Qualification Accredited

OCR
Oxford Cambridge and RSA

GCSE (9–1)

PHYSICAL EDUCATION

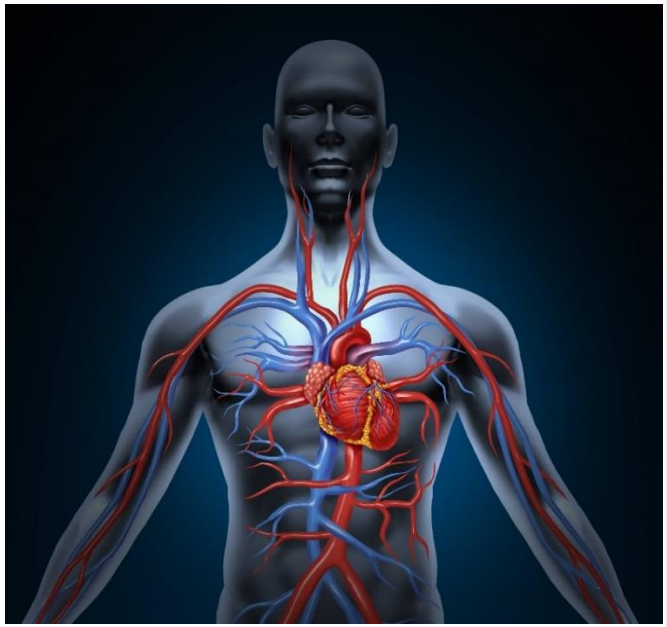
J587
For first teaching in 2016

Applied Anatomy and Physiology

1.1.d. The Cardiovascular and respiratory systems

STRUCTURE AND FUNCTION OF THE CARDIOVASCULAR SYSTEM

LEARNING OUTCOMES

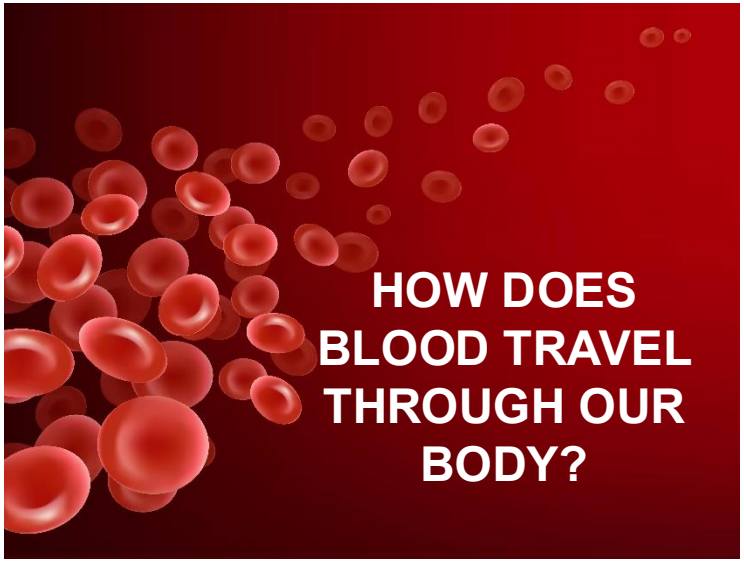


BY THE END OF THIS TOPIC YOU SHOULD …

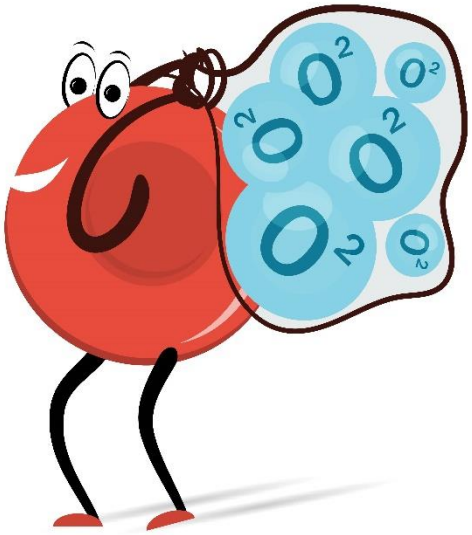
- **Know the double-circulatory system (systemic and pulmonary)**
- **Know the different types of blood vessel**
  - arteries
  - capillaries
  - veins
- **Understand the pathway of blood through the heart:**
  - Atria
  - Ventricles
  - Valves of the heart
  - Septum and major blood vessels
  - Aorta
  - Pulmonary artery
  - Vena cava
  - Pulmonary vein
- **Know the definitions of:**
  - Heart Rate
  - Stroke Volume
  - Cardiac Output
- **Know the role of red blood cells.**

The Cardiovascular and respiratory systems

THINKING QUESTIONS…...



HOW DO WE GET OXYGEN TO OUR MUSCLES?

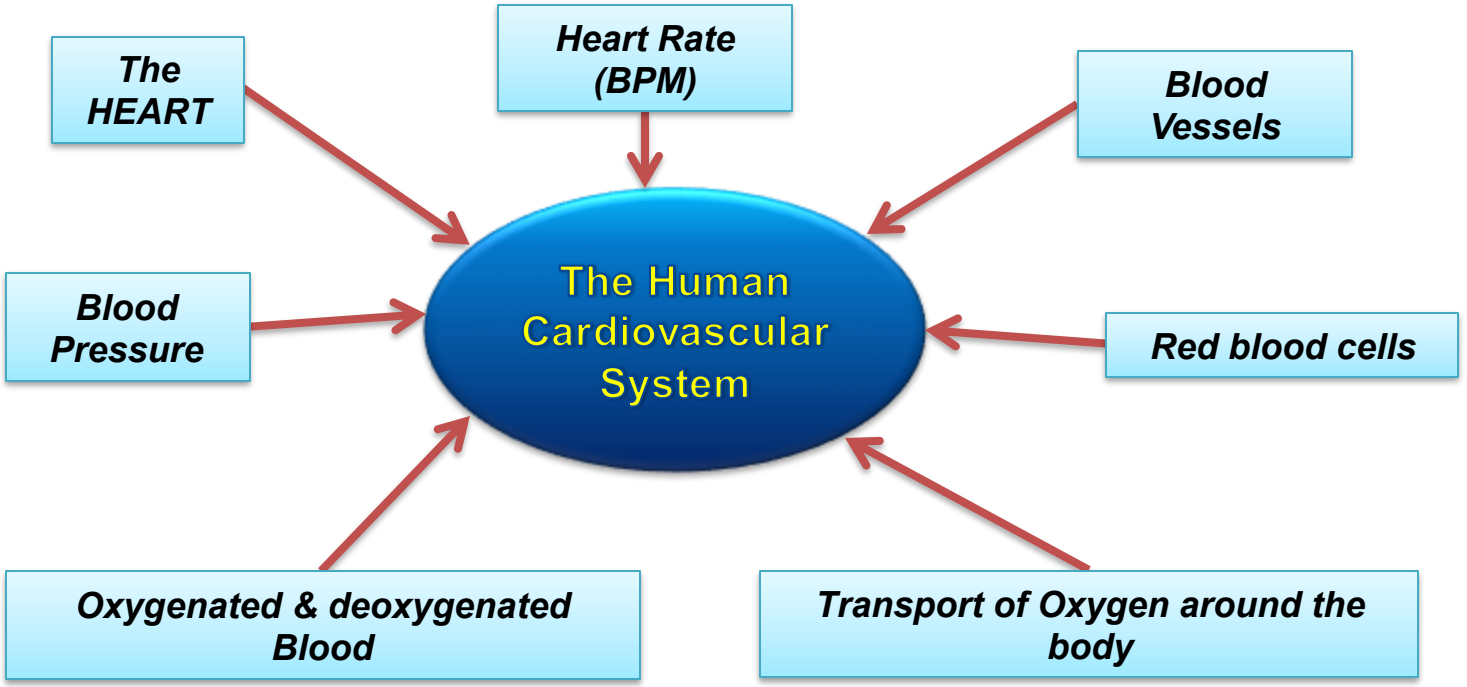


WHICH ORGAN IS MORE IMPORTANT HEART OR LUNGS?

THE CARDIOVASCULAR SYSTEM

SO WHAT DO WE KNOW ALREADY?

TASK: add to the spider diagram any words you would associate with the ***cardiovascular system***



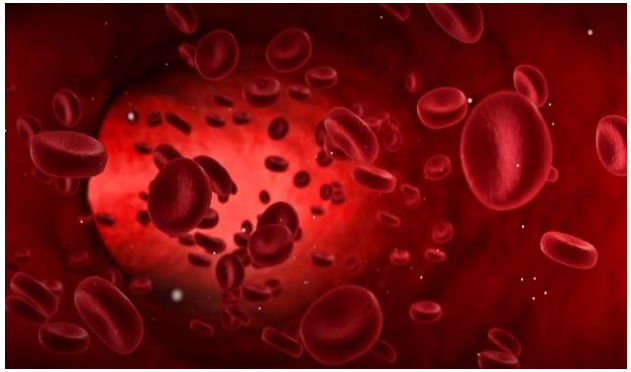
Structure and function of the cardiovascular system

What is the Cardiovascular system?

