

Circulatory system

Level 2 Anatomy and physiology
for exercise and fitness instructors

Learning outcomes

By the end of this session you will be able to:

- Identify the location and function of the heart
- Describe the structure of the heart
- Describe how blood moves through the four chambers of the heart
- Describe systemic and pulmonary circulation

Learning outcomes

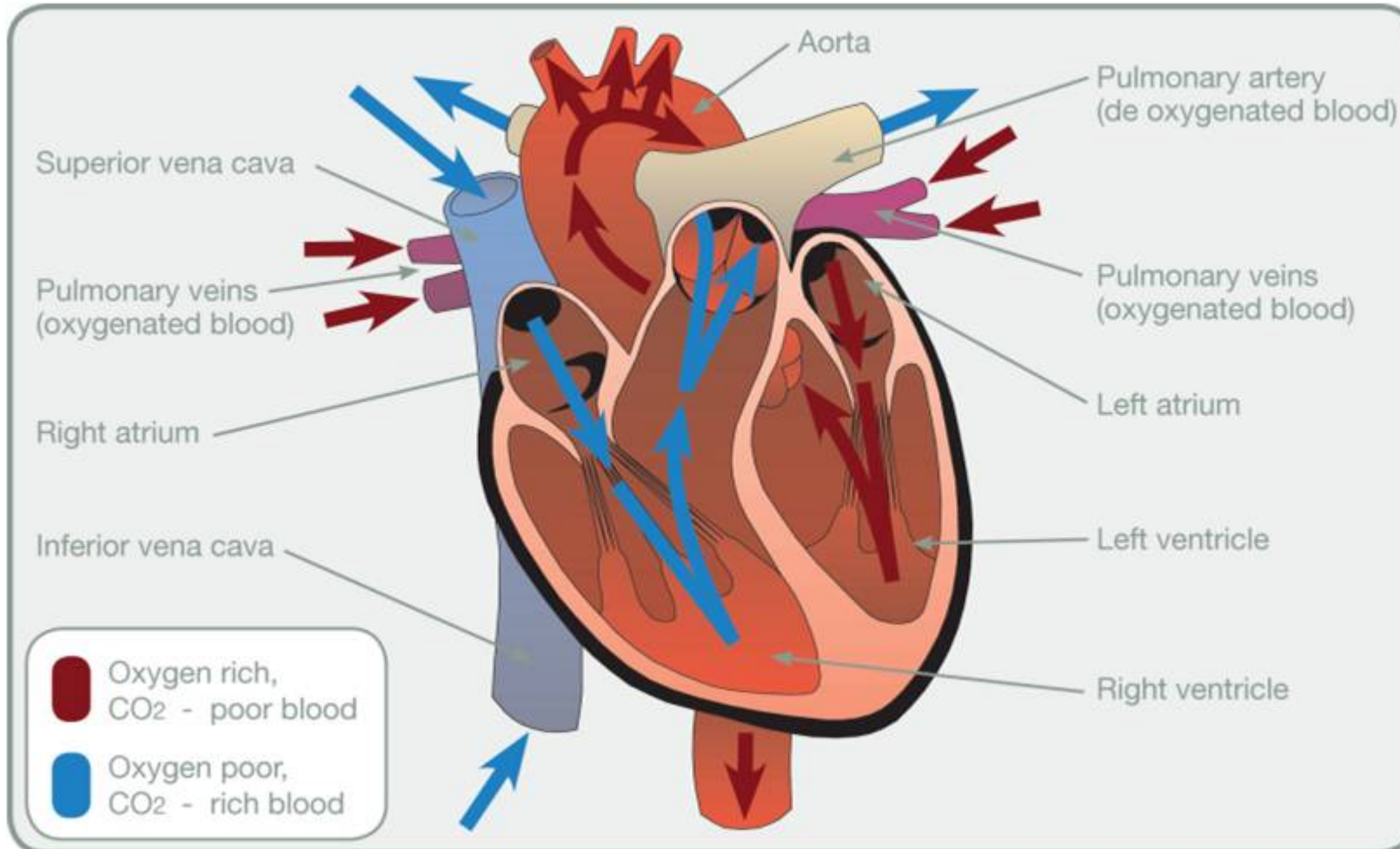
By the end of this session you will be able to:

- Describe the structure and functions of blood vessels
- Define blood pressure
- Identify blood pressure classifications

