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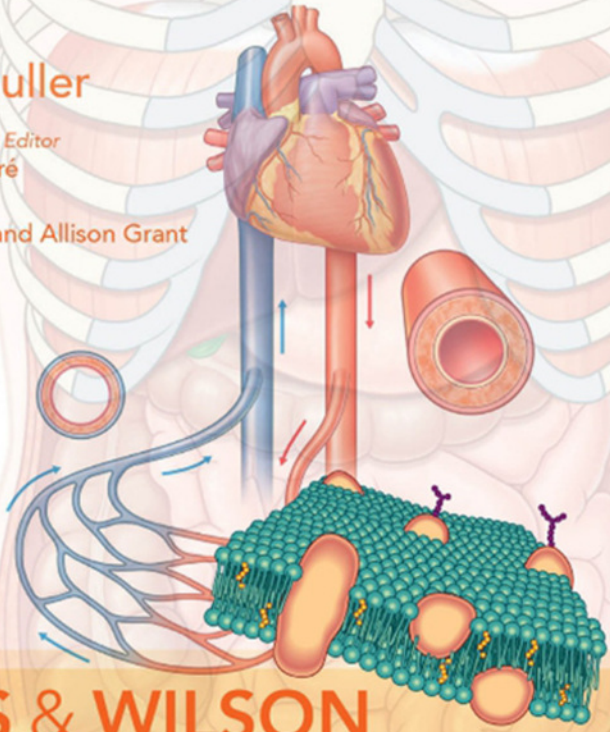

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Pocket Reference Guide to Anatomy and Physiology

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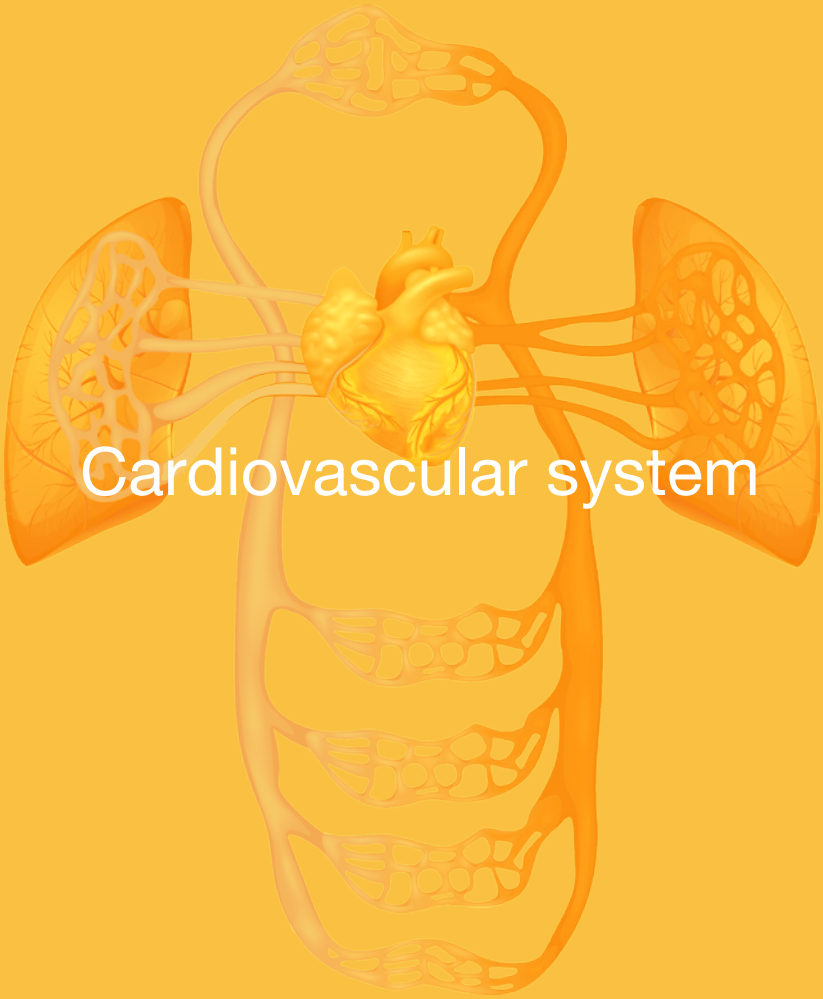
Foreword

This portable revision aid has been translated from a French volume by Anne Muller, and is designed to be a user-friendly, concise source of information. Its systematic, clear and well-illustrated content is drawn from the best-selling *Ross and Wilson Anatomy and Physiology in Health and Illness* publications, although it can also be used as a stand-alone resource to complement alternative textbooks. Whatever your anatomy and physiology learning needs are, we hope you find this book a convenient and helpful asset, and we wish you success in your studies.