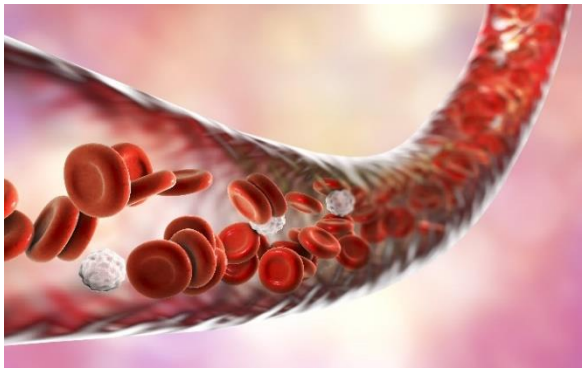
The cardiovascular system consists of the

Heart

Blood



Blood Vessels



The Heart is a muscular pump, which pushes blood around the body's network of blood vessels.

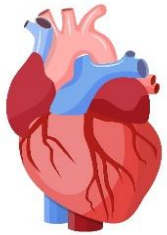
Heart rate (aka ***Pulse Rate***) is the number of times the heart **B**eats **P**er **M**inute (**BPM**).

Resting Heart Rate should be between **60-80 BPM** (**72** often regarded as the average resting Heart Rate).

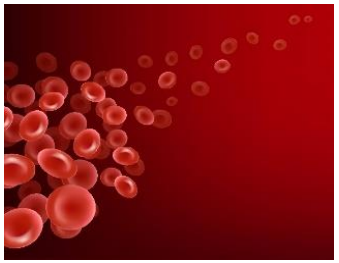
TASK: find and take your Resting HR

Structure and function of the cardiovascular system

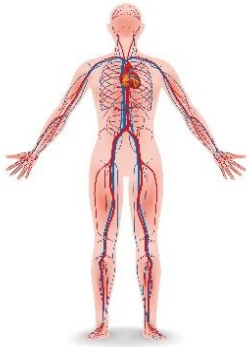
The heart - Is a muscular pump, which pushes blood along the many blood vessels in the body



Blood – Blood is pumped around the body by the heart and has two functions.



Blood vessels – Run throughout the body allowing blood to travel to organs, muscles etc.
(3 types - Arteries, Veins & Capillaries).



What does the cv system do?

Structure and function of the cardiovascular system

Cardiovascular System

The Function of the Cardiovascular system is

1. To supply the body with oxygen & nutrients
2. To remove waste products (e.g. CO2)

The heart operates a

double circulatory system

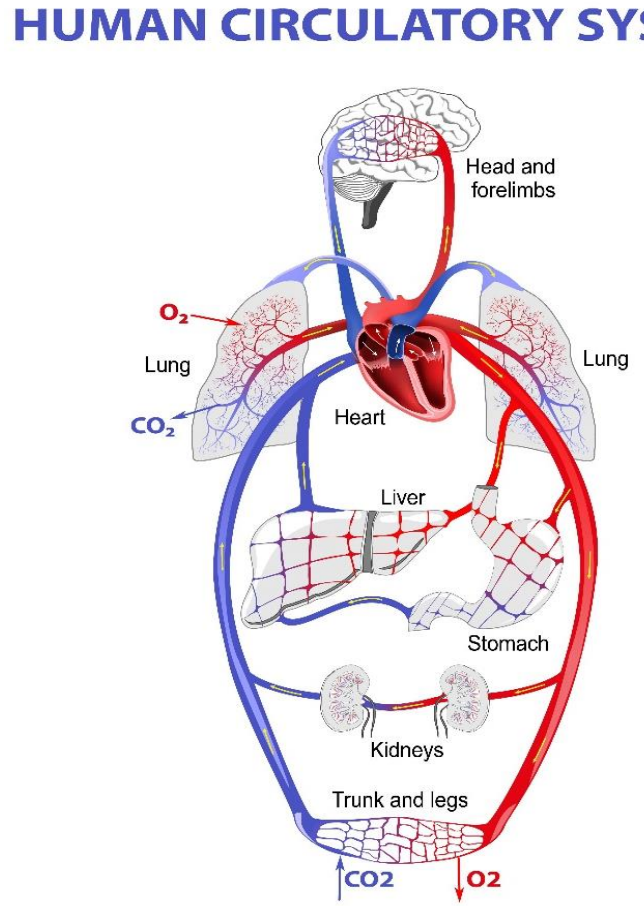
in which blood flows through the heart twice.

1. Pulmonary circulation

i.e. blood flow between the heart and lungs.

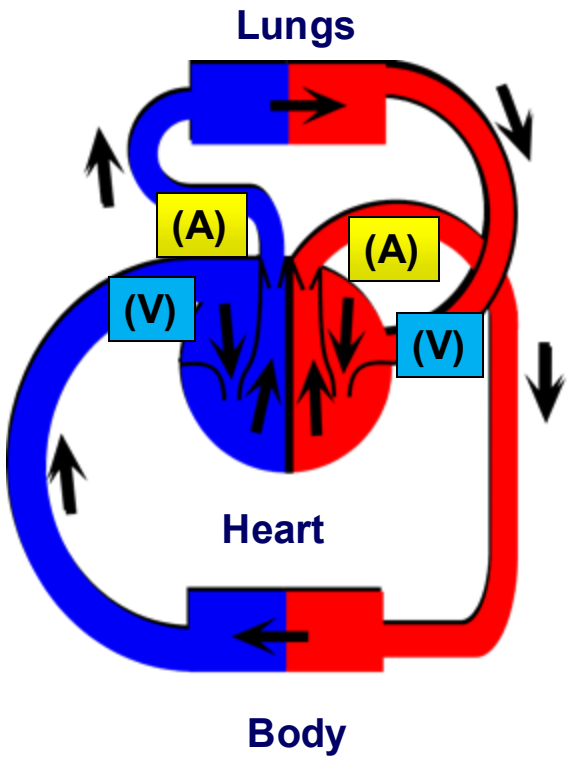
2. Systemic circulation

i.e. movement of blood from the heart through the rest of the body (excluding the lungs), then back to the heart.



How Blood is Pumped around the Body

- Blood flows around the body in a 'figure of eight' circuit, passing through the heart twice on each circuit.
- Blood travels **Away** from the heart through **Arteries (A).**
- Blood **returns** to the heart through **veins (V).**



There are 2 separate 'loops' to the circuit:

- The **top loop** – carries blood from the heart to the lungs and back.
- The **bottom loop** – carries blood from the heart to all over the body and back.

Blood vessels

Once blood leaves the heart, it is transported around the body in three main types of blood vessels:

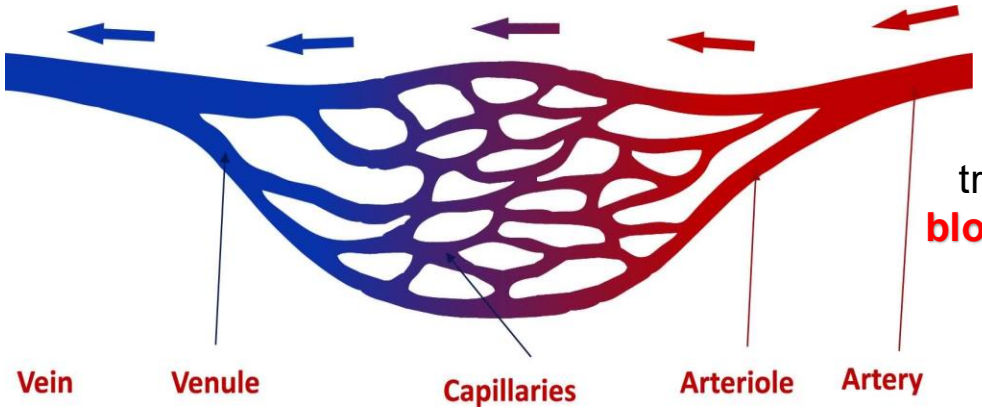
- **Arteries**
- **Veins**
- **Capillaries**

https://www.youtube.com/watch?v=PgI80Ue-AMo&list=PL806169ECA3C97794

Structure and function of the cardiovascular system

Veins

transport blood from all over the body **back** to the heart and lungs for **re-oxygenation**.



Arteries

transport the **oxygenated blood away** from the left side of the heart.

Veins carry blood under a low pressure

They are **blue** because they carry blood that is full of **waste products**, and are low in oxygen.

Arteries carry blood under a high pressure

The largest artery in the body, connected directly to the heart, is the **Aorta**.

Structure and function of the cardiovascular system

An unique feature of **Veins** is that they have **valves**.

Like the valves in the heart, they are there to **prevent a backflow** of blood.

