TOPIC: RESPIRATION

Respiration

- *Recall*: Respiration: exchange of O_2 and CO_2 with the blood.
- Respiration relies on _____ gradients.
  - O_2 and CO_2 move from areas of _____ pressure to areas of _____ pressure.

- **External Respiration**: happens in the _____.
  - P_{O_2} in air __ P_{O_2} in blood.
  - P_{CO_2} in air __ P_{CO_2} in blood.

- **Internal Respiration**: happens in the _____.
  - P_{O_2} in blood __ P_{O_2} in tissues.
  - P_{CO_2} in blood __ P_{CO_2} in tissues.

- Henry's law allows us to use the same _____ (partial pressure) for gases and gases dissolved in a liquid.

PRACTICE

When determining the directions that molecules will move in external and internal respiration:

a) Molecules will always move down the pressure gradient according to their individual partial pressures.

b) Molecules will move up the pressure gradient for internal respiration and down the pressure gradient for external respiration.

c) CO_2 will always move up the pressure gradient, while O_2 will always move down the pressure gradient.

d) Molecules will always move from the area of greatest total pressure to the area of lowest total pressure.

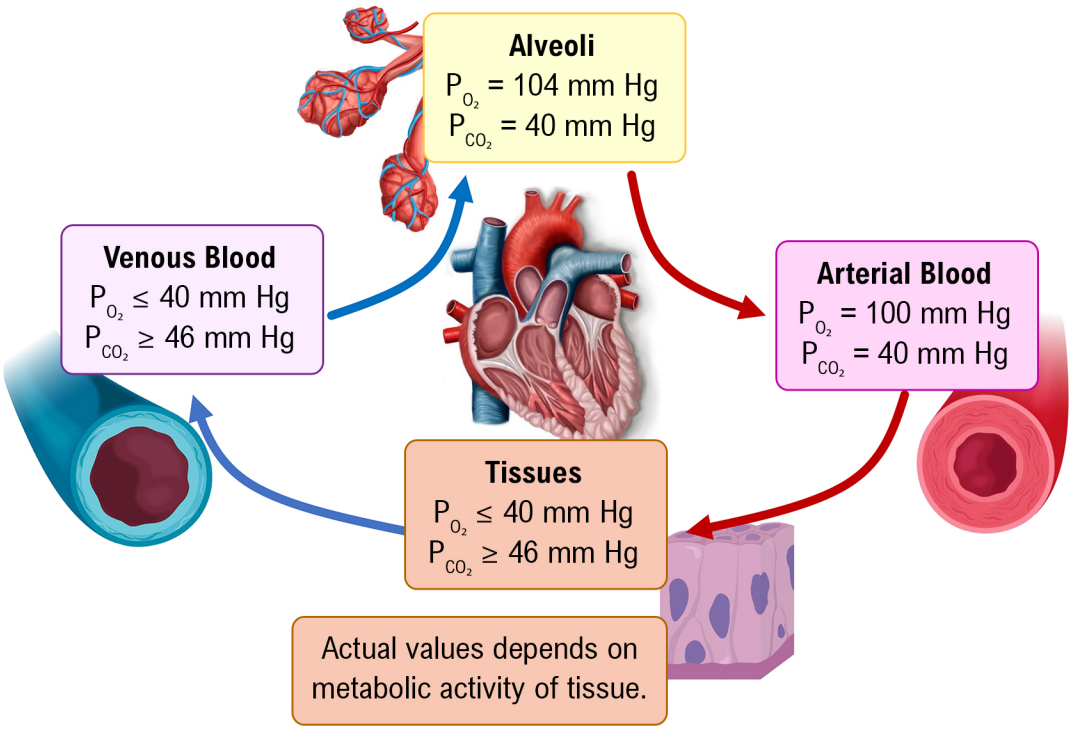
TOPIC: RESPIRATION

Internal and External Respiration

◆ Composition of atmospheric air is _____ than the air in the alveoli.

	Atmospheric		Alveoli	
Gas	% Composition	Partial Pressure	% Composition	Partial Pressure
Nitrogen	78.1	593.6	74.9	569
Oxygen	20.9	159.8	13.7	104
Carbon Dioxide	0.04	0.3	5.2	40
Water Vapor	0.96	7.3	6.2	47
Total	100	760	100	760

◆ 2 gradients determine the movement of gases in the body: 1) _____ & Blood. 2) Blood & _____.



