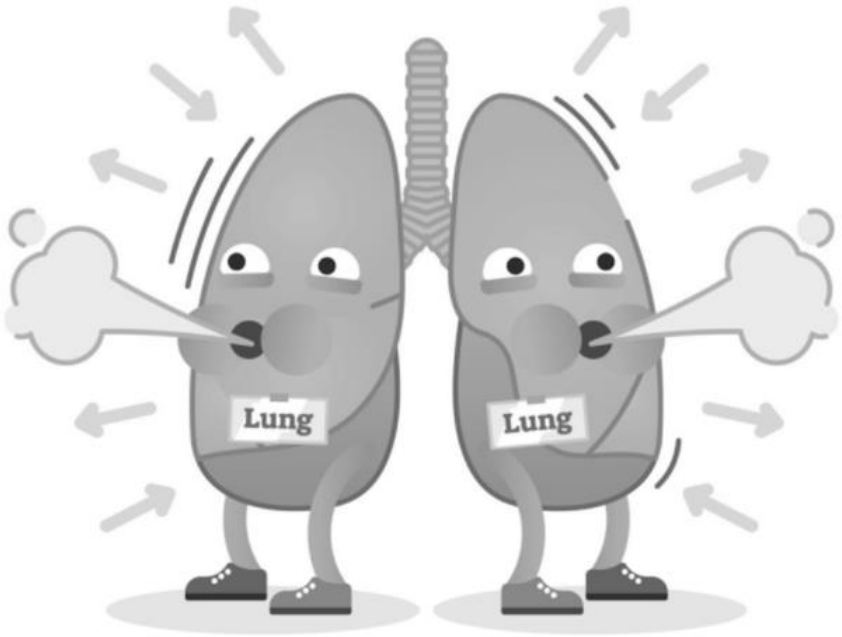
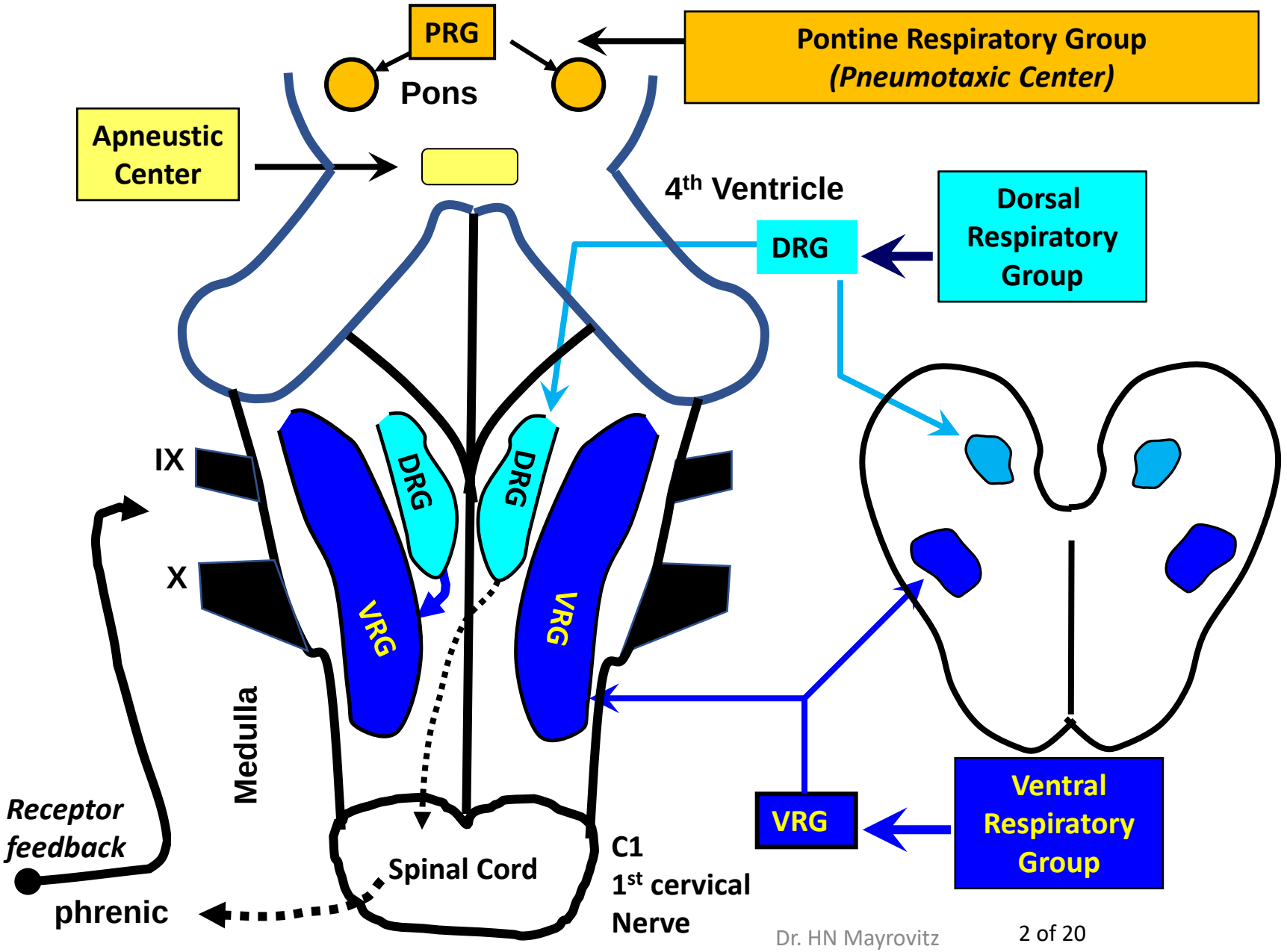
KPCOM Respiratory System Lecture 5
03/28/2025 1310-1400

Control of Respiration

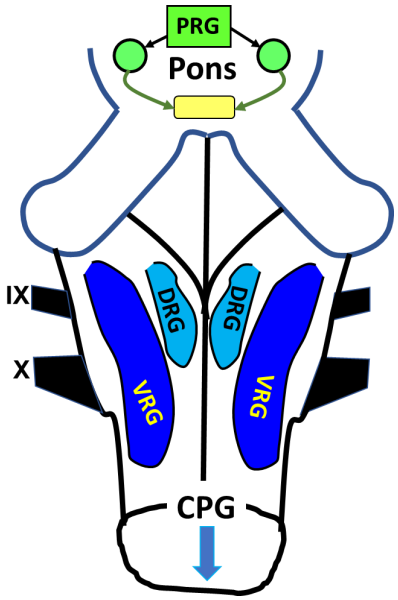


HN Mayrovitz PhD
mayrovit@nova.edu
drmayrovitz.com

Respiratory Cell Groups



Respiratory Center Actions: Summary



Pneumotaxic Center (PRG)