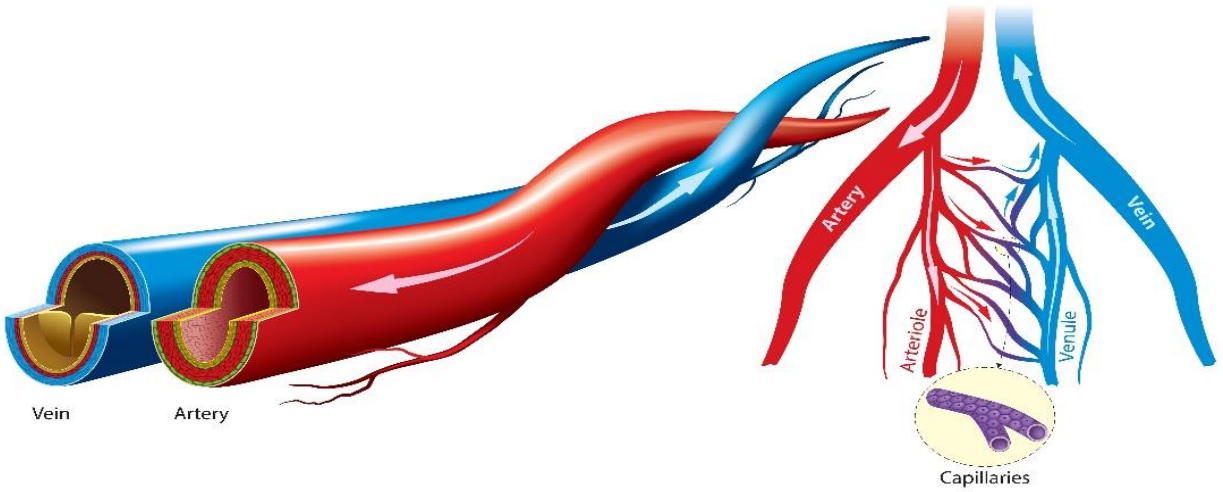
The blood must flow in one direction only, against gravity in most cases, back to the heart.

https://www.youtube.com/watch?v=hXrZI4P4hYg

Structure and function of the cardiovascular system

Capillaries are small blood vessels that carry blood to and from the body's cells.

They are **one cell thick** and are exchange points where oxygen and carbon dioxide cross into the tissue cells (muscles) from the arterioles.

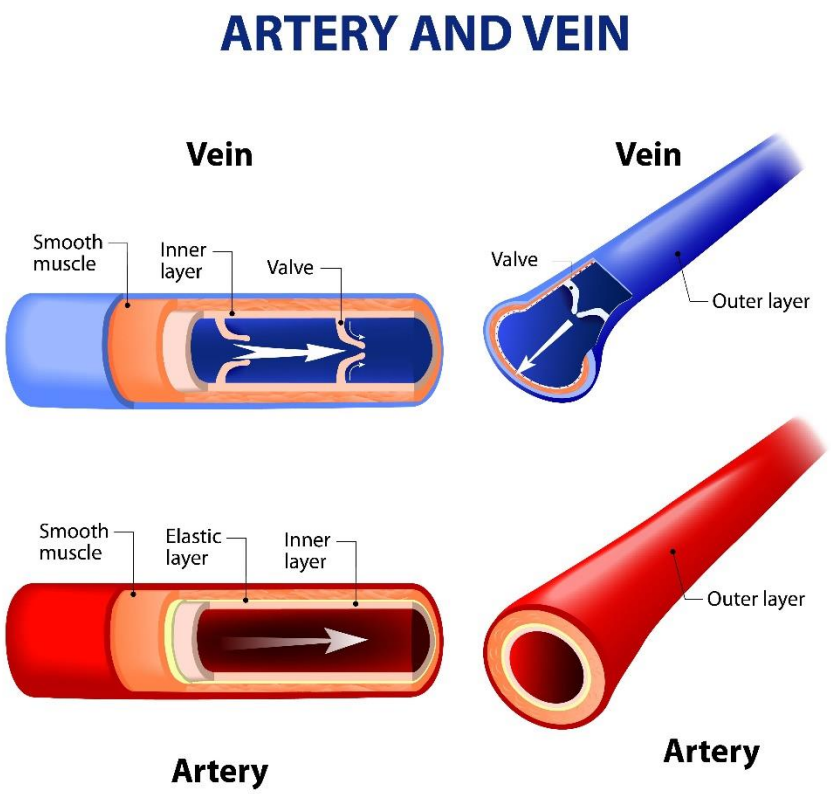


https://www.youtube.com/watch?v=CjNKbL_-cwA

Structure and function of the cardiovascular system

ARTERIES

- Take blood away from the heart
- Walls are thick and elastic
- Has small lumen
- Has a pulse and blood travels in spurts
- Have no valves

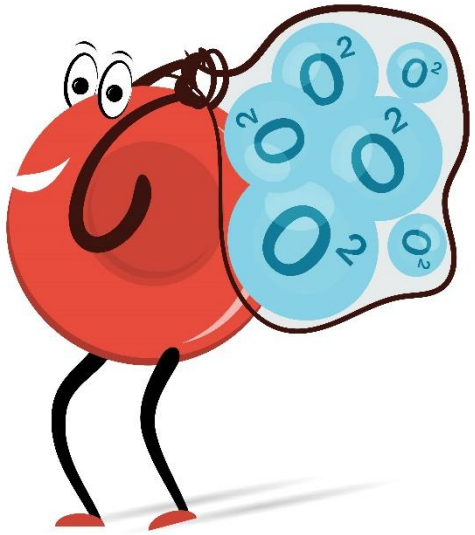


VEINS

- Take blood to the heart
- Walls are thin
- Has large lumen
- Has no pulse and blood travels smoothly
- Have valves

Structure and function of the cardiovascular system

The role of red blood cells



Red blood cells carry oxygen from the lungs to the muscles & Removes CO_2 from muscles to lungs.

Contain a red-coloured compound called **haemoglobin** which bonds with oxygen to form **oxyhaemoglobin**.
These cells are responsible for carry oxygen to working muscles.
Without these cells performers would fatigue and stop.

How do red blood cells help a sports performer?

Redistribution of blood during exercise

During exercise, blood flow to muscles increases to meet the increase in oxygen demand.

This redirection of blood flow to the areas where it is most needed is known as **vascular shunt**.

Redistribution of blood during exercise

The body uses two mechanisms to control this redistribution.

1. Vasoconstriction (narrowing) of blood vessels to areas of the body not involved in exercise (stomach, brain etc).

2. Vasodilation (expanding) of blood vessels suppling blood to areas of the body involved in exercise (working muscles).

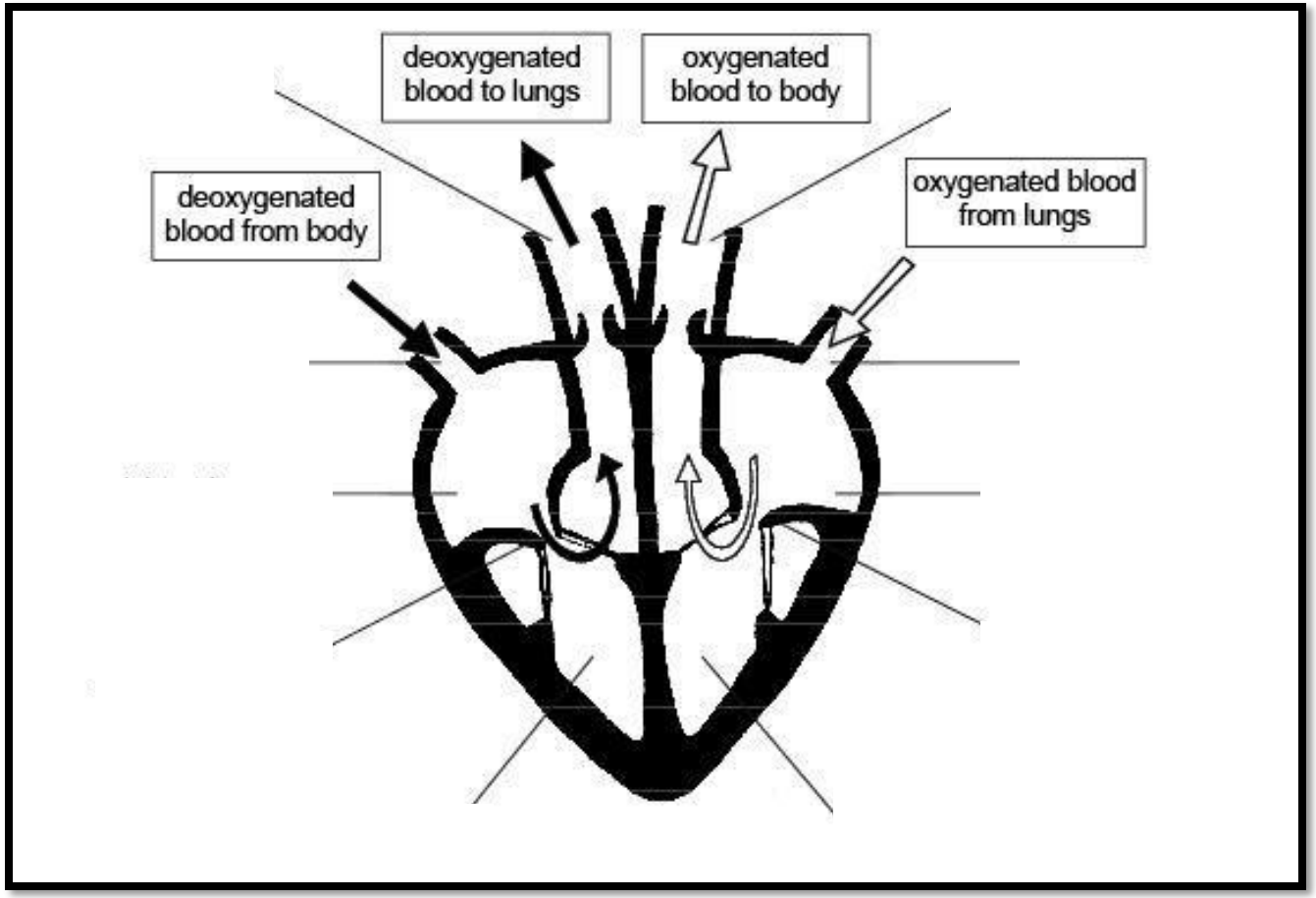
Result is greater blood flow (carrying oxygen) to working muscles.

