

The arteriovenous system

Part one – the anatomy

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This article, the first part of three, explores the normal anatomy and physiology of the cardiovascular system – arteries and veins – including the main arteries and veins and blood pressure recording. The heart is covered in previous articles but should be used in conjunction with this series (Docherty, 2005a; 2005b; 2005c; 2005d).

Part two will look at arterial dysfunction, related conditions and nursing care. Part three will explore venous dysfunction, related conditions and nursing care.

There are two halves to the circulation system with the heart acting on both halves as the mid-point and main pump (Fig 1). Blood from the right side of the heart is dark red (low in oxygen) and flows along the pulmonary arteries to the lungs where it receives a fresh supply of oxygen and becomes bright red (Ehrlich and Schroeder, 2004). It flows along pulmonary veins back to the heart's left side and from there to the aorta and through arteries. These gradually divide into capillaries, where oxygen and nutrients are released into the body cells, and carbon dioxide and other waste products are returned to the bloodstream (Tortora and Grabowski, 2002). The blood then travels in veins back to the right side of the heart.

The average person has around 4–5 litres of blood. About 8 million blood cells die in the human body every second, while the same number is produced (Tortora and Grabowski, 2002). It takes 20–60 seconds for a red blood cell to travel the circulatory network and they make approximately 250,000 round trips (Ehrlich and Schroeder, 2004). Red blood cells are generated and recycled in the bone marrow, and each cell has a life span of approximately four months (Tortora and Grabowski, 2002).

The cardiovascular cycle is imperative to maintain homeostasis and oxygenation and requires that normal cardiac output, myocardial function, haemoglobin levels, systemic resistance and other factors are balanced to create an optimal internal environment (Ehrlich and Schroeder, 2004). Dysfunction in the system will therefore lead to disease processes, which are often difficult to manage or have negative effects. Common examples will

FIG 1. THE ANATOMY OF THE CIRCULATORY SYSTEM

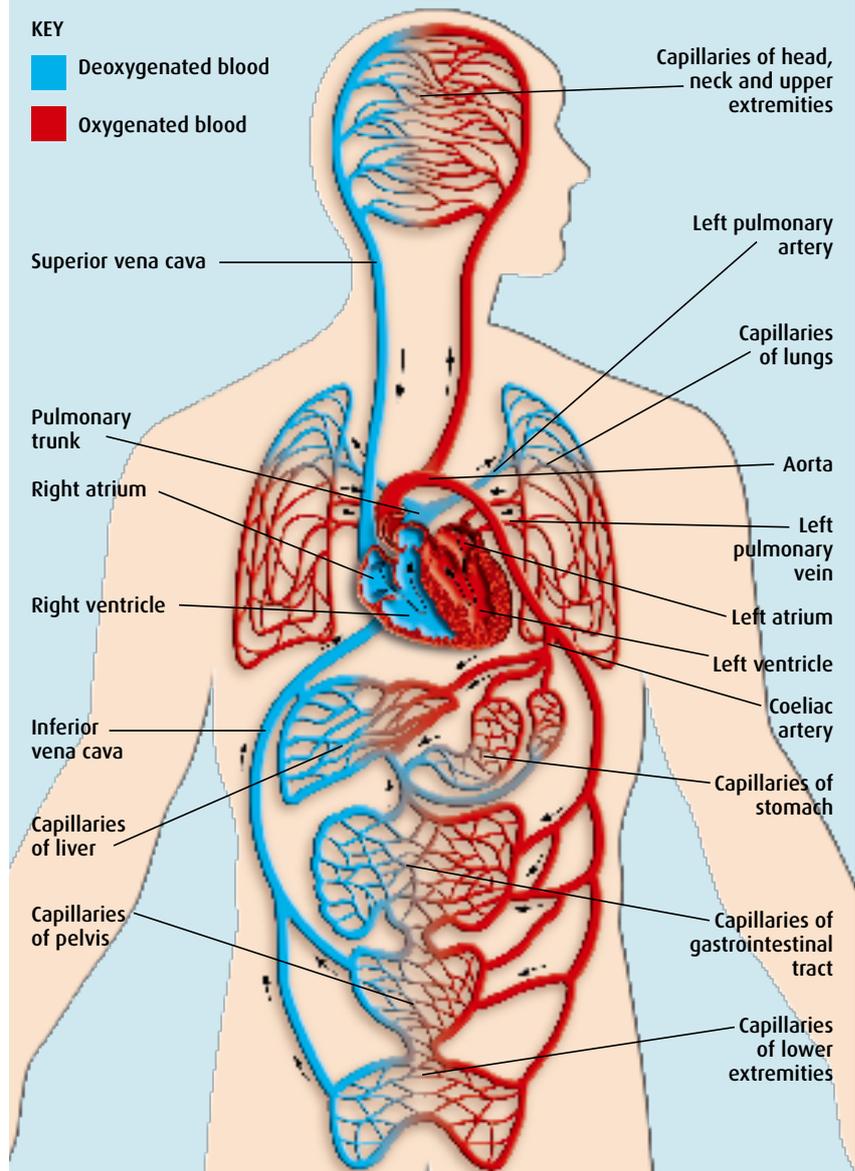
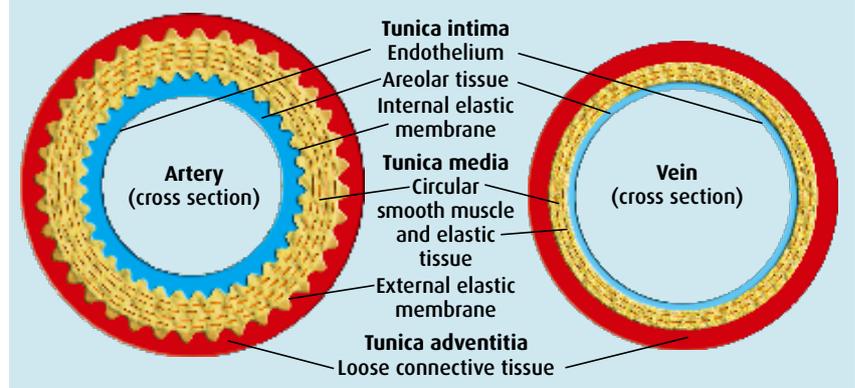


