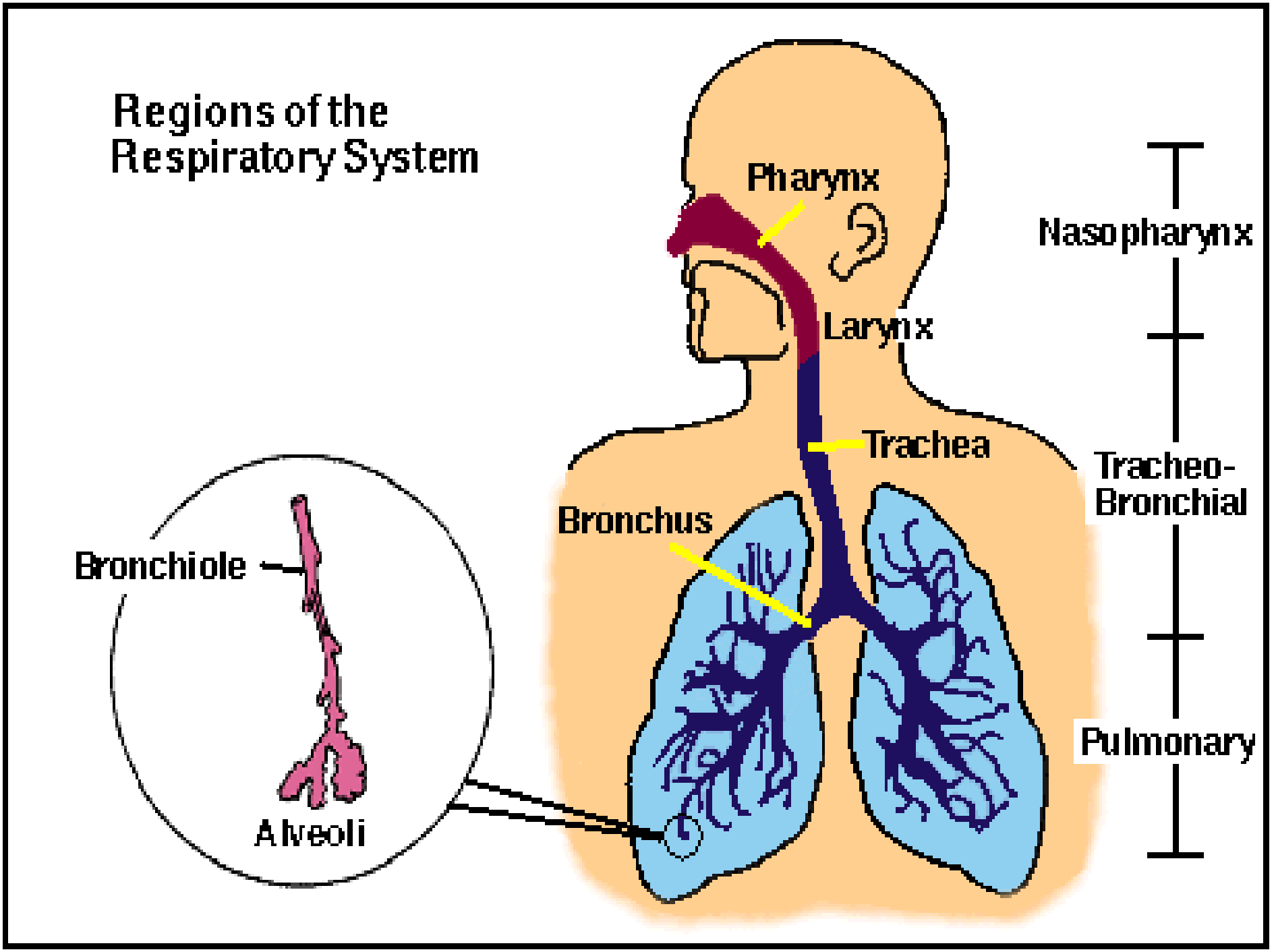
TOPIC: REGULATION OF RESPIRATION
SUBJECT: MOLECULAR PHYSIOLOGY
BY
DR SAIMA SHARIF

WHAT IS RESPIRATION

- In physiology, **respiration** is defined as the transport of oxygen from the outside air to the cells within tissues, and the transport of carbon dioxide in the opposite direction.