Think about the following:

1. **Where is the blood needed when you exercise?**
2. **Where is blood needed just after a meal?**
3. **What will happen to blood vessels around the muscles?**

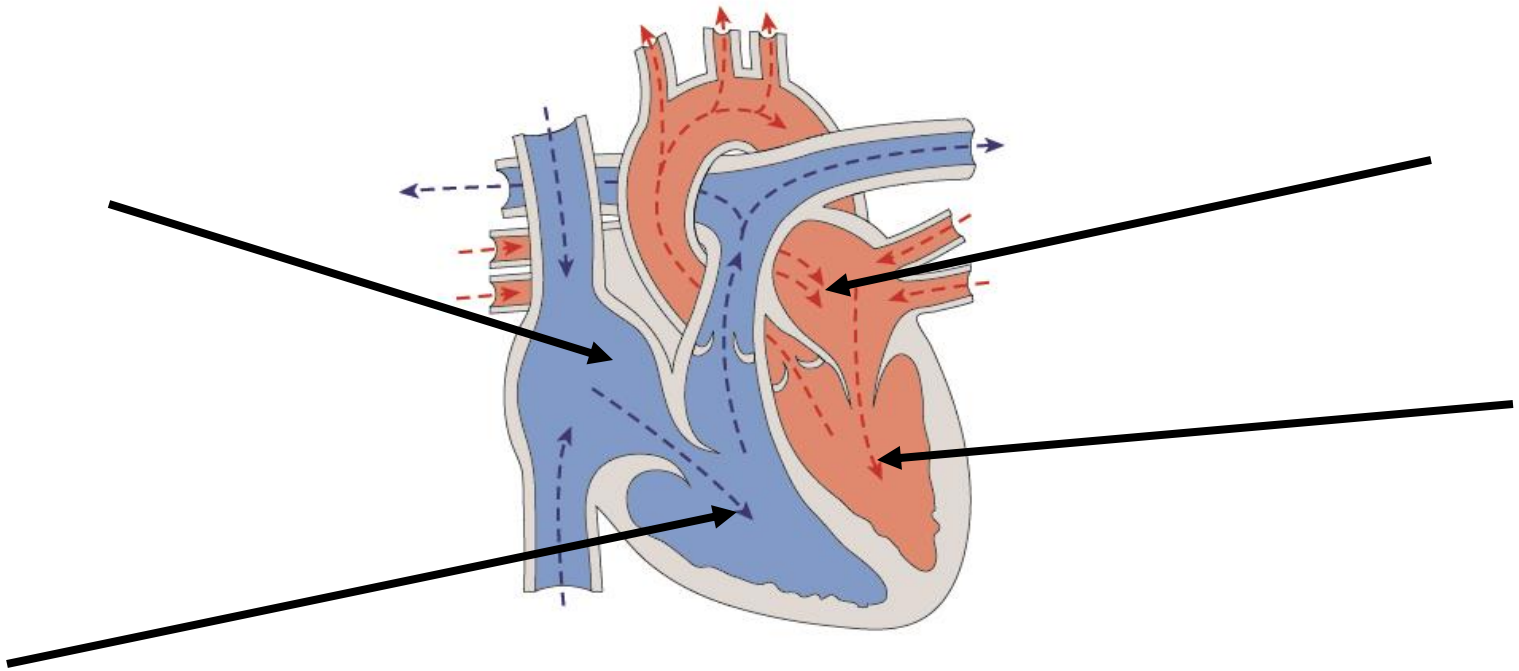
Structure and function of the cardiovascular system

TASK: **Label the diagram below in your table groups…**



Structure and function of the cardiovascular system

TASK: **Label the diagram below**



Structure and function of the cardiovascular system

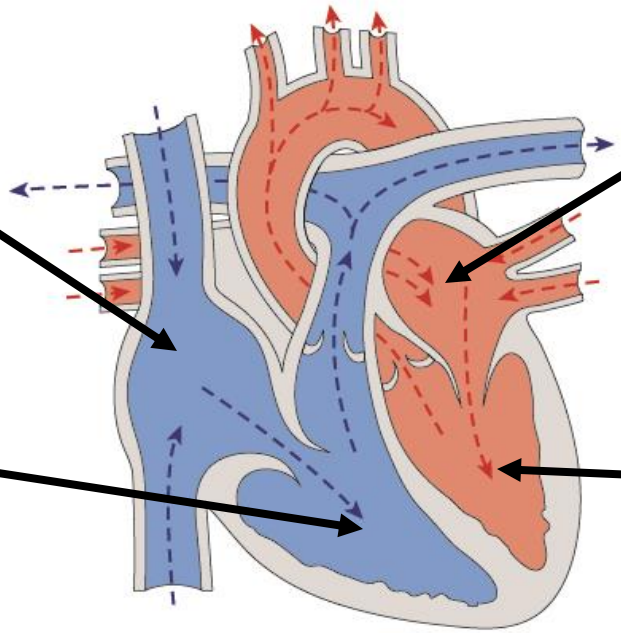
The ANSWERS

RIGHT ATRIUM

An upper chamber receiving de-oxygenated blood from the body.

LEFT ATRIUM

An upper chamber receiving oxygenated blood from the lungs



RIGHT VENTRICLE

A lower chamber containing de-oxygenated blood, to be pumped to the LUNGS

LEFT VENTRICLE

A lower chamber containing oxygenated blood, to be pumped around the body.

Structure and function of the cardiovascular system

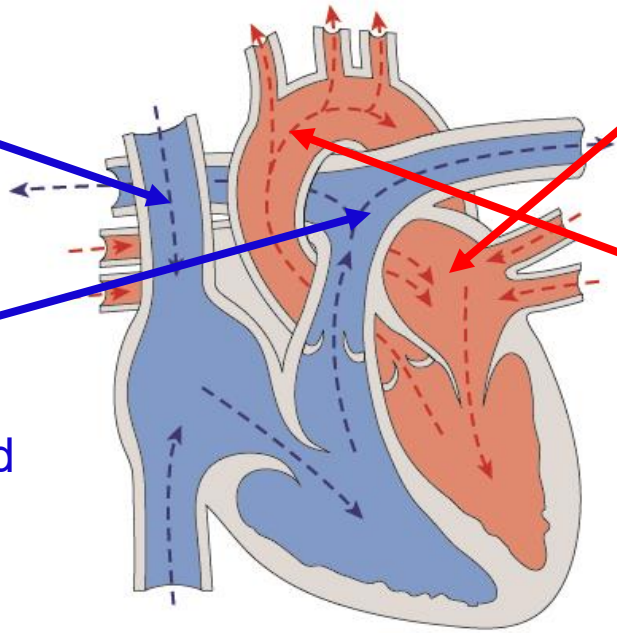
Main blood vessels

Vena Cava

Returns deoxygenated blood to the heart.

Pulmonary artery

Carries deoxygenated blood from the heart to the lungs.



Pulmonary vein

Returns oxygenated blood to the heart.

Aorta

Oxygenated blood is pumped at high pressure from the heart to the body

REMEMBER:

1. **Pulmonary circulation** – i.e. blood flow between the heart and lungs
2. **Systemic circulation** – i.e. movement of blood from the heart through the rest of the body (excluding the lungs), then back to the heart

Structure and function of the cardiovascular system

Other important structures of the cardiovascular system

Prevent blood flowing back into the left atrium.

Bicuspid valve

Prevent expelled blood flowing back into the heart.

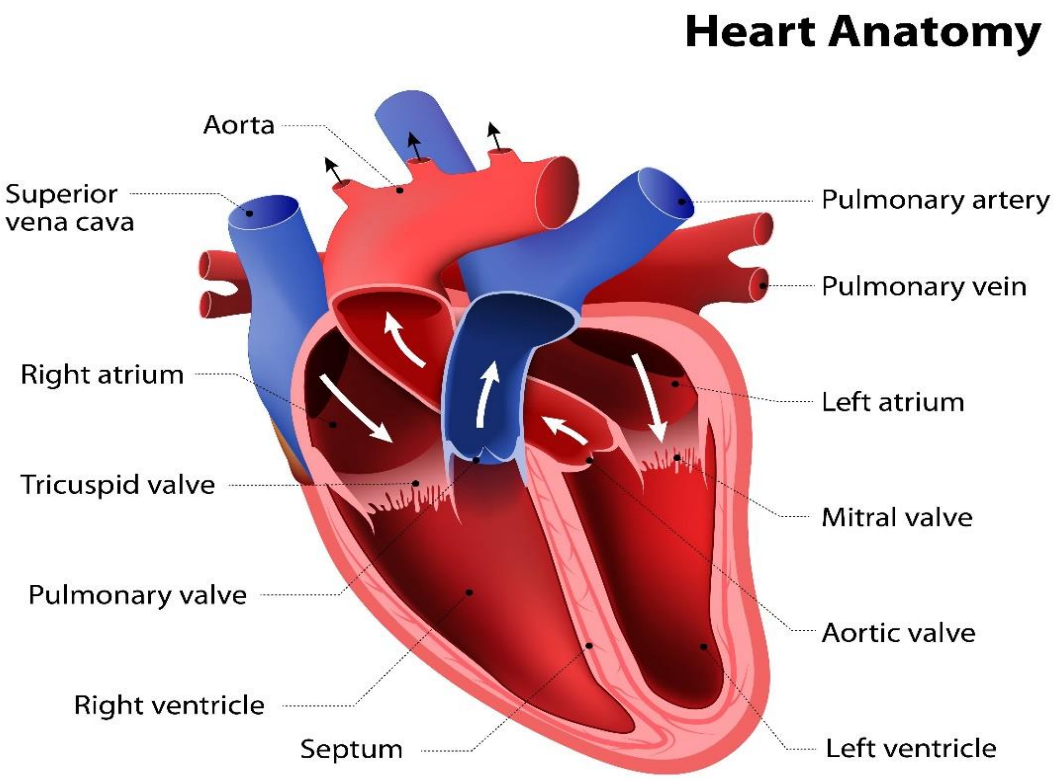
Semi-lunar valves

Prevent blood flowing back into the right atrium from the ventricle.

