## Respiratory System

**Respiratory passages -**
**upper** –
**lower** –
**ventilation –**
**Gas exchange** –
**Panes of glass analogy** –
**Surfactant** –
**Intrapulmonary pressure** –
**Intralpleural pressure -**
**Why is this important?** .
**We breathe in by** –
**Exhaling-**
**Compliance** –

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## Respiratory System

**Respiratory passages -**
**upper** – from the larynx up
**lower** – trachea, bronchi, bronchioles
**ventilation –** the movement of air through the respiratory passages.
**Gas exchange** – the actual movement of oxygen in and CO2 out between the alveoli and the capillaries/blood.
**Panes of glass analogy** – put a drop of water between two planes of glass and they will stick together. Water itself is sticky. It will keep the alveoli from opening up.
**Surfactant** – substance that reduces the surface tension of water molecules in the alveoli and allows them to expand fully. (CF – surfactant is never developed)
**Intrapulmonary pressure** – pressure inside the lungs.
**Intralpleural pressure -** pressure inside the pleural sac.
**Why is this important?** Pleural space around the lungs has less than atmospheric pressure so they keep the lungs from collapsing.
**We breathe in by** – contracting the diaphragm
**Exhaling-** is totally passive. We relax and the air leaves...
**Compliance** – we relax and the lung cavity returns to it's normal size.

## Terminology

Atmospheric pressure (1 ATM) -
Resting Intrapulmonary pressure –
Resting Intrapleural pressure –

Inspiration intrapulmonary pressure –
Inspiration intrapleural pressure –

Expiration intrapulmonary pressure –
Expiration intrapleural pressure –
Pressure facts:
1)
2)

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## Terminology

Atmospheric pressure (1 ATM) the pressure exerted at sea level by the atmosphere. This is equal to 760 mm of mercury.
Resting Intrapulmonary pressure – 760mm Hg
Resting Intrapleural pressure – 756mm Hg

Inspiration intrapulmonary pressure – 758mm Hg
Inspiration intrapleural pressure – 754mm Hg

Expiration intrapulmonary pressure – 763mm Hg
Expiration intrapleural pressure – 756mm Hg

Pressure Facts:
1) The pressure in the pleural sac is always less in the lungs – because this is what keeps the lungs open.
2) The pressure in the lungs drops below 760 mm Hg on inhalation and raises above 760mm Hg during expiration which means – The flow of air in and out of the lungs just follows the pressure gradient. It is purely passive.

## Lung volumes to know

**Tidal Volume** –
Ratio between the following is:
**Inspiratory reserve volume** –
**Expiratory reserve volume** –
**Residual volume** –
**Vital Capacity** –
**Dead Space** –

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## Lung Volumes to Know

**Tidal Volume** – the air moved during normal breathing. 500mL
The important thing between these two is the ratio. (about 2.5 or 3 to 1)
**Inspiratory reserve volume** – The amount of additional air you can inhale at the end of a normal inhalation. 3100mL
**Expiratory reserve volume** – The amount of air you can exhale after the end of normal exhalation. 1200mL
**Residual volume** – At the end of forced exhalation, you still have air remaining in the lungs. 1200mL
**Vital Capacity** – The amount of air that can be forcefully removed from the lungs after maximum inspiration followed by maximum exhalation. 4800mL
**Dead Space** – The amount of air in the air passages that never make it to the alveoli. 150 mm Hg
Only 15% of the alveolar air gets replenished with each breath. This is good. Otherwise there would be too great an influx of oxygen on each breath and too great a fluctuation in physiology.

