Unit 1.1.d - The cardiovascular and respiratory system

For this unit you need to be able to...

Learning Outcomes:	Covered?	Confident?
Understand and be able to give sporting examples of when each respiratory system might be used (7-8)		
Understand the structure of the respiratory system, the difference between aerobic and anaerobic respiration and the mechanics of breathing (5-6)		
Define the terms 'heart rate', 'cardiac output' and 'stroke volume' ***and*** describe the differences between veins, arteries and capillaries (3-4)		
Identify and label the components of the heart (1-2)		

Name: XXXX

The Cardiovascular System

Starter Activity - First thoughts:

What does cardiovascular stand for?

Cardiovascular relates to the heart and blood vessels.

What is the Cardiovascular System made up of?

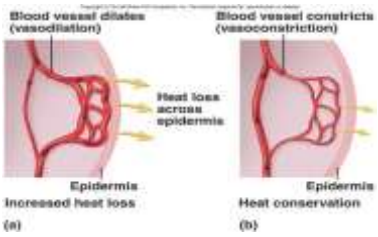
The heart, blood vessels and blood.

Why is the Cardiovascular system so important?

It transports oxygen and important nutrients around our body.

How many functions does the Cardiovascular System have?

2 main functions



The 2 functions of the system

1. Transportation:

Blood carries essentials – oxygen and nutrients to the muscles and vital organs.

- Oxygen is important as our muscles need it to work.
- Blood also carries carbon dioxide and other waste materials to the lungs, kidneys, and digestive system to be removed from the body.

2. Temperature Control:

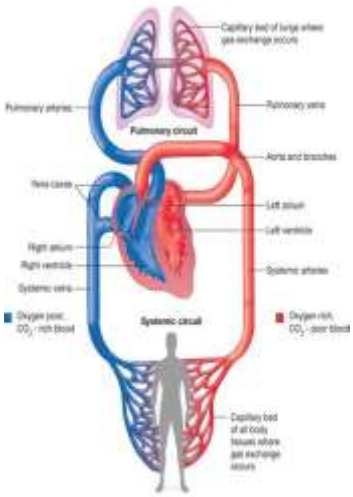
Blood transfers heat around the body so that we do not overheat during exercise or become too cold.

- When it's too hot: blood vessels supplying blood to the skin can swell or dilate (vasodilation). This allows more warm blood to flow near the surface of the skin, where the heat can be lost to the air. This is why some people's skin looks redder when they feel too hot.

- But when it's too cold: the blood vessels supplying warm blood to the skin become narrow or constrict (vasoconstriction). This reduces the flow of warm blood near the surface of the skin, and reduces heat loss. This is why some people's skin looks paler when they feel too cold

The heart operates a double circulatory system in which blood flows through the heart twice.

Pulmonary Circulation: This is blood flow between the heart and the lungs. The pulmonary artery takes the deoxygenated blood to the lungs where it is oxygenated.
Systemic Circulation: This is oxygenated blood flow from the heart to the rest of the body (excluding the lungs) and then returns deoxygenated blood back to the heart.



Blood Vessels

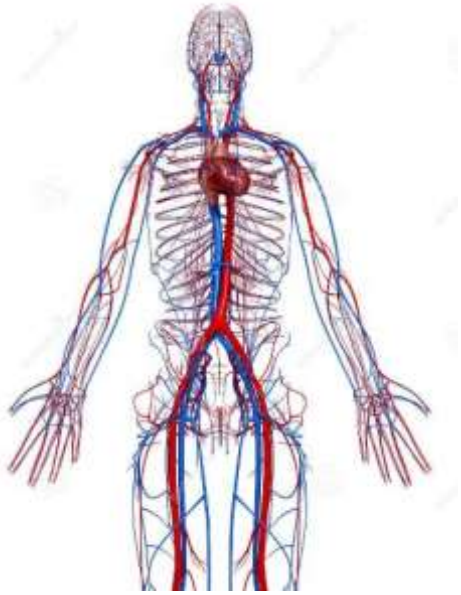
When the blood leaves the heart it is transported around the body in three main types of blood vessels.