Tricuspid valve

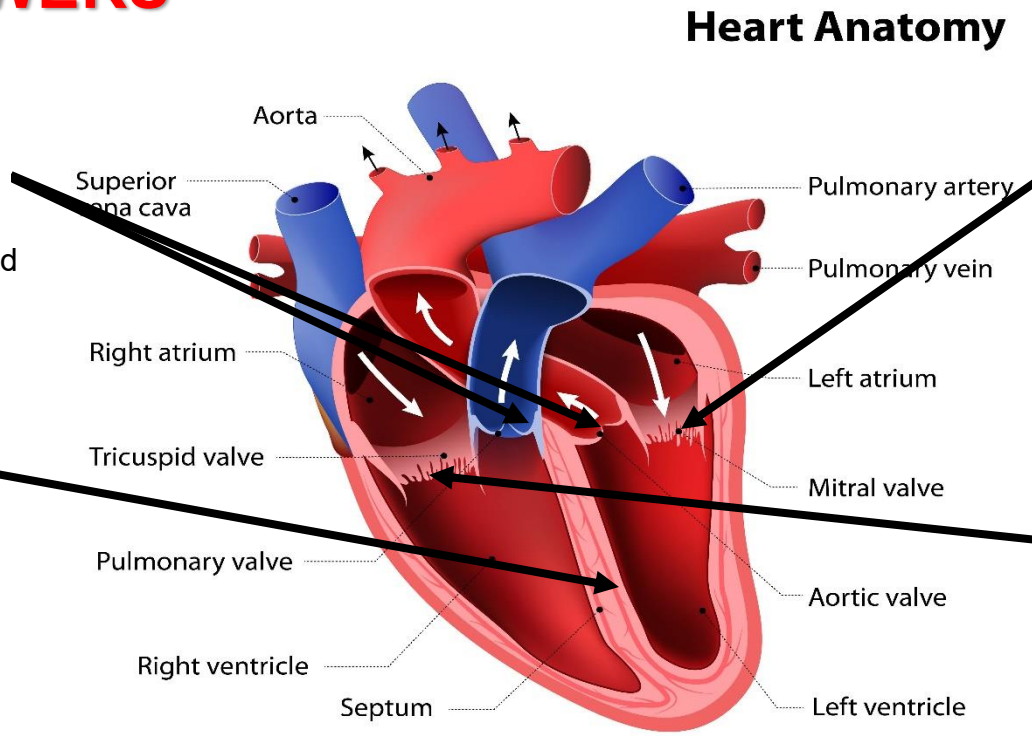
The wall dividing the left and right sides of the heart.

Septum



Structure and function of the cardiovascular system

The ANSWERS



Semi-lunar valves

Prevent expelled blood flowing back into the heart.

Septum

The wall dividing the left and right sides of the heart.

Bicuspid valve

Prevent blood flowing back into the left atrium.

Tricuspid valve

Prevent blood flowing back into the right atrium from the ventricle.

Structure and function of the cardiovascular system

The Cardiac Cycle

The heart makes two very important sounds:

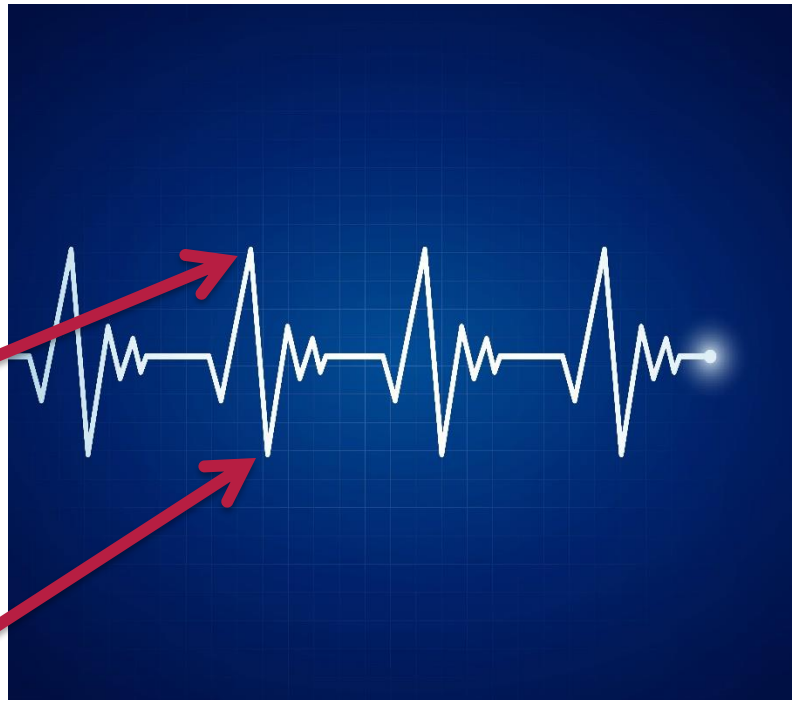
Lub / Dub!

The ***systole*** and ***diastole***.

Systole: The heart emptying.
The heart contracts

Diastole: The heart filling with blood.
The heart is relaxing

Remember this process starts in the right atrium and right ventricle moving to the left atrium and finally the left ventricle.



Structure and function of the cardiovascular system

Key Terms You NEED to know

Heart rate (HR)

The heart contracts and relaxes in a rhythm, which produces a heartbeat (started by an electrical impulse from the Sino-Atrial (SA) Node)

Measurement of the Heart Rate = Beats per Minute (HR=Bpm)

Average resting HR = 75bpm

Measuring Heart Rate:

- Done by checking the Radial Pulse
- Index and middle fingers on the palm side of the wrist just below the thumb.

TASK: Record your own Resting Heart Rate is it normal?

Structure and function of the cardiovascular system

Key Terms You NEED to know

Stroke Volume (SV):

The volume of blood pumped out of the heart by each ventricle during one contraction

Measurement of the Stroke Volume = milliliters per beat (ml per beat)

Cardiac Output (Q):

The amount of blood ejected from the heart (Left Ventricle) in one minute

Measurement of the Cardiac Output = litres/min

The higher the cardiac output, the more oxygen can be delivered to the muscles and the longer and harder the athlete can work

Interpreting heart rate data & graphs

Figure 2 below shows Freddie's cardiovascular and respiratory measurement taken at rest and during exercise.

Rest

Heart rate (bpm)	Stroke volume (ml)	Breathing rate (number per min)	Muscle temperature
72	60	18	Normal

During exercise

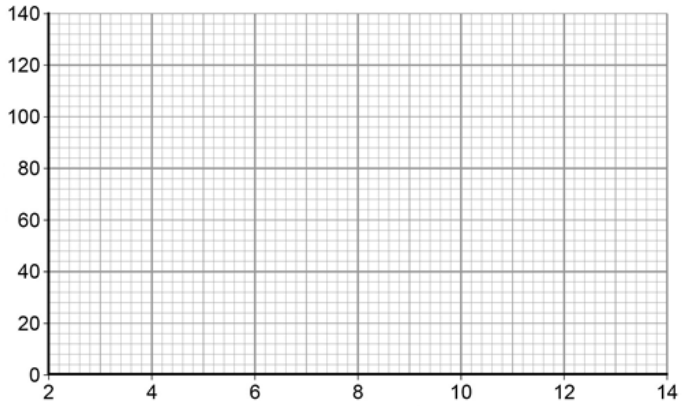
Heart rate (bpm)	Stroke volume (ml)	Breathing rate (number per min)	Muscle temperature
156	140	48	Hot

Describe what the tables tell you?
Discuss why these changes have taken place?

Interpreting heart rate data & graphs

TASK: Plot the information shown in the table on the graph paper below to show how heart rate has changed over time. Label the axes and join up the points to make a line graph.

Time (minutes)	2	4	6	8	10	12	14
Heart rate (beats per minute)	68	80	104	120	120	140	90



Describe what the graph tells you?

