Respiratory Physiology -3

Recommended Textbooks:

Respiratory Physiology: The Essentials John B. West, ISBN 0781751527
Respiratory Physiology Lectures, Dr. John B. West Playlist (YouTube)
Vander's Human Physiology, 12th edition, Chapter 13

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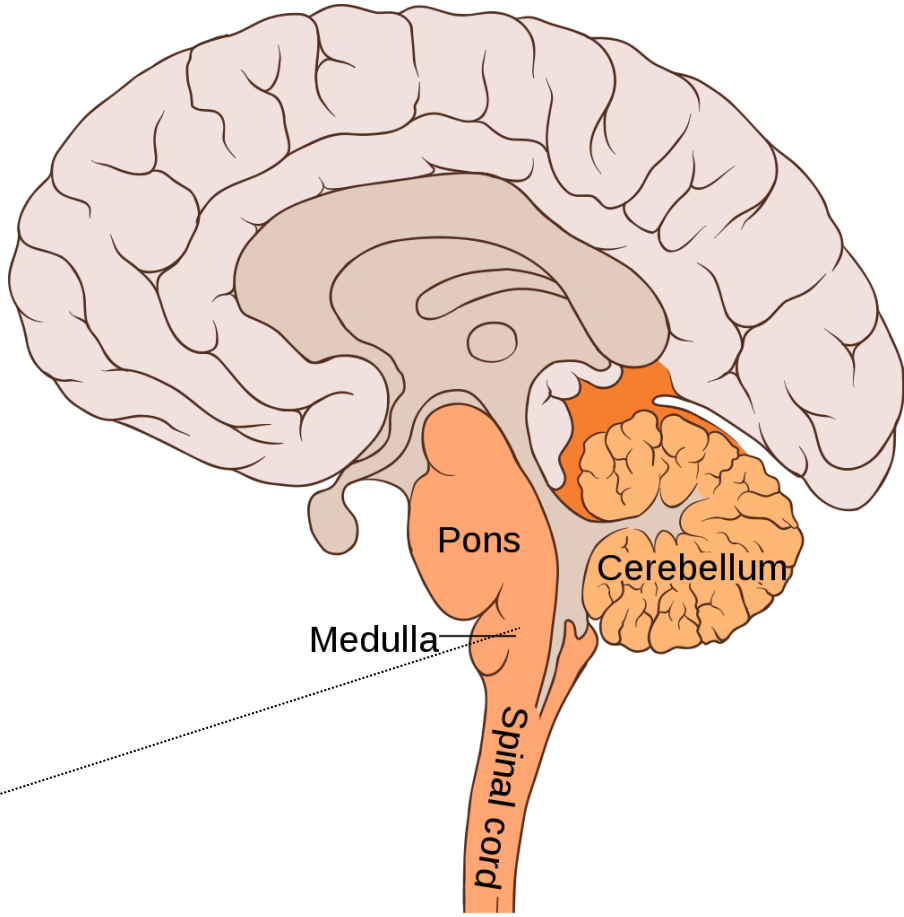
Control of Ventilation

Obviously both rate and depth of breathing may be controlled voluntarily … but,
under normal circumstances,
breathing parameters are controlled by a combination of:

