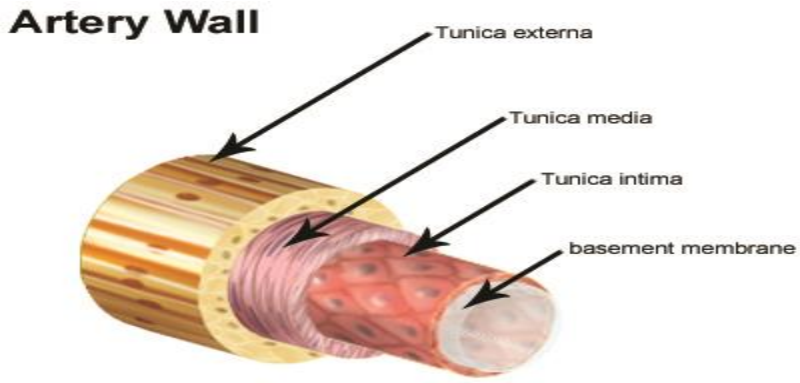
Classification & Structure of Blood Vessels

Blood vessels are the channels or conduits through which blood is distributed to body tissues. The vessels make up two closed systems of tubes that begin and end at the heart. One system, the pulmonary vessels, transports blood from the right ventricle to the lungs and back to the left atrium. The other system, the systemic vessels, carries blood from the left ventricle to the tissues in all parts of the body and then returns the blood to the right atrium. Based on their structure and function, blood vessels are classified as either arteries, capillaries, or veins.

Arteries

Arteries are strong tubes and muscular in nature. These blood vessels carry oxygen-rich blood from the heart to all the tissues of the body. Aorta is one of the main arteries that arise from the heart and branches further. Arteries carry blood away from the heart. Pulmonary arteries transport blood that has a low oxygen content from the right ventricle to the lungs. Systemic arteries transport oxygenated blood from the left ventricle to the body tissues. Blood is pumped from the ventricles into large elastic arteries that branch repeatedly into smaller and smaller arteries until the branching results in microscopic arteries called arterioles. The arterioles play a key role in regulating blood flow into the tissue capillaries. About 10 percent of the total blood volume is in the systemic arterial system at any given time.

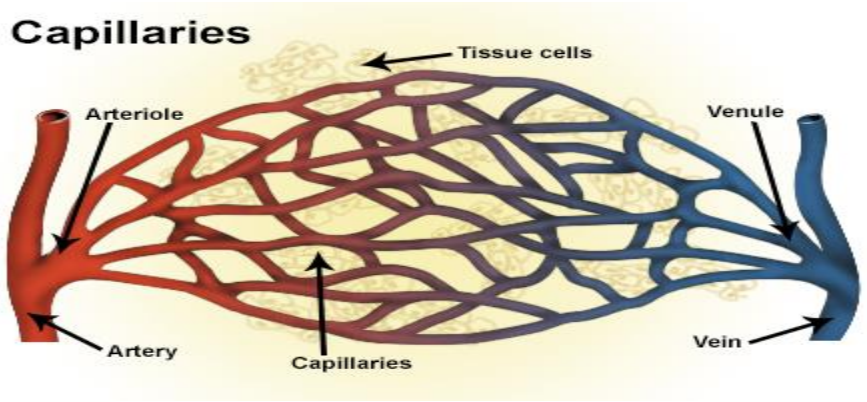


The wall of an artery consists of three layers. The innermost layer, the tunica intima (also called tunica interna), is simple squamous epithelium surrounded by a connective tissue basement membrane with elastic fibers. The middle layer, the tunica media, is primarily smooth muscle and is usually the thickest layer. It not only provides support for the vessel but also changes vessel diameter to regulate blood flow and blood pressure. The outermost layer, which attaches the vessel to the surrounding tissue, is the tunica externa

or tunica adventitia. This layer is connective tissue with varying amounts of elastic and collagenous fibers. The connective tissue in this layer is quite dense where it is adjacent to the tunic media, but it changes to loose connective tissue near the periphery of the vessel.

Capillaries

Capillaries, the smallest and most numerous of the blood vessels, form the connection between the vessels that carry blood away from the heart (arteries) and the vessels that return blood to the heart (veins). The primary function of capillaries is the exchange of materials between the blood and tissue cells.