Inhibits apneustic output
Switches off Inspiration

Apneustic Center

Pons

Maintenance of signal
Prolongs inspiration

Receptor Feedback Via IX & X

Inspiratory Center DRG
NTS

Expiratory Center VRG

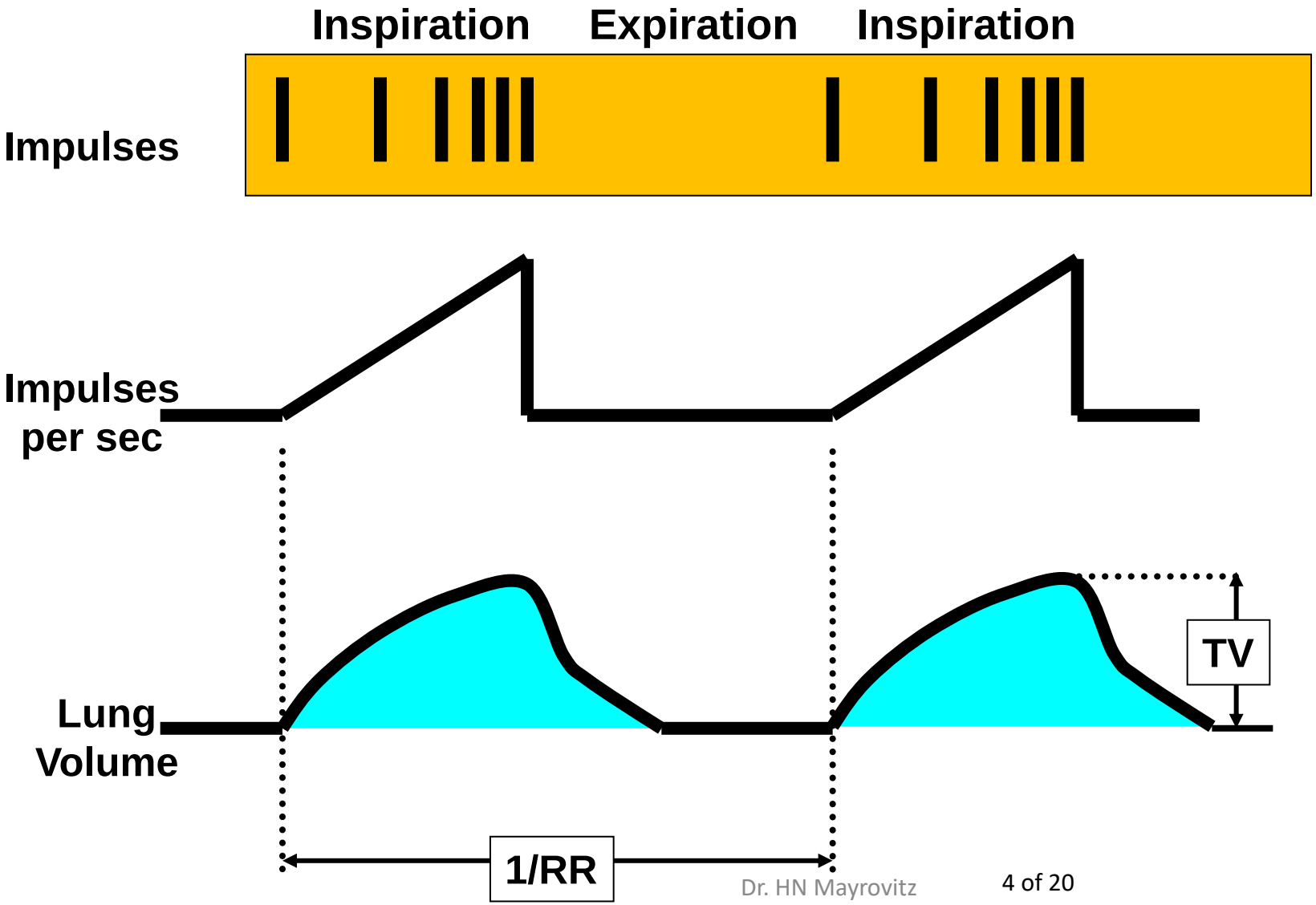
Medulla

To inspiratory muscles

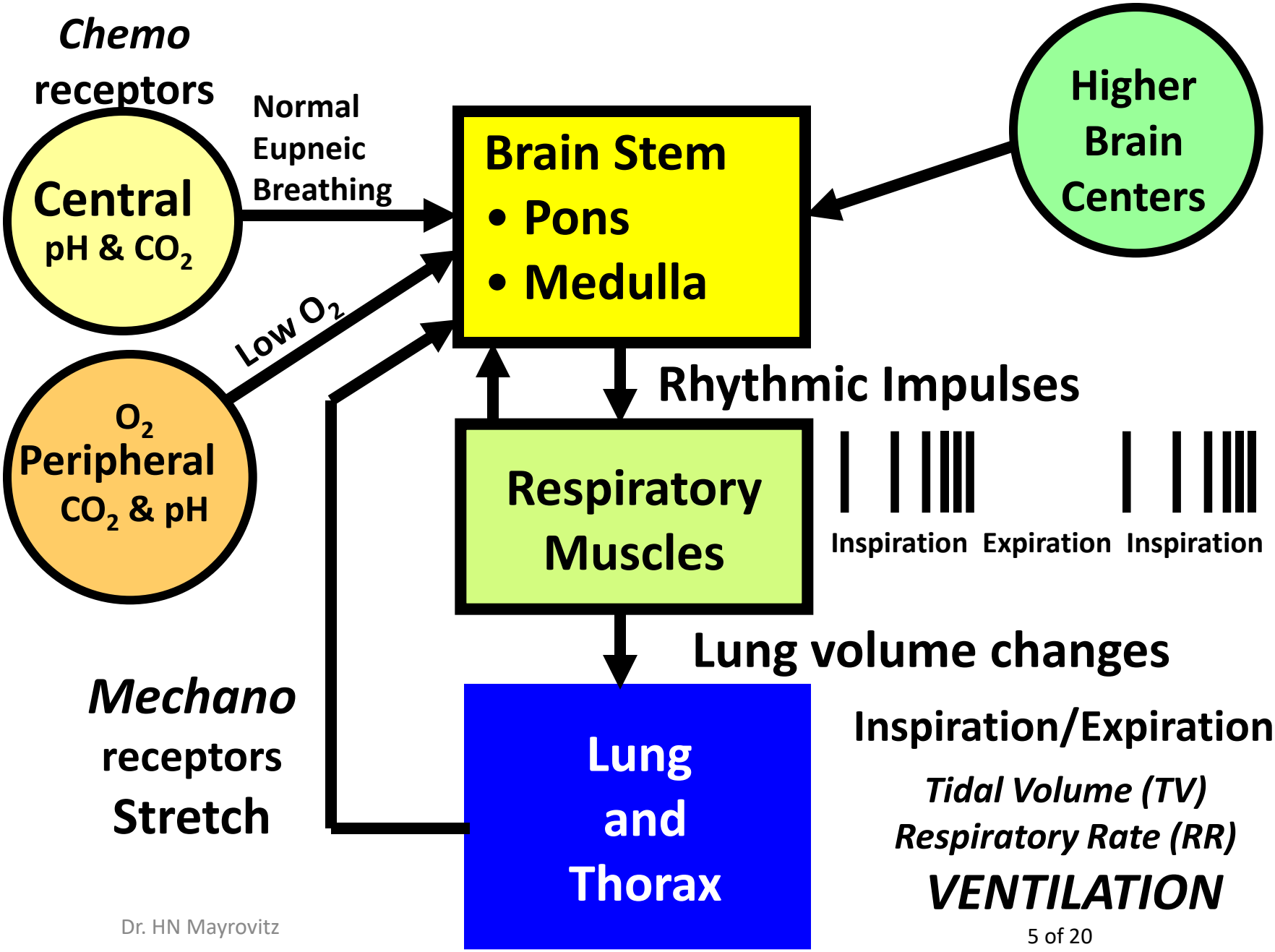
Basic rhythm is generated in medulla
(Central Pattern Generator)
CPG → Cause is unknown

NTS = Nucleus Tractus Solatarius
CPG = central pattern generator
VRG = ventral respiratory group
DRG = dorsal respiratory group
PRG = pontine respiratory group

Impulses to Respiratory Muscles From Medullary Central Pattern Generator (CPG) Cause Inspiration



