Respiratory System

Function:

to bring oxygen into the body and remove carbon dioxide.

Alveoli:

➢These are small air sacs found in the lungs.
➢This is were gaseous exchange takes place within the respiratory system.
➢Oxygen enters the blood stream to be sent to the heart.
➢Carbon dioxide replaces the oxygen (**exchanged**) in the alveoli so that it can be removed from the body.

Key features of the Alveoli:

- Alveoli walls are only **one cell thick** and are **moist** – easy to exchange gases
- They are **very small**, however their are **millions** within the lungs – large surface area
- Covered with **huge network of capillaries** – constant blood supply

Aerobic Respiration (exercise):

- Energy is created **with** the presence of oxygen.
- Used for **low intensity, long duration** activities.
- Very effective method of producing energy. However the process is slow and gradual, much slower than anaerobic.

Anaerobic Respiration (exercise):

- Energy is created **without** the presence of oxygen.
- This is not an efficient process as it produces 1/20th as much energy as aerobic respiration.
- However the process is three times as quick so energy can be produced for **high intensity** (explosive) activities performed over a **short period of time**.
- After a short period of time performance drops as lactic acid builds up, resulting in oxygen debt.

Oxygen Debt

- The amount of oxygen needed to break down the lactic acid within the body.
- Lactic acid is produced due to the body not having enough oxygen to break down the glucose. This means that the glucose is only partially broken down.
- Oxygen is paid back when the performer has stopped working

Key Terms:

1) Respiratory rate - breathes per minute
2) Tidal volume – amount of air inhaled / exhaled per breath
3) Minute Volume= Respiratory Rate x Tidal Volume– amount of air inhaled per minute
4) Residual volume = the volume of air that remains in the lungs after maximal expiration.
5) Expiratory reserve volume (ERV) = the additional air that can be forcibly exhaled after the expiration of a normal tidal volume.
6) Inspiratory reserve volume (IRV) = the additional air that can be forcibly inhaled after the inspiration of a normal tidal volume.

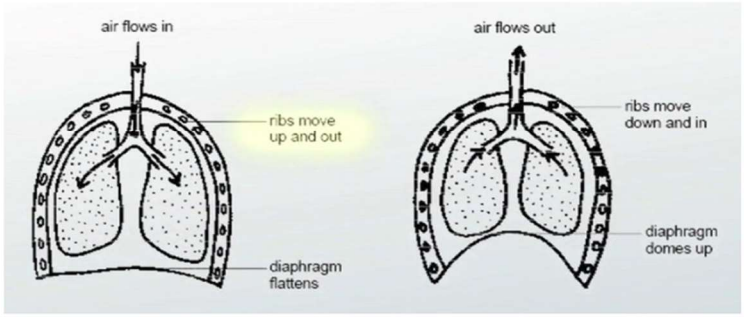
Inspiration / Expiration

Inspiration (How we breathe in):

- The diaphragm contracts and flattens.
- The intercostal muscles contract which causes the rib cage to rise.
- Both these actions cause the chest cavity to increase in size / volume.
- This reduces the pressure in the chest cavity, due to this the air passes from the higher pressure outside of the lungs to the lower pressure inside the lungs.
- This causes the lungs to expand and fill the chest cavity

Expiration (How we breathe out):

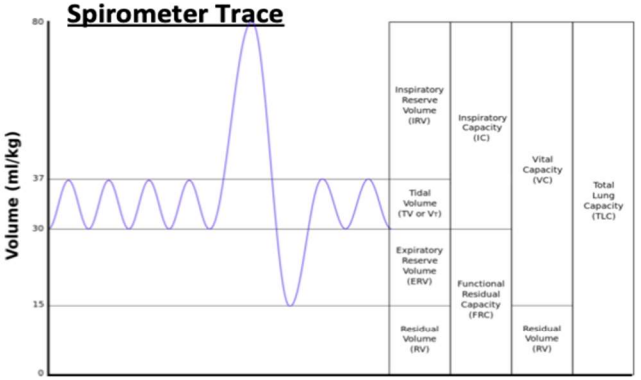
- The diaphragm relaxes and bulges up, returning to its original dome shape.
- The intercostal muscles also relax causing the ribs cage to lower.
- Both these actions cause the chest cavity to decrease in size / volume.
- The reduction in the size of the chest cavity increases the pressure of the air in the lungs and causes it to be expelled.
- The air passes from the high pressure in the lungs to the low pressure in the bronchi and trachea.