TOPIC: RESPIRATION

EXAMPLE

Place the following areas in order from highest to lowest according to their expected partial pressure of oxygen (P_{O_2}). Then do the same for partial pressure of CO_2 (P_{CO_2}). In some cases, the values are the same; if that is the case, circle the equal sign between the two values. If the values are not the same between locations, circle the greater than sign between each value.

a) Body tissues b) Arterial blood c) Venous blood d) External air e) Air in the alveoli

1) $\mathbf{P}_{O_2}$: _____ >/= _____ >/= _____ >/= _____ >/= _____

2) $\mathbf{P}_{CO_2}$: _____ >/= _____ >/= _____ >/= _____ >/= _____

PRACTICE

What is the approximate partial pressure of oxygen in the blood as it enters and leaves the capillaries of the alveoli?

a) Enters: 40 mm Hg, Leaves: 46 mm Hg.

b) Enters: 46 mm Hg, Leaves: 40 mm Hg.

c) Enters: 100 mm Hg, Leaves: 46 mm Hg.

d) Enters: 40 mm Hg, Leaves: 100 mm Hg.

PRACTICE

What is one difference between air in the alveoli compared to air in the atmosphere?

a) The total pressure of air in the alveoli will be greater than the total pressure of air in the atmosphere.

b) The partial pressure due to water vapor is much greater in the alveoli than in the atmosphere.

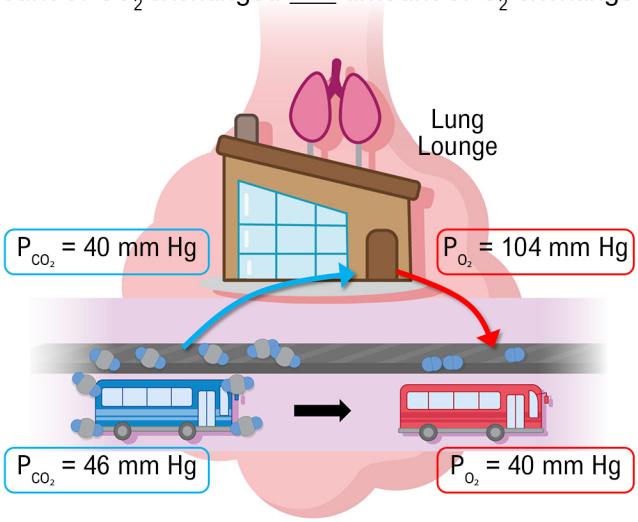
c) The partial pressure due to carbon dioxide is greater in the atmosphere than in the alveoli.

d) The partial pressure of oxygen is equal to the partial pressure of carbon dioxide in the alveoli, but not in the atmosphere.

TOPIC: RESPIRATION

External Respiration

- **External Respiration:** exchange of gases between the blood and the _____ air.
  - Net movement of _____ into the blood & _____ into the air.
- *Recall*: Hemoglobin: protein in red blood cells that carries O_2 (and CO_2).
  - Total amount of CO_2 exchanged ___ amount of O_2 exchanged.



Difference in gradients:

- CO_2 Gradient: ____ mm Hg.
- O_2 Gradient: ____ mm Hg.
  - CO_2 is 20x more _____ than O_2, so it requires less of a gradient.

EXAMPLE

Hyperventilation occurs when the rate and/or tidal volume of ventilation increases to a point where the composition of alveolar air more closely resembles atmospheric air.

a) Based on the above description, when hyperventilating, would you expect the relative change in P_{CO_2} or P_{O_2} to be greater? _____

b) The normal partial pressure of oxygen and carbon dioxide in arteriole blood is listed below. Next to each, write an up arrow or down arrow based on whether you expect that value to increase or decrease during hyperventilation.

P_{CO_2} = 40 mm Hg ____ P_{O_2} = 100 mm Hg ____

c) Hemoglobin leaving the alveoli is usually 98% saturated, meaning 98% of the hemoglobin molecules are carrying the maximum amount of oxygen molecules. Knowing this, and based on your previous answers, would you expect hyperventilation to affect the amount of oxygen molecules carried by the blood or carbon dioxide molecules more?