Anne Waugh and Allison Grant
September 2018



Cardiovascular system

The relationship between the pulmonary and systemic circulations

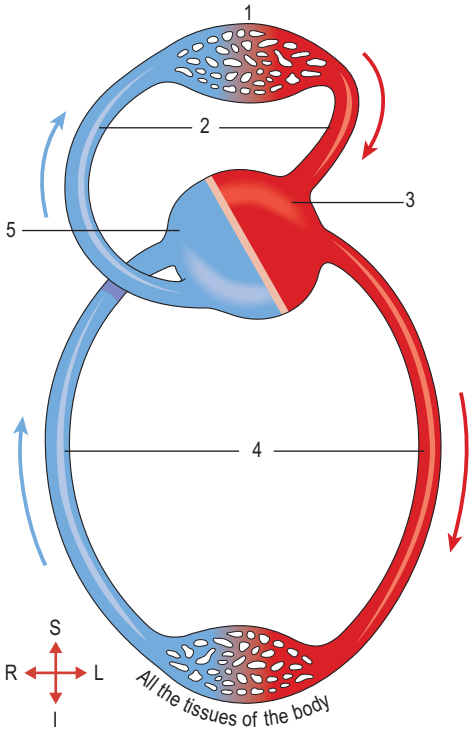


Fig 1

1. Lungs
2. Pulmonary system
3. Left side of the heart
4. Systemic circulation
5. Right side of the heart

Comments

Anatomical: There are two anatomically separate vascular systems. The pulmonary circulation—or the lesser circulation—carries blood from the right heart to the lungs and includes the pulmonary arteries and veins. The systemic circulation—or the greater circulation—carries blood from the left heart to the rest of the body and includes the aorta and its branches, as well as the venae cavae and their tributaries.

Physiological: The blood is the mode of transport of oxygen and carbon dioxide between the lungs and the cells of the body. In the lungs, where gas exchange occurs in the alveolar sacs, the blood extracts oxygen and releases carbon dioxide. The blood flowing to the organs of the body is rich in oxygen and nutrients, which are picked up by the cells of the body as they release their waste products into the blood for excretion.

Clinical: The arterial systolic pressure is higher in the systemic circulation. The colour of the skin and of the nails, whether pink or blue, reflects the functional state of the vascular and respiratory systems.

The inner aspect of a vein

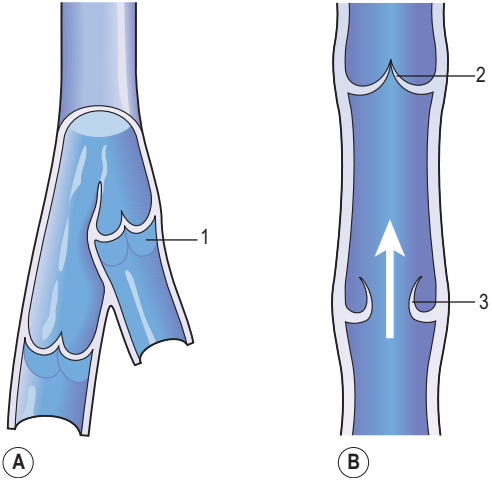


Fig 2 **(A)** The valves and the cusps. **(B)** The direction of blood flow through the valves.

1. Cusp
2. Cusp in closed position
3. Cusp in open position

Comments

Anatomical: The veins and arteries are made up of the same three tissue layers; the venous wall, however, is thinner because it contains fewer muscular and elastic fibres. The veins carry blood towards the heart. The insides of some veins contain semilunar valvular cusps, with their cavities pointing towards the heart to prevent any venous reflux.