During Exercise the following happens:

1) Respiratory rate - Increases
2) Tidal volume – increases
3) Minute Volume= increases
4) Residual volume = stays the same.
5) Expiratory reserve volume (ERV) = decreases
6) Inspiratory reserve volume (IRV) = decreases

Spirometer Trace



Exam Example:

11) As soon as we start to exercise our breathing rate and depth of breathing increases.
(a) Explain **two** reasons why the respiratory system responds in this way when beginning exercise.

1. **Explanation 1:** Increased/more demand for oxygen (1) to supply (working) muscles/because need (more) energy for exercise/removal of lactate/removal of lactic acid (1)

2. **Explanation 2:** More carbon dioxide is produced during exercise **(1)** therefore there is an increased need to remove carbon dioxide **(1)**

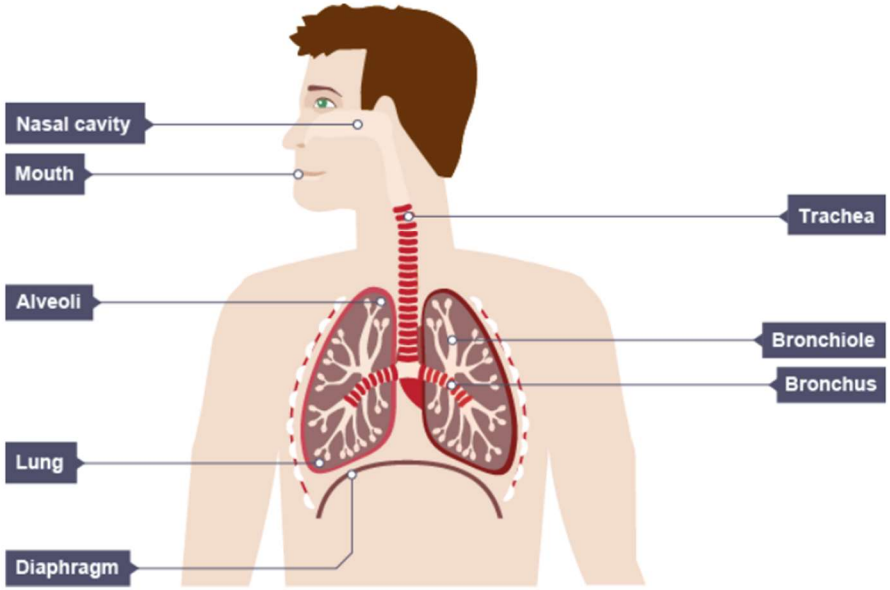
Additional muscles used during inspiration and expiration during exercise:

During inspiration:
When exercising the **PECTORALS** and **STERNOCLEIDOMASTOID** muscles contract assisting the performer inhale air. These allow the chest cavity to further increase in size (have a larger volume) so more air can enter the lungs.

During expiration:
When exercising the **ABDOMINAL** muscles contract assisting the performer exhale air. They help force air out of the lungs faster and so speed up expiration.

The Pathway of Air into the Body

- When we breathe in, air moves through the mouth and nose.
- It then travels down the trachea. The inner surface of the trachea is covered in tiny hairs called **CILIA**, which catch particles of dust. The trachea is kept open **by RINGS OF CARTILAGE**.
- Near the lungs the trachea divides into two tubes called bronchi (one enters left lung and the other the right).
- Once in the lungs the bronchi split into smaller bronchi before dividing into even smaller tubes called bronchioles.
- At the end of each bronchiole are openings to the alveoli. There are usually several alveoli coming from one bronchiole, forming a little clump that resembles a cluster of grapes.
- At the alveoli gaseous exchange occurs. Capillaries carrying blood surround each alveoli resulting in oxygen being passed into the bloodstream from the alveoli in exchange for carbon dioxide which passes from the blood stream into the alveoli.