Extension Task:

A musical quiz on the circulatory system (Heart quiz)

https://www.youtube.com/watch?v=T2iVqTckmPQ

Structure and function of the Respiratory system

STRUCTURE AND FUNCTION OF THE RESPIRATORY SYSTEM

LEARNING OUTCOMES

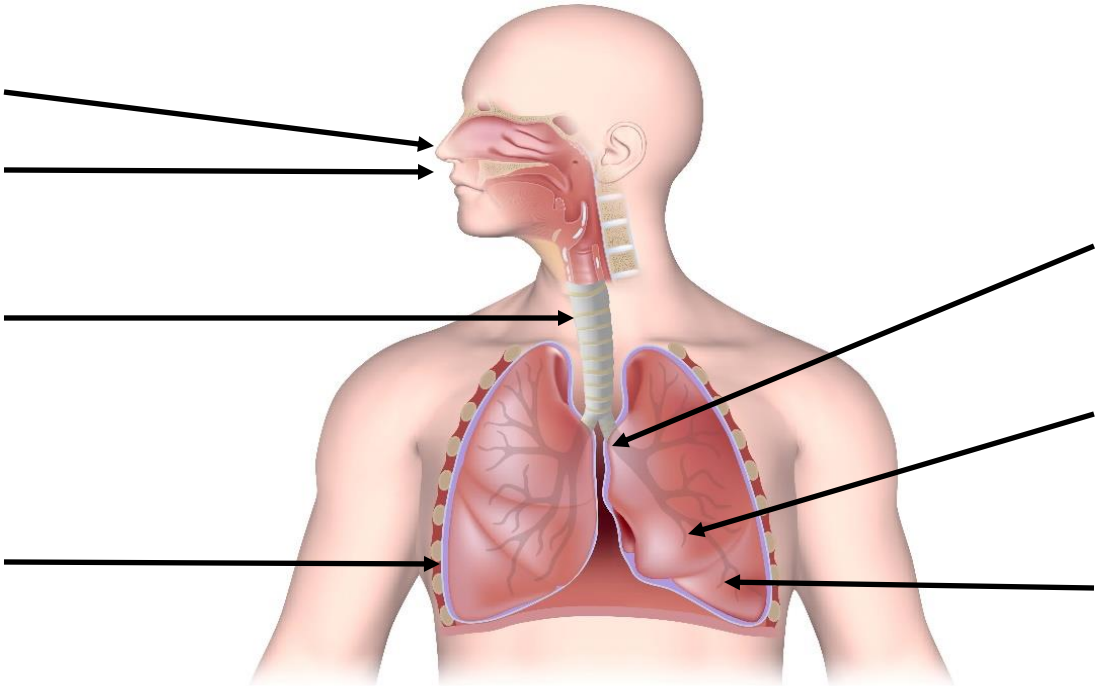
BY THE END OF THIS TOPIC YOU SHOULD …..

- **Understand the pathway of air through the respiratory system**
- **Know the role of respiratory muscles in breathing**
  - Diaphragm
  - Intercostals
- **Know the definitions of :**
  - Breathing Rate
  - Tidal Volume
  - Minute Ventilation
- **Understand about alveoli as the site of gaseous exchange**

Structure and function of the Respiratory system

The pathway of air

TASK: What do you already know? Can you label the diagram below?



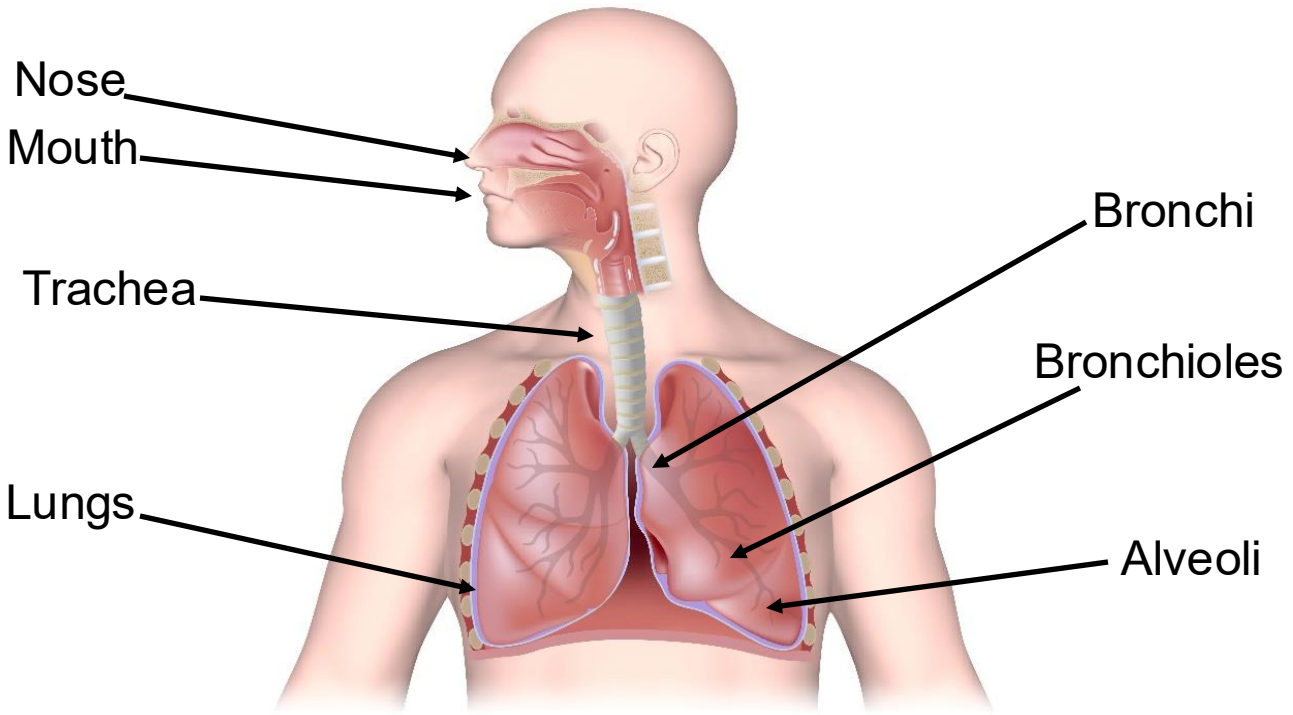
Structure and function of the Respiratory system

The pathway of air

Oxygen travels along the following pathway from the mouth/nose to the alveoli.

The Respiratory System has 2 main Functions:

1. **To ensure Oxygen is brought into the body**
2. **To ensure Carbon Dioxide is removed from the body**



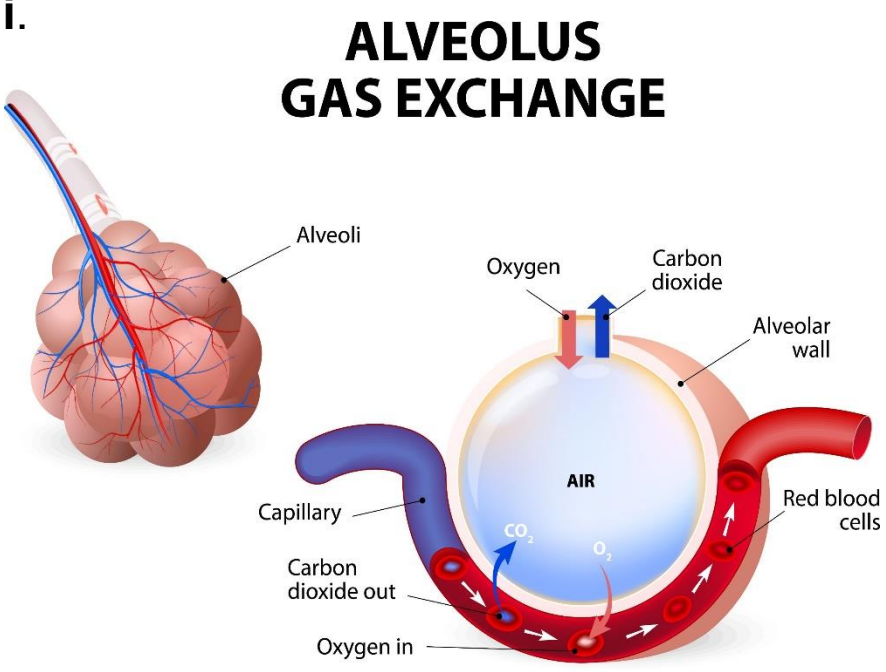
Structure and function of the Respiratory system

Gaseous exchange at the alveoli

Gaseous exchange takes places at the **alveoli**.

The alveoli are tiny air sacks inside the lungs.

When you breathe in, they fill with air.



<u>The following features assist the process of gaseous exchange:</u>

The alveoli are covered in **tiny capillaries** (blood vessels).

Gases can pass through the thin walls and travel into the blood stream.

With training this process of gaseous exchange becomes more efficient and therefore improves performance

Structure and function of the Respiratory system

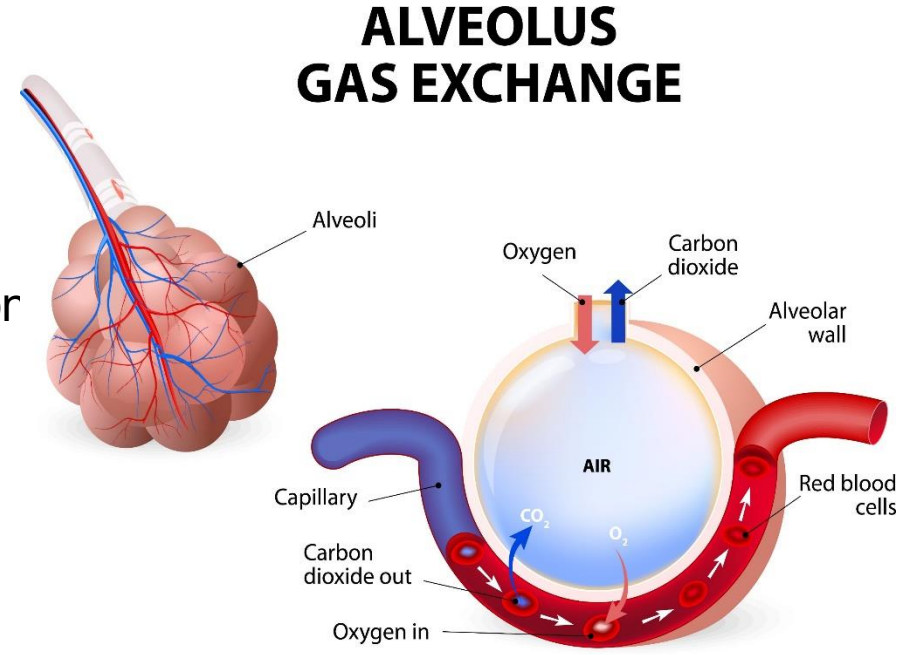
Gaseous exchange at the alveoli

A large blood supply. An increased red blood cell content increases the amount of oxygen supplied to muscles and other body tissues.

