.04%)

Cellar accident during fall

1% --> respiratory frequency rises
5% --> dyspnoe
10% --> unrest, headache
15% --> black out, muscle spasms
20-30% --> CO_2 narcose

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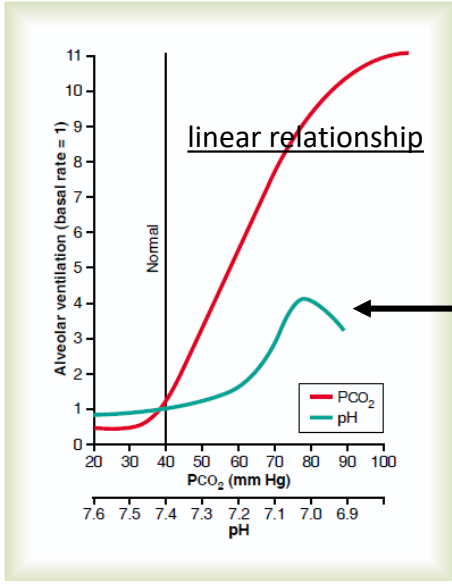
Ventilation und pHa



in the periphery only the glomus caroticus receptors react (Kussmaul Ventilation)

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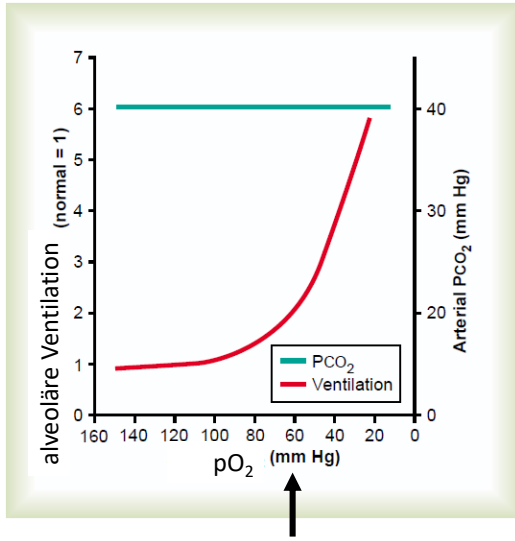
Ventilation and paO_2
(hypoxic respiratory response)



not-linear
relationship

CO_2 dominates!

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Adaptation to CO_2

- chronic increase of the arterial PCO_2
- sleeping pill poisoning

driving force for the respiration: O_2 receptors
consequences of extra O_2

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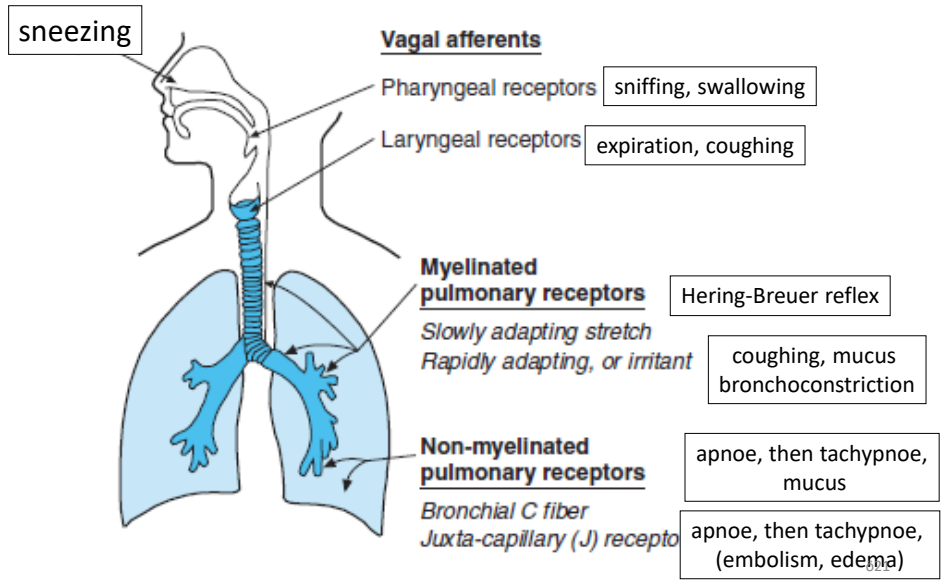
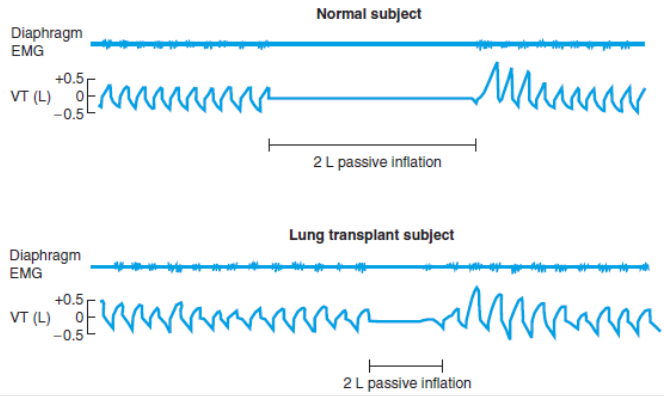
Respiratory reflexes