Overview of Ventilation Control with Feedback



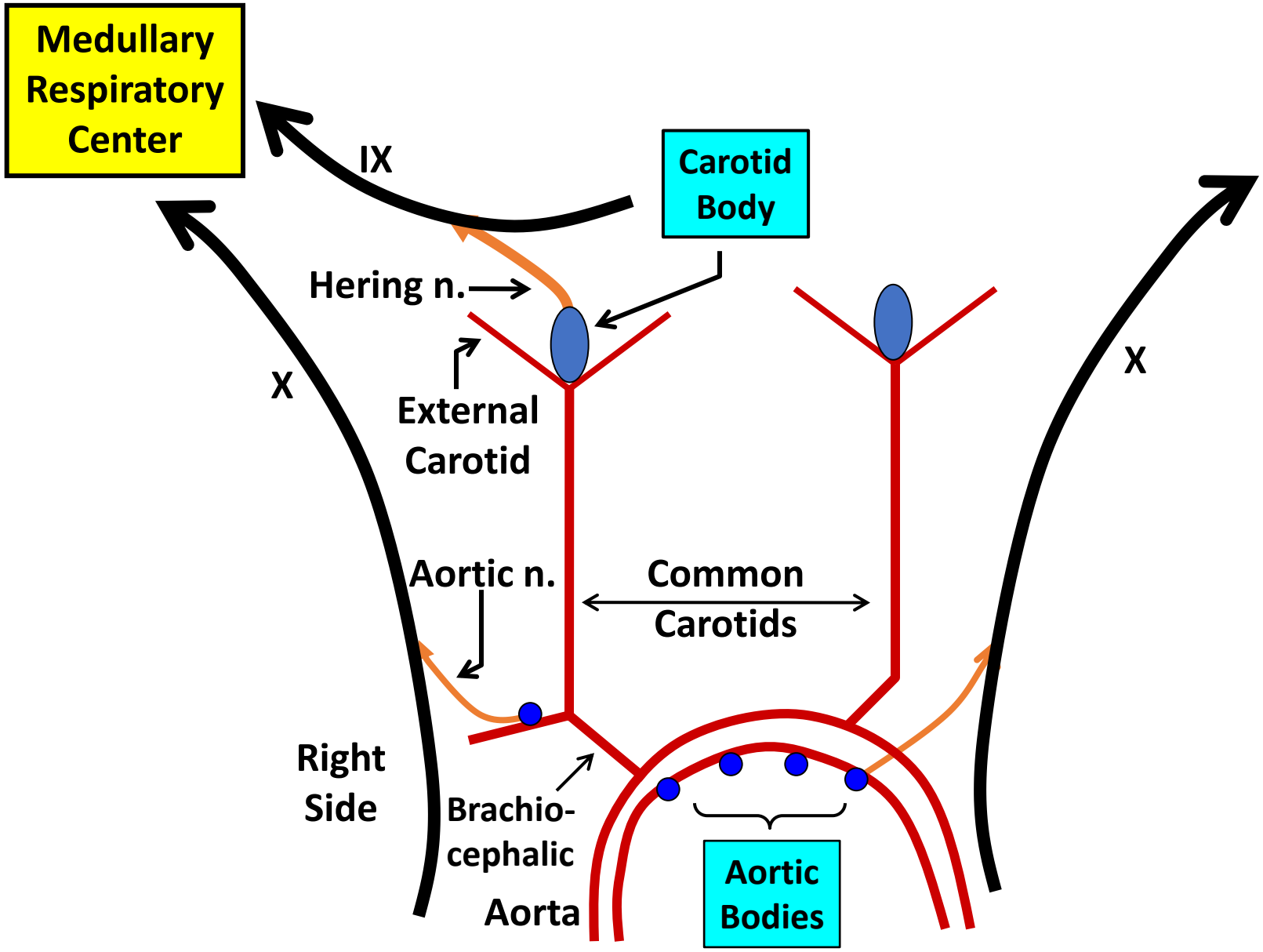
Chemical Control

Chemical Control Mediated via

Peripheral Chemoreceptors
- **Carotid Bodies**
- **Aortic Bodies**

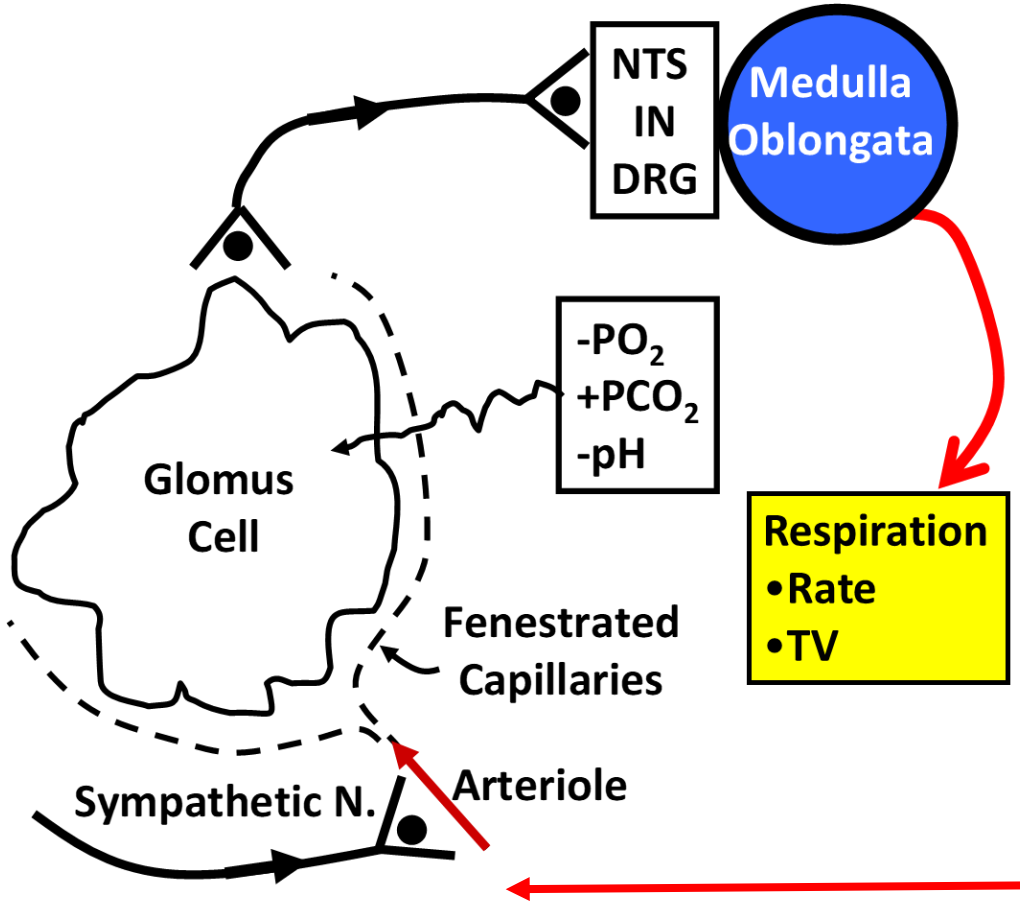
Central Chemoreceptors

Peripheral Chemoreceptor (PCR): Pathways



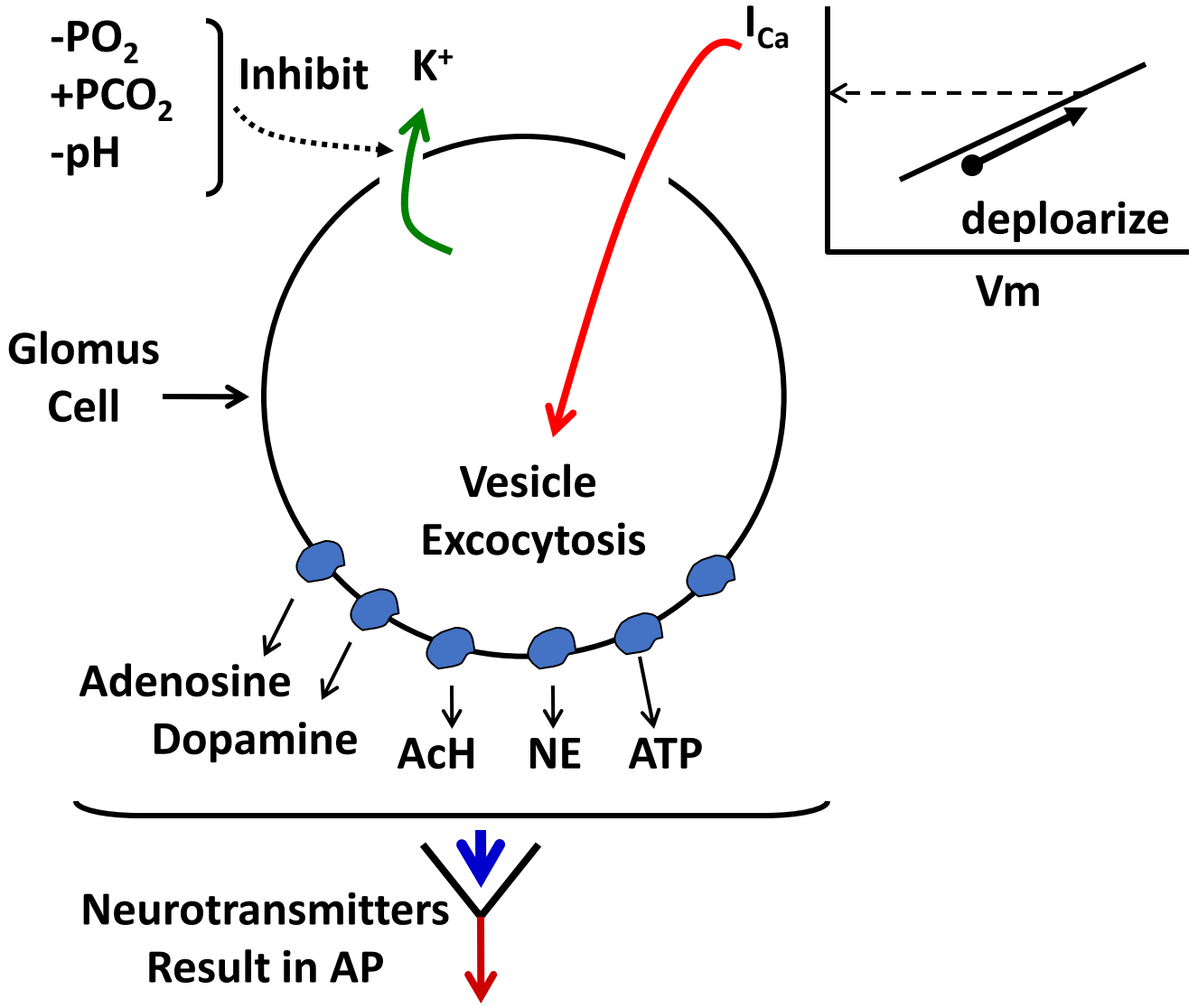
Carotid Body Function: Overview

NTS and DRG:
Nucleus Tractus Solitarius
Dorsal Respiratory Group



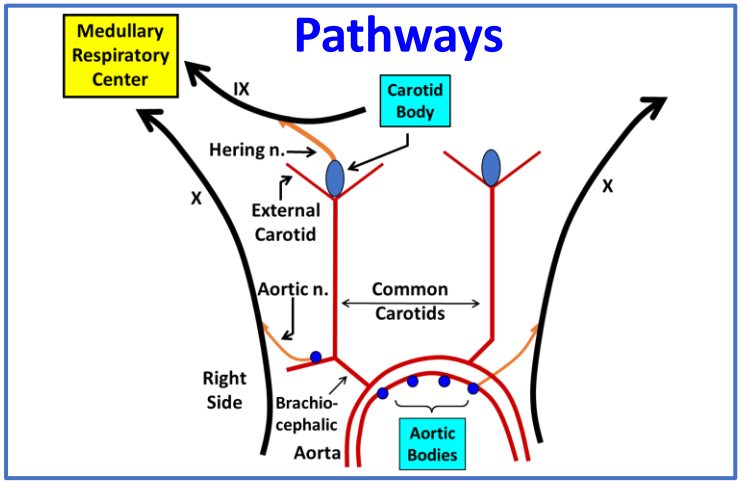
- Carotid body: very high blood flow/g
- Advantage to sample blood chemistry
- Glomus cells in carotid body monitors blood PO_2, PCO_2 and pH
- For indicated directional changes, afferent nerve traffic to the respiratory center is increased
- Results is increased efferent nerve traffic from dorsal respiratory cell groups (DRG) causing increased respiration rate and tidal volume
- Certain activities may be modulated by sympathetic nerve vascular control of arterioles feeding the glomus cells

