Biology Grade 9

CHAPTER 2: RESPIRATION

Activity 3: Respiratory Gas Exchange

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Activity 3: Respiratory Gas Exchange

❖ Gas exchange in the lung:

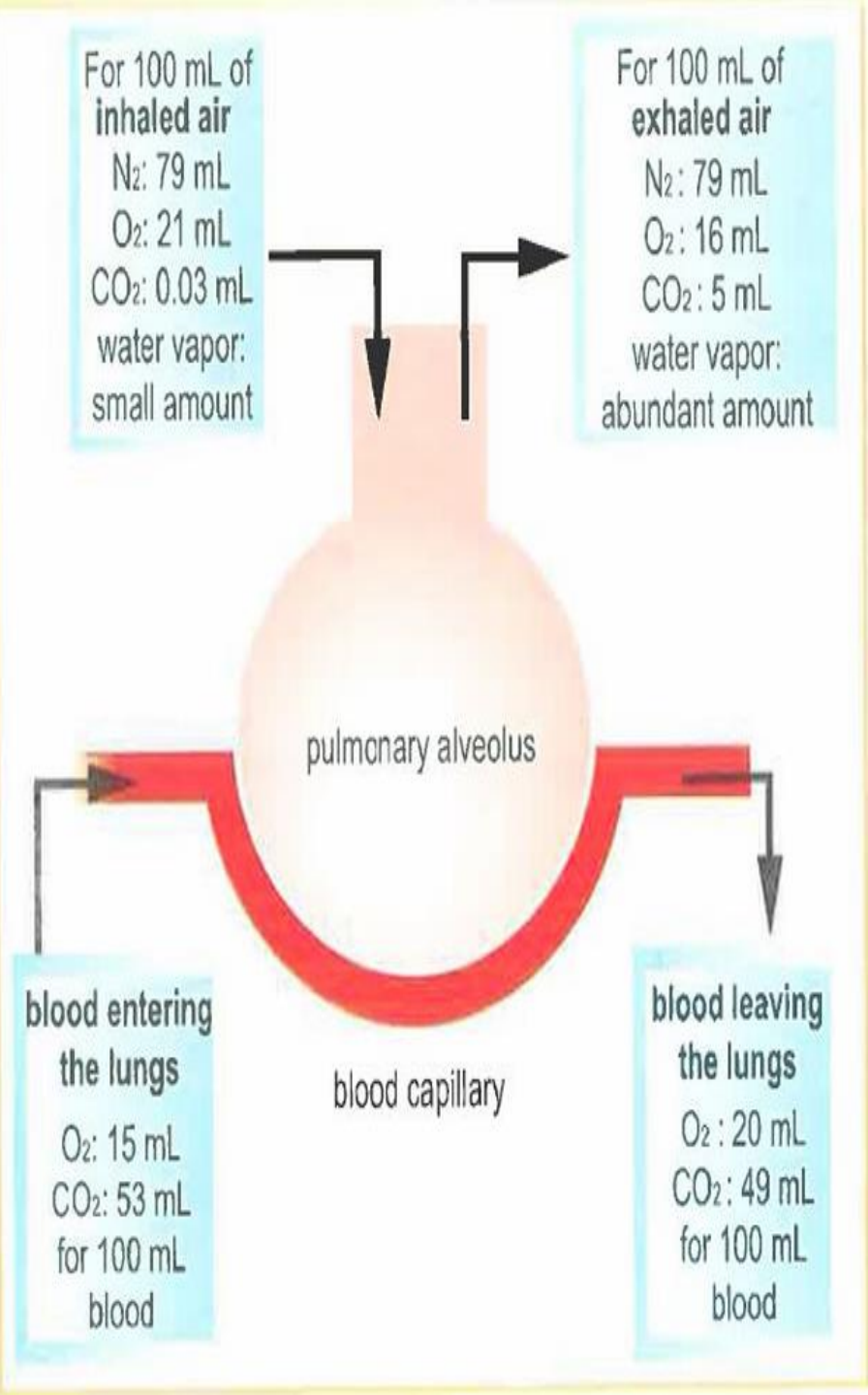
Comparison between the composition of exhaled air and that of inhaled air as well as the composition of blood entering and leaving the lungs.

The renewal of air in the respiratory system is brought about by alternating inhalation and exhalation, which constitute the respiratory movements.