## Calculated Lung Values

**Minute ventilation** –
**Alveolar ventilation** –
**Inspiratory capacity** –
**Functional residual capacity** –
**Vital capacity** -
**Forced vital capacity** –
**Total Lung capacity –**

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## Calculated Lung Values

**Minute ventilation** – tidal volume * breaths per minute
**Alveolar ventilation** – volume of fresh air entering the alveoli each minute. (Tidal volume – dead space) * breaths per minute.
**Inspiratory capacity** – sum of inspiratory reserve volume and tidal volume.
**Functional residual capacity** – volume of air left in the lung after normal end exhalation.
**Vital capacity** - The amount of air that can be forcefully removed from the lungs after maximum inspiration followed by maximum exhalation.
**Forced vital capacity** – A macho test of breathing plotted against time. (As quick as you can.)
**Total Lung capacity –** Total amount of air in the lungs after forced inhalation. 6000mL

## Partial Pressures of Note

Approximate percentages of gases in th air we breathe.
Nitrogen:
Oxygen:
Water Vapor:
Carbon dioxide:

By the time air has reached the alveolar spaces the percentages have changed.
$N_2$ –
$O_2$ –
$CO_2$ –
$H_20$ –

Now the air we breath out: Not important for class.
$O_2$ –
$CO_2$ –

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## Partial Pressures of Note

Approximate percentages of gases in th air we breathe.
Nitrogen: 79% $PN_2$ – 600mm Hg
Oxygen: 21% - $PO_2$ – 160mm Hg
Water Vapor: 0.5%
Carbon dioxide: 0.04% - $PCO_2$ 0.3 mm Hg

By the time air has reached the alveolar spaces the percentages have changed.
$N_2$ – 74.9%
$O_2$ – 13.6% - $PO_2$ 104 mm Hg
$CO_2$ – 5.3% - $PCO_2$ 40 mm Hg
$H_20$ – 6.2% - $PH_2O$ 47 mm Hg

Now the air we breath out: Not important for class.
$O_2$ – 15.7 $PO_2$ – 120 mm Hg
$CO_2$ – 3.6 – $PCO_2$ – 30 mm Hg

# Partial Pressures In Respiration

**Resistance to air passage:**
**Inspired air**
**Venous blood**
**Air in the alveoli**
**Fresh arterial blood** is
**$O_2$ in the blood**

- ✗
- ✗

**Hemoglobin increases the $O_2$ carrying capacity**
**When the body needs more $O_2$**
$CO_2$ is carried in the blood by three different methods:

- ✗
- ✗
- ✗

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# Partial Pressures In Respiration

**Resistance to air passage:** There is no resistance to the passage of air in a normal person. Even minor changes in the air passageway can cause big differences in air exchange. (i.e. Various lung diseases)
**Inspired air** $PO_2$ 160, and a $PCO_2$ of 0.3
**Venous blood** - that is returned to the lungs by the right side of the heart has a $PO_2$ of 40mm Hg and a $PCO_2$ of 45mm Hg
**Air in the alveoli** $PO_2$ of 104mm Hg and $PCO_2$ of 40mm Hg
**Fresh arterial blood** is $PO_2$ of 97mm Hg and $PCO_2$ of 40mm Hg
**$O_2$ in the blood** is

- ✗ 3% dissolved
- ✗ 97% attached to the hemoglobin red blood cell.

**Hemoglobin increases the $O_2$ carrying capacity** by something like 70 folds.
**When the body needs more $O_2$**, in increases the rate of blood flow and rate of breathing. It does not change the amount of $O_2$ carried in the blood. It makes you breath faster and deeper.
$CO_2$ is carried in the blood by three different methods:

- ✗ A small amount is – dissolved in plasma
- ✗ Some is loosely combined with – hemoglobin (The $CO_2$ hemoglobin connection is different than $O_2$.)
- ✗ Most of the CO2 is converted into the bicarbonate ion ($HCO_3$-) inside the red blood cells. Without getting into details, just know that this is a major ion in acid/base balance in regulating the pH of the blood – a buffer.

## Control Of Respiration

**Cells in the RCC directly monitor increased levels of –**
**with increased levels of these two products the RCC tells the body to breathe –**
**There are chemoreceptors in the aortic arch and in a sensing structure in the carotid artery called the carotid sinus. -**
RCC is
Stretching of lung tissue -

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## Control of respiration.