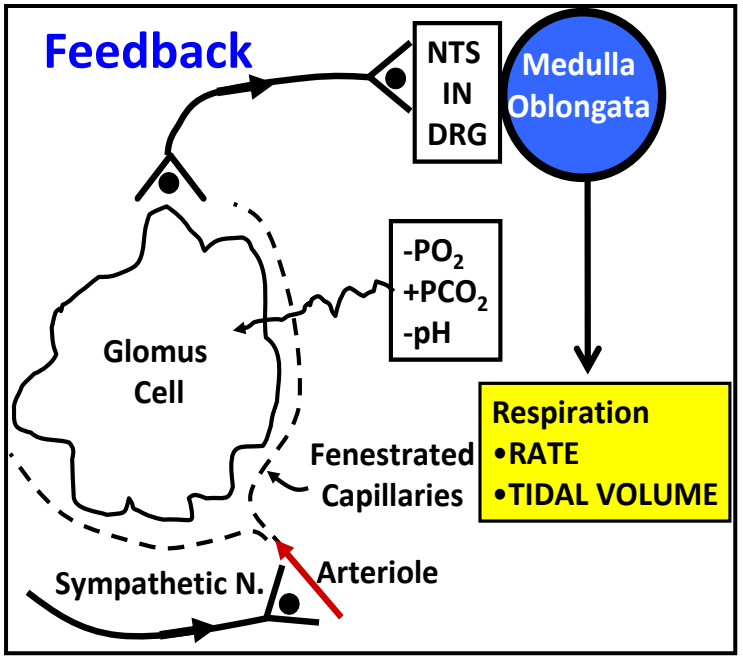
Carotid Body Partial Mechanism

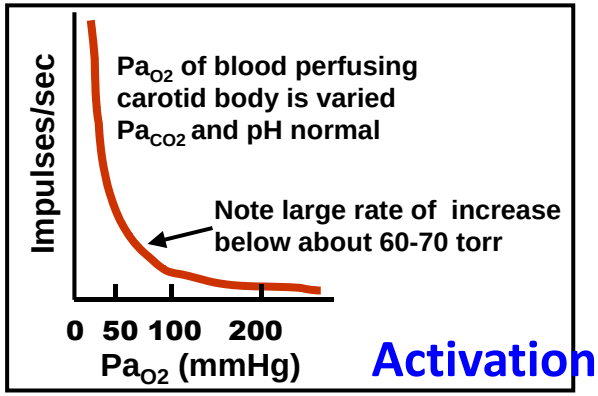


Peripheral Chemoreceptors (PCR): Summary

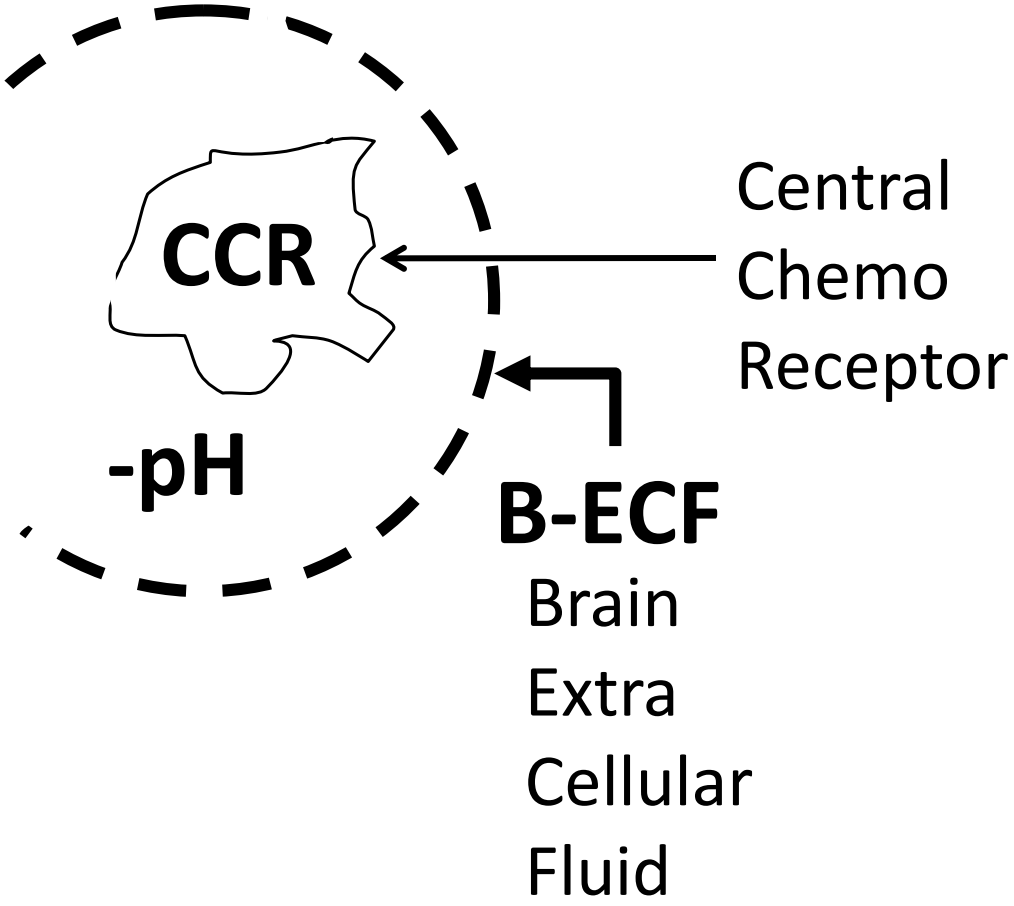
- Located bilaterally in carotid and aortic bodies
- Respond to Hypoxia, Hypercapnia and Acidosis
- Afferent pathways for:
  - Carotid body → Hering's nerve
  - Aortic body → vagus nerve
- Large afferent impulse traffic at normal blood gases
- Increased afferent activity caused by
  - (1) decreased arterial Pa_{O2}
  - (2) increased Pa_{CO2}
  - (3) decreased arterial pH
- Feedback to respiratory center → increased V'
- Response to hypoxemia depends on Pa_{CO2} & pH
  - More Pa_{CO2} or lower pH → greater $\Delta V'$ for same ΔPa_{O2}