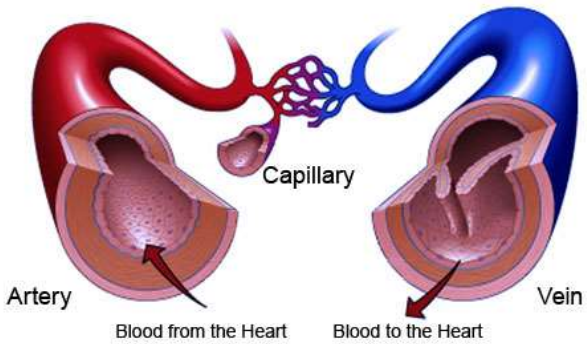
Blood Vessel:	Function/Role:	Characteristics:
Arteries	Transports oxygenated blood away from the left side of the heart, through the aorta. This occurs at a high pressure. Small internal diameter (lumen – space inside where the blood is)	• They have thick, muscular and elastic walls adapted for carrying blood at very high pressures. • Pressure increases during exercise as the working muscles demand more oxygen increasing blood flow • Muscles in the walls contract and relax automatically • Muscle in the walls relaxes – dilate – so there is more room for the oxygenated blood to travel through to the working muscles • Muscles in the walls contract – constrict - so there is less blood being carried to inactive areas of the body
Veins	• Capillaries feed the veins, which carry deoxygenated blood from the muscles back to the heart, to be re-oxygenated. • This is important to ensure the cycle continues as well as making sure our body gets rid of waste products. • It works at a low pressure. • Large internal diameter (lumen)	• Wide internal diameter allows blood to pass through more easily • Thinner walls and less muscle • Valves, help return blood to the heart by preventing backflow due to low pressure. (due to gravitational pull)

Capillaries	• Links smaller arteries with smaller veins • Where blood becomes de-oxygenated the blood will flow at very low pressure • Allows gaseous exchange **Activities happen at both ends:** Diffuse the oxygen to the muscles Carbon dioxide diffuses into the blood	• Walls are very thin (once cell thick, semi-permeable) to allow gases and nutrients to pass through them. • Small internal diameter

Task: Next to the following statements write whether you think arteries, veins or capillaries are being described. Do this without looking at your notes.

Statement:	Arteries, veins or capillaries:
Their role is to carry oxygenated blood at high pressure away from the heart through the aorta	Arteries
Their role is to link arteries to the veins and allow oxygen and carbon dioxide to pass through their walls	Capillaries
Their role is to carry deoxygenated blood back to the heart	Veins
They have thin walls	Veins
They carry blood under high pressure	Arteries
They have valves	Veins
They contain blood under pressure	Capillaries
The do not have valves	Capillaries and Arteries
They are only one cell thick	Capillaries
They have thick, muscular, elastic walls	Arteries





Blood Flow During Exercise

During exercise, blood flow to the 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 a vascular shunt.

Exam question: Using examples, describe what is meant by the term 'blood shunting'. (3 marks)

This is the term for the process when blood flow to different parts of the body is altered. When an athlete performs exercise the blood flow to the muscles increase as the demand for oxygen has increased. For example when a cyclists peddles they use the muscles in their legs a lot, in order to keep using those muscles the body will redirect the blood flow to the area needing oxygen (the legs). This redirection is called a vascular shunt.

The Structure of the Heart

Semi-lunar Valves:

Prevent expelled blood flowing back into the heart.

Aorta:

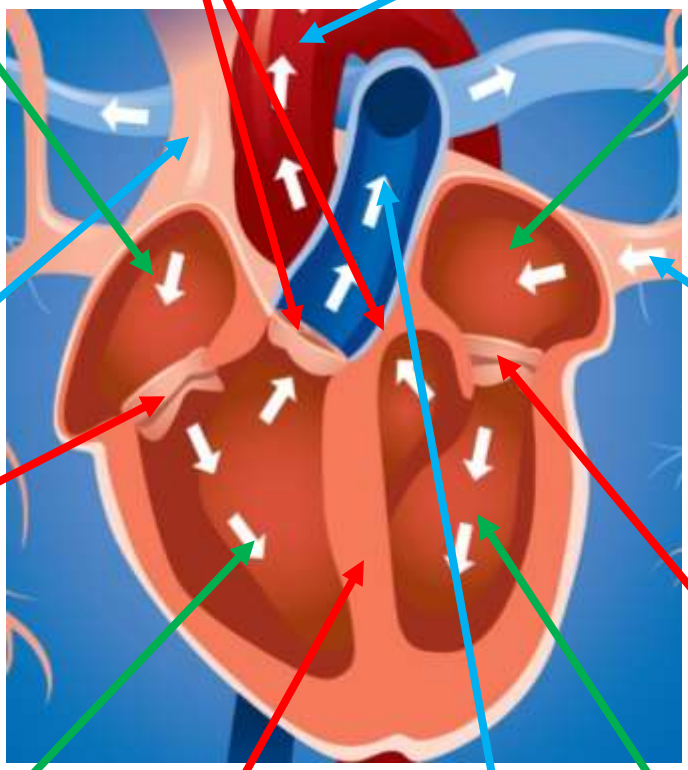
Carries oxygenated blood which is pumped through at high pressure from the heart to the body.