Physiological: The veins allow the vascular system to adapt to changes in blood volume. If the volume increases, the veins, being capacitance vessels, dilate to increase the volume of blood being transported. If the blood volume decreases, they contract to prevent a fall in arterial pressure. The valves and their cusps inside the veins prevent venous reflux from happening. The veins collapse down when they are cut.

Clinical: The volume of blood in the veins amounts to two-thirds of the blood in the body. The cusps are numerous in the veins of the lower limbs but are not seen in the large veins of the thorax and of the abdomen, or in the venules. Dilated and tortuous veins indicate a build up of blood resulting from a slowing of the venous return. Varicosities, associated with pain and fatigue felt in the legs, are often seen in the saphenous and tibial veins.

The location of the heart in the thorax

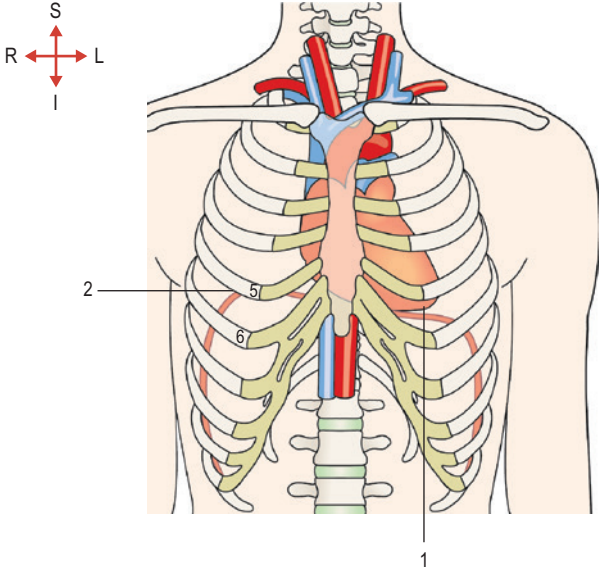


Fig 3

1. Apex of the heart in the fifth intercostal space, 9 cm from the median plane
2. The diaphragm at the level of the eighth thoracic vertebra

Comments

Anatomical: The region of the heart is demarcated by the lungs, the trachea and the large blood vessels. The heart, a hollow conical muscular organ, about 10 cm in length, is intrathoracic, lying within the mediastinum, which is the space between the two lungs. It is located towards the left side and the front of the body, with its pointed apex lying inferiorly in the fifth intercostal space and its base at the level of the second rib.

Physiological: The heart is responsible for supplying the whole body with blood.

Clinical: A man's heart is heavier than a woman's (310 g vs. 225 g). Anatomically locating the ribs helps position the electrodes efficiently during electrocardiography. The location of the heart explains the location of cardiac pain, which is thoracic for angina pectoris or myocardial infarction, with possible extension into the left arm and the jaw. This pain is transmitted by the T2 nerve, which arises at the level of the second thoracic vertebra and supplies a part of the arm and the skin of the axillary fossa.

Organs in relation to the heart

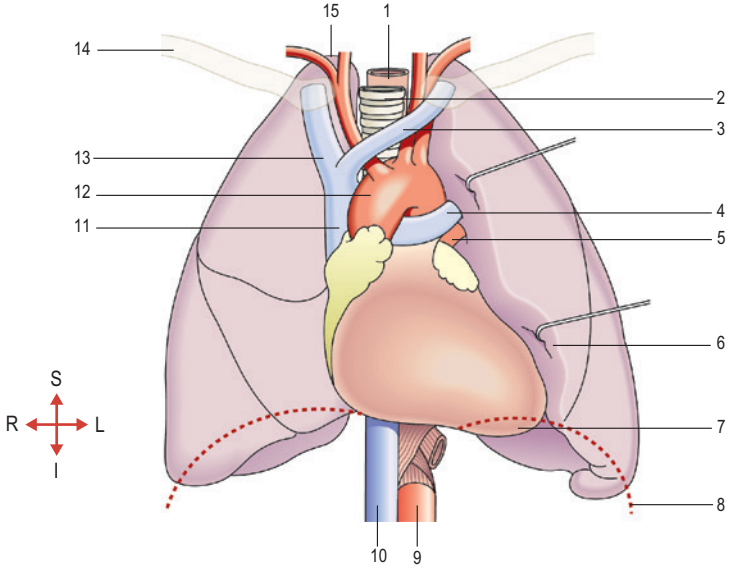


Fig 4

1. Oesophagus
2. Trachea
3. Left brachiocephalic vein
4. Pulmonary artery
5. Left pulmonary vein
6. Left lung (retracted)
7. Cardiac apex
8. Diaphragm
9. Aorta
10. Inferior vena cava
11. Superior vena cava
12. Aorta
13. Right brachiocephalic vein
14. Clavicle
15. Pulmonary apex