- ✓ **During inhalation, air is pulled into the lungs.**
- ✓ **During exhalation, air is expelled outside the lungs.**

1. Compare the composition of the gases in the inhaled and exhaled air.

The amount of N2 gas in the inhaled is **the same** as its amount in the exhaled air (79 ml). **While** the amount of O2 gas in the inhaled air is 21 ml **greater than** that in the exhaled air that is 16 ml**. whereas** the amount of CO2 gas in the inhaled air is 0.03 ml **less than** that in the exhaled air that is 5 ml.



Even though the inhaled air contains N_2 however it is completely released by exhalation.

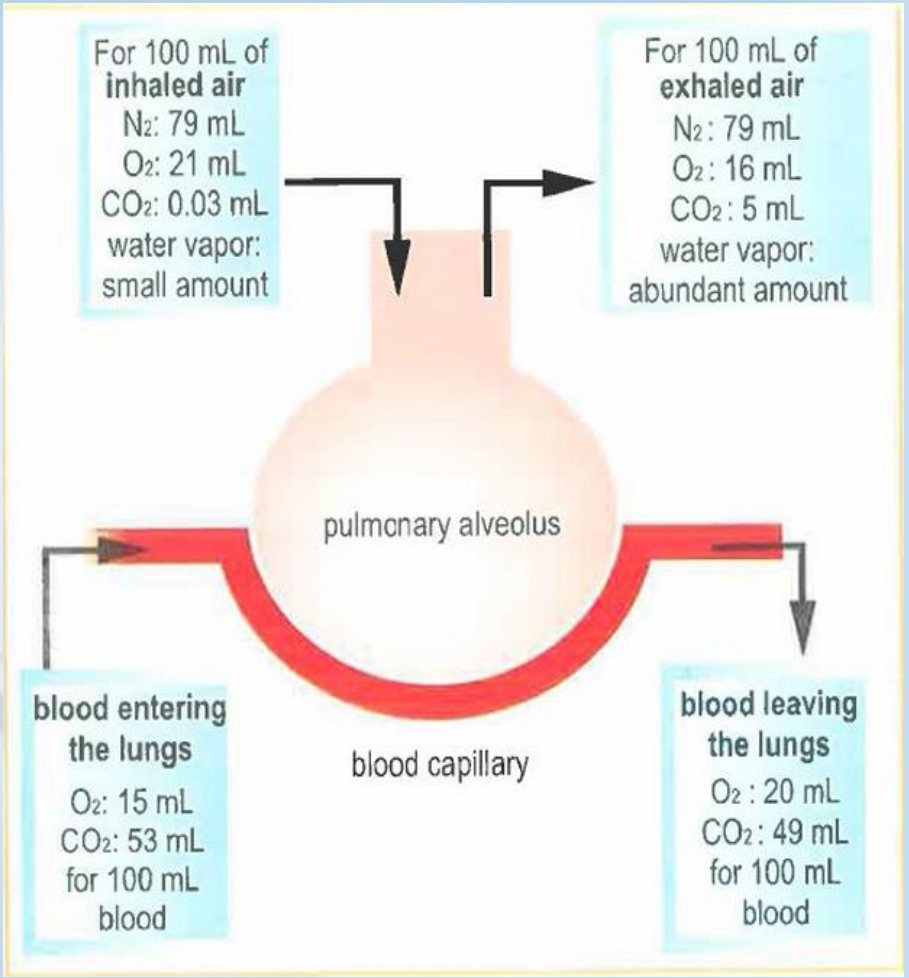
2. Formulate a hypothesis explaining this fact.

Hypothesis: N_2 gas has no effect on body functions and not used by tissue cells.

3. Compare the composition of gases in blood entering the lungs and blood leaving the lungs. What can you conclude?

The amount of oxygen gas in the blood entering the lungs is 15 ml **less than** that in the blood leaving the lungs that is 20 ml. However, the amount of carbon dioxide gas in the blood entering the lungs is 53 ml **greater than** that in blood leaving the lungs that is 49 ml.