N. Vagus cut



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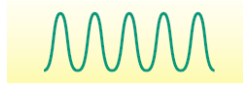
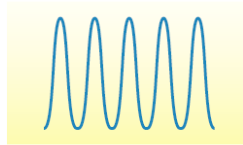
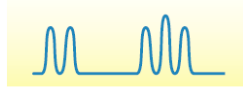
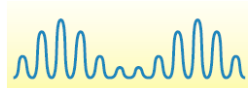
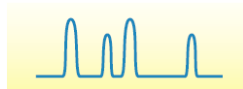
Special respiratory rhythms

normal		
Kussmaul		acidose (respiration compensates)
biot		brainstem lesion, meningitis
Cheyne-Stokes		sleep, high altitude, opiates
Apneusis		medullary and pontin lesions
Gasping		agony

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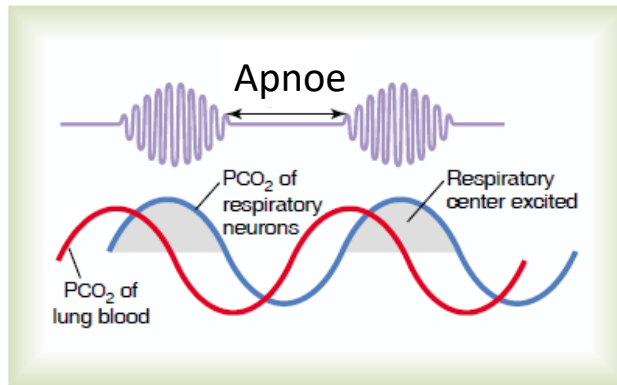
Cheyne-Stokes pattern



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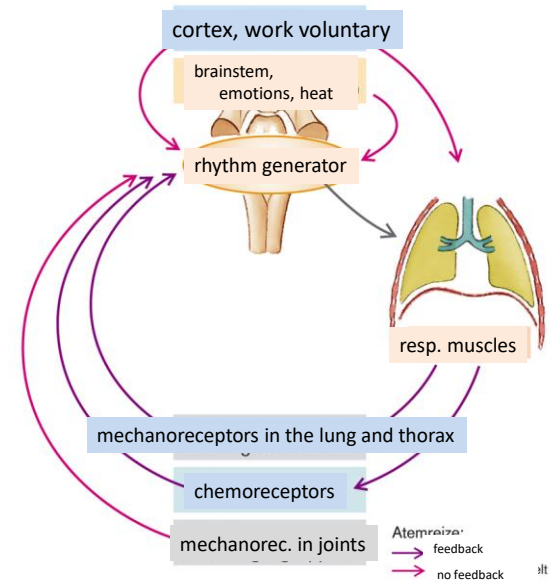
Control circuit for respiration



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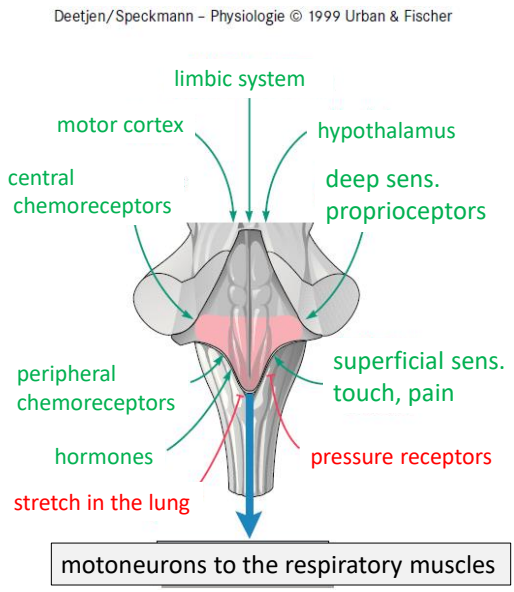
Integration of peripheral stimuli