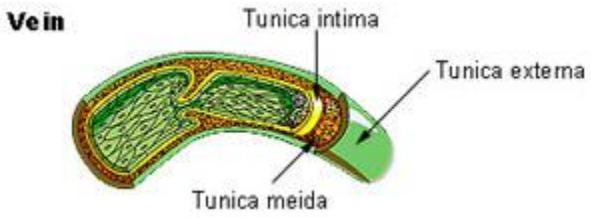
Capillary distribution varies with the metabolic activity of body tissues. Tissues such as skeletal muscle, liver, and kidney have extensive capillary networks because they are metabolically active and require an abundant supply of oxygen and nutrients. Other tissues, such as connective tissue, have a less abundant supply of capillaries. The epidermis of the skin and the lens and cornea of the eye completely lack a capillary network. About 5 percent of the total blood volume is in the systemic capillaries at any given time. Another 10 percent is in the lungs. On reaching tissues, arteries branch further into extremely thin tubes called capillaries. Capillaries bring about the exchange of substances between blood and tissues.

Smooth muscle cells in the arterioles where they branch to form capillaries regulate blood flow from the arterioles into the capillaries.

Veins

Veins are elastic blood vessels which carry deoxygenated blood from all parts of the body to the heart. An exception is the umbilical and pulmonary veins. The Pulmonary vein carries oxygenated blood to the heart from the lungs and the umbilical vein carries oxygenated blood from the placenta to the foetus. Veins carry blood toward the heart. After

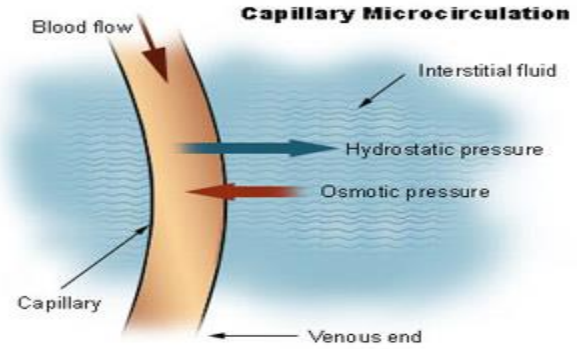
blood passes through the capillaries, it enters the smallest veins, called venules. From the venules, it flows into progressively larger and larger veins until it reaches the heart. In the pulmonary circuit, the pulmonary veins transport blood from the lungs to the left atrium of the heart. This blood has a high oxygen content because it has just been oxygenated in the lungs. Systemic veins transport blood from the body tissue to the right atrium of the heart. This blood has a reduced oxygen content because the oxygen has been used for metabolic activities in the tissue cells.



The walls of veins have the same three layers as the arteries. Although all the layers are present, there is less smooth muscle and connective tissue. This makes the walls of veins thinner than those of arteries, which is related to the fact that blood in the veins has less pressure than in the arteries. Because the walls of the veins are thinner and less rigid than arteries, veins can hold more blood. Almost 70 percent of the total blood volume is in the veins at any given time. Medium and large veins have venous valves, similar to the semilunar valves associated with the heart, that help keep the blood flowing toward the heart. Venous valves are especially important in the arms and legs, where they prevent the backflow of blood in response to the pull of gravity.

Physiology of Circulation

Roles of Capillaries



In addition to forming the connection between the arteries and veins, capillaries have a vital role in the exchange of gases, nutrients, and metabolic waste products between the blood and the tissue cells. Substances pass through the capillary wall by diffusion,

filtration, and osmosis. Oxygen and carbon dioxide move across the capillary wall by diffusion. Fluid movement across a capillary wall is determined by a combination of hydrostatic and osmotic pressure. The net result of the capillary microcirculation created by hydrostatic and osmotic pressure is that substances leave the blood at one end of the capillary and return at the other end.

Blood Flow

Blood flow refers to the movement of blood through the vessels from arteries to the capillaries and then into the veins. Pressure is a measure of the force that the blood exerts against the vessel walls as it moves the blood through the vessels. Like all fluids, blood flows from a high pressure area to a region with lower pressure. Blood flows in the same direction as the decreasing pressure gradient: arteries to capillaries to veins.

The rate, or velocity, of blood flow varies inversely with the total cross-sectional area of the blood vessels. As the total cross-sectional area of the vessels increases, the velocity of flow decreases. Blood flow is slowest in the capillaries, which allows time for exchange of gases and nutrients.