Right Atrium:

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

Left Atrium:

An upper chamber receiving oxygenated blood from the lungs.



Vena Cava:

Returns de-oxygenated blood to the heart.

Pulmonary Vein:

Returns oxygenated blood to the heart.

Tricuspid Valve:

Prevent blood flowing back into the right atrium.

Bicuspid Valve:

Prevent blood flowing back into the left atrium.

Right Ventricle:

A lower chamber containing de-oxygenated blood.

Septum:

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

Pulmonary Artery:

Carries de-oxygenated blood from the heart to the lungs.

Left Ventricle:

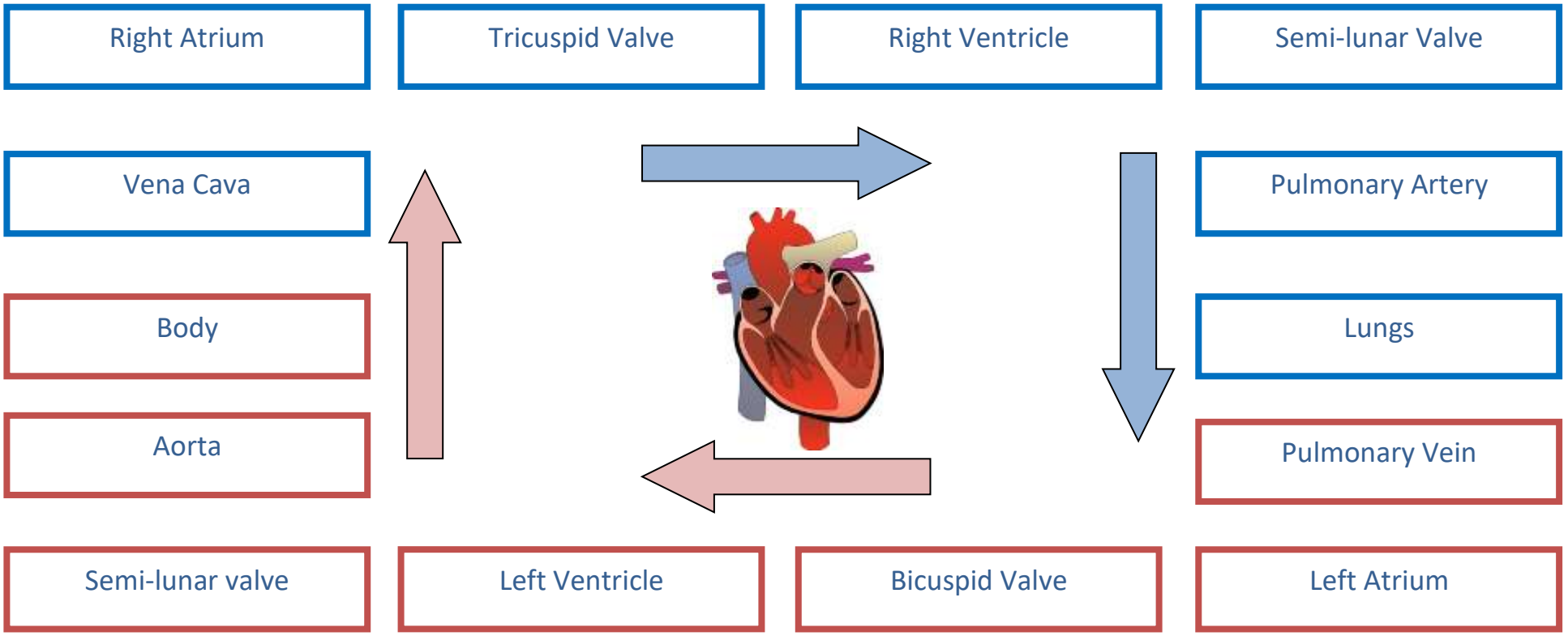
A lower chamber containing oxygenated blood.