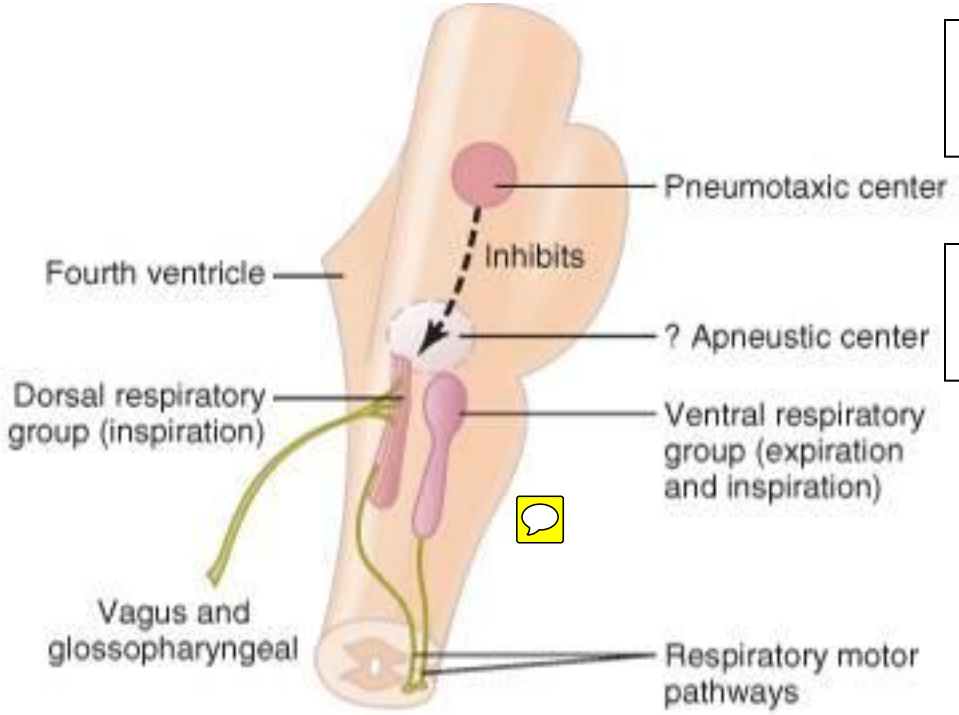
1) spontaneous, rhythmic discharge of some of the neurons within the respiratory control centre (situated in the brain stem)

2) inputs from receptors (chemoreceptors and stretch receptors) to the control centre.



By means of experiments in which the respiratory pattern was observed following either sectioning of the brainstem