Circulatory, Aerobic and Anaerobic Systems

Heart as a Double Pump:

- Left side pumps oxygenated blood to the body (cells and working muscles)
- Right side pumps deoxygenated blood to the lungs.

Terms:

1) Heart rate - beats per minute
2) Stroke volume – blood pumped out per beat
3) Cardiac output = stroke volume x heart rate – amount of blood pumped out per minute
4) Maximum heart rate – 220 – age
5) Resting heart rate – lowest possible heart rate when you are inactive
6) Recovery rate – time taken for heart rate to get back to normal

Exam examples:

Explain why it is important that a performers heart rate increases during exercise?

- Need oxygen for muscles due to exercise/ need to get O2 to the working muscles quicker to sustain performance.
- More CO2 is produced by the muscles and this needs to be removed.

Explain why resting heart rate is lower than recovery heart rate?

- Resting heart rate is lower because this is the heart rate whilst the individual is inactive (1)
- At rest the body has its lowest demand on the circulatory system/lower demand for oxygen/less blood flow/less CO2 (1)
- recovery heart rate is higher as the body needs increased blood flow/ more oxygen to recuperate after exercise/pay back oxygen debt **(1)**

Structure of the Heart:

- Left / Right Atriums – Upper Chambers
- Left / Right Ventricles – Lower Chambers
- The heart contains valves to prevent the backflow of blood
- Vena Cava – Vein that brings deoxygenated blood back to the right side of the heart.
- Aorta – Artery that takes oxygenated blood from the left side of the heart to the body tissues / cells.
- Pulmonary Artery – only artery in the body that carries deoxygenated blood. This artery takes the blood from the right side of the heart to the lungs.
- Pulmonary Vein – only vein in the body that carries oxygenated blood. This vein takes blood from the lungs and returns it to the left side of the heart.

Blood Pressure:

- The force exerted by circulating blood on the walls of the blood vessels.
- Systolic = when the heart contracts (beats)
- Diastolic = in between heart beats when the heart is relaxed.

Systolic
Diastolic

Red Blood Cells:

- Carry oxygen around the body
- Produced in the bone marrow of our long bones.
- Contain haemoglobin to which the oxygen attaches to create oxyhaemoglobin

Cardiac Cycle

Two phases:

Diastole Phase – When the heart relaxes and fills with blood

Systole Phase – When the heart contracts and sends blood out of it.

Arteries:

- Carry blood away from the heart.
- Most arteries carry oxygenated blood (oxygen rich).
- Thick walls to withstand the high blood pressure.
- Small / narrow lumen so that the blood is forced around the body at a high pressure.
- Strong elastic walls that can easily increase and decrease in diameter.

Veins:

- Veins carry blood towards the heart.
- Most veins carry deoxygenated blood (carbon dioxide rich).
- Thinner walls than arteries as the blood is pumped through at a low pressure.
- Due to the low pressure veins contain valves to prevent the backflow of blood.
- They also have a large lumen to allow more blood to pass through them

Capillaries:

- In Capillaries gaseous exchange takes place.
- Capillaries are one cell thick to enable substances to enter and leave the blood stream (allows rapid diffusion).
- Capillaries surround our alveoli and body tissues (e.g. muscles) to allow gaseous exchange to take place (the exchange of oxygen and carbon-dioxide).
- Huge network throughout the body linking arteries and veins (large surface area for gaseous exchange to take place).