The Cardiac Cycle and the Pathway of the Blood

The filling of the heart follows a particular sequence. This process starts in the right side of the heart. There are two stages to each heart beat.

1. Diastole – The heart filling with blood. The heart is relaxing.
2. Systole – The heart is emptying. The heart contracts.

Task: Complete the correct pathway of the blood below.



Question:
1) What makes the pulmonary artery different from all other arteries?
It is the only artery in the body that carries deoxygenated blood.

2) What makes the pulmonary vein different to all other veins?
It is the only vein that carries oxygenated blood.

The Role of Red Blood Cells

Red blood cells carry oxygen from the lungs to the muscles and removes carbon dioxide from the muscles to the lungs.

They contain haemoglobin which bonds with oxygen to form oxyhaemoglobin. These cells carry oxygen to the working muscles. Without these cells performers would fatigue and stop.

Task: How do the red blood cells help a sports performer? Choose one of the sporting examples below and explain.

Red blood cells are extremely important for a marathon runner. Since the marathon runner constantly uses their legs for a long period of time, the lower half of the body will need more oxygen. Without the blood cells the oxygen inhaled would not reach the leg muscles causing quick fatigue and will result in the athlete stopping. Therefore a marathon runner needs red blood cells to carry the oxygen down to the legs in order to help them withstand the log period of work.

Cardiovascular

Terms

You need to know the following terms.

Heart Rate: The number of beats per minute.

Stroke Volume: The amount of blood pumped out of the left ventricle per beat.

Cardiac Output: The amount of blood pumped out of the left ventricle per minute.
Heart Rate x Stroke Volume = Cardiac Output

Interpreting Heart Rate Data and Graphs

Task: View the data in the tables from when Jamie is at rest and exercising. In the box below describe what the tables tell you. Discuss why these changes have taken place.

Heart Rate (bpm)	Stroke Volume (ml)	Breathing Rate (per min)	Muscle Temperature
64	60	17	Normal

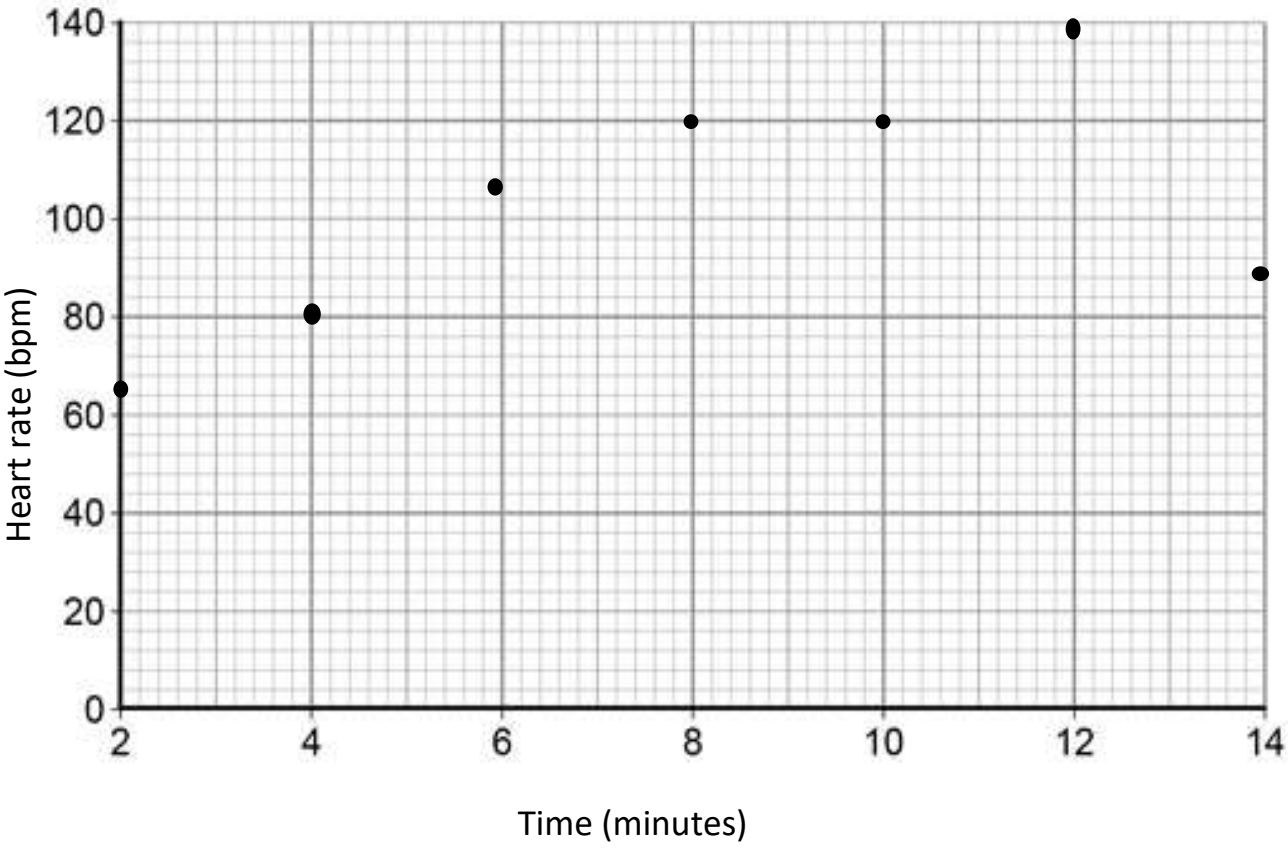
Heart Rate (bpm)	Stroke Volume (ml)	Breathing Rate (per min)	Muscle Temperature
152	140	46	Hot