ANATOMY OF THE RESPIRATORY SYSTEM

- The entire respiratory system's anatomy is housed in the head, neck, and thorax.
- In general, the anatomy in the head and neck is the upper respiratory tract, while the anatomy from the trachea through the lungs is the lower respiratory tract.
- We have a pair of external nostrils opening out above the upper lips. It leads to a nasal chamber through the nasal passage.


Regions of the
Respiratory System
Pharynx
Larynx
Trachea
Bronchus
Bronchiole
Alveoli
Nasopharynx
Tracheo-
Bronchial
Pulmonary

- Take a deep breath now with your mouth closed, and trace the air in that breath as it travels on its route the air enters the nasal cavity through the nose.
- From there it goes to the pharynx, to the larynx, to the trachea, to the bronchi (where it enters the lungs), to the bronchial tree, and finally to the tiny air sacs called alveoli.

FUNCTIONS

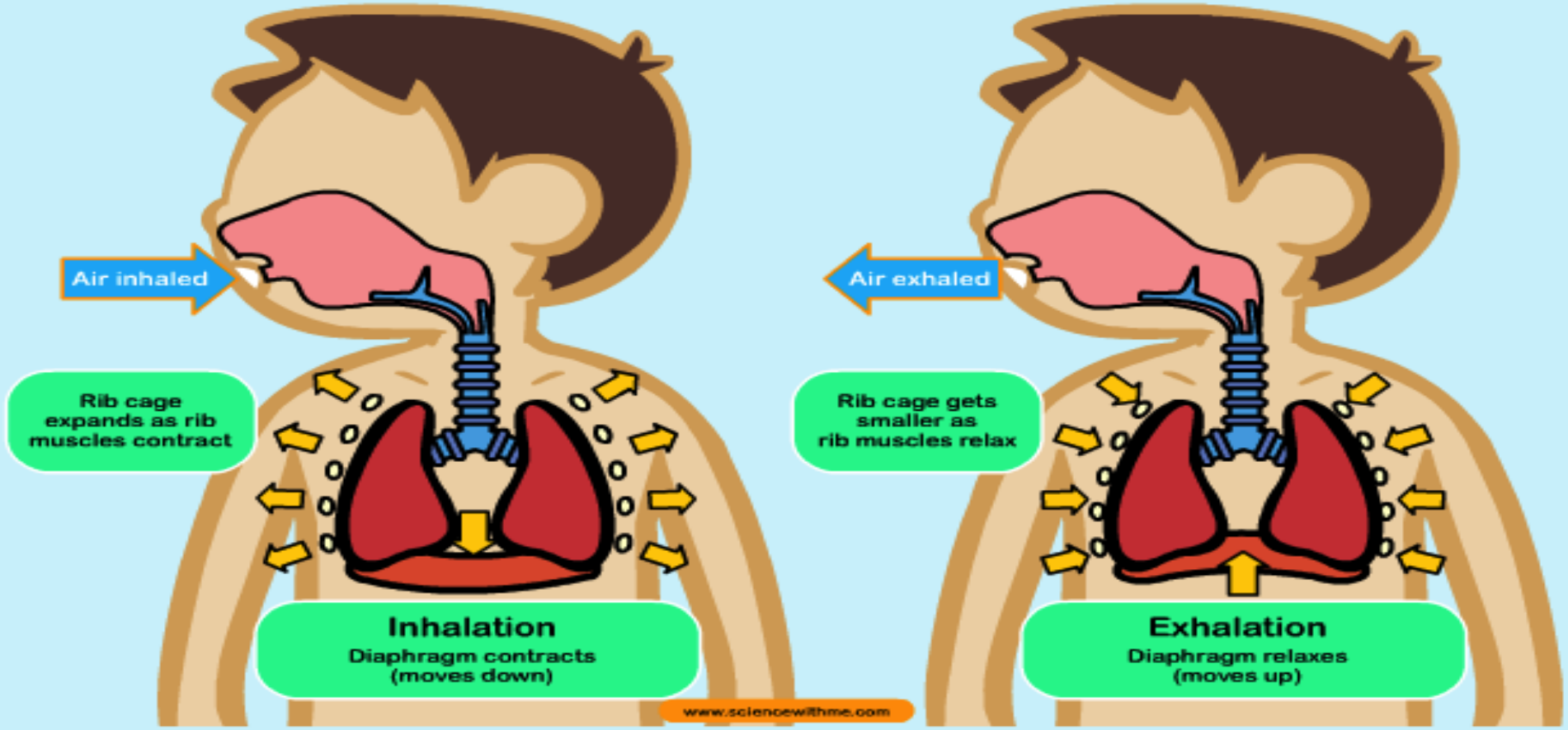
- Breathing
- External Respiration
- Internal Respiration
- Cellular Respiration