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Diver accident

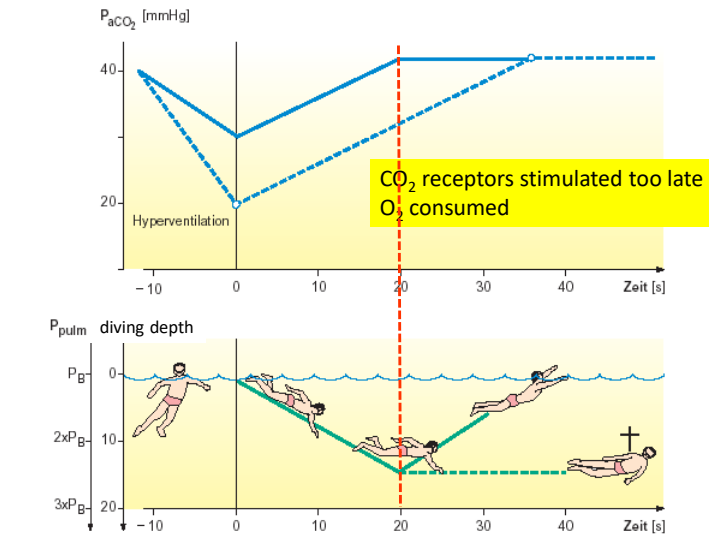

Abb. 8-34 Tieftauchen mit Atemanhalten. Bei zu starker Hyperventilation vor dem Tauchen (gestrichelte Kurven) wird der kritische P_{aCO_2}, der das empfindlichste Signal für das rechtzeitige Auftauchen darstellt, zu spät erreicht. P_B = Barometerdruck, P_{pulm} = intrapulmonaler Druck.

27

Biology of the airways

Learning objectives: 32

10 000 L air /day on 70m^2 alveolar surface

Protection of the airways

- role of the upper airways sneezing, caughing
- alveolar macrophages: dust, smoke, silicium, asbestos (lysosomes)
- club (Clara) cells: surfactant production, stemcells
- tissue mast cells: histamin, allergy

mucociliar clearance:

- cells with cilia, 10Hz
- mucus above the epithel moves toward pharynx, 1mm/min
- fate of particles: > 5 µm, 5-2 µm, < 2 µm

act on mucociliar clearence:

- n. X, cold/heat, smoking, dehydration, dry air, anesthesia, drugs
- (→ atelectasia, infections, hypoxia)

28

Clearing/activating functions of the lung

physical filtering: pulmonary capillaries, Ø 7 µm

chemical filtering: plasminogen activators, heparin

neutralizing vasoactive substances: serotonin, NA, bradykinin, prosztaglandins, adenozin

ACE: Angiotensin I. → Angiotensin II. (blood pressure control)

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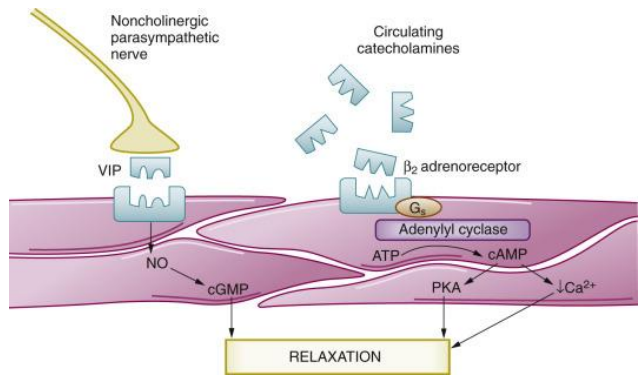
Bronchomotor tone:

n. X → constriction, diurnal rhythm (early morning asthma!)
histamin

non cholinergic parasy., circulating symp. mediators. → dilatation



see: https://academic.oup.com/bjaed/article/13/3/98/278874%20

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