**Cells in the RCC directly monitor increased levels of** – carbon dioxide and hydrogen ions. (too acidic an environment)
**with increased levels of these two products the RCC tells the body to breathe** – faster and more deeply.
**There are chemoreceptors in the aortic arch and in a sensing structure in the carotid artery called the carotid sinus.** These two receptors read concentrations of carbon dixode, hydrogen and oxygen. It reads increases and decreases. In this case, the RCC tells the body to breath increase or decrease in respiration.
**RCC is** in the brain stem.
**Stretching of lung tissue** interrupts breathing, the RCC reads it up to a certain point, and then kicks off the stimulation of the diaphragm.

# Circulatory System

**Cardiovascular system** –
**Atria** -

- ✗
- ✗

**Ventricles**

- ✗
- ✗

Four sets of valves

**AV** – atrioventricular

- ✗
- ✗

Ventrical

- ✗
- ✗

**systemic** – from the left heart to the body back to right heart
**pulmonary** –
**Vena cava (superior and inferior)**
**Carotid** –
**Pulmonary trunks and arteries** –
**Pulmonary veins** –
**Aorta** –

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# Circulatory System

**Cardiovascular system** – function is to move blood to tissues of the body, bring waste products from tissues of the body.
**Atria** -

- ✗ R. Atrium - receives used blood from the body
- ✗ L. Atrium – Receives fresh bllod from the lungs

**Ventricles**

- ✗ R. Ventricles – from the r. atrium and then to the lungs.
- ✗ L. Ventricle – from the l atrium, to the body

Four sets of valves

**AV** – atrioventricular

- ✗ **Tricuspid** – Right AV
- ✗ **Mitral** – bicuspid – left AV

Ventrical

- ✗ **Pulmonic** – (R. semilunar) r. ventricles and pulmonary system/lung
- ✗ **Aortic** – (L. semilunar) l ventricles and the aorta

**systemic** – from the left heart to the body back to right heart
**pulmonary** – from the right heart, to the lungs, back to the left side of the heart
**Vena cava (superior and inferior)** (superior – above the diaphragm) returns blood to the heart.
**Carotid** – blood from the heart to the right ventricles
**Pulmonary trunks and arteries** – to the lungs from the right.
**Pulmonary veins** – back to the L heart from the lungs
**Aorta** – from the left heart to everything else.

## Cardiac Terminology

**SA Node** –
**AV Node** –
**Arteries** –
**Arterioles** –
**Capillaries** –
**Venules** –
**Veins** –
**Capillaries** –
**Polarization** -
**Right and left atria contract**
**The AV node**
**Then**
New terms:
**Systole** –
**Diastole** –
**Cardiac Cycle** –
**When are the right and left AV valves**
**Pulmonic and aortic valves**

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## Cardiac Terminology

**SA Node** – sinoatrial node – right atrium. Serves the atria. Initiates the heartbeat.
**AV Node** – the atrioventricular node- sites between the right atrium and right ventricle. Momentarily stops the flow of stimulation, and then stimulates the right and left ventricles.
**Arteries** – carry blood away from the body.
**Arterioles** – contain smooth muscle in the walls and act like valves
**Capillaries** – microscopic in diameter (one cell wall thick) actual exchange of gases and nutrients takes place here.
**Venules** – the beginning of the return trip back to the heart. Not the equivalent of the arterioles.
**Veins** – Main tubing system back to the heart.
**Capillaries** – one cell thick to faciliate the passing of gases, liquids, and some solids.
**Polarization** - heart is at rest.
New terms:
**Systole** – cardiac muscle contraction (depolarization)
**Diastole** – cardiac muscle relaxation. (repolarization)
**Cardiac Cycle** – one complete cycle of systole/diastole
**When are the right and left AV valves open** – during atrial systole/closed during ventricular systole.
**Pulmonic and aortic valves** are open during ventricular systole. They are closed during ventricular diastole