MECHANISM OF BREATHING

- Breathing involves two stages:
- **inspiration** during which atmospheric air is drawn in.
- **expiration** by which the alveolar air is released out.

- **Inspiration** can occur if the pressure within the lungs (intra-pulmonary pressure) is less than the atmospheric pressure.

- **Expiration** takes place when the intra-pulmonary pressure is higher than the atmospheric pressure.


Air inhaled
Rib cage expands as rib muscles contract
Inhalation
Diaphragm contracts (moves down)
www.sciencewithme.com
Air exhaled
Rib cage gets smaller as rib muscles relax
Exhalation
Diaphragm relaxes (moves up)

GAS EXCHANGE

- (1) Carbon dioxide is a waste product produced in the tissues through cellular respiration and

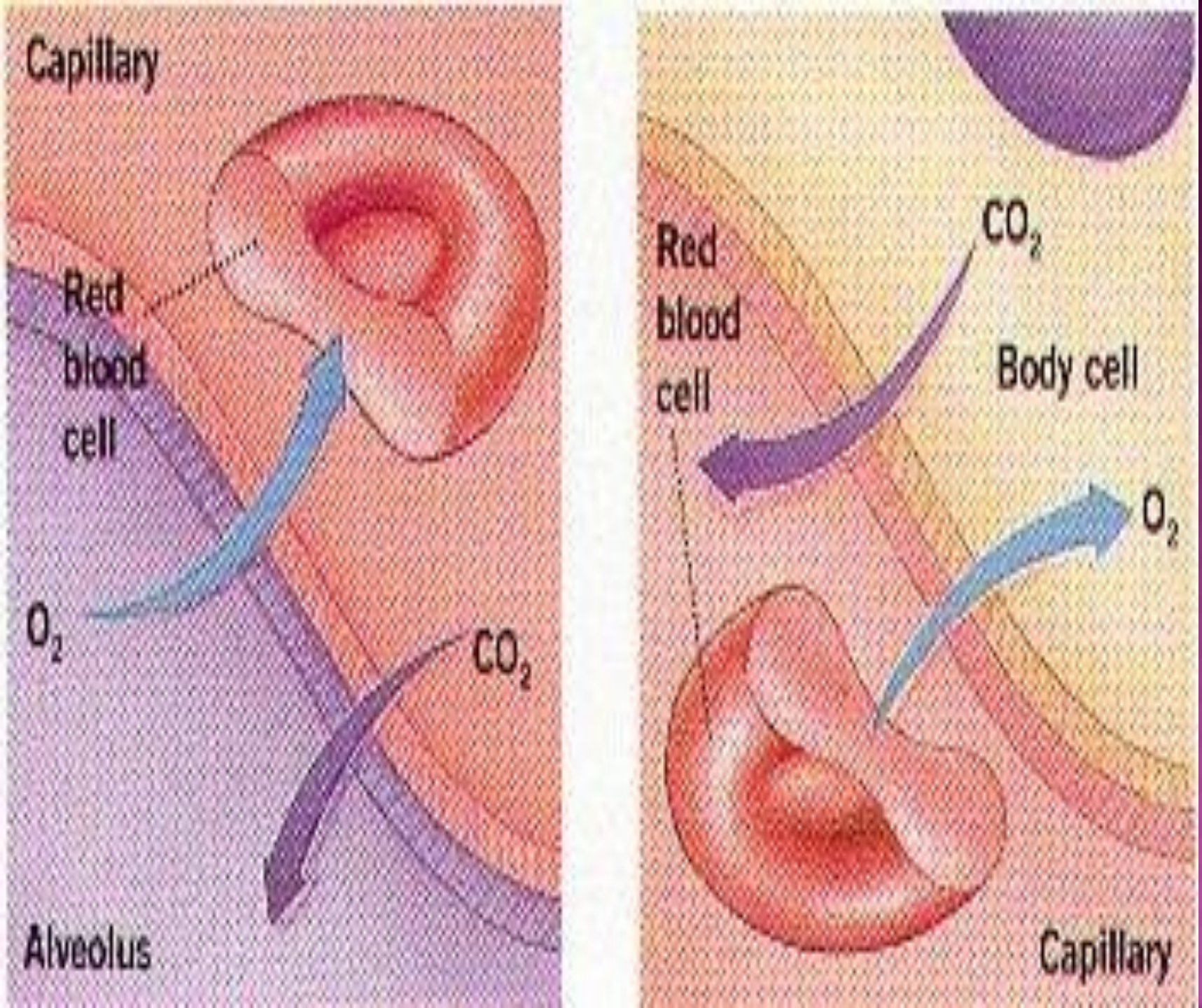
- (2) blood travels to the lungs to be oxygenated.