_____

TOPIC: RESPIRATION

PRACTICE

Which gradient most directly determines the direction that oxygen and carbon dioxide molecules will move between the air in the alveoli and the blood:

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a) The pressure gradient between alveolar air and the blood plasma.

b) The concentration gradient between the hemoglobin and the blood plasma.

c) The concentration gradient between carbon dioxide and oxygen.

d) The pressure gradient between the hemoglobin and alveolar air.

PRACTICE

Choose which of the following statements is correct.

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a) The pressure gradient for O_2 is much less than the pressure gradient for CO_2, but because of hemoglobin, more O_2 can be carried in the blood.

b) Because the pressure gradient for O_2 is greater than the pressure gradient for CO_2, more molecules of O_2 will be exchanged in the alveoli than molecules of CO_2.

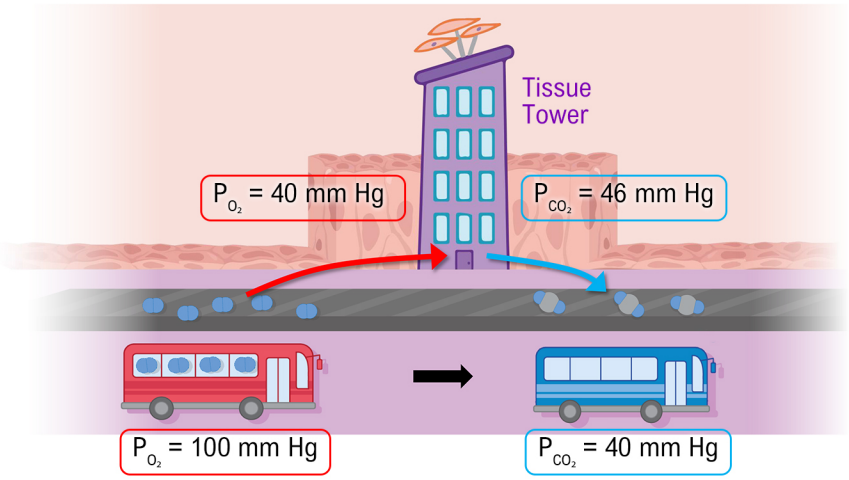
c) Most molecules of O_2 are carried by hemoglobin, but it is the gradient between the plasma and the alveoli that determines determines the movement of O_2 in and out of the blood.

d) O_2 is 20 times more soluble than CO_2, meaning that much more O_2 can be carried in the blood plasma than CO_2.

TOPIC: RESPIRATION

Internal Respiration

- **Internal Respiration:** exchange of gases between the blood and the _____ tissue.
  - Net movement of _____ into the blood & _____ into the tissue.
- In any tissue, total amount of CO_2 exchanged ___ amount of O_2 exchanged.



Difference in gradients:

- O_2 Gradient: ____ mm Hg.
- CO_2 Gradient: ____ mm Hg.

* Gradients depend on metabolic activity.

EXAMPLE

For the statements below, identify whether it to applies to respiration in the alveoli, the tissues, or neither by writing the letter on the correct line. If the statement applies to respiration in both the alveoli and the tissues, write the letter on both lines.

a) Site of internal respiration.

b) Site of external respiration.

c) P_{O_2} is ~6 mm Hg greater than in the blood.

d) P_{CO_2} is ~6 mm Hg less than in the blood.

e) The P_{O_2} is more than twice the P_{CO_2}.

f) The P_{CO_2} is more than twice the P_{O_2}.

g) There is a net release of O_2 from hemoglobin.

h) There is a net movement of CO_2 into the blood.

i) The net movement of total O_2 and CO_2 molecules will be aproximately equal.

Alveoli	Tissues	Neither
_____	_____	_____

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PRACTICE

For internal respiration, which of the following must be true:

I. The total amount of CO_2 exchanged equals the amount of O_2 exchanged.

II. Carbon dioxide will move down its concentration gradient to enter the blood.

III. The partial pressure of O_2 in the tissue before gas exchange is $\geq$ 40 mm Hg.

a) I only. b) I and II. c) III only. d) I, II, and III are true.