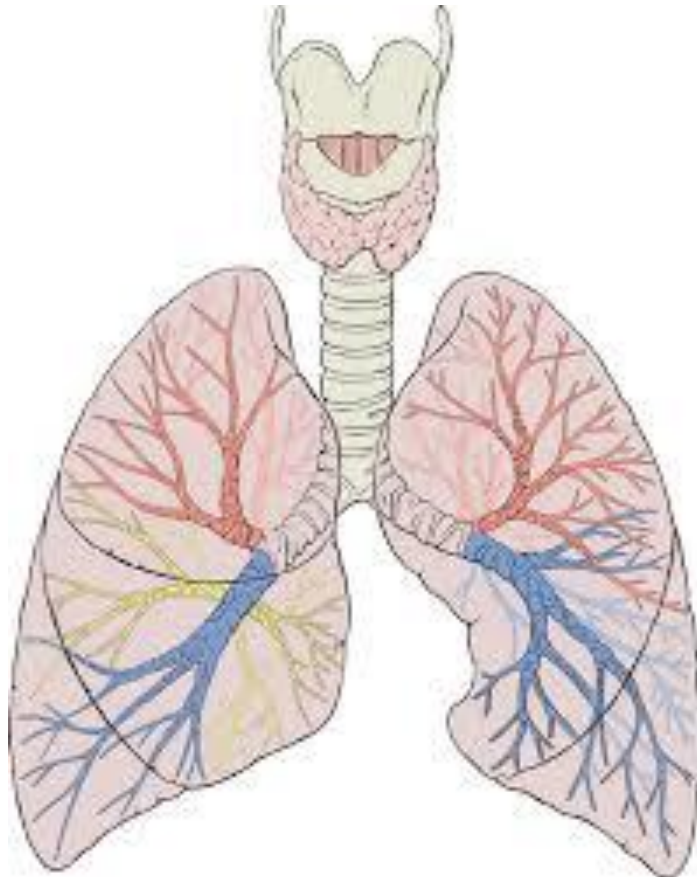


## 1.3 The Respiratory System

### Teacher Answer Booklet



Content	Additional Information	Pupil comments – How confident do you feel on this topic?
Understanding of lung volumes and the impact of and on physical activity and sport.	Residual volume. Expiratory reserve volume. Inspiratory reserve volume. Tidal volume. Minute Ventilation	
Gas exchange systems at alveoli and muscles.	Oxygen and carbon dioxide. Principles of diffusion and partial pressures	
The neural and chemical regulation of pulmonary ventilation during physical activity and sport	Sympathetic and parasympathetic. Carbon dioxide.	
Receptors involved in regulation of pulmonary ventilation during physical activity.	Chemoreceptor, proprioceptor, baroreceptor.	
Impact of poor lifestyle choices on the respiratory system.	Smoking. Oxygen transport.	

**The Pathway of Air:**

What is the main organ involved in respiration? \_\_\_\_\_

Unscramble the words below to uncover which other parts of the body are involved in respiration...

RAHCAET \_\_\_\_\_

VLAOILE \_\_\_\_\_

PRADIGMH \_\_\_\_\_

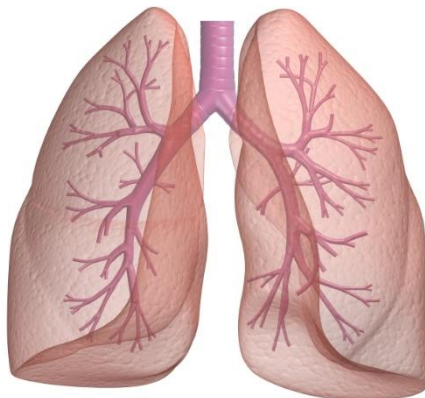
RNIHBCO \_\_\_\_\_

RNIHBCOSLOE \_\_\_\_\_

When inhaling the \_\_\_\_\_ tightens, changing from a dome shape to a flatter shape. This action opens up the \_\_\_\_\_ and allows air to rush in. When we exhale the \_\_\_\_\_ relaxes, moving up and back to a dome shape.