The Heart

- Located in the chest, slightly to the left
- About the size of an adult clenched fist
- A muscular pump that circulates blood around the body
 - Circulates oxygen and nutrients to the body within the blood
 - Circulates carbon dioxide and waste products to be expelled from the body within the blood
- Heart walls formed from cardiac muscle (myocardium)

The Heart



The Heart

Two halves

- Right, deoxygenated blood
- Left, oxygenated blood

Four chambers

- 2 upper collecting chambers – atria
- 2 lower pumping chambers – ventricles

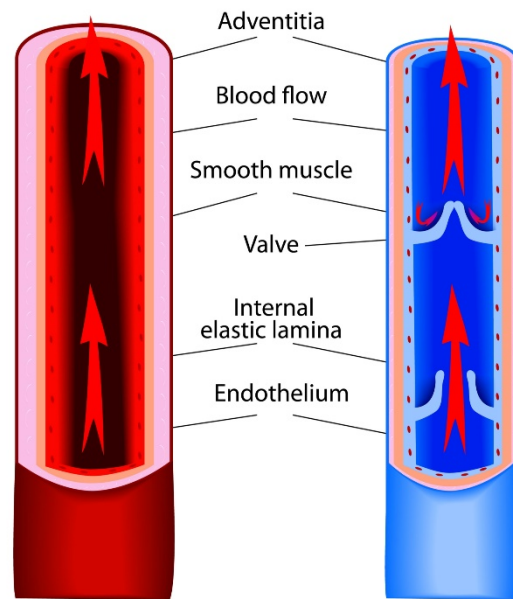
The Heart

- Atria are smaller than the ventricles and have less muscular walls
- The left ventricle has thicker, more muscular walls than the right ventricle to enable it to pump blood to the body via the aorta
- Valves ensure the flow is one way
- Coronary arteries supply the heart muscle with oxygenated blood

The Heart

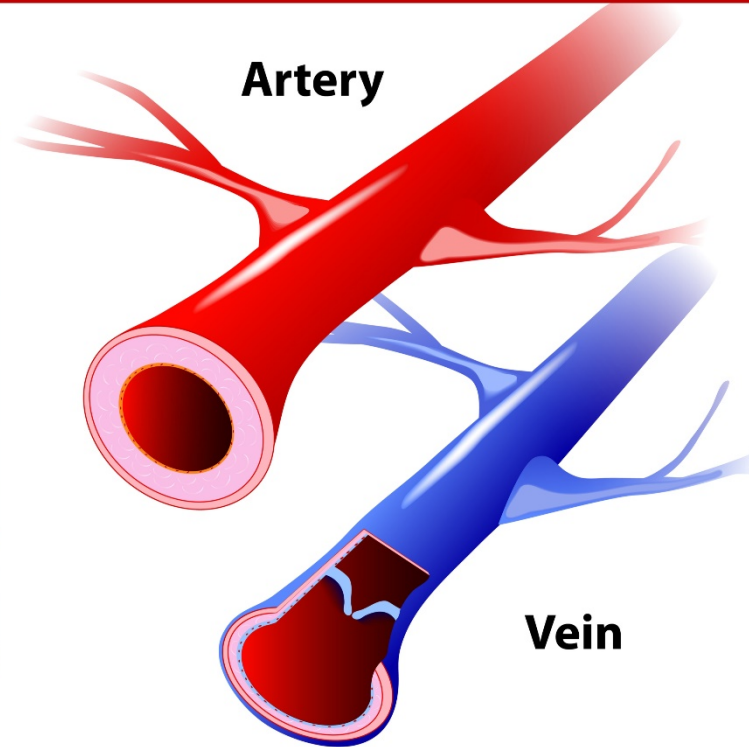
- Atrioventricular valves (tricuspid valve and bicuspid or mitral valve)
- Semilunar valves (pulmonary valve on right and aortic valve on left)
- Sinoatrial valve - the pacemaker of the heart which initiates the heartbeat

ARTERY AND VEIN



Artery

Vein



Arteries

- Arteries carry oxygenated blood away from the heart supplying vital organs and tissues*

Remember 'A' = 'A'way

- Thicker, smooth muscular wall to allow blood to be shunted around the body
- Dealing with blood under high pressure
- The aorta is the major artery that carries blood from the left ventricle to the body