Comments

Anatomical: The heart lies obliquely more towards the left in the mediastinum. Its relations with the adjacent organs include the following:

a. *Posteriorly*—the trachea and the oesophagus, the main right and left bronchi, the descending aorta, the inferior vena cava and the thoracic vertebrae
b. *Anteriorly*—the sternum, the ribs and the intercostal muscles
c. *Laterally*—the lungs
d. *Superiorly*—the large vessels, the aorta, the superior vena cava, the pulmonary artery and the pulmonary veins
e. *Inferiorly*—the apex of the heart, supported by the central tendon of the diaphragm at the level of the fifth intercostal space

Physiological: The superior and inferior venae cavae drain into the right atrium. The blood then flows into the right ventricle and is propelled into the pulmonary trunk. The pulmonary veins return the oxygenated blood into the left atrium, from where it is conveyed into the left ventricle, across the mitral valve, before being ejected into the aorta.

Clinical: The pain due to pericarditis is thoracic and is exacerbated during deep breathing. The heart rate varies normally from person to person but can also vary as a result of disease. The heart rate is calculated as the number of cardiac beats per minute. An abnormally slow pulse is called *bradycardia*; an abnormally fast pulse is called *tachycardia*.

Layers of the wall of the heart

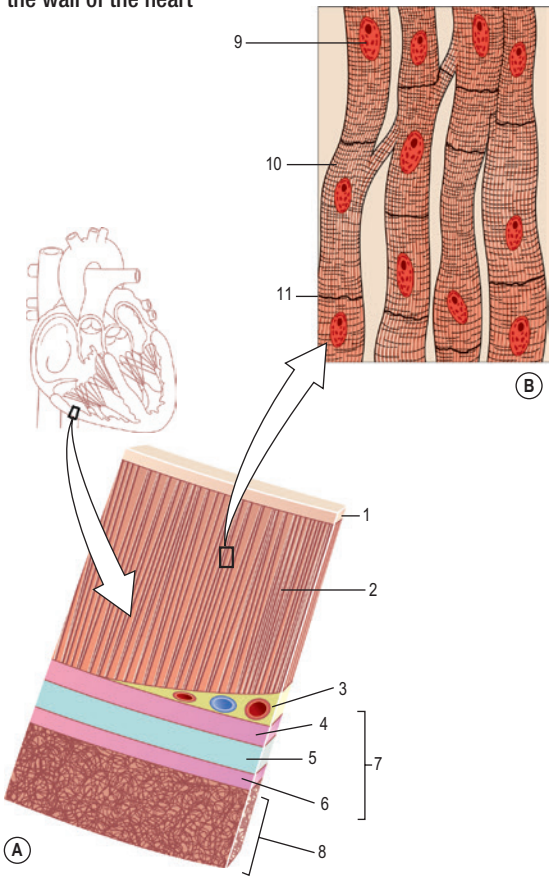


Fig 5 (A) Layers of the cardiac wall: endocardium, myocardium and pericardium. **(B)** Heart muscle.

1. Endocardium
2. Myocardium
3. Fatty tissue and coronary vessels
4. Visceral pericardium
5. Pericardial space with pericardial fluid
6. Parietal pericardium
7. Serous pericardium
8. Fibrous pericardium
9. Nucleus
10. Branching cell
11. Intercalated disc

Comments

Anatomical: Three tissue layers make up the wall of the heart—the pericardium, the myocardium and the endocardium. The pericardium is the outer layer, consisting of two sacs, the outer one being the fibrous pericardium and the inner one being the serous pericardium. The fibrous pericardium is adherent to the diaphragm. Its nonelastic fibres restrict any excessive distention of the heart. The serous pericardium is made up of two layers, the parietal pericardium carpeting the fibrous pericardium and the visceral pericardium adherent to the cardiac muscle. The myocardium is a striated muscle tissue that specifically escapes voluntary control. Each myocardial fibre contains a nucleus and multiple branches. The cells are branched at their ends and form functional complexes, such as the partition-like intercalated discs. The myocardium is thicker at the apex at the level of the left ventricle. The endocardium, a thin and smooth membrane, covers the myocardium and the cardiac valves.

