C.4.4. Partial Pressures

A. Air is a mixture of several gasses; partial pressures.

1. Before we start looking inside the alveoli and study the "exchange" of gasses, we need to look a bit closer to **air**. This air is is actually a **mixture** of several gasses:	2. a. nitrogen (79%) b. oxygen (18%) c. water (0.5 %) d. carbon dioxide (0.04%)
3. All these gasses together form a **total pressure**, which is equal to the **atmospheric pressure** (about 760 mmHg at sea level).	4. Each of these gasses makes up a **partial** pressure. Nitrogen will have the highest partial pressure because it is the most common (79%) while oxygen will have a much lower partial pressure (18%).
5. In fact, it is easy to calculate the **partial pressure** for each gas, as it is simply the percentage of the total pressure (some countries call this Henry's law).	6. The small 'p' in front of each gas stands for 'partial'.
pN_2 = 79% x 760 = 600 mmHg pO_2 = 18% x 760 = 137 mmHg pH_2O = 0,5% x 760 = 3.8 mmHg pCO_2 = 0,04% x 760 = 0.31 mmHg	
7. **Important point**: all the partial pressures together can never exceed the atmospheric pressure (approx. 760 mmHg).	8. A nice example of this phenomenon is visible when you analyze the air that is inspired! *Next*.

B. Pushy Water!

1. The air that you inspire is relatively dry; it contains about 0.5% water (unless you are in a sauna!).	2. But as the air is inspired and conducted through the nose, pharynx and trachea, it gets **warm and moist**. This water is actively secreted by the mucosa and is absorbed by the relatively dry air.
3. In other words, the partial pressure for H_2O (which is also a gas!) is gradually increased as the air is conducted to the lungs.	4. By the time the air reaches the alveoli, the pH_2O has reached a partial pressure of 47 mmHg (from 3.8 mmHg!).

5.
But the total pressure in the alveoli is still the same as the pressure outside: 760 mmHg. Actually, the pressure is a little bit lower. *Why?*

6.
In other words, the partial pressure of all the other gasses, such as nitrogen and oxygen, has to decrease to accommodate the increase in water pressure!

7.
As you can see in the table, the oxygen pressure has actually decreased from 159 to 149 mmHg.

8.
The water vapor has pushed approximately 10 mmHg oxygen away!

Partial Pressures of Nitrogen, Oxygen, Water and Carbon dioxide inside and outside the lungs:

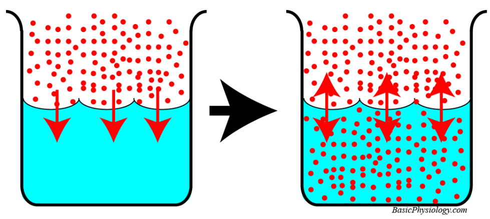
	Outside air		Humidified air	
	%	mmHg	%	mmHg
pN_2	78.6 %	597	74.9 %	563
pO_2	20.9 %	**159**	19.7 %	**149**
pH_2O	0.5 %	3.8	6.2 %	47
pCO_2	0.04 %	0.3	0.04 %	0.3
Total	*100 %*	*760*	*100%*	*760*

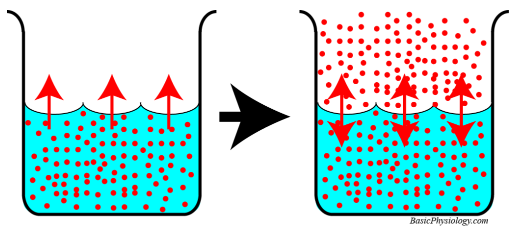
Why? Air would not flow to the alveoli if the pressure was not a little bit lower there than in the outside air (760 mmHg)?

C. Partial pressures in air and in water:

1.
It becomes even more interesting when we also look at the partial pressures of the gasses dissolved in water.

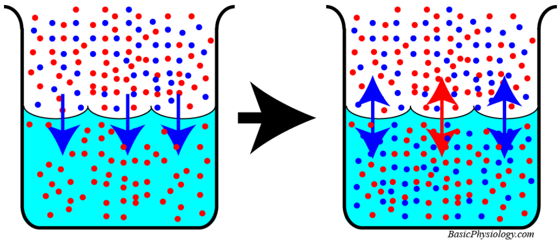
2.
In principle, if gas molecules can diffuse between water and air, then the partial pressures in water will be the **same** as in the air.





3.
So, in the above diagram, if there is a lot of a gas above the water, then, after some time, this gas will also be dissolved in the water, and achieve the same partial pressure.

4.
It also works the other way; if the water has a lot of this gas, then this gas will diffuse into the air; this continues until the partial pressure of this gas is the same in the water and the air.

5. So, for example, if there is a mixture of 50% nitrogen (red) and 50% oxygen (blue) in the air above the beaker (see diagram), then there will be a similar pressure distribution of these two gases in the water.	
6. If, for some reason, the oxygen pressure in water is lower, then oxygen molecules will diffuse from the air to the water. If the oxygen pressure in the water is higher, then oxygen molecules will diffuse from the water to the air.	7. In other words, the diffusion of gas molecules is determined by their partial pressures. This is also what happens in the alveoli.
8. **Important point**: The **pressure** of a gas in water is not the same as the amount (=**volume**) of that gas in the water. This depends on the **solubility** of that gas with water.	9. In this context, it is important to note that **nitrogen** is hardly soluble in water whereas **carbon dioxide** (= CO_2) is highly soluble. In fact, carbon dioxide is **20x** more soluble than oxygen. Oxygen itself is **moderately** soluble in water.

So, what happens in the alveoli? Next section!