When breathing in, air passes through the wind pipe, which is also known as the \_\_\_\_\_. From here, the air enters one of two branches called the \_\_\_\_\_, through which air passes into each \_\_\_\_\_. Smaller branches called \_\_\_\_\_ extend out from the \_\_\_\_\_ and at the very end of these there are millions of tiny sacs called \_\_\_\_\_. Here is where gaseous exchange takes place and oxygen is passed into the blood so that it can supply the body.

Label the diagram below and also outline the position of the diaphragm when inhaling.



**Lung Volumes:**

**Tidal Volume**

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**Expiratory Reserve Volume**

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**Inspiratory Reserve Volume**

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**Residual Volume**

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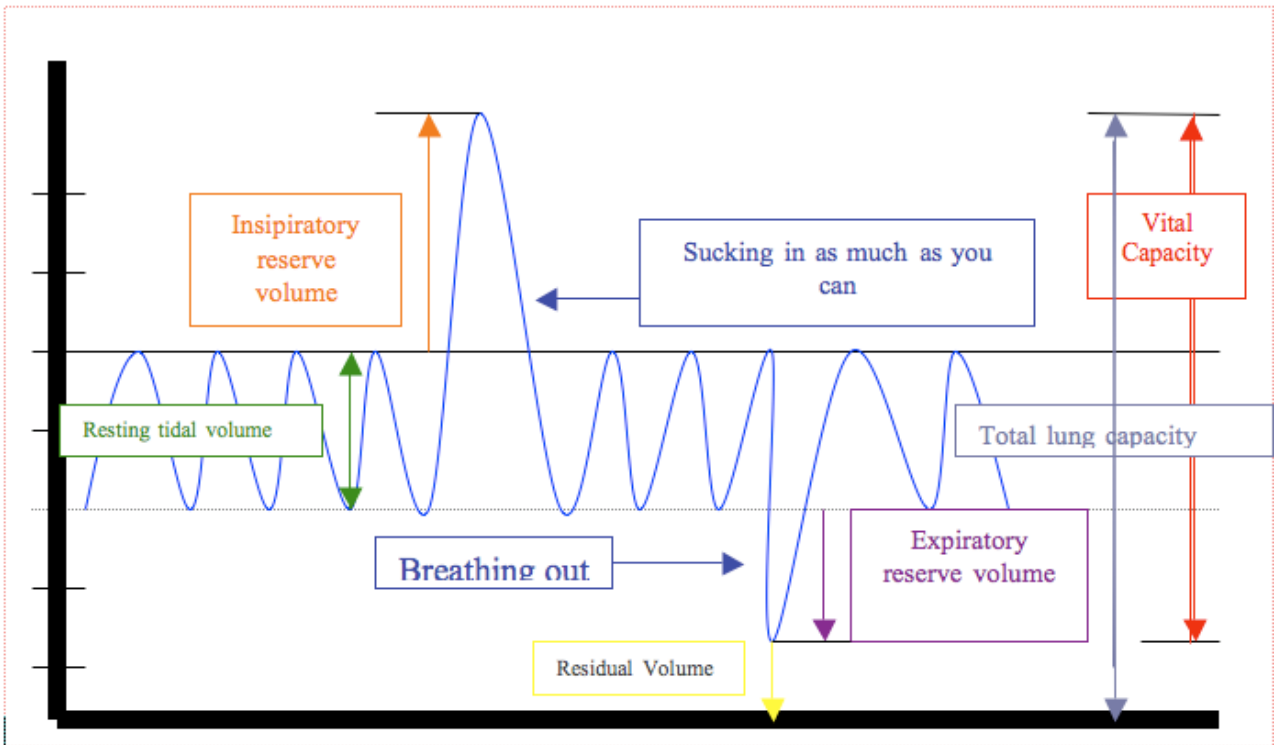
**Minute Ventilation**

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The image below shows how these terms can be displayed on a graph. This graph is showing the values for a person **at rest**. Take some times to understand this graph before having a go at the questions below.



**Tidal volume** increases during exercise. Why does this occur?

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Does **residual volume** change during exercise?