Physiological: The branches and the intercalated discs allow the electrical impulses to propagate and the cardiac muscle to contract as a syncytium. The contraction of the atria and of the ventricles is coordinated because of the sheet-like arrangement of the myocardium. A network of conducting fibres transmits the electrical signals to the heart muscle. The endocardium allows the blood to flow through the heart.

Clinical: Any irregular transmission of the electrical impulse and any slowing or speeding up of its transmission reflect conduction disturbances. Bradycardia can be a sign of an atrioventricular block and tachycardia a sign of atrial extrasystoles.

Inner aspect of the heart

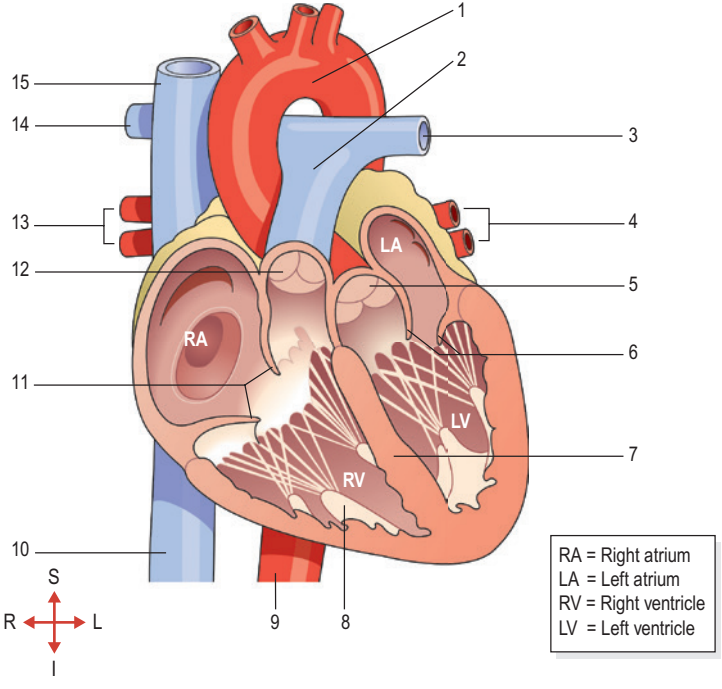


Fig 6

1. Aortic arch
2. Pulmonary trunk
3. Left pulmonary artery
4. Left pulmonary veins
5. Aortic valve
6. Mitral valve
7. Septum
8. Papillary muscle with chordae tendineae
9. Aorta
10. Inferior vena cava
11. Tricuspid valve
12. Pulmonary valve
13. Right pulmonary veins
14. Right pulmonary artery
15. Superior vena cava

Comments

Anatomical: The heart is divided by the cardiac septum into two parts, right and left. Each part is separated by an atrioventricular valve into an atrium and a ventricle. Derived from the endocardium, each valve contains cusps, three for the tricuspid and two for the mitral valves. The atrial myocardium is thinner than the ventricular myocardium. The pulmonary trunk arises from the upper part of the right ventricle, and the aorta arises from the upper part of the left ventricle.

Physiological: Blood flows from the atria towards the ventricles. The atria propel the blood towards the ventricles through the atrioventricular valves. The more powerful right and left ventricles expel the blood into the lungs and the rest of the body, respectively.

Clinical: After birth, the blood cannot move from the right to the left side of the heart via the septum. Blood moving to and fro between the two sides is abnormal.