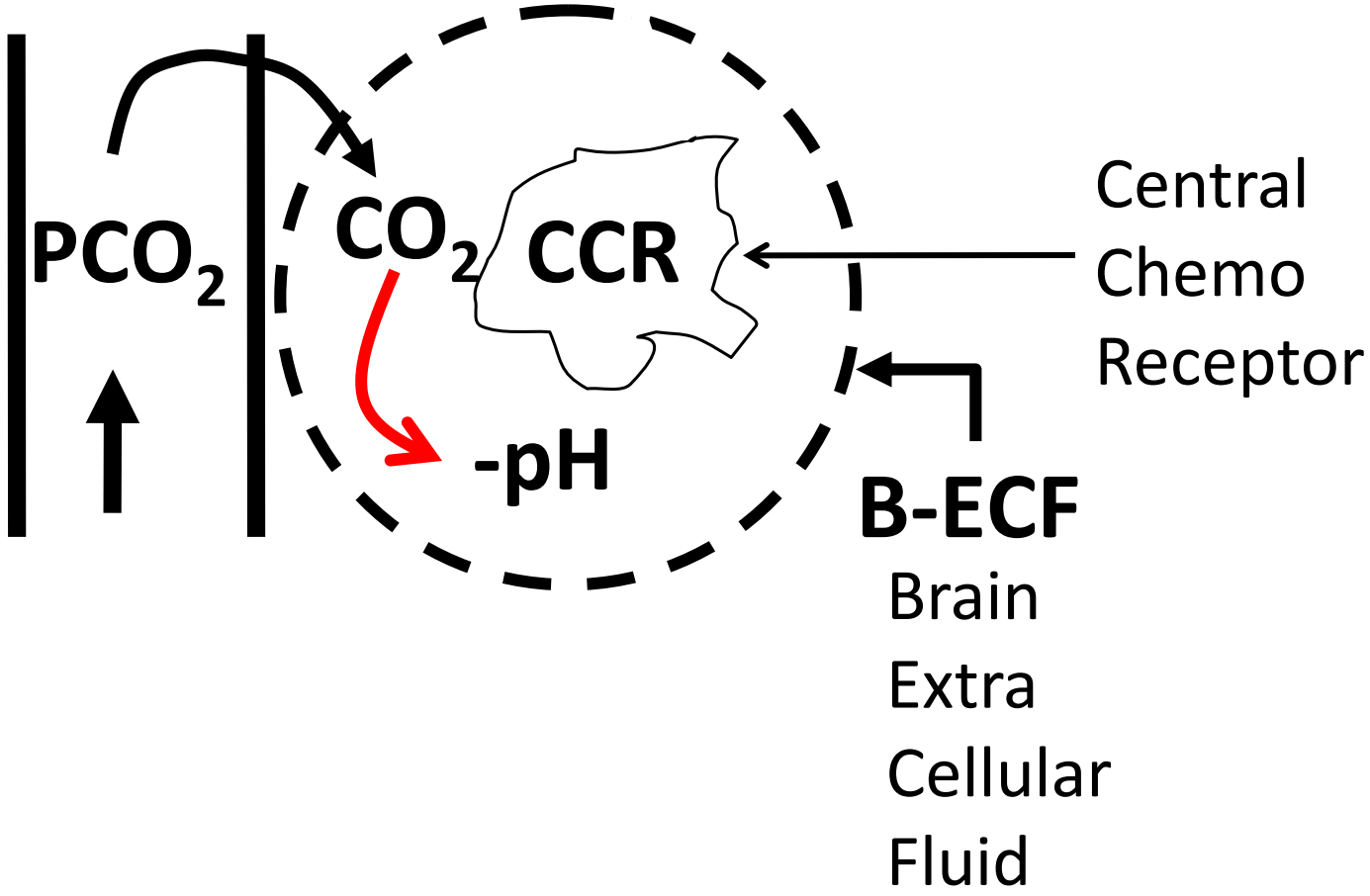




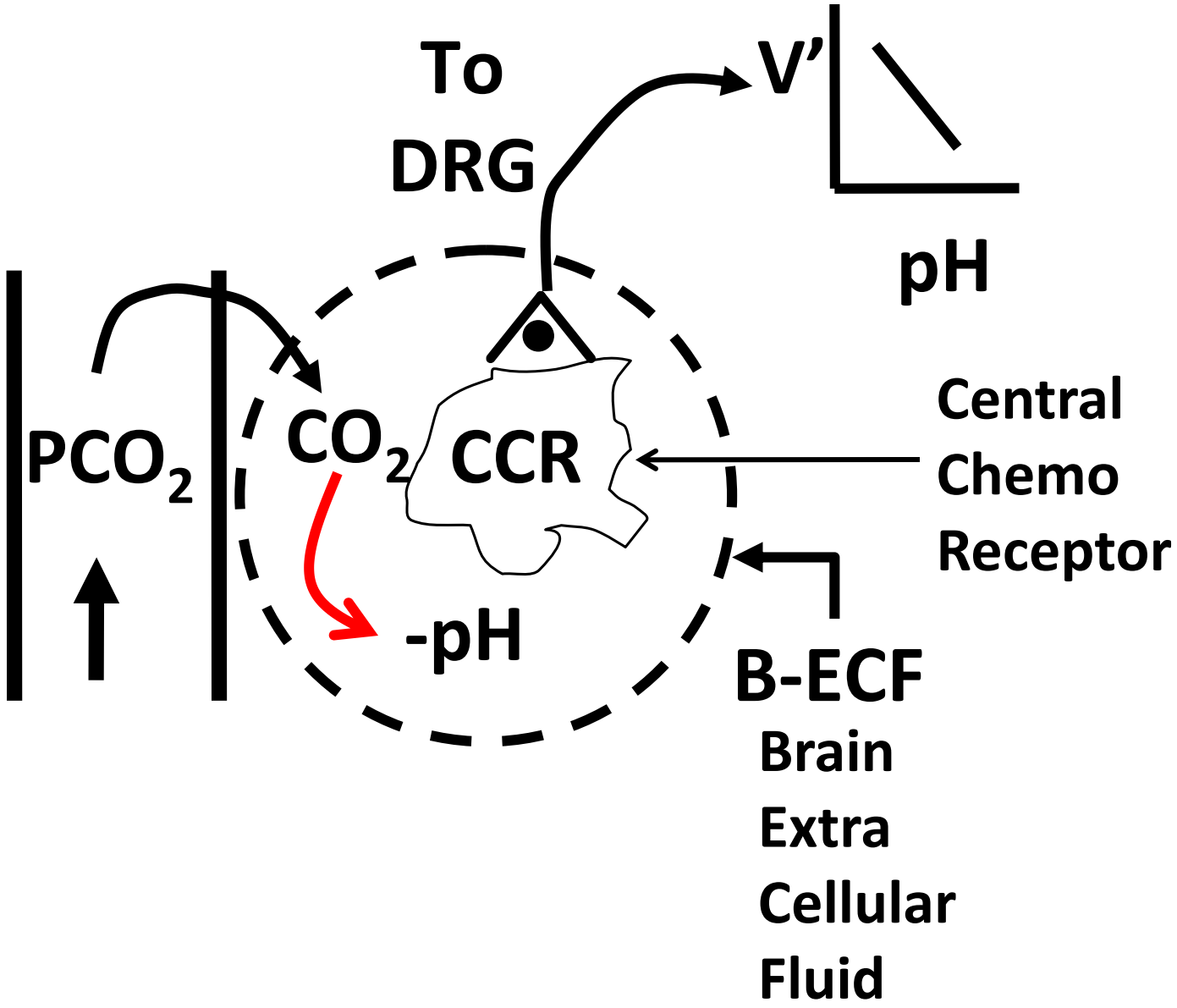
Central Chemoreceptor Function Overview



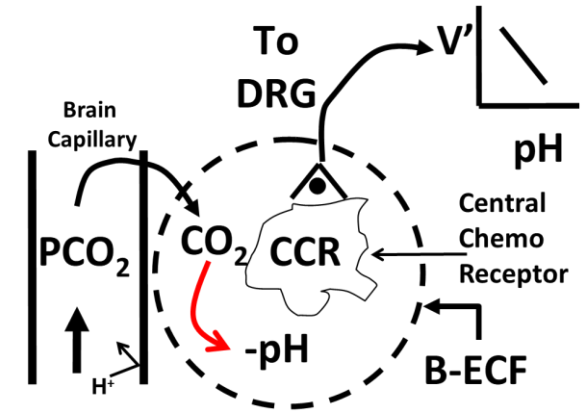
Central Chemoreceptor Function Overview



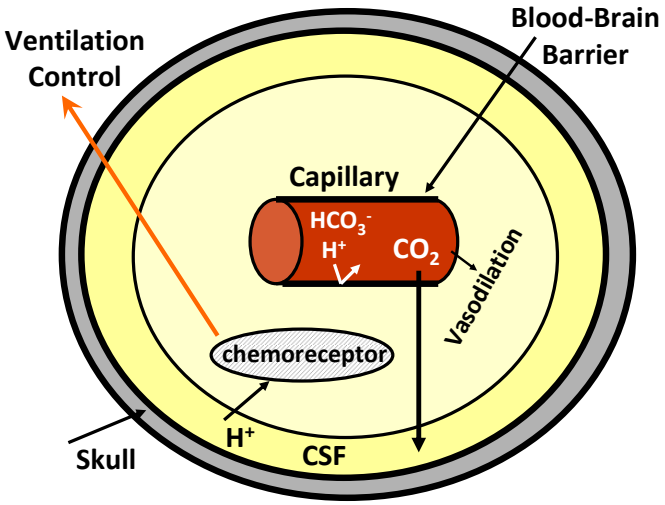
Central Chemoreceptor Function Overview



Central Chemoreceptors: Summary

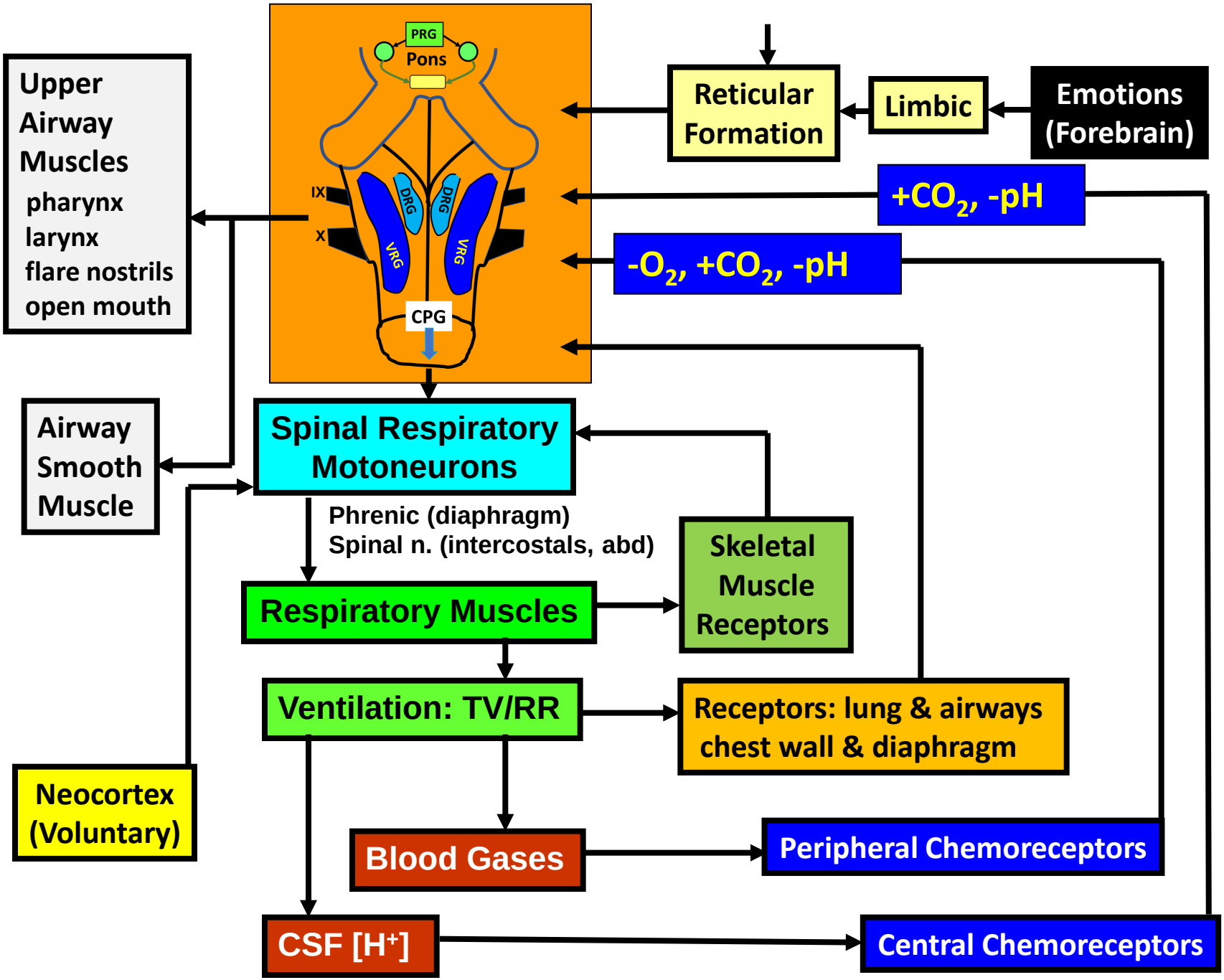


B-ECF = Brain Extracellular Fluid



- CCR in brain parenchyma bathed in brain extracellular fluid/CSF
- If blood gases and pH near normal CCR are main control of ventilation
- CCR are sensitive to arterial hypercapnia (and associated fall in pH)
- CCR actually sense pH (H^+) around receptor neurons bathed in CSF
- pH changes may occur due to:
  1) increased cerebral blood CO_2 diffusing across the blood brain barrier resulting in a rapid (60 sec) decrease in the pH of CSF
  2) decreased pH of brain or CSF not due to changes in Pa_{CO2} (delayed)
- CCR do not respond to hypoxia