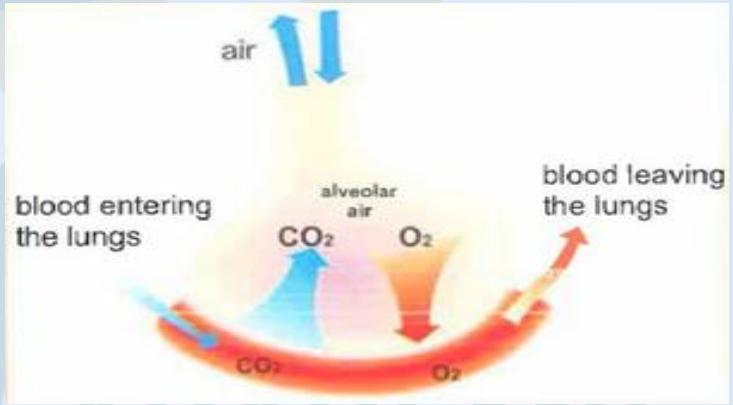
Thus, at the level of the lungs (alveoli), the blood becomes rich in oxygen and poor in carbon dioxide.

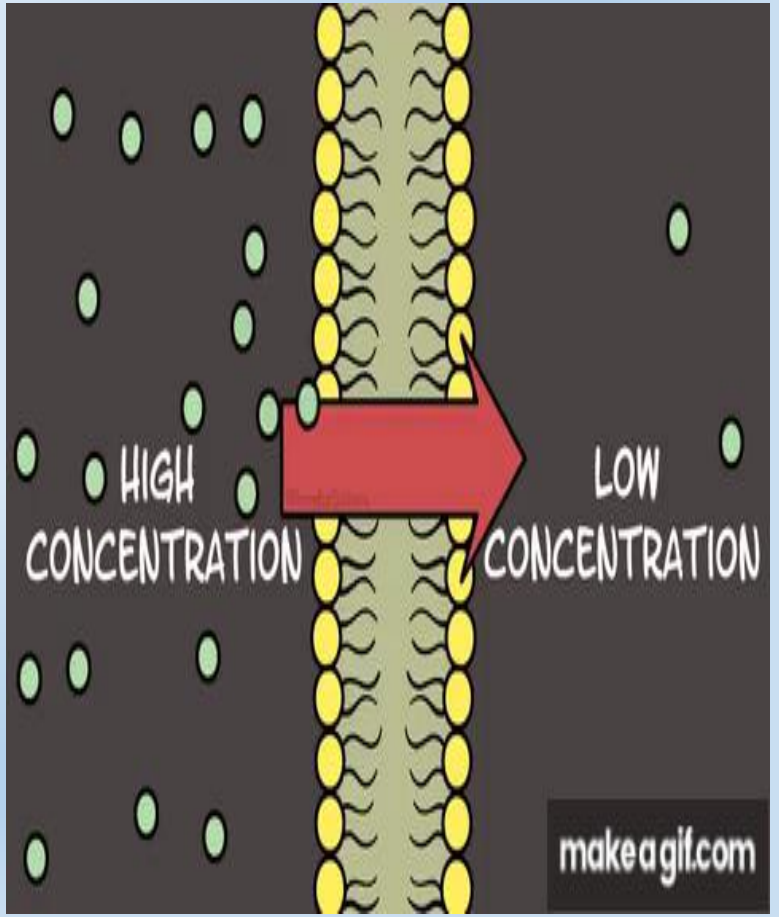


❖ Diffusion of respiratory gases at the level of an alveolus:

The characteristics of the alveoli favor the gas exchange between air and the blood that is accomplished by **diffusion**. This physical phenomenon ensures that the dissolved gas moves or diffuses from a medium of high pressure to a medium of low pressure.

Medium	Pressure (in mm of mercury)	
	Oxygen gas	Carbon dioxide
Alveolar air	100	40
Blood entering the lungs	35 to 40	46





1. Based on the above paragraph, pick out the definition of "diffusion".

Diffusion is a physical phenomenon that ensures that the dissolved gas moves from a medium of high pressure to a medium of low pressure.

The following document represents the respective pressure of oxygen gas and carbon dioxide gas in the **alveolar air and in blood entering the lungs**.

2. Compare the respective pressure of oxygen gas and carbon dioxide gas in the alveolar air and in blood entering the lungs.

The pressure of oxygen gas in alveolar air is 100 mmHg **greater than** in blood entering the lungs that is 35-40 mmHg. Whereas, the pressure of carbon dioxide gas in alveolar air is 40 mmHg **less than** that in blood entering the lungs that is 46 mmHg.