* except for the pulmonary artery - transports deoxygenated blood from the heart to the lungs

Arteries

The vena cava has two branches (inferior and superior) and returns blood from the body back to the right atrium

The pulmonary veins return blood back to the left atrium

Arterioles are smaller versions of arteries

Veins

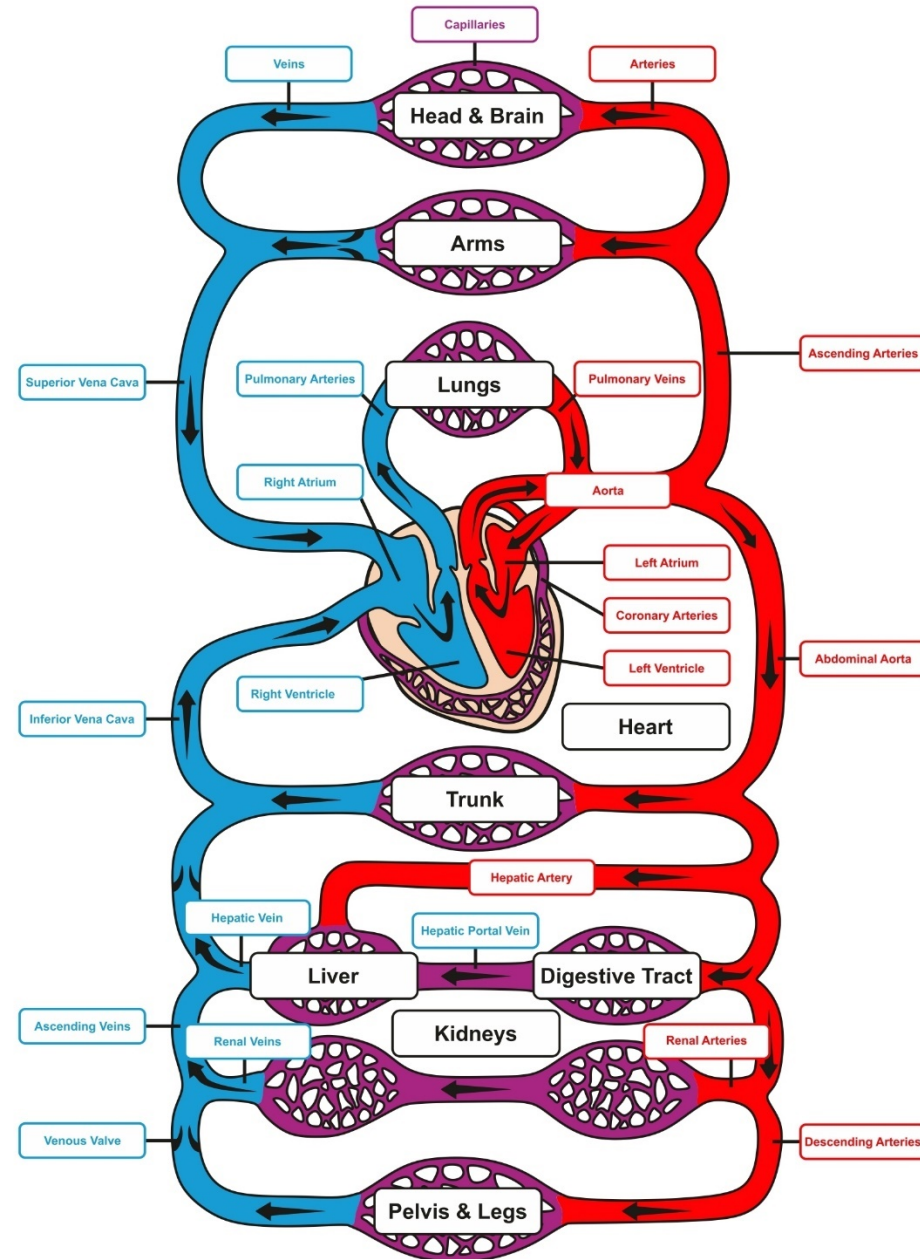
- Veins carry deoxygenated blood back towards the heart*
- Remember 'Ve-in' = 'way in'**
- Thinner, less muscular wall
 - One-way return valves to assist blood flow back to the heart and prevent back flow
 - Require the assistance of skeletal muscle to help venous return
 - Venules are smaller versions of veins