Oxygen combines with the red blood cells to form ***oxyhaemoglobin***.

The same haemoglobin also transports carbor dioxide back from the tissues to the lungs.

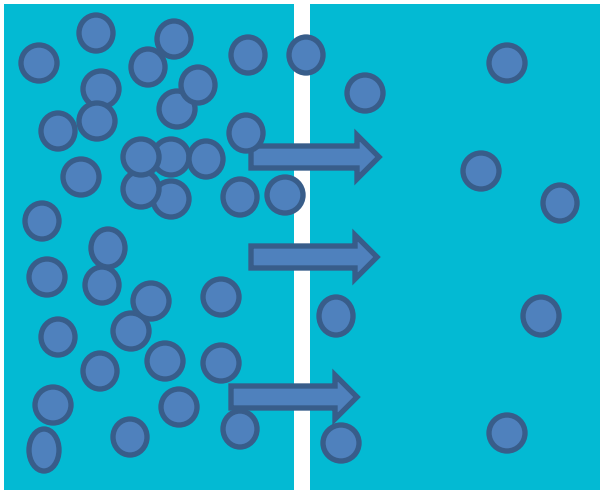
- **Capillaries are very near to alveoli, so diffusion distance is very short.**
- **Large surface area of alveoli allows diffusion to take place.**
- **Moist thin walls (one cell thick) of the cells promotes quick diffusion.**

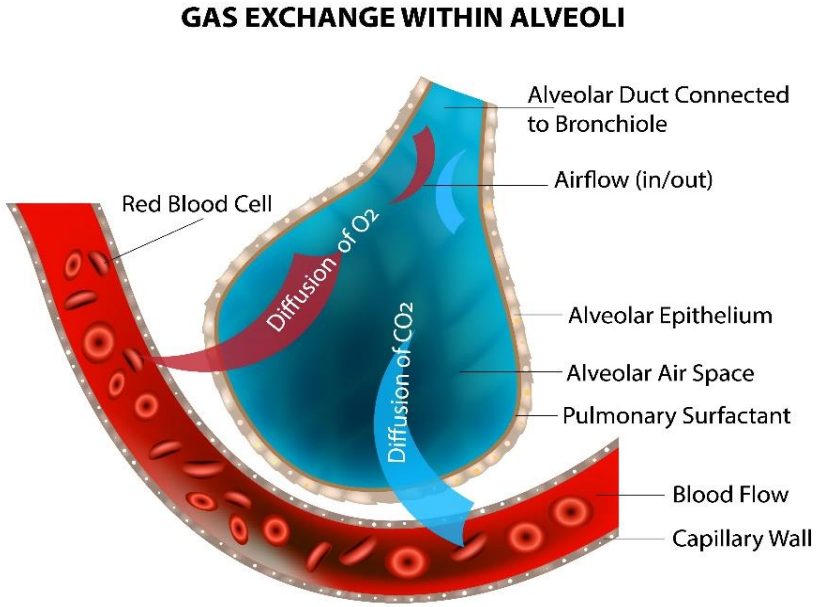


Structure and function of the Respiratory system

Gaseous exchange at the alveoli

- Gases will always move from areas of high concentration to areas of a low concentration.





Alternatively think of it as….
A gas will always move from areas where there is more of it, to areas where there is less of it

Structure and function of the Respiratory system

The mechanics of breathing

Breathing is the first stage in supplying oxygen to our body cells.

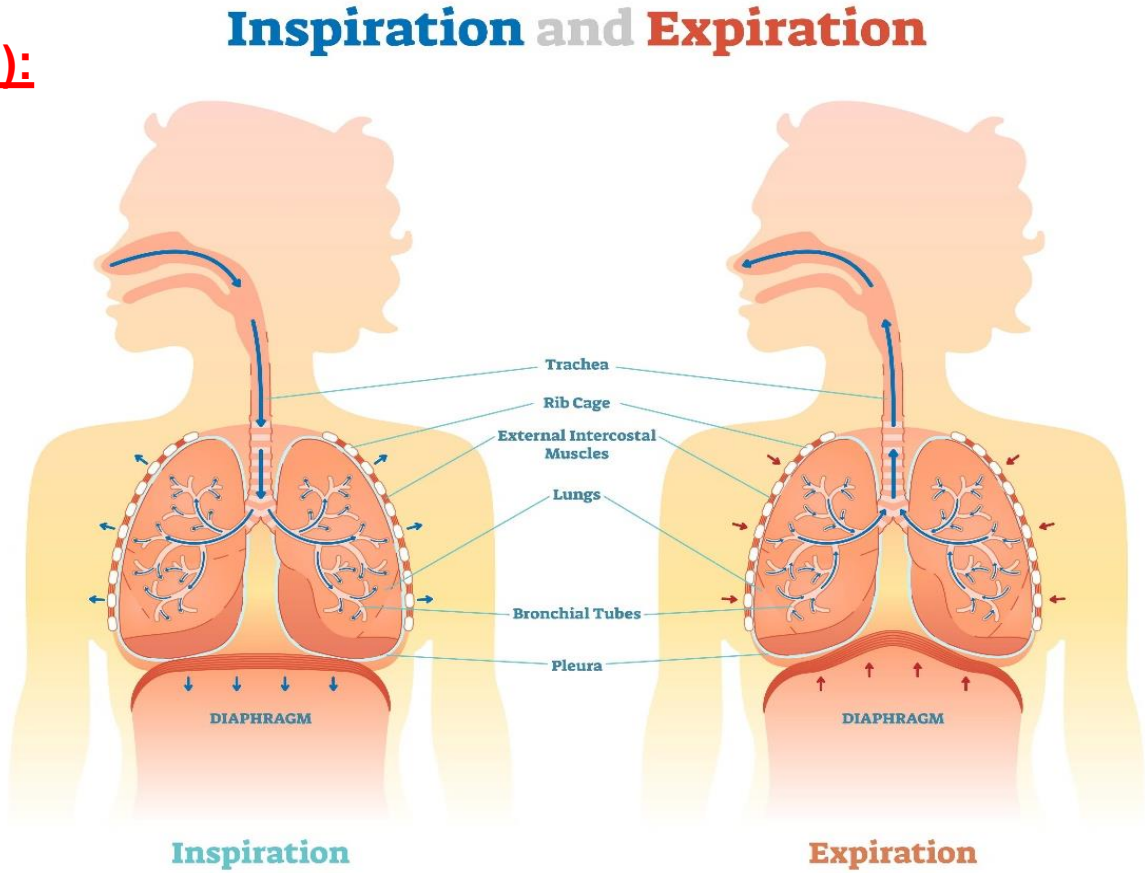
When breathing in (inspiration):

The intercostal muscles contract, lifting the ribs upwards and outwards causing the chest to expand.

The diaphragm contracts. It pulls down and flattens out the floor of the rib cage.

The lungs increase in size as the chest expands.

The pressure inside our lungs falls as they expand. The higher higher pressure of air outside means air is now sucked into the lungs through the nose and mouth.