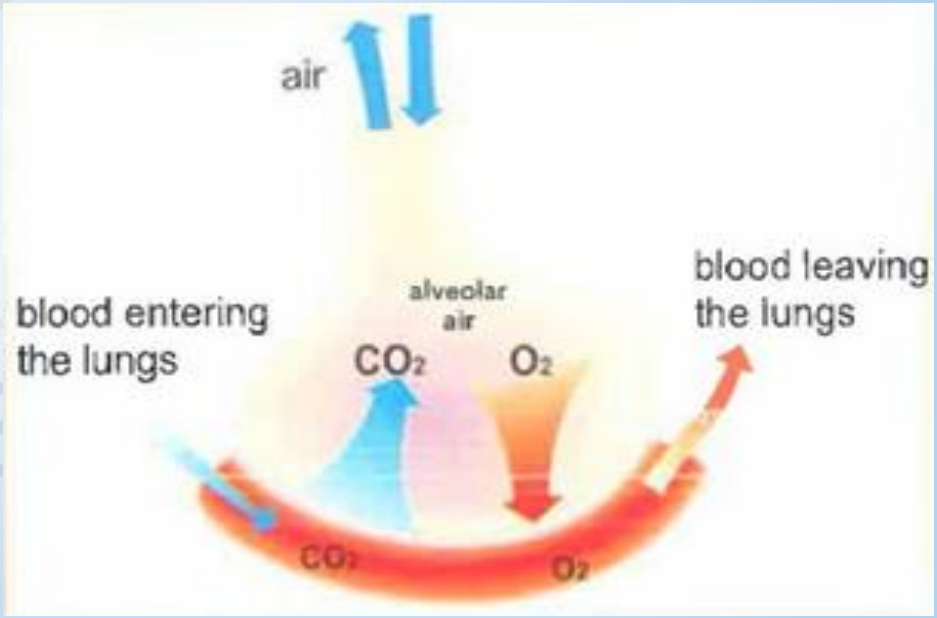
Medium	Pressure (in mm of mercury)	
	Oxygen gas	Carbon dioxide
Alveolar air	100	40
Blood entering the lungs	35 to 40	46

3. Indicate the direction of the exchange of respiratory gases that takes place between air and blood. Justify your answer.

Medium	Pressure (in mm of mercury)	
	Oxygen gas	Carbon dioxide
Alveolar air	100	40
Blood entering the lungs	35 to 40	46

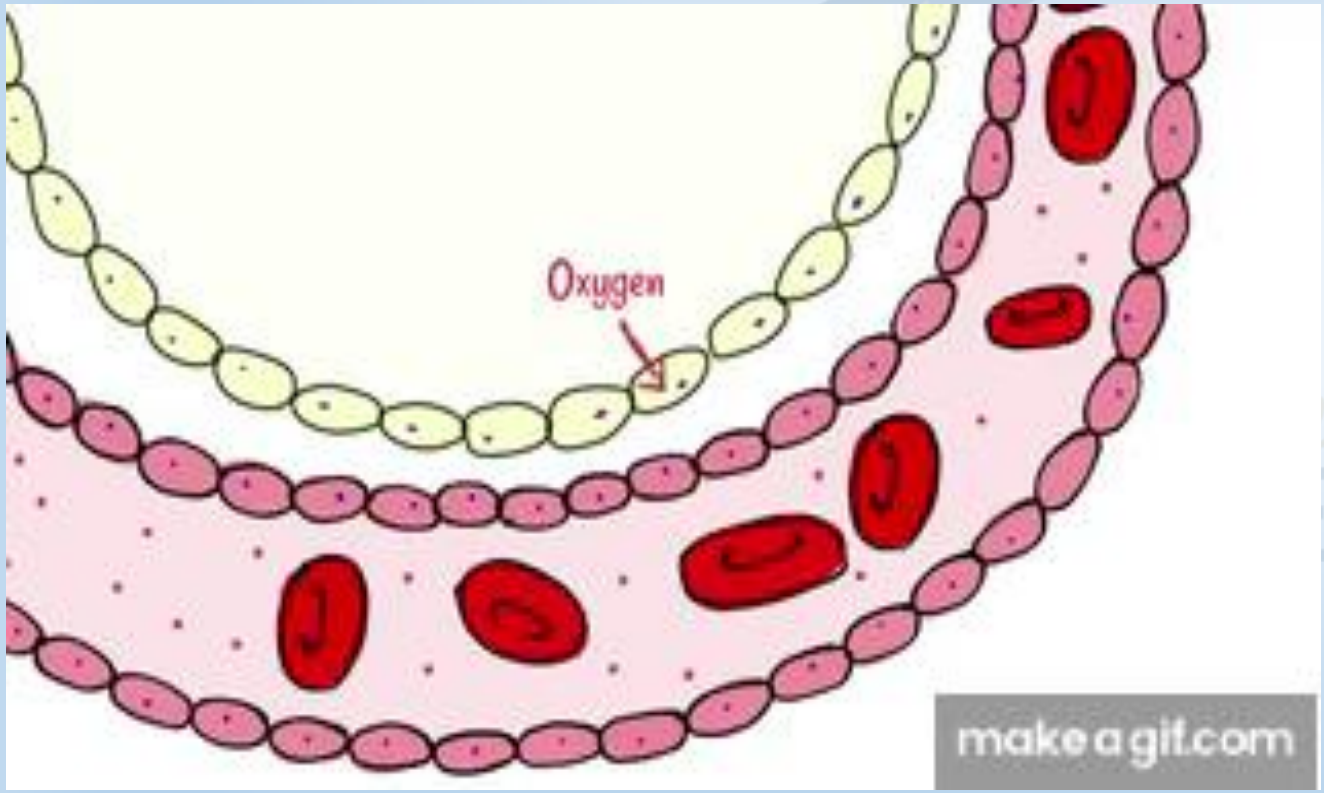
- Oxygen gas diffuses out of the alveoli into blood, since pressure of oxygen gas in blood entering the lungs (35-40 mmHg) is lower than that in the alveolar air (100 mmHg) and according to the **law of diffusion** that states that dissolved gas diffuses from a medium of high pressure (alveolar air) to a medium of low pressure (blood).