Resistance is a force that opposes the flow of a fluid. In blood vessels, most of the resistance is due to vessel diameter. As vessel diameter decreases, the resistance increases and blood flow decreases.

Very little pressure remains by the time blood leaves the capillaries and enters the venules. Blood flow through the veins is not the direct result of ventricular contraction. Instead, venous return depends on skeletal muscle action, respiratory movements, and constriction of smooth muscle in venous walls.

Pulse and Blood Pressure

Pulse refers to the rhythmic expansion of an artery that is caused by ejection of blood from the ventricle. It can be felt where an artery is close to the surface and rests on something firm.

In common usage, the term blood pressure refers to arterial blood pressure, the pressure in the aorta and its branches. Systolic pressure is due to ventricular contraction. Diastolic pressure occurs during cardiac relaxation. Pulse pressure is the difference between systolic pressure and diastolic pressure. Blood pressure is measured with a sphygmomanometer and is recorded as the systolic pressure over the diastolic pressure. Four major factors interact

to affect blood pressure: cardiac output, blood volume, peripheral resistance, and viscosity. When these factors increase, blood pressure also increases.

Arterial blood pressure is maintained within normal ranges by changes in cardiac output and peripheral resistance. Pressure receptors (barareceptors), located in the walls of the large arteries in the thorax and neck, are important for short-term blood pressure regulation.

Layers of Blood Vessels

Both arteries and veins consist of three layers.

- **Tunica Intima**: It is one of the innermost and thinnest layers of arteries and veins. It comprises endothelial cells. They are in direct contact with the flow of blood.
- **Tunica Media**: It is the middle layer of an artery or vein. Tunica media is made up of smooth muscle cells.
- **Tunica Externa:** It surrounds tunica media. It is made up of collagen and is also supported by the elastic lamina in arteries.

Blood pressure

Blood pressure is the pressure of blood on the walls of your arteries as your heart pumps blood around your body. Blood pressure does not stay the same all the time. It changes to meet your body's needs and it is normal for your blood pressure to go up and down throughout the day. It is affected by various factors, including body position, breathing, emotional state, exercise and sleep.
If blood pressure remains high over a long period of time, it can lead to a heart attack, stroke, heart failure or kidney disease.The medical name for high blood pressure is hypertension. The medical name for low blood pressure is hypotension.

Blood pressure is recorded as two numbers, such as 120/80. The larger number is the pressure in the arteries as the heart pumps out blood during each beat. This is called the systolic blood pressure.
The lower number is the pressure as the heart relaxes before the next beat. This is called the diastolic blood pressure. Both are measured in units called millimetres of mercury (mmHg).

Measuring blood pressure

It is best to measure blood pressure when you are relaxed and sitting. Blood pressure is usually measured with an inflatable pressure cuff that wraps around your upper arm. This cuff is part of a machine called a sphygmomanometer.

Your blood pressure changes to meet your body's needs. If a reading is high, your doctor may measure your blood pressure again on several separate occasions before diagnosing high blood pressure.

Your doctor may recommend that you have your blood pressure recorded at home with a monitoring device. This is also known as 24-hour ambulatory blood pressure monitoring and it involves measuring your blood pressure at regular intervals (usually every 20-30 minutes), while you do your usual activities including sleeping. Your doctor will organise this service if required.

If you are considering buying a blood pressure device to use at home, it is best to speak to your doctor to see if this is needed. If so, then buy a device that measures blood pressure accurately. See this list of devices that have been approved by the British and Irish Hypertension Society.

Diagnosing high blood pressure

What is considered a healthy blood pressure varies from person to person. Your doctor will explain what your ideal blood pressure is based on a range of factors, including your overall health.
The following numbers should only be used as a guide:

Meaning	Top number (systolic) mm Hg	Bottom number (diastolic) mm Hg
Optimal	Less than 120	and Less than 80
Normal	120 to 129	and/or 80 to 84
High-normal	130 to 139	and/or 85 to 89
High	Greater than 140	and/or Greater than 90

High blood pressure usually does not have any symptoms. You can have high blood pressure and feel perfectly well. The only way to find out if your blood pressure is high is to have it checked regularly by your doctor.

Low blood pressure can be a problem if it has a **negative impact on your body or affects the way you feel**. Low blood pressure can make people feel dizzy or faint. See you doctor if you think you have low blood pressure.