at various levels or stimulation at various points within the brainstem, a fairly complex control system has been elaborated.

Respiratory Centres



controls the duration of the filling phase

assists in regulating the depth of inflation

There two important centres located in the medulla:

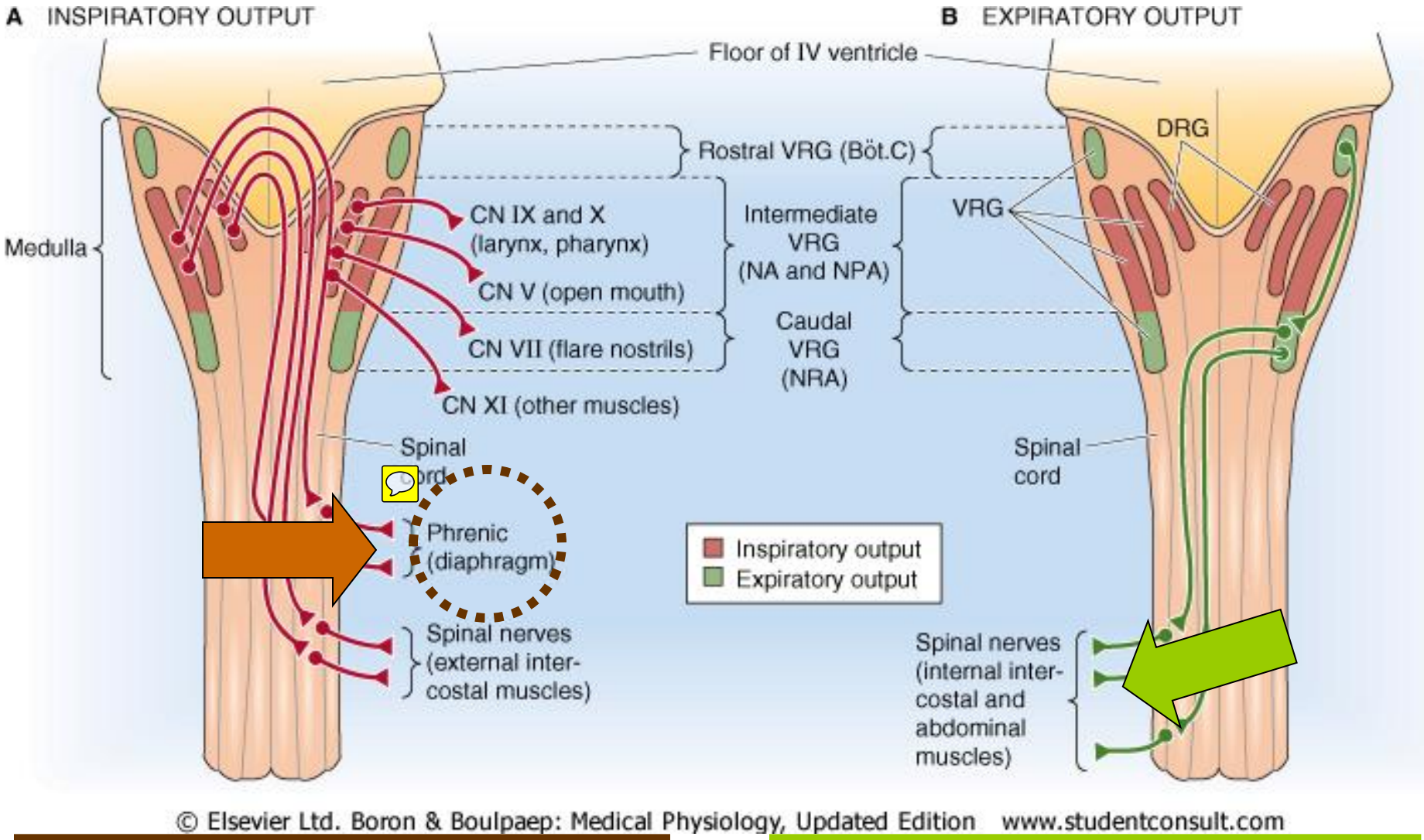
(1) dorsal respiratory group (DRG):