* except for the pulmonary vein – transports oxygenated blood from the lungs to the heart

Capillaries

- Arteries become smaller to form arterioles which link to capillaries
- Capillaries are one cell thick to allow gaseous exchange
- From the capillaries venules take blood into the veins, into the Vena Cavae

Blood Circulatory System



Blood flow through the heart

- The atria receive blood from the body or lungs
- The ventricles pump blood to the body or lungs
- The left atrium receives oxygenated blood from the lungs via the pulmonary veins
- The right atrium receives blood from the vena cava
- The left ventricle pumps oxygenated blood through the aorta to the rest of the body
- Two large veins (inferior and superior vena cava) return de-oxygenated blood from the body to the right atrium
- When the right ventricle contracts, de-oxygenated blood is pumped to the lungs via the pulmonary arteries

Cardiac cycle

The cardiac cycle is the sequence of events in one beat of the heart (the alternate contraction and relaxation of the heart)

- Systole - the contraction phase which causes a volume of blood to be pumped to the arteries
- Diastole - the relaxing phase - blood flows into the heart from the veins

Heart rate

A healthy adult resting heart rate is between 60–80 beats per minute (bpm)

A well-conditioned individual may have a resting heart rate of around 35–50 bpm

The heart is a muscle and, just as skeletal muscles get stronger when exercised, so does the heart.

Stroke volume

The stroke volume is the amount of blood pumped by a ventricle per heartbeat

A normal stroke volume at rest is between 70–80ml per beat

In well-trained individuals, it may be 100–110ml per beat

During exercise, the stroke volume increases. In well-trained individuals, values as high as 200ml per beat have been recorded.

Cardiac output

Cardiac output is the amount of blood pumped out by the ventricles in one minute

During exercise, cardiac output must increase to meet the body's demand for oxygen

Cardiac output = stroke volume x heart rate

If an average stroke volume is 71ml, and an average resting heart rate is 70 bpm, cardiac output = $71 \times 70 = 4,970$ ml per minute, or nearly 5 litres of blood

Pulmonary and systemic circulation

Pulmonary circulation

- The flow of blood from the right side of the heart to the lungs and then back to the left side of the heart
- Lower pressure

Systemic circulation

- The flow of blood from the left side of the heart to all parts of the body
- Higher pressure

Blood pressure

- The measure of force against the artery walls
- Produced by the contraction of the heart
- Systolic blood pressure is the pressure in the arteries during ventricular contraction
- Diastolic blood pressure is the pressure in the arteries during ventricular relaxation
- Regular exercise can lead to the reduction or normalising of high blood pressure

Blood pressure

Hypotension is low blood pressure - 90/60mmHg or less

Pre-hypertension (elevated blood pressure) above 120/80 mmHg but below 140/90 mmHg

Hypertension is high blood pressure - 140/90mmHg or higher

Stage 1,2 and 3 hypertension

Blood pressure – NICE guidelines

Stage 1 hypertension

140/90 mmHg or higher

Stage 2 hypertension

160/100 mmHg or higher

Severe hypertension

Systolic blood pressure is 180 mmHg or higher, or diastolic blood pressure is 110 mmHg or higher

Blood pressure guidelines

Blood pressure guidelines vary depending on what resource you are using

Classification of Blood Pressure for Adults		
BP Classification	Systolic BP (mmHg)	Diastolic BP (mmHg)
Normal	<120	And <80
Pre-hypertension	120-139	Or 80-89
Stage 1 Hypertension	140-159	Or 90-99
Stage 2 Hypertension	≥160	Or ≥100

Blood pressure

Check the current and up-to-date guidelines detailed from the following bodies:

- British Heart Foundation (BHF)
- World Health Organisation (WHO)
- National Institute for Health and Clinical Excellence (NICE)
- American College of Sports Medicine (ACSM)

Blood pressure and exercise (Blood pressure UK)

The implications for exercise for hypertension

Blood pressure level

Below 90/60

90/60-140/90

140/90 – 179/99

180/100 – 199/109

200/110 or above

General ability to be more active

Low blood pressure, client should speak to their doctor before starting any new exercise

It is safe to be more active, and it will help to keep blood pressure in this ideal blood pressure range

It should be safe to start increasing physical activity to help lower high blood pressure

Client should speak to their doctor before starting any new exercise

Do not start any new activity – speak to doctor