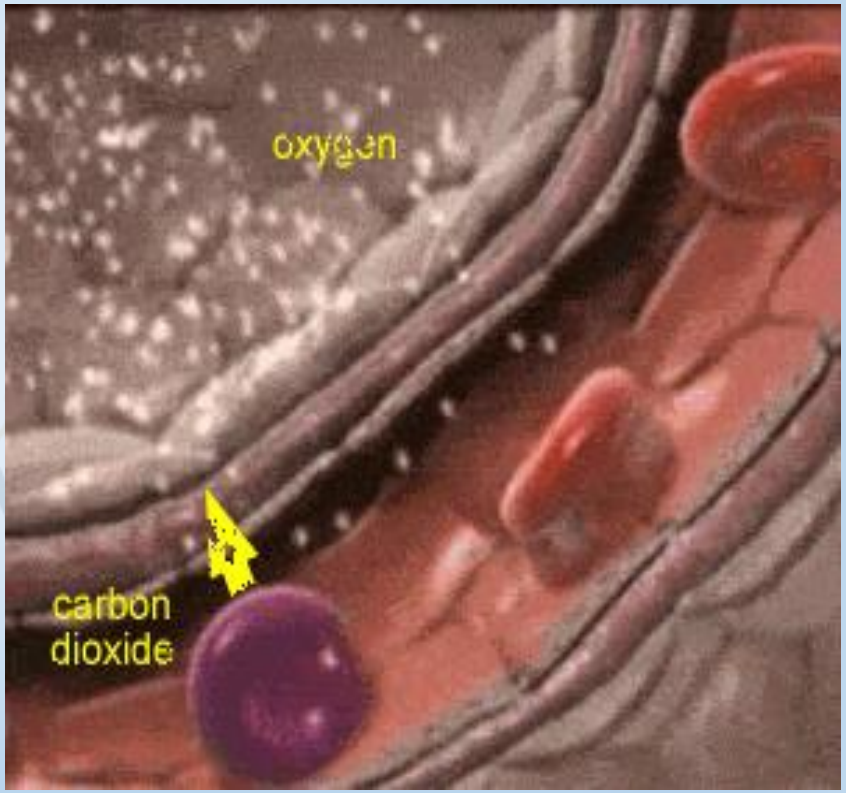
- Carbon dioxide diffuses from blood entering the lungs into the alveoli, since the pressure of carbon dioxide in blood entering the lungs (46 mmHg) is greater than the pressure of carbon dioxide gas in the alveolar air (40 mmHg), and according to the **law of diffusion,** gas diffuses from a medium of high pressure (blood) to a medium of low pressure (alveolar air).