- CCR and PCR both affect ventilation response to increased CO_2 levels

Overall Respiratory Control Summary


PRG
Pons
IX
X
DRG
DRG
VRG
VRG
CPG
Upper Airway Muscles
pharynx
larynx
flare nostrils
open mouth
Reticular Formation
Limbic
Emotions (Forebrain)
+CO2, -pH
-O2, +CO2, -pH
Airway Smooth Muscle
Spinal Respiratory Motoneurons
Phrenic (diaphragm)
Spinal n. (intercostals, abd)
Skeletal Muscle Receptors
Respiratory Muscles
Ventilation: TV/RR
Receptors: lung & airways chest wall & diaphragm
Neocortex (Voluntary)
Blood Gases
Peripheral Chemoreceptors
CSF [H+]
Central Chemoreceptors

Respiratory Mechanoreceptors

Receptors Located in

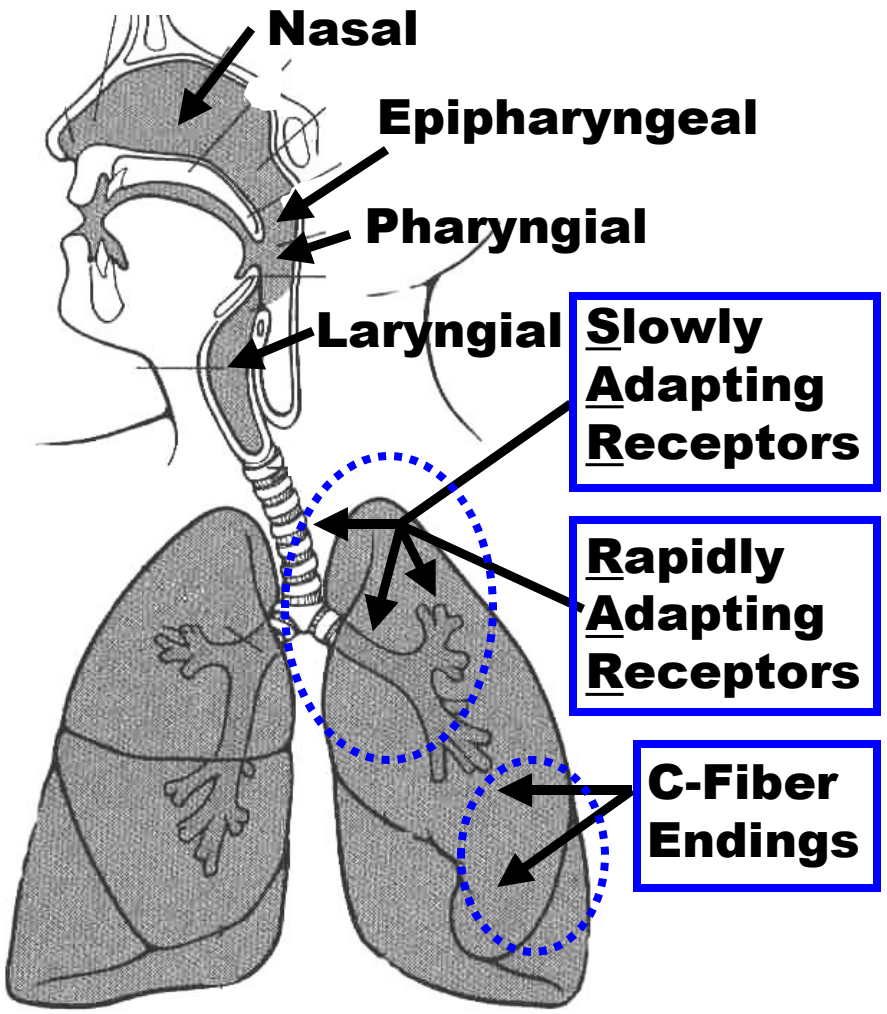
- Upper respiratory
- Tracheo-bronchial tree
- Lung parenchyma

Broadly three types

- Slowly Adapting (SAR)
  Among ASM cells
- Rapidly Adapting (RAR)
  Among airway epithelial cells
- C-fiber endings (J-receptors)
  near blood vessels/capillaries