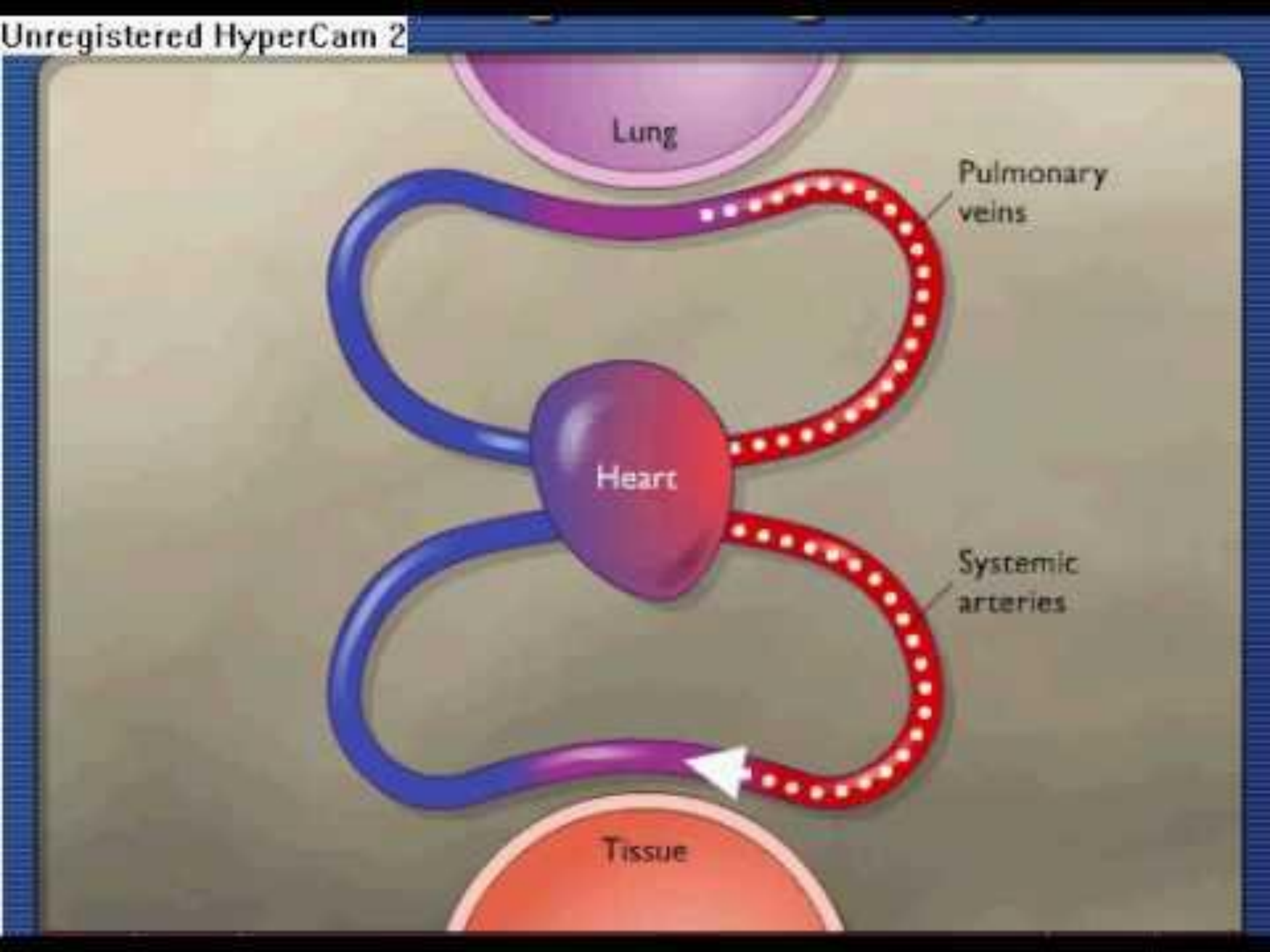
- Respiration servers as a means for the body to exchange gases with the atmosphere via the blood.

- 1. The partial pressure of oxygen (Po2) in the air in the alveolar spaces in the lungs is greater than the Po2 in the blood, Po2 in lungs >Po2 in blood. So oxygen diffuses in red cells from air in the lungs.

- 2. Also, the partial pressure of carbon dioxide (Pco2) in the air in the lungs is less than the Pco2 in the blood (Pco2 in lungs< Pco2 in blood), so CO2 diffuses out from red cells and into the airs in the lungs.

  Oxygen rich blood is carried through pulmonary veins to the heart and then pumped through systemic arteries to the body.