4. Indicate the respiratory gases lost and gained by the blood during the external pulmonary respiration.

During the external pulmonary respiration, pulmonary capillary blood gains oxygen gas and loses carbon dioxide gas.





❖ Gas exchange in the organs / tissues / cells:

The following document represents the respective pressure of oxygen gas and carbon dioxide gas in the blood entering an organ and inside the cells.

Medium	Pressure (in mm of mercury)	
	Oxygen gas	Carbon dioxide
Blood entering an organ	98 to 100	40
Cells	30 or less	50

1. Compare the respective pressure of oxygen gas and carbon dioxide gas in the blood entering and organ and inside the cells.

The pressure of oxygen gas in the blood entering an organ is 98 to 100 mmHg **greater than** that inside a cell which is 30 mmHg or less. However, the pressure of carbon dioxide gas in the blood entering an organ is 40 mmHg **less than** that inside a cell which is 50 mmHg.

2. Indicate the direction of the exchange of the respiratory gases that takes place between blood and cells. Justify your answer.

- Oxygen gas diffuses out the blood into tissue cells, since the pressure of oxygen gas in blood entering an organ (98 to 100) mmHg is **greater than** the pressure of oxygen gas in the tissue cells (30 or less mmHg), and **according to the law of diffusion,** gas diffuses from a medium of high pressure (blood) to a medium of low pressure (cell).

- Carbon dioxide gas diffuses from tissue cells into the blood, since the pressure of carbon dioxide gas in blood entering an organ (40 mmHg) is **less than** the pressure of carbon dioxide gas inside tissue cells (50 mmHg) , and **according to the law of diffusion,** gas diffuses from a medium of high pressure (cells) to a medium of low pressure (blood).

Medium	Pressure (in mm of mercury)	
	Oxygen gas	Carbon dioxide
Blood entering an organ	98 to 100	40
Cells	30 or less	50

3. Justify each of the following statements:

3.1. The pressure of oxygen gas in the blood entering an organ is greater than the pressure of oxygen gas in the tissues.

- Since the cells constantly use oxygen gas to produce energy, the pressure of oxygen gas in blood entering an organ is greater than the pressure of oxygen gas in tissue cells.

3.2. The pressure of carbon dioxide gas inside the cell is greater than that of blood entering an organ.

- Since tissues are constantly producing carbon dioxide gas, the pressure of carbon dioxide in the cells is greater than that of blood entering an organ.

4- Indicate the respiratory gases that are lost and gained by the blood entering an organ and cells during the internal pulmonary respiration.

- During internal pulmonary respiration, blood loses oxygen and gains carbon dioxide gas, while cells gain oxygen and lose carbon dioxide gas.

❖ Cellular gas exchange:

During internal respiration, oxygen gas diffuses out of the blood capillaries into cells and carbon dioxide gas diffuses from cells into the blood capillaries.

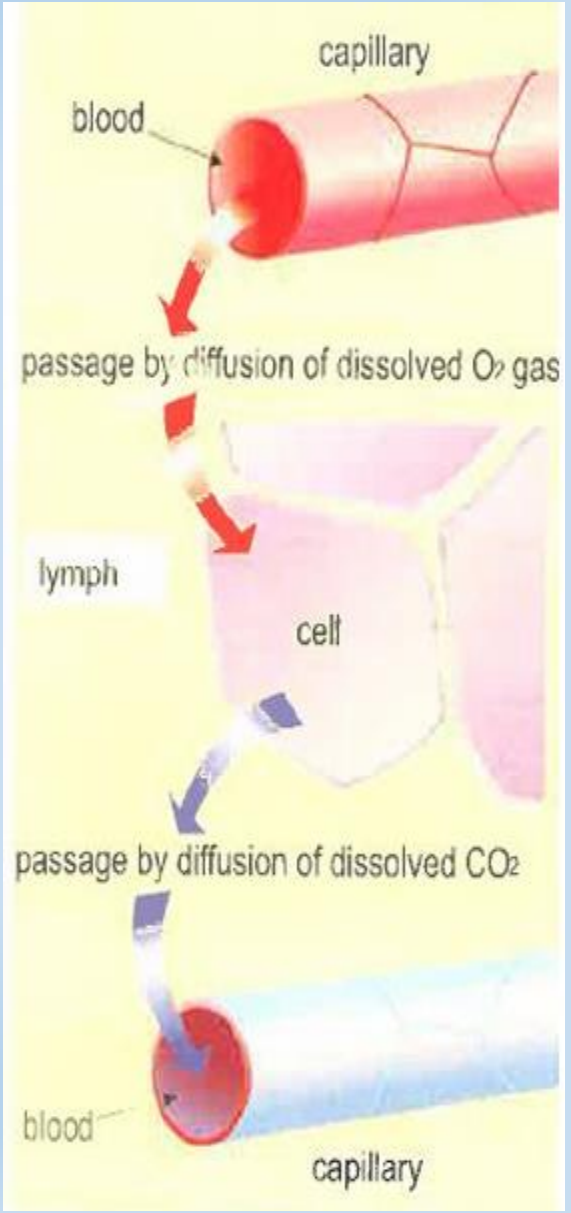
1. Indicate the medium where this gas exchange occurs.