FIG 2. THE ANATOMY OF THE ARTERIES AND VEINS



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be discussed in parts two and three but include:

- Aneurysm;
- Artherosclerosis;
- Hypertension;
- Chronic venous insufficiency;
- Varicose veins;
- Venous leg ulcers.

Artery anatomy

Oxygenated blood is pumped from the heart along arteries, which are muscular and consist of three layers (Tortora and Grabowski, 2002) (Fig 2). They divide like tree branches until they are slender. The largest is the aorta, which connects to the heart and picks up oxygenated blood from the left ventricle. The only artery that picks up deoxygenated blood is the pulmonary artery, which runs between the heart and lungs (Tortora and Grabowski, 2002). The following main arteries come off the aorta:

1. **Coronary (right and left)** – supplying blood to the heart;
2. **Brachiocephalic** – supplying blood to the head, neck and arms;
3. **Subclavian** – the right subclavian artery extends from the brachiocephalic artery to the right side of the body. The left subclavian artery extends from the aortic arch to the left side of the body;
4. **Carotid** – the right artery extends from the brachiocephalic artery and the left from the aorta;
5. **Iliac** – the common iliac artery extends from the descending aorta and branches into internal and external iliac arteries, carrying oxygenated blood to the legs and feet (Tortora and Grabowski, 2002; Ehrlich and Schroeder, 2004)

Capillaries

Arteries branch into arterioles as they get smaller. These become capillaries, which are very thin and branching (Tortora and Grabowski, 2002). Capillaries are more like a web than branched tubes (Ehrlich and Schroeder, 2004).

The exchange between the blood and cells takes place in the capillaries, where the blood releases its oxygen and takes on carbon dioxide (Tortora and Grabowski, 2002). In the renal capillaries, the blood gives up waste products to form urine (Ehrlich and Schroeder, 2004). White blood cells can leave the blood from the capillaries to attack harmful antagonists (Tortora and Grabowski, 2002). Capillaries are so small that blood cells pass through in single file (Ehrlich and Schroeder, 2004). As they thicken and merge, they become venules and then veins (Tortora and Grabowski, 2002).

Vein anatomy

Veins are generally smaller in diameter than arteries and have one-way valves, instead of a thick muscle layer, to stop blood back-flowing (Tortora

and Grabowski, 2002). Generally, veins carry deoxygenated blood to the heart, where it is sent to the lungs to enrich the haemoglobin (Tortora and Grabowski, 2002). The exception is the network of pulmonary veins, which take oxygenated blood from the lungs to the heart.

The main veins are:

1. **Vena cavae** – the two largest veins. They carry deoxygenated blood to the right atrium. The superior vena cava carries blood from the head, neck, arm and chest, while the inferior vena cava carries it from the lower body.
2. **Brachiocephalic veins** – two large veins that join to form the superior vena cava. They carry deoxygenated blood from the head, neck and arm.
3. **Iliac veins** – two main veins that join to form the inferior vena cava and carry blood from the legs and lower regions of the body. (Tortora and Grabowski, 2002; Ehrlich and Schroeder, 2004).

Blood pressure

Blood pressure is the amount of force exerted on the artery walls by the pumping blood (Tortora and Grabowski, 2002). When the heart contracts, the blood inside the left ventricle is forced into the aorta and arteries.

The pressure inside the left ventricle is high (120mmHg) and this is maintained in the large arterial vessels (Ehrlich and Schroeder, 2004). The blood then enters the arterioles, which are small vessels with muscular walls.

Reduced flow of blood is mainly detected in the brain and kidneys, which stimulate nerve reflexes to produce hormones (catecholamines) (Tortora and Grabowski, 2002). This induces the heart to beat more forcefully so that the blood pressure is maintained at a higher level to overcome the restricted flow through the arterioles.

Adjustments to high or low blood pressure occur normally through negative feedback mechanisms (Tortora and Grabowski, 2002). The diastolic pressure does not drop to zero because the arterial walls are elastic. This moves the arterial blood on between beats, resulting in a constant arterial pressure (Ehrlich and Schroeder, 2004).

When recording blood pressure, an inflatable cuff is wrapped around the upper arm. The bag is connected to a pressure-measuring instrument known as a sphygmomanometer or an electronic equivalent. The left arm is normally used to take blood pressure because this more truly reflects left heart pressure (Docherty, 2002).

The exerted pressure, when above the systolic will occlude flow. When flow is detected, that means the pressure is equal to the systolic and that measurement is noted. When the sound of arterial movement is absent, then the pressure is lower than the diastolic value (Docherty, 2002). ■

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