Structure and function of the Respiratory system

The mechanics of breathing

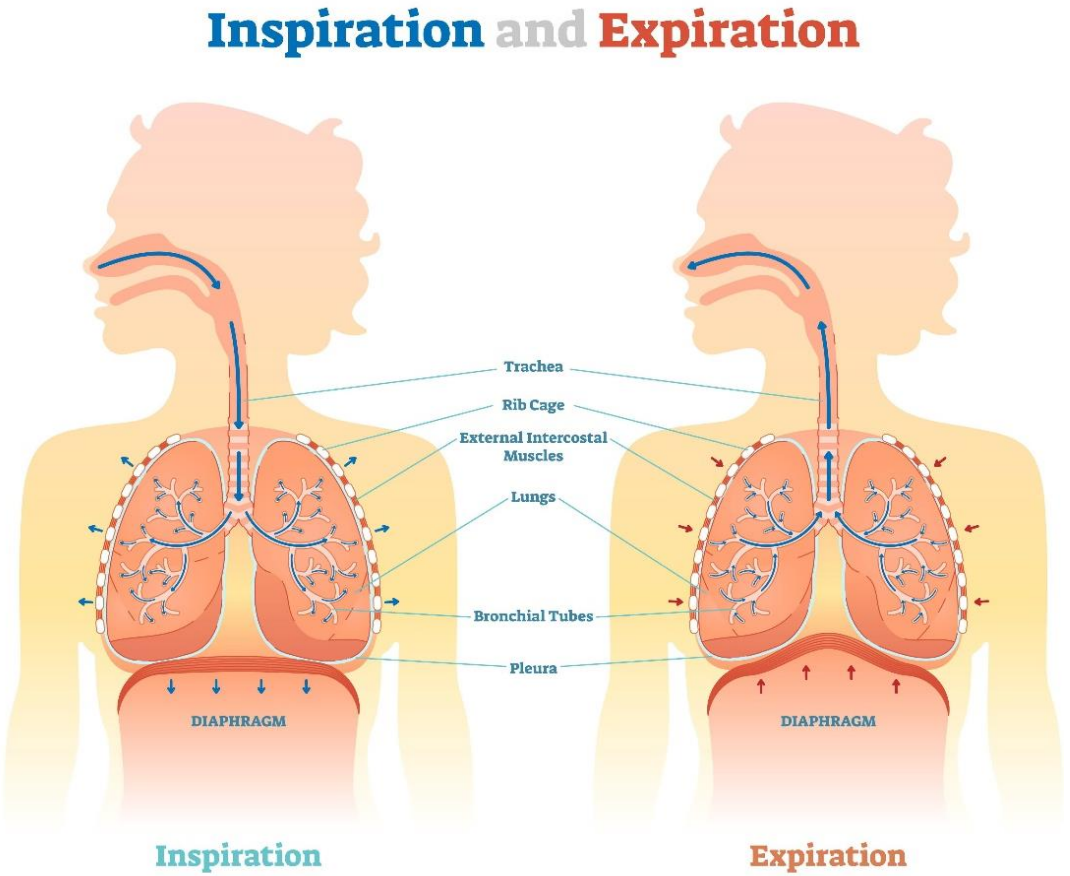
When breathing out (expiration):

The intercostal muscles relax. The ribs move downwards and inwards under their own weight. The cheat gets smaller.

The diaphragm relaxes. It is pushed back into a domed position by the organs underneath it.

The lungs decrease in size as the chest gets smaller. They are squeezed by the ribs and diaphragm.

The pressure inside the lungs increases as they get smaller. The air pressure outside is now lower than in our lungs. Air is forced out of the lungs through the nose and mouth.



Structure and function of the Respiratory system

Tidal Volume

The volume of air inspired or expired per breath.
This increases during exercise.

Breathing Rate

The number of breaths per minute.
The typical respiratory rate for a healthy adult at rest is 12-20 breaths per minute.

Minute Ventilation

The minute ventilation is the amount of air a person breaths in a minute.
This is calculated using the following equation:

Minute ventilation = Tidal Volume x Respiratory Rate.

TASK:
Look at the two tidal volume readings below.
What changes have taken place and why?

Name	Tidal volume at rest (ml)	Tidal volume during exercise (ml)
James	500	3500

Tidal volume:

This is the amount you breathe in and out in one normal breath.

Structure and function of the Respiratory system

Breathing volumes and exercise

Name	Tidal volume at rest (ml)	Tidal volume during exercise (ml)
James	500	3500

Exercise causes an increase in breathing rate and depth of breathing.

This is due to a greater need for oxygen in the body and removal of carbon dioxide. .

Tidal volume can increase up to 5-9 times during exercise.

At rest = 0.5L
During jogging = 3L

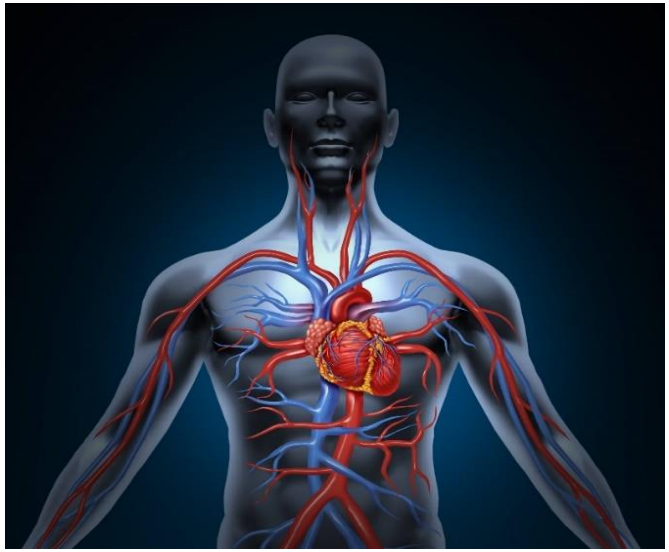
Structure and function of the Respiratory system

Cardiovascular and respiratory System

Responses by the respiratory and cardiovascular system do not work in isolation.

The demands of exercise cause changes in both systems and one cannot work without the other.

i.e. An increase in breathing rate means more oxygen is inhaled and can only benefit the body if heart rate increases too to pump more blood to working muscles.



Aerobic & anaerobic Respiration

AEROBIC AND ANAEROBIC EXERCISE

LEARNING OUTCOMES

BY THE END OF THIS TOPIC YOU SHOULD …

- **Know the definitions of:**
  - Aerobic Exercise
  - Anaerobic Exercise
- **Be able to apply practical examples of aerobic and anaerobic activities in relation to intensity and duration.**

Aerobic & anaerobic Respiration

Aerobic Vs Anaerobic

Aerobic Activity **Working WITH Oxygen**

When the demand for oxygen does not overwhelm the body and we are able to supply the working muscles with the oxygen needed to release the required energy for the exercise.

glucose → energy + carbon dioxide + water

Anaerobic Activity **Working WITHOUT Oxygen**

Maximal Effort: When we work at this rate it is not possible to supply the muscles with oxygen they need to release energy for the exercise, so we work without oxygen **anaerobically** and repay the **OXYGEN DEBT** once the exercise is complete (Lactic Acid)

Example: (Short, Sharp, Powerful Movements) e.g. Javelin Throw, Shot Putt, 100m Sprint, etc…

glucose → energy + lactic acid

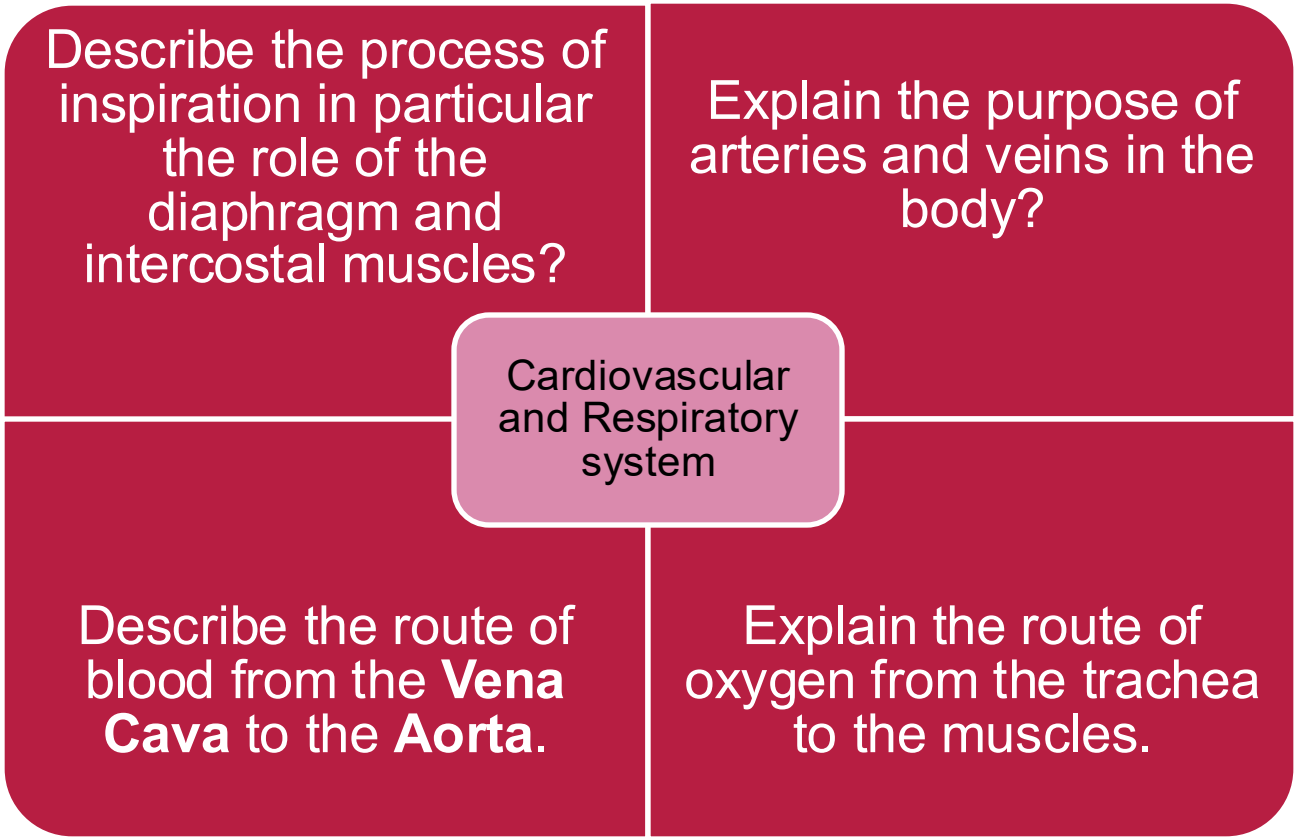
Aerobic & anaerobic Respiration

Anaerobic and Aerobic exercise

TASK: Which respiration system do you think the follow sportspeople mainly use?

Aerobic & anaerobic Respiration

Extension Task



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