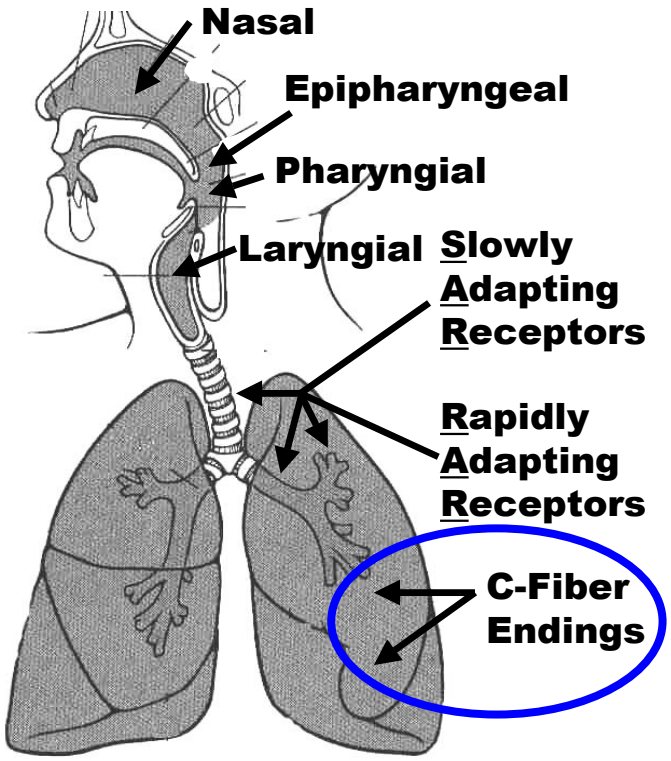
Vagal Afferents

- Connect to respiratory cntr
- Initiate many reflexes



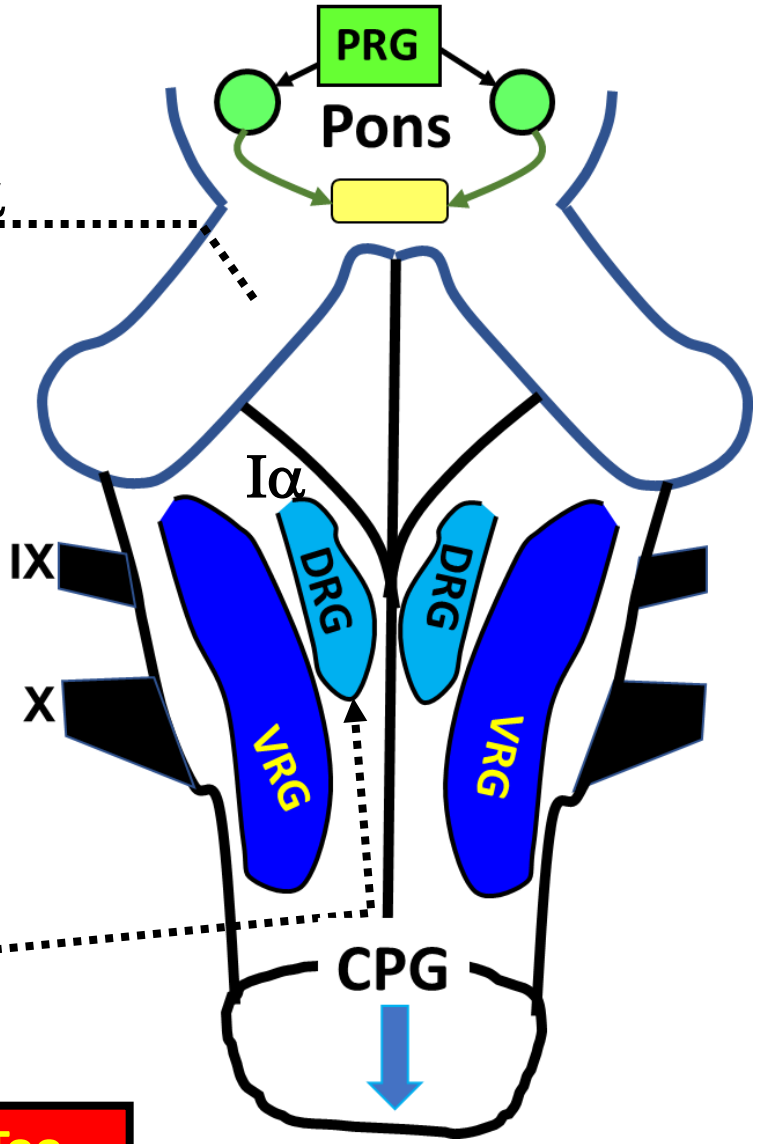
C-Fiber Receptors (Juxtacapillary or J Receptors)

- Network of small unmyelinated axons (C-fibers) innervate receptors in alveoli near or in the walls of pulmonary capillaries
- Sensitive to distension and/or distortion caused by increases in capillary or interstitial volume
- Increased distention leads to increased ventilation (*pulmonary congestion* by LV failure)
- Decreased distention leads to decreased ventilation (e.g. pulmonary *embolism* that obstructs flow proximal to capillaries)



Hering-Breuer INFLATION Reflex

H-B Inflation Reflex
Operative in
- *Adults if TV > 800 ml*
- *Infants*



Too much or Too Rapid lung Inflation

→ **SAR among ASM cells**

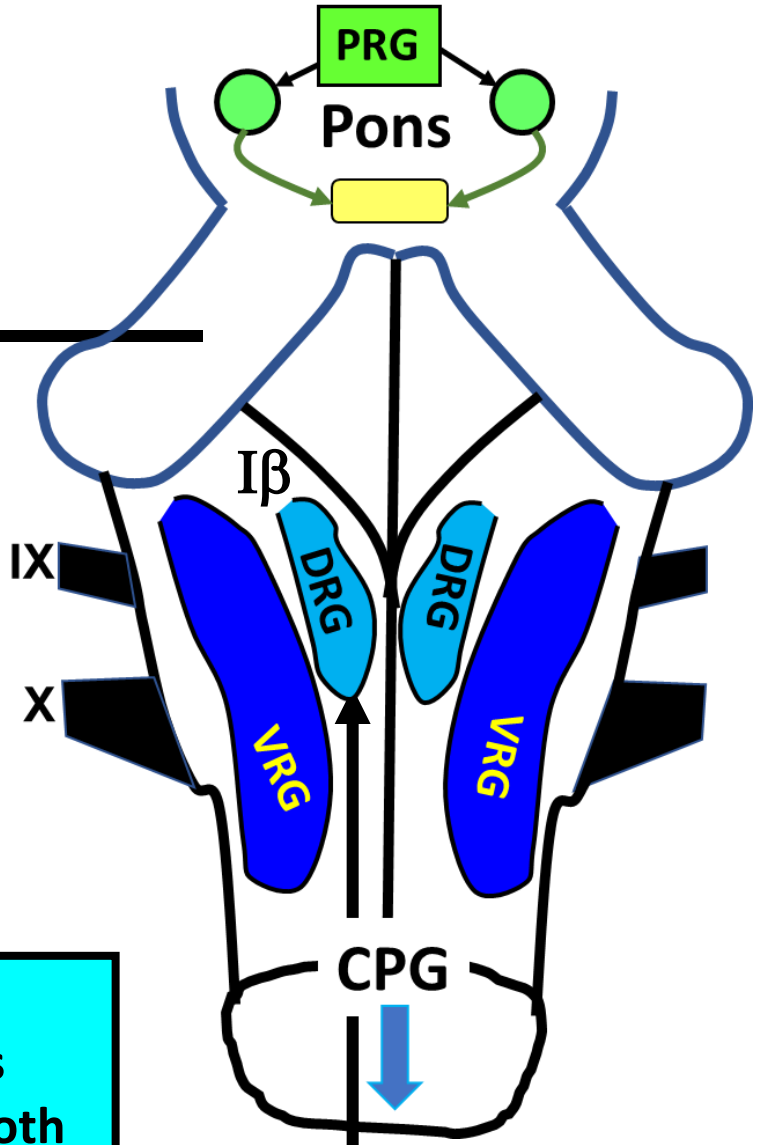
→ **Inhibitory impulses to DRG via Vagus**

→ **Impulses to inspiratory muscles are decreased**

- **Reduces inspiration duration**
- **Reduces TV**
- **Prevents overdistention**

Hering-Breuer DEFLATION Reflex

- *Pneumothorax → RAR*
- *Trigger for sighs*
- *Maintain Infant FRC low chest wall force*



Impulses to inspiratory muscles are increased

Hyperpnea
- **Tachypnea +RR**
- **Hyperpnea +TV & +RR**

Less stretch or rapid deflation increase receptor activity causes a reflex that promotes either/both increased TV and RR

End Respiratory Physiology Lecture 5

Dr. HN Mayrovitz