The left mitral valve

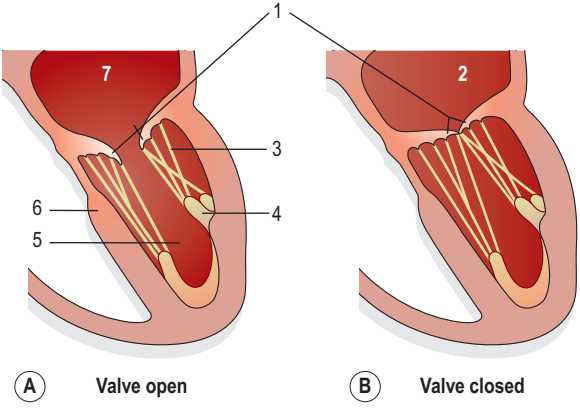


Fig 7

1. Mitral valve (left atrioventricular valve)
2. Atrium
3. Chordae tendineae
4. Papillary muscle
5. Ventricle
6. Septum
7. Atrium

Comments

Anatomical: The mitral valve has two cusps. It is kept in place by the chordae tendineae, running from its internal aspect to the papillary muscles, which are structures derived from the myocardium and covered by endothelium.

Physiological: Blood flows from the atrium towards the ventricle. The mitral valve opens between the atrium and the ventricle when the pressure in the atrium is greater than that in the ventricle. It closes passively during ventricular contraction or ventricular systole, when the intraventricular pressure exceeds the intraatrial pressure. Its closure prevents reflux from ventricle into atrium.

Clinical: Reflux into the atrium during systole is due to malfunctioning of the mitral valve, such as mitral regurgitation.

Direction of blood flow inside the heart

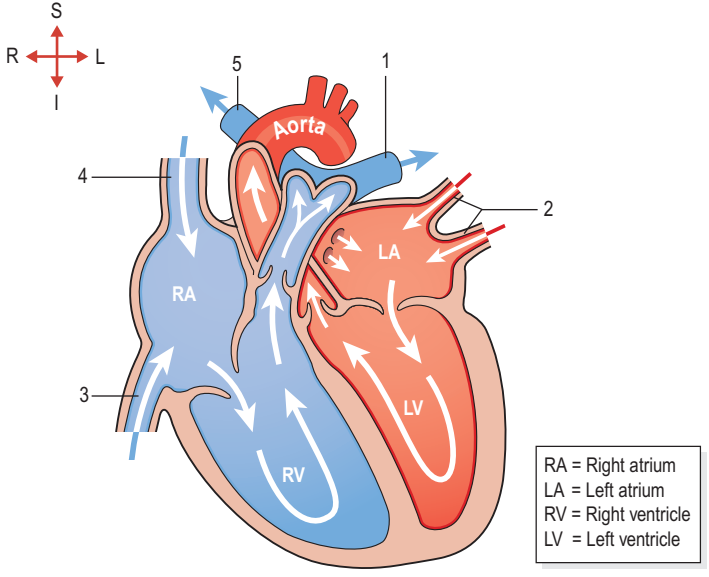


Fig 8

1. Left pulmonary artery
2. Left pulmonary veins
3. Inferior vena cava
4. Superior vena cava
5. Right pulmonary artery

Comments

Anatomical: The pulmonary and aortic valves are formed by three semilunar cusps.

Physiological: Blood transported by the inferior and superior venae cavae enters the right atrium, crosses the tricuspid valve and flows into the right ventricle, which propels it into the pulmonary trunk across the pulmonary valve. This then prevents reflux of blood from the pulmonary trunk into the ventricle when the latter relaxes. The pulmonary trunk divides into two branches, the right and the left, which carry venous blood into the lungs, where there is gas exchange of oxygen and carbon dioxide. The oxygen is absorbed, and the carbon dioxide is excreted. Two pulmonary veins carry the oxygenated blood from each lung into the left atrium; there are four pulmonary veins involved. The blood crosses the mitral valve to enter the left ventricle, from where it is ejected into the aorta.

Clinical: Pulmonary oedema and oedema of the lower limbs can indicate a valvulopathy or valvular malfunction due to defective opening or closing of the valve. The aortic and mitral valves are the two valves that are most frequently involved.