- contributes mostly to inspiration

(2) ventral respiratory group (VRG):

- functions in both inspiration and expiration; also plays a role is forced expiration
- is the site of respiratory central pattern generator (equivalent to the cardiac pacemakers)

Respiratory Centres -- Output



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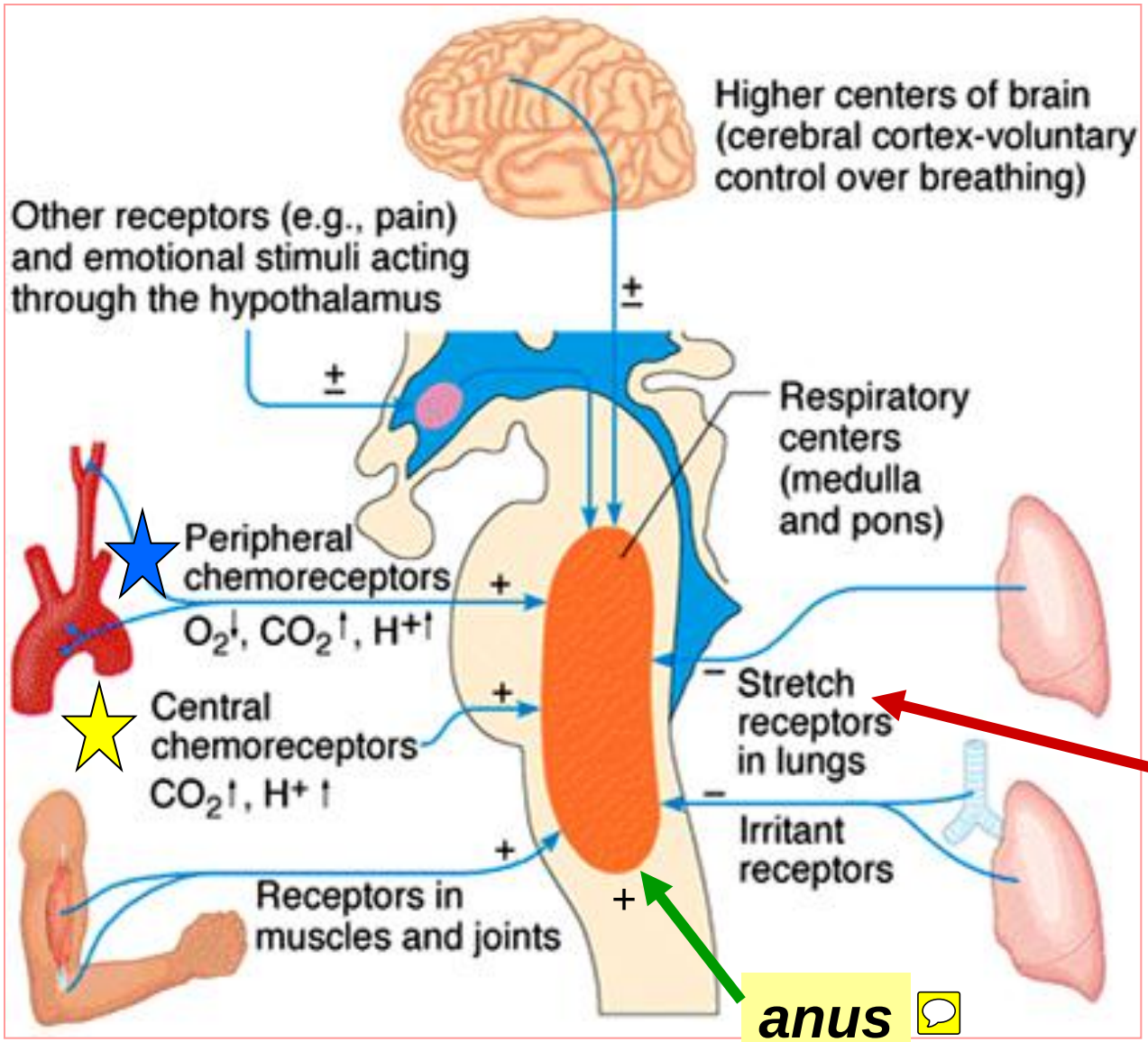
involves stimulation of diaphragm and external intercostal muscles