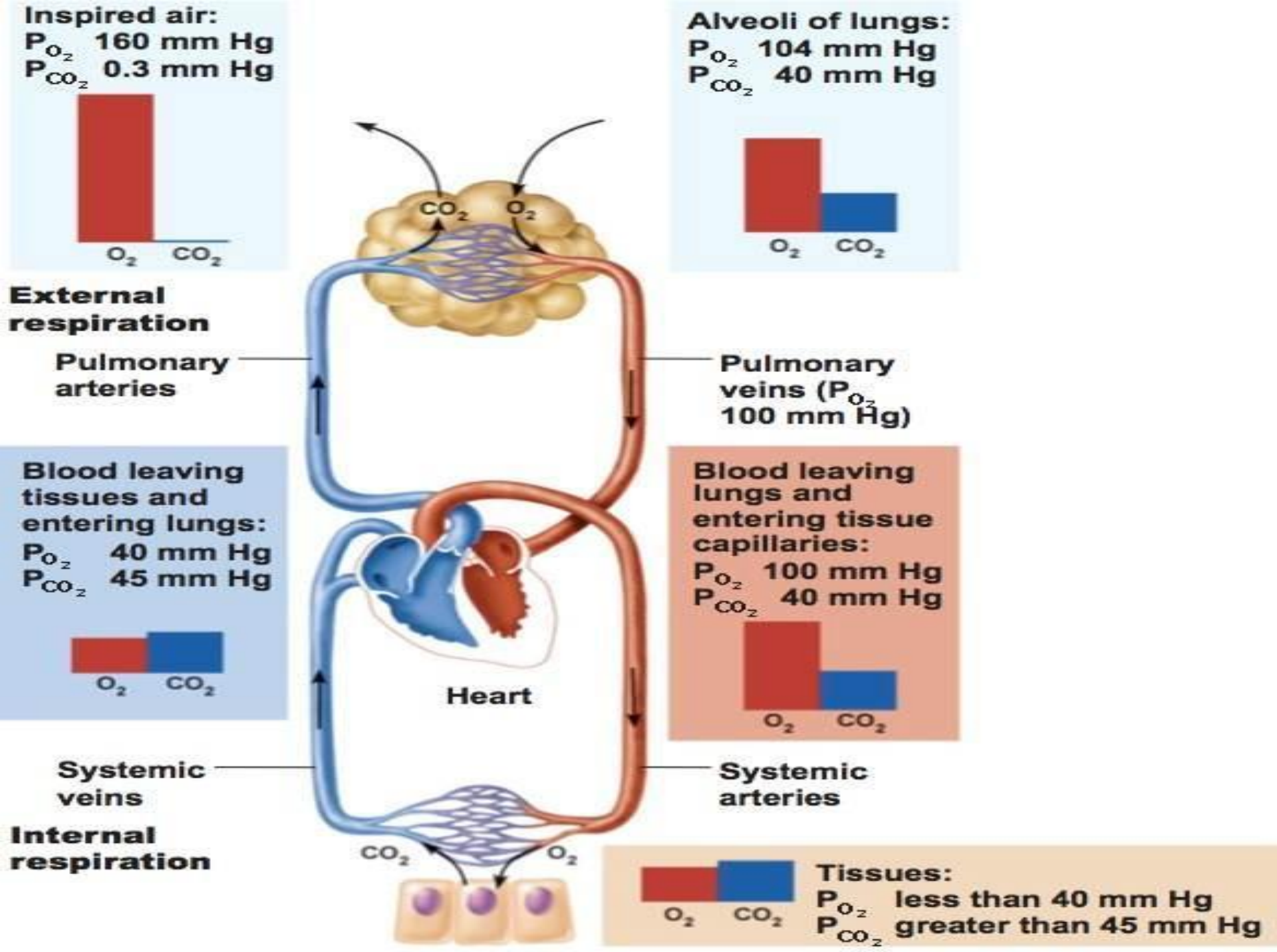

Capillary
Red blood cell
O_2
CO_2
Alveolus
Red blood cell
CO_2
Body cell
O_2
Capillary



3. Po2 in the blood is higher than Po2 in the tissues (Po2 in blood>Po2 in tissues). So O2 diffuses out from the red cells at the body tissue.

4. Also, Pco2 in the blood is lower than the Pco2 in the body tissues (Pco2 in blood<Pco2 in tissues), so CO2 diffuses into the red cells.

Oxygen poor blood is carried through systemic veins back to the heart and is pumped through pulmonary arteries t the lungs where gas exchange again replenishes the blood with O2 and remove CO2.


Inspired air:
P_{O_2} 160 mm Hg
P_{CO_2} 0.3 mm Hg
O_2 CO_2
Alveoli of lungs:
P_{O_2} 104 mm Hg
P_{CO_2} 40 mm Hg
O_2 CO_2
External respiration
CO_2 O_2
Pulmonary arteries
Pulmonary veins (P_{O_2} 100 mm Hg)
Blood leaving tissues and entering lungs:
P_{O_2} 40 mm Hg
P_{CO_2} 45 mm Hg
O_2 CO_2
Blood leaving lungs and entering tissue capillaries:
P_{O_2} 100 mm Hg
P_{CO_2} 40 mm Hg
O_2 CO_2
Heart
Systemic veins
Systemic arteries
Internal respiration
CO_2 O_2
O_2 CO_2
Tissues:
P_{O_2} less than 40 mm Hg
P_{CO_2} greater than 45 mm Hg