Pathway of Blood Around the Body:

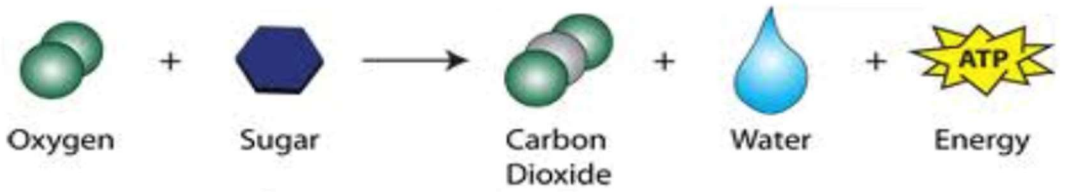
- Deoxygenated blood from the right atrium passes through valves into the right ventricle. The valves prevent the blood from returning to the atrium.
- The deoxygenated blood is then sent from the right ventricle to the lungs via the pulmonary artery.
- At the lungs gaseous exchange takes place in capillaries around the alveoli. Carbon-dioxide is passed from the blood stream into the alveoli in exchange for oxygen.
- The now oxygenated blood is taken back to the left atrium via the pulmonary vein.
- The oxygenated blood then passes from the left atrium to the left ventricle.
- From the left ventricle the oxygenated blood is sent around the body at high pressure through the aorta.
- At the body gaseous exchange takes place again. This time oxygen is taken from the red blood cells and passed to the body tissues in exchange for carbon-dioxide.
- The deoxygenated blood is taken back to the right atrium at low pressure by the vena cava.

Vasoconstriction / Vasodilation

- Vasoconstriction and vasodilation work together to cause 'blood shunting' (the redistribution of blood around the body).
- Vasoconstriction is reducing the diameter of small arteries, so by reducing the blood flow to certain parts of the body.
- Vasodilation is increasing the diameter of small arteries to increase blood flow to certain parts of the body.
- This occurs during exercise. Vasoconstriction reduces blood flow to parts of the body not needed during exercise e.g. bladder / stomach, and that blood is redistributed to the muscles that are being used in the activity.
- Vasodilation occurs around the muscles so that more blood, carrying oxygen, can get to the muscles to create more energy. This will allow a performer to perform for longer and maintain their standard of play.

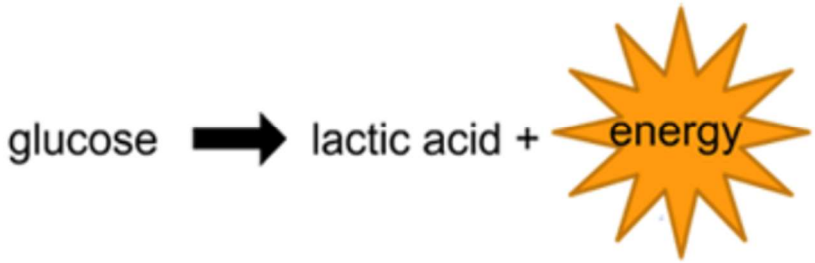
Aerobic Respiration / Exercise:

- Creating energy with the presence of oxygen.
- Occurs at low to moderate levels of exertion, where the performer usually performers for a long period of time.



Anaerobic Respiration / Exercise:

- Creating energy without the presence of oxygen.
- Occurs during high intensity activities, but can only be sustained for a short period of time.
- Due to the glucose only being partly broken down, lactic acid is produced. Lactic acid causes fatigue to occur in muscles causing the performer to slow down and eventually stop.



- The build up of lactic acid causes fatigue and results in OXYGEN DEBT, a state in which the body needs more oxygen than it can provide. (temporary oxygen shortage in the body due to strenuous exercise).

- Excess post-exercise oxygen consumption (EPOC) is maintaining an increased rate of oxygen intake after the anaerobic exercise.
- This allows the performer to repay the oxygen debt created.

Recovering from Anaerobic Exercise

Cool Down:

- Maintain elevated breathing / respiratory rate and heart rate (EPOC) to maintain blood flow around the body. This allows the body to remove all the lactic acid

- Stretching, Ice Baths / Massage to prevent of delayed onset of muscle soreness (DOMS). This is when the muscles get sore and stiff several hours after exercise.