involves stimulation of abdominal and internal intercostal muscles

Respiratory Centres -- Input

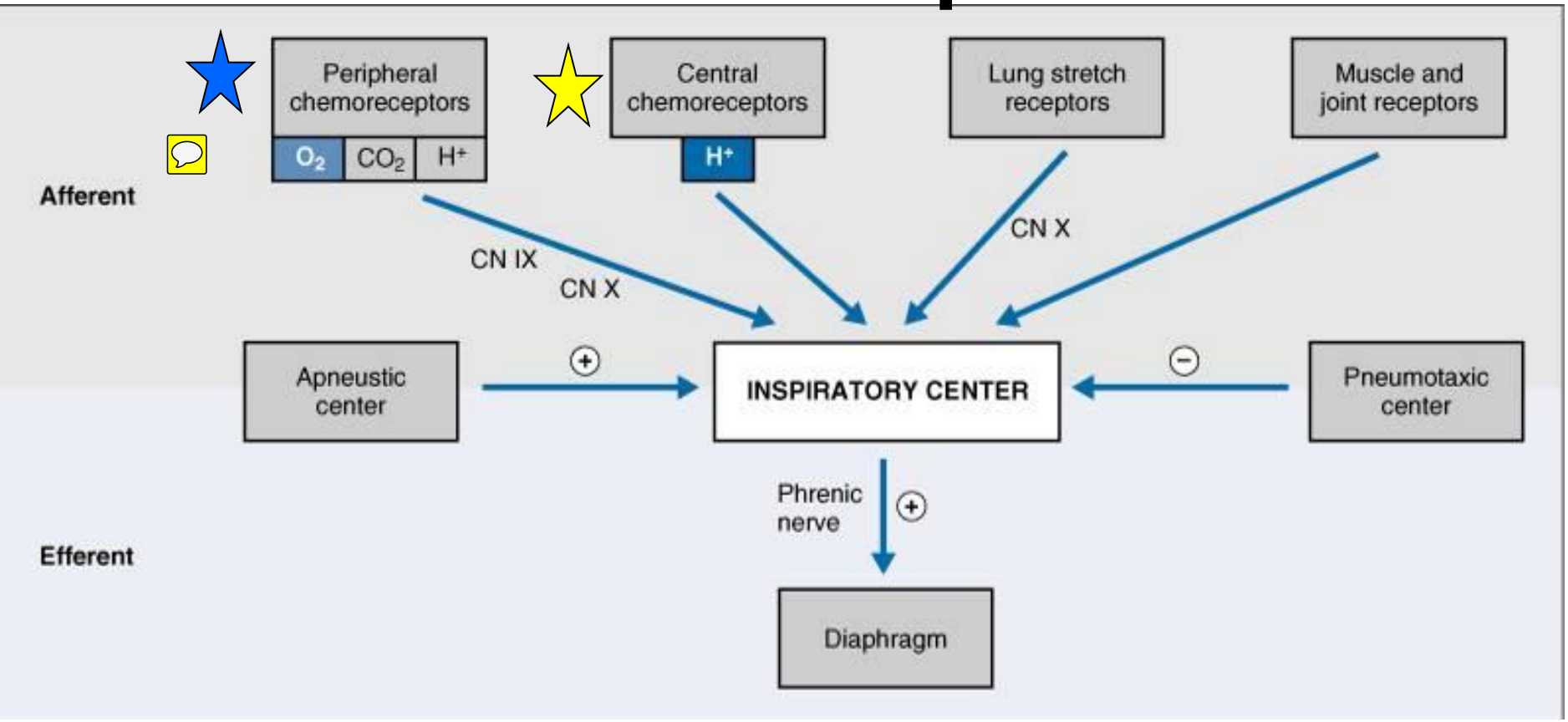


e.g. speaking, eating, heavy lifting, yoga

stretch: when the lungs become overly inflated, negative feedback stops further inspiration. This is called the *Hering-Breuer reflex.*