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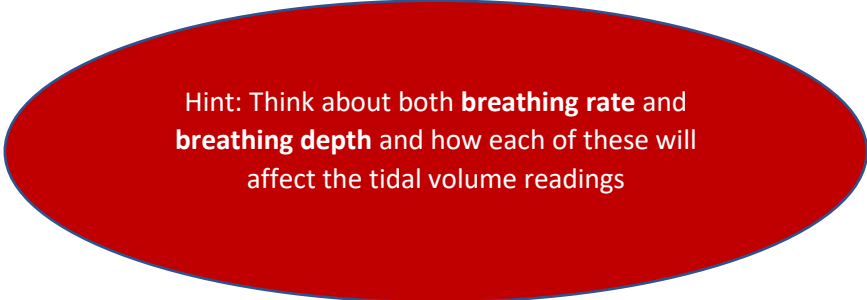
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Hint: Think carefully before answering this question

It is important that you are able to understand how the graph shown above will vary at exercise.

**Task – Think carefully before using a separate piece of paper to draw out the same graph to show a trace for a 1500m runner towards the end of a race.**



Use the knowledge that you have gained to describe what happens to each volume during exercise.

<b>Lung Volume</b>	<b>Definition</b>	<b>Change during exercise</b>
Tidal Volume		
Inspiratory Reserve Volume		
Expiratory Reserve Volume		
Residual Volume		
Minute Ventilation		

## Gas Exchange:

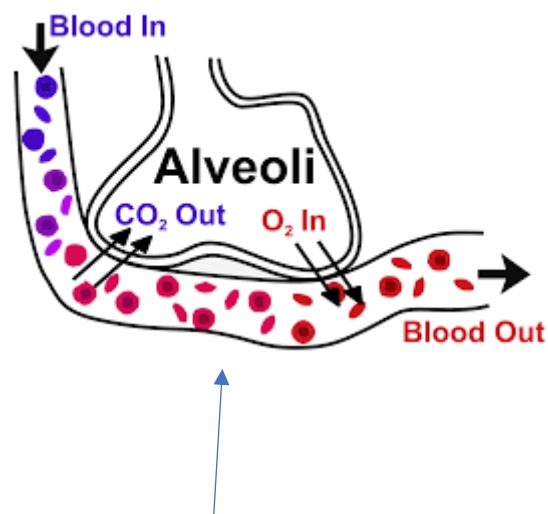
This takes place at the site of the **alveoli** and at the site of the **muscle tissue**. The process of gas exchange allows us to get \_\_\_\_\_ to our muscles and for us to get rid of waste products such as \_\_\_\_\_ and \_\_\_\_\_.

There are three key parts to gas exchange and they are outlined below:

**Diffusion** – The movement of a substance from an area of high concentration to an area of low concentration.

**Partial Pressure** – The pressure of an individual gas when it exists amongst a mixture of gases

**Concentration Gradient** – The process of particles moving through a solution or gas from an area with a higher number of particles to an area with a lower number of particles



At the alveoli, the blood stream contains a large partial pressure of CO<sub>2</sub> and a small partial pressure of oxygen. The alveoli contains a high partial pressure of oxygen and a small partial pressure of CO<sub>2</sub>. Therefore a concentration gradient is present and diffusion will occur.

At the site of the lungs:

<u>Location</u>	<u>Partial Pressure of Oxygen (P<sub>O2</sub>)</u>	<u>Partial Pressure of Carbon Dioxide (P<sub>CO2</sub>)</u>
Alveoli	100 mm Hg	40 mm Hg
Blood Capillary	40 mm Hg	46 mm Hg

Use the table above to explain how diffusion takes place at the alveoli:

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<u>Location</u>	<u>Partial Pressure of Oxygen (P<sub>O2</sub>)</u>	<u>Partial Pressure of Carbon Dioxide (P<sub>CO2</sub>)</u>
Blood Capillary	100 mm Hg	40 mm Hg
Muscle Tissue	40 mm Hg	46 mm Hg

At the site of the muscle tissue:

Use the table above to explain how diffusion takes place at the muscle tissue:

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In order for diffusion to take place effectively, the capillaries and alveoli have the following features:

Large Surface Area

One Cell Thick

Narrow Diameter

Sample Exam Questions

'Tidal volume  $\times$  respiratory frequency' is an equation.