Section of the aorta opened to show the semilunar cusps of the aortic valve

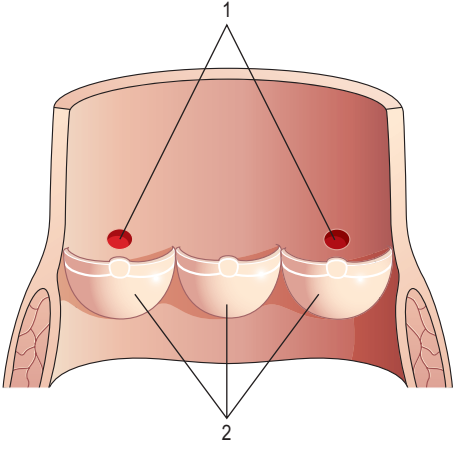


Fig 9

1. Orifices of the right and left coronary arteries
2. Semilunar cusps

Comments

Anatomical: The aortic valve is a cardiac valve, an anatomical structure separating the ventricle from the aorta. It is made up of three semilunar cusps—one dorsal, one anterolateral on the left and one anterolateral on the right. Above these cusps arise the coronary arteries, which supply the cardiac muscle with blood.

Physiological: The semilunar cusps prevent reflux of blood into the left ventricle. During systole, the blood-filled ventricle contracts and ejects its contents into the aorta across the aortic valve to supply the organs with blood. During diastole, the aortic valve is closed. Its opening and closure are passive, depending on the pressure difference on either side of the valve. It opens when the pressure downstream is less than the pressure upstream; it closes when the pressures are reversed.

Clinical: Normally, the arterial pressure is less than 140/90 mmHg. The first number is the systolic pressure (the pressure associated with systole) and the second is the diastolic pressure (the pressure associated with diastole). Closure of the aortic valve corresponds to the second heart sound on cardiac auscultation; the first heart sound corresponds to the closure of the mitral and tricuspid valves. Shortness of breath made worse by lying down or by physical exertion, fatigue, a feeling of heavy discomfort in the chest, palpitations, bilateral ankle oedema and weight gain are signs of an anatomical lesion or malfunction of the valve.

The flow of blood inside the heart and the systemic and pulmonary circulations

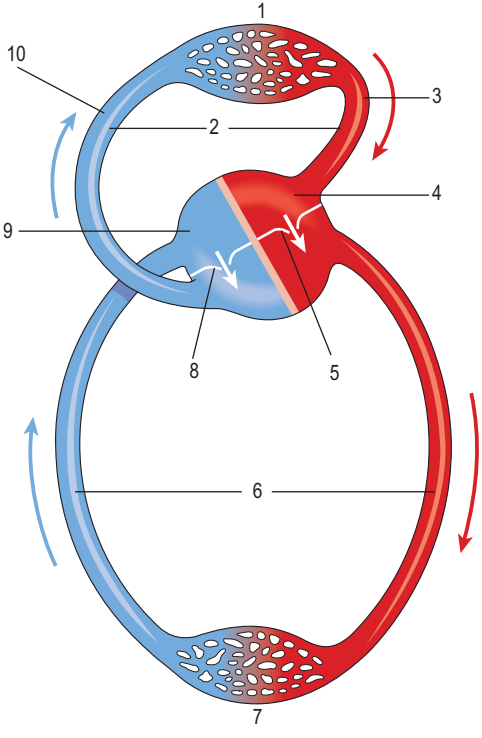


Fig 10

1. Lungs
2. Pulmonary circulation
3. Pulmonary vein
4. Left side of the heart
5. Mitral valve
6. Systemic circulation
7. All the body tissues
8. Tricuspid valve
9. Right side of the heart
10. Pulmonary artery

Comments

Physiological: The systemic circulation propels blood from the left heart to and from the organs of the body via the aorta and its branches and the venae cavae and their collaterals. The aorta arises from the heart, carries blood rich in oxygen and poor in carbon dioxide to all the organs of the body and then ensures return of the blood, now poor in oxygen and rich in carbon dioxide, to the heart via the superior and inferior venae cavae. The blood flows from the right side to the left side of the heart via the pulmonary circulation, which conveys the blood from the right heart through the lungs in the pulmonary arteries and veins. The pulmonary trunk carries the venous blood poor in oxygen and rich in carbon dioxide to the pulmonary alveoli for reoxygenation and ensures its return to the heart via the pulmonary veins.

Clinical: Arterial hypotension occurs when the systolic pressure is below 100 mmHg. When a person stands up rapidly from a lying down or sitting position, this change of position can cause a drop in blood pressure known as *orthostatic arterial hypotension*. Obesity, pyrexia, physical activity, emotion and some diseases may cause hypertension, which may be transient. Persistent hypertension wears out the heart.