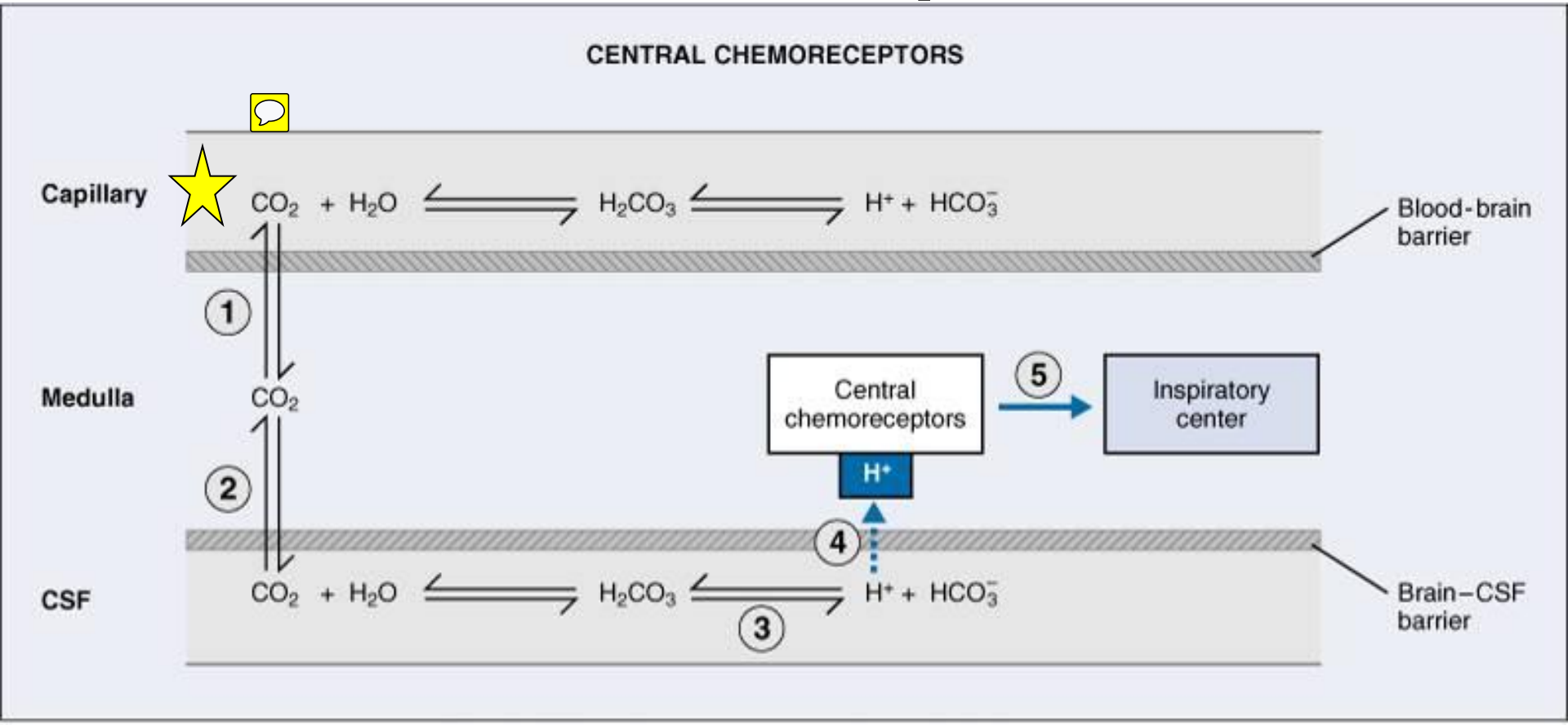
cough, sneeze

Chemoreceptors



Chemoreceptors may be generally subdivided into peripheral and central types.
Peripheral chemoreceptors: located within the arterial system, in the carotid artery and the aorta.
These receptors are primarily sensitive to changes in arterial pO2.
When PaO2 falls, the receptors fire messages to the brainstem resulting in an increase respiratory minute volume. These receptors are not very sensitive however. At a normal PaCO2 (about 40 mmHg), **PaO2 must drop below 60 mmHg before any significant effect on respiration follows.**