Gas exchange between cells and blood capillaries occurs across the lymph.

2. Indicate the factors that favor the gas exchange between blood and tissues. Justify the answer.

The factors that favor the gas exchange **between blood and tissues** are the following:

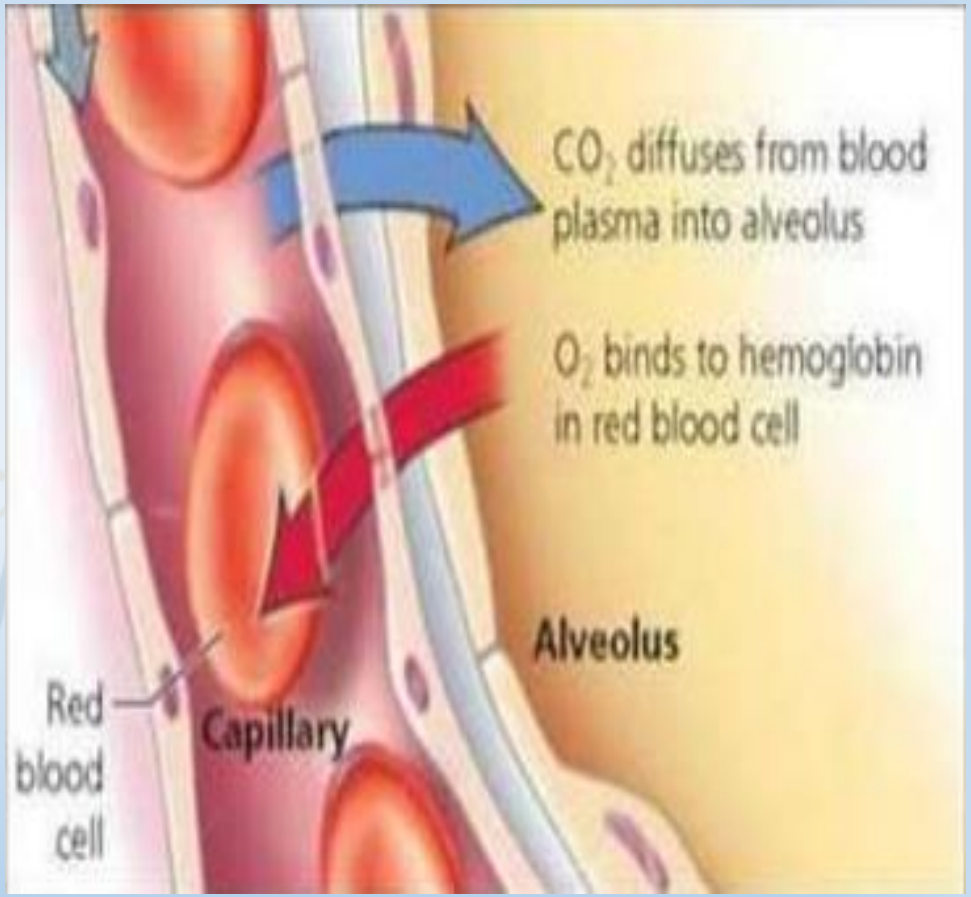
- Presence of millions of blood capillaries
- Thin wall
- Slow circulation of blood
- Presence of lymph between cells and blood capillaries (moist medium).