REGULATION OF BLOOD PH

- Many of us are not aware of the importance of maintaining the acid/base balance of our blood. It is vital to our survival.
- Normal blood pH is set at 7.4, which is slightly alkaline or "basic".
- If the pH of our blood drops below 7.2 or rises above 7.6 then very soon our brains would cease functioning normally and we would be in big trouble.

- Buffer is the important factor of this process. Buffers are molecules which take in or release ions in order to maintain the H+ ion concentration at a certain level.

- When blood pH is too low and the blood becomes too acidic (acidosis), the presence of too many H+ ions is to blame. Buffers help to soak up those extra H+ ions.

- If the lack of H+ ions causes the blood to be too basic (alkalosis).
- In this situation, buffers release H+ Ions.
- Buffers function to maintain the pH of our blood

- The most important buffer we have in our bodies is a mixture of carbon dioxide (CO_2) and bicarbonate ion (HCO_3).
- CO_2 forms carbonic acid (H_2CO_3) when it dissolves in water and acts as an acid giving up hydrogen ions (H^+) when needed.
- HCO_3 is a base and soaks up hydrogen ions (H^+) when there are too many of them.
- Blood pH is determined by a balance between bicarbonate and carbon dioxide.

REGULATION OF RESPIRATION

- Neural Regulation
- Chemical Regulation

NERVOUS REGULATION OF RESPIRATION:

- Normal quiet breathing occurs in voluntarily. Adult human beings breathe 12 to 14 times per minute, but human infants breathe about 44 times per minute.

- The 'respiratory centre' is composed of groups of neurons located in the medulla oblongata and pons varolii.

- The respiratory centre is divided into three major collections of neurons.