Chemoreceptors

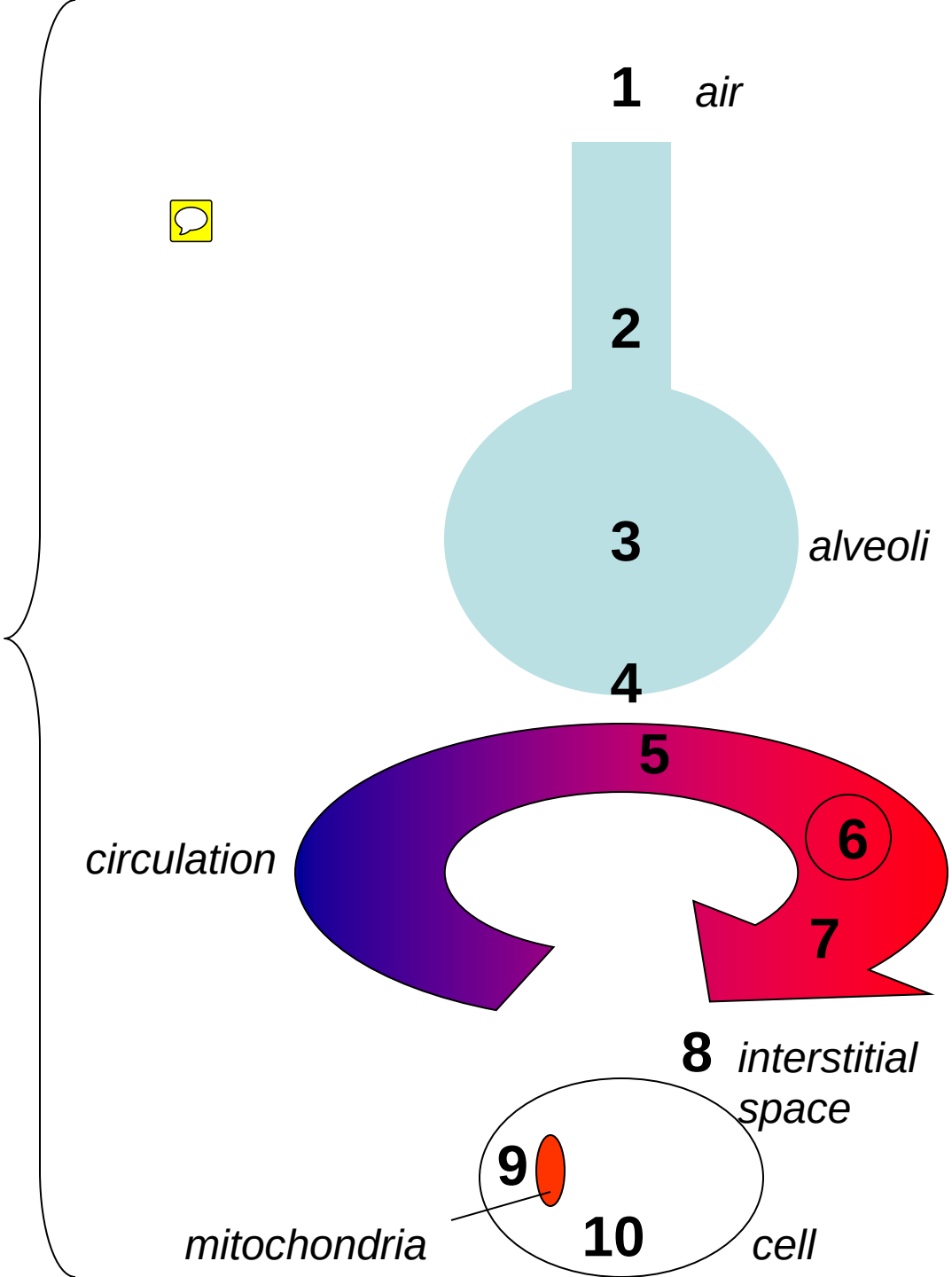


Central chemoreceptors: located in the medulla very close to the respiratory centres. They respond primarily to a rise in PaCO2 . The actual stimulus, however, is the resulting change in the pH of the extracellular fluid of the brain. CO2 diffuses from the blood into the cerebrospinal fluid (CSF) where it combines with H2O to form H2CO3 and subsequently H+ and HCO3-. The hydrogen ions in turn diffuse into the ECF and stimulate the central chemoreceptors. **In chronically elevated pCO2, chemoreceptors become desensitized and pO2 drives inspiration (watch out for O2 treatment)**

Ten Causes of Hypoxia:

<u>hypoxia</u>:

inadequate oxygen delivery to the tissues



Ten Causes of Hypoxia

These five causes of hypoxia are accompanied by hypoxemia (*reduced p_aO_2*)

1. **O_2 deficit in inspired air**
   (high altitude)

2. **Alveolar hypoventilation**
   - **a. won't breathe**
     (defective neuronal stimulus)
     e.g. head trauma
     drugs (narcotics, sedatives)
   - **b. *can't breathe***
     (defective equipment)
     e.g. muscular incapacity
     restrictive disease
     airway resistance (severe asthma)

p_AO2 is low

Ten Causes of Hypoxia

These five causes of hypoxia are accompanied by hypoxemia (*reduced p_aO_2*)

1. **O_2 deficit in inspired air** *(high altitude)*
2. **Alveolar hypoventilation** *(severe asthma)*
3. **V / Q mismatch** *(pulmonary embolism)*
4. **Problems with diffusion** *(damaged alveolar membrane)*
5. **Right→Left shunt** *(congenital defects)*

p_AO2 is low

p_AO2 is normal

Ten Causes of Hypoxia

These five causes of hypoxia are accompanied by normal p_aO_2

6. **Hypoxia of transport**
   (anemia, CO poisoning)
7. **Ischemic hypoxia**
   (circulatory shock)
8. **Troubles with diffusion at the interstitial (tissue) level**
   (interstitial oedema)
9. **Histotoxic hypoxia**
   (cyanide poisoning)
10. **Cellular overuse of oxygen (muscular rigidity, fever, chills, intense exercise)**