Which **one** of these physiological measures does the equation allow you to calculate?

- A Expiratory reserve volume
- B Inspiratory reserve volume
- C Minute ventilation
- D Residual volume

(Total 1 mark)

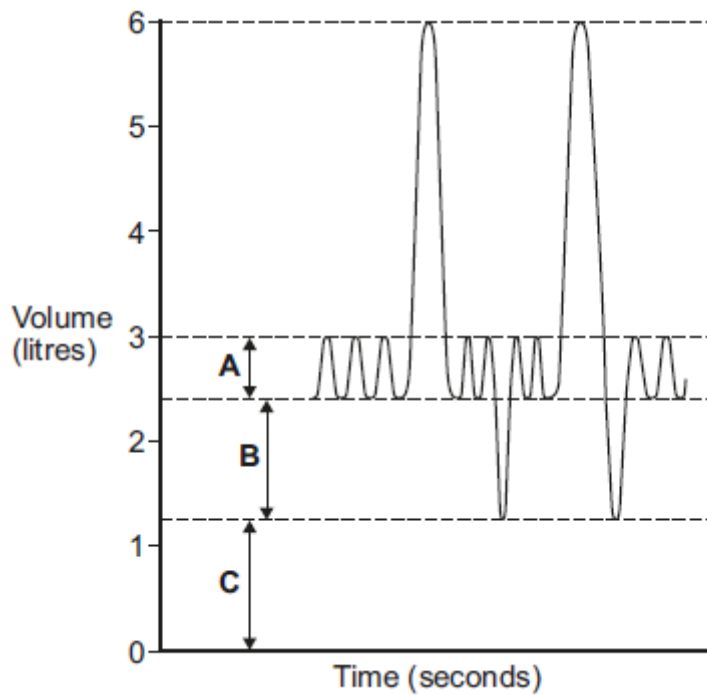
Identify which **one** of the following statements defines expiratory reserve volume.

- A The amount of air breathed in or out per breath
- B The amount of air left in the lungs after maximal expiration has occurred
- C The amount of air that can be forcibly expelled after a normal breath
- D The amount of air that can be forcibly inspired at the end of a breath

(Total 1 mark)

Many athletes will use continuous training to maintain a good level of fitness.

The diagram below shows a spirometer trace of an athlete at rest.



- (i) Complete the table to identify the type of lung volumes **A**, **B** and **C** shown in the diagram above.

	Lung Volume
A	
B	
C	

(3)

- (ii) What effect does a continuous exercise session have on lung volumes **B** and **C** in the diagram above?

Volume **B**:

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Volume **C**:

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(2)

(Total 5 marks)

The table below shows the partial pressure of oxygen (PO<sub>2</sub>) and carbon dioxide (PCO<sub>2</sub>) in a blood capillary and a muscle.

	PO <sub>2</sub> (mmHg)	PCO <sub>2</sub> (mmHg)
Blood capillary	100	40
Muscle	40	46

Using the table above, describe how oxygen **and** carbon dioxide move between the blood and the muscles.

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[Total 4 marks]

**Neural & Chemical Regulation of Pulmonary Ventilation:**

**Neural** refers to the nervous system whereas **chemical** refers to blood acidity.

As we have discovered whilst learning about the **cardiovascular system**, receptor systems are present in our body in order to detect when an increase or decrease in heart rate are required.

What are the roles of the:

**Chemoreceptors:** \_\_\_\_\_  
 \_\_\_\_\_

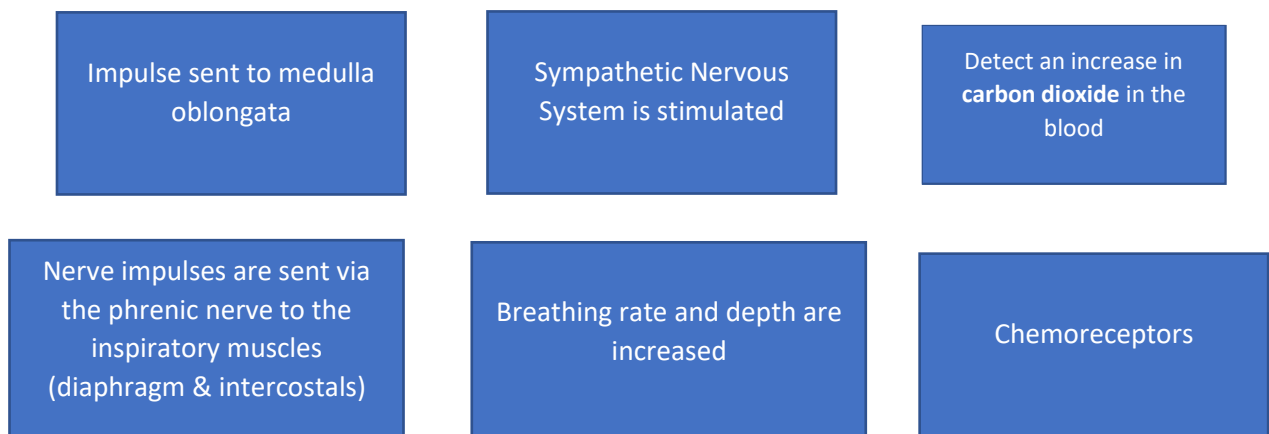
**Baroreceptors:** \_\_\_\_\_  
 \_\_\_\_\_

**Proprioceptors:** \_\_\_\_\_  
 \_\_\_\_\_

During exercise, the receptor systems send impulses to the \_\_\_\_\_  
in the brain, which then stimulates the \_\_\_\_\_ nervous system and heart rate is \_\_\_\_\_.

Following exercise, the receptor systems send impulses to the \_\_\_\_\_  
\_\_\_\_\_ in the brain, which then stimulates the \_\_\_\_\_ nervous system and heart rate is \_\_\_\_\_.

The same process can be applied to the respiratory system, whereby rather than increasing or decreasing the heart rate, the medulla oblongata can signal for an increase or decrease in breathing rate and depth. The **Inspiratory Centre** and **Expiratory Centre** are found in the medulla oblongata and are responsible for changes in breathing rate. Put the following statements in order to explain how this is achieved:



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**Stretch Receptors:**

These are located in the lungs. They prevent the lungs over-inflating by sending signals to the **expiratory centre**, which can signal for a decrease in breathing rate and depth.

In relation to breathing mechanics, how can an athlete's proprioceptors work to aid performance in a 5000m race?

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An athlete is close to exhaustion at the end of a 5000m race. How do their stretch receptors respond in order to ensure the safety of the lungs?

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Sample Exam  
Questions

How is breathing rate regulated by the body to meet the increasing demands of exercise during a game of netball?

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(Total 4 marks)

Smoking is a poor lifestyle choice because of the negative effect it can have on health and performance.

Identify **one** physiological effect of smoking on the respiratory system **and** explain its impact on performance in endurance events.

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(Total 4 marks)



**Key Terms:**

**Tidal Volume** – Volume of air breathed in or out per breath

**Inspiratory Reserve Volume** – Volume of air that can be forcibly inspired following a normal breath

**Expiratory Reserve Volume** – Volume of air that can be forcibly expired following a normal breath

**Residual Volume** – Volume of air that remains in the lungs after maximum expiration

**Minute Ventilation** – Volume of air breathed in or out per minute

**Diffusion** – The movement of a substance from an area of high concentration to an area of low concentration.

**Partial Pressure** – The pressure of an individual gas when it exists amongst a mixture of gases

**Concentration Gradient** – The process of particles moving through a solution or gas from an area with a higher number of particles to an area with a lower number of particles

**Stretch Receptors** – A sensory receptor that responds to the over-expanding of the lungs

**Inspiratory Centre** – Located in the medulla oblongata and responsible for breathing (inspiration)

**Expiratory Centre** – Located in the medulla oblongata and responsible for breathing (expiration)

**Cilia** – Tiny cells located in the bronchi and bronchioles

**Nicotine** – An addictive stimulant found in cigarettes

**Tar** – A toxic substance found in cigarette smoke