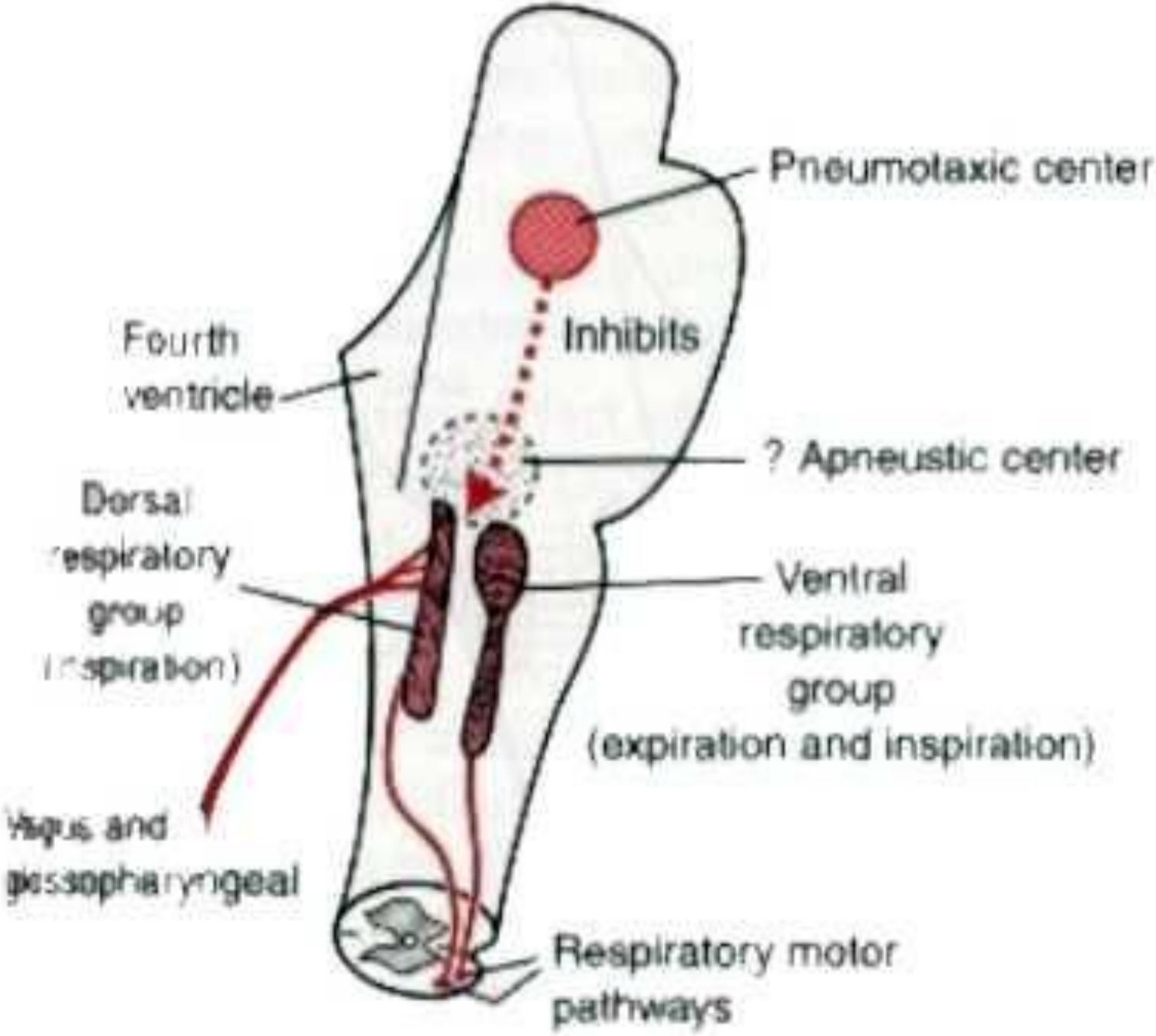
- **Dorsal Respiratory Group**: It is located in dorsal portion of the medulla oblongata. Nerve impulses from the dorsal respiratory group stimulate the muscles of the diaphragm (primary inspiratory muscle) to flatten the latter and the external intercostal muscles to raise the ribs. This brings about inspiration. Thus the dorsal respiratory group mainly causes inspiration.

- **Ventral Respiratory Group**: It is located in the ventroleteral part of the medulla oblongata. It issues signals for both inspiration and expiration. Thus the ventral respiratory group can cause either inspiration or expiration.

- **Pneumotoxic Centre**: It is located in the dorsal part of pons varolii. It issues impulses to all the neurons of the dorsal respiratory group and only to the inspiratory neurons of ventral respiratory group.

- These impulses regulate the time of inspiration in both normal and abnormal breathing. Therefore, the function of the pneumatic centre is primarily to limit inspiration.

- There is another strange centre called the **apneustic centre**, located in the lower part of the pons varolii. It is thought that it operates in association with the pneumotaxic centre to control the depth of inspiration.


Pneumotaxic center
Inhibits
Fourth ventricle
? Apneustic center
Dorsal respiratory group (inspiration)
Ventral respiratory group (expiration and inspiration)
Vagus and glossopharyngeal
Respiratory motor pathways

CHEMICAL REGULATION OF RESPIRATION:

- The largest numbers of chemoreceptors are located in the corotid bodies. However, a sizable number of chemoreceptors are in the aortic bodies.

- These chemoreceptors of carotid and aortic bodies are stimulated by an increase in carbon dioxide concentration and by an increase in hydrogen ion concentration (pH) in the arterial blood

- Increased CO2 lowers the pH resulting acidosis. These chemoreceptors send signals to the inspiratory and expiratory centres. Thus rate of breathing is increased.

DISORDERS OF RESPIRATORY SYSTEM

- Asthma
- Emphysema
- Occupational Respiratory Disorders

THANK YOU ☺