As Jamie starts to do exercise his heart rate, stroke volume, breathing rate and muscle temperature increases. These changes take place because the heart has to pump more oxygenated blood around the body to the muscles in need, this helps to ensure they continue working and don't get fatigued. To do this your heart can increase the frequency of the pump as well as increasing its stroke volume by pumping more forcefully or increasing the amount of blood that fills the left ventricle before it pumps. Since the body needs more oxygen the breathing rate must increase in order to inhale more oxygen, hence why both heart rate and breathing rate increases. The muscle temperature increases because the blood vessels supplying blood can swell or dilate (vasodilation) as more blood is being circulated. This allows more warm blood to flow near the surface of the skin, where the heat can be lost to the air.

Interpreting Heart Rate Data and Graphs

Task: Plot the data shown in the table in your workbook to show how Jamie's heart rate has changed over time. Label the axes and join up the points to make a line graph. In the box below describe what the graph tells you.

Time (Minutes)	2	4	6	8	10	12	14
Heart rate (bpm)	66	80	106	120	120	140	90



From 2 minutes to 8 minutes Jamie built up in intensity of work (increasing intensity of exercise). From 8 minutes to 10 minutes he worked at the same consistent intensity. At 12 minutes he increased his work to a high intensity meaning his muscles needed more oxygen hence why his heart rate has increased. Finally at 14 minutes he has slowed down his heart rate as he has decreased the level of intensity resulting in his muscles needed less oxygen.

Mini quiz – Cardiovascular System

1. State 3 differences between veins and arteries.

Veins bring blood back to the heart; arteries take blood away from the heart.
Arteries carry blood at high pressure; veins carry blood at low pressure.
Veins have valves but arteries don't.

2. What structure divides the heart into two halves?

The septum.

3. Where are the tricuspid valves found?

On the right side of the heart between the right atrium and right ventricle

4. What is the function of valves?

To prevent the back flow of blood.

5. Name the 4 chambers of the heart.

The right atrium, left atrium, right ventricle and left ventricle.

6. Name the 4 major blood vessels.

Vena cava, Pulmonary artery, Pulmonary vein and Aorta

7. Define stroke volume.

The amount of blood leaving the left ventricle per beat.

8. What is the equation for cardiac output?

Heart rate x stroke volume = cardiac output.

9. Does cardiac output increase or decrease during exercise? Why?

Increases because of the increase in demand of oxygen for the working muscles.

10. What is the role of red blood cells?

To carry oxygen and carbon dioxide. Red blood cells take oxygen to the working muscles allowing us to exercise and not fatigue.