Summary

❑ Gas exchange in lungs:

- It is accomplished by **diffusion**. The gas diffuses from a high pressure (concentration) medium to a low pressure (concentration) medium.
- The respiratory system delivers O2 to the alveoli.
- The thin wall of the alveoli is permeable and coated with a moist film. This makes gas exchanges done by diffusion easier.
- O2 molecules pass by simple diffusion from the alveoli where they are more concentrated into the blood in the pulmonary capillaries, where they are less concentrated.
- At the same time, CO2 moves from the blood, where it's more concentrated, to the alveoli, where it's less concentrated.



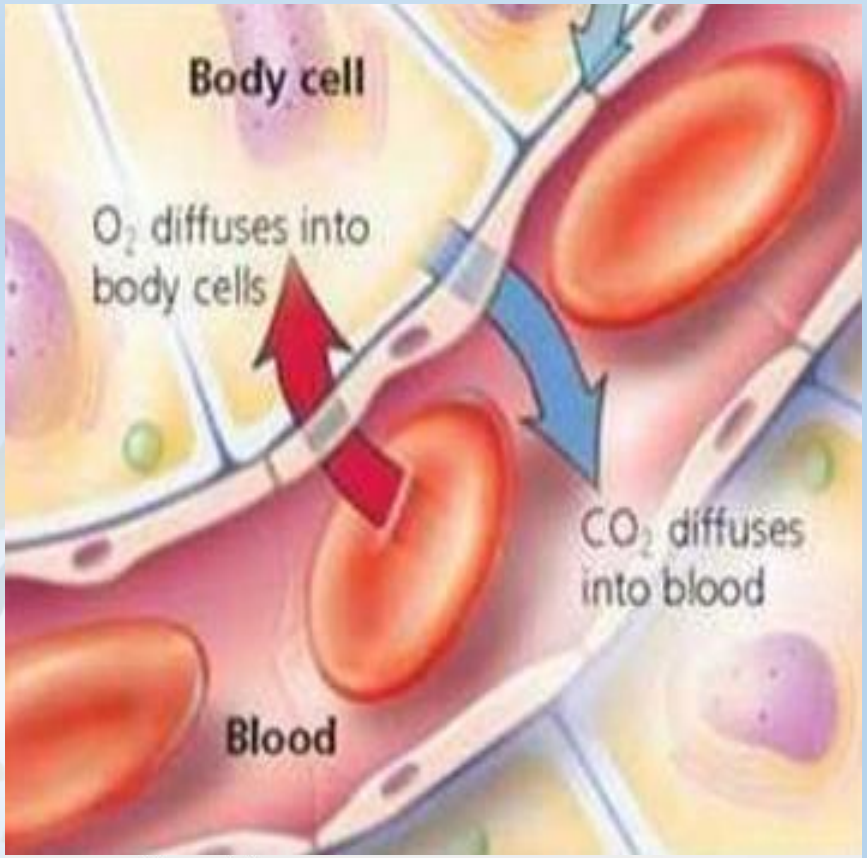
❑ Gas exchange in the tissues:

- Organs of the body are made up of tissues which are made of cells. These cells produce CO2 and consume O2 during their activities.

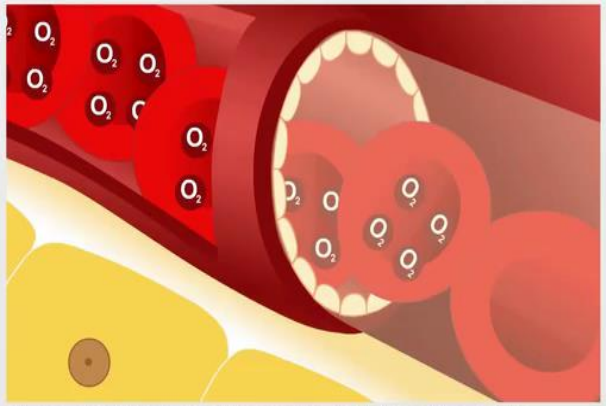
- The concentration of O2 in the cells is lower than in capillaries entering the tissues, and the concentration of CO2 is higher in the cells than in the capillaries.

- O2 moves from the blood entering the cell, where it's more concentrated, to the cell where it's less concentrated.

- At the same time, CO2 moves from the cells, where it's more concentrated, to the blood, where it's less concentrated.



Haemoglobin wellcome trust



Oxygen unloads from haemoglobin one molecule at a time and haemoglobin returns to its deoxyhaemoglobin structure.