

2.5

BLOOD AND TISSUE FLUID

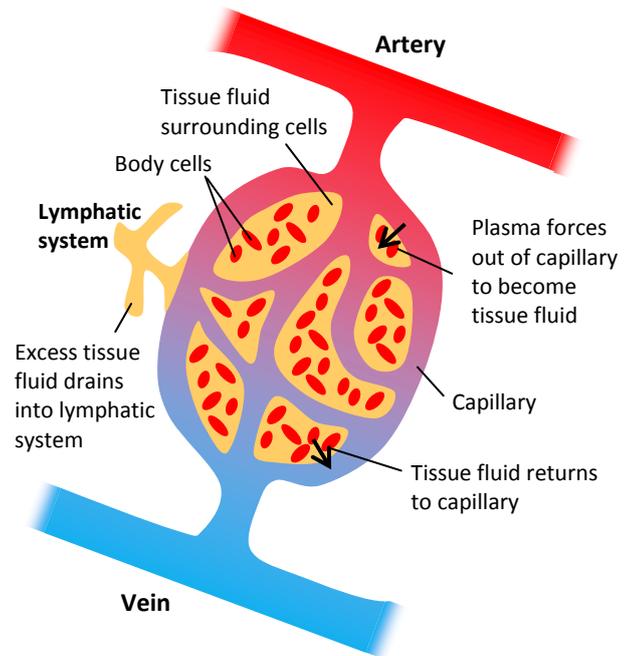
The differences between blood and tissue fluid and the formation of tissue fluid and lymph

Blood consists of blood cells in a watery fluid called **plasma** which contains many dissolved substances including oxygen, carbon dioxide, salts, glucose, fatty acids, amino acids, hormones and **plasma proteins**. The cells include **red blood cells (erythrocytes)**, various types of **white blood cell (leucocytes)** and fragments called **platelets**.

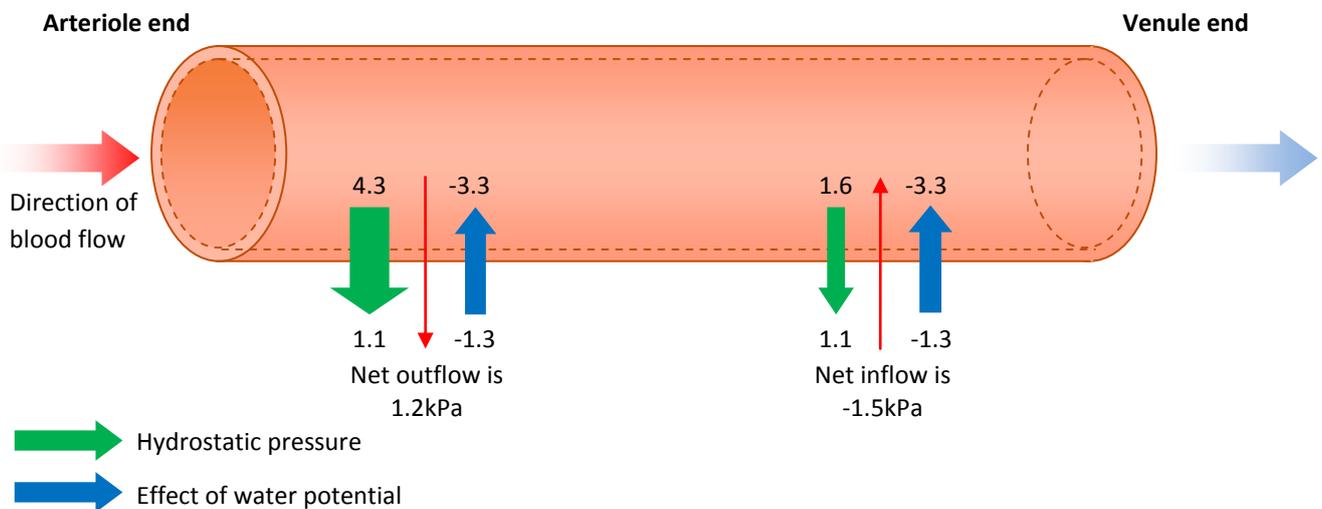
Tissue fluid is similar to blood, but doesn't contain most of the cells found in blood, nor does it contain plasma proteins. The role of tissue fluid is to transport and nutrients from the blood to the cells, and to carry carbon dioxide and other wastes back to the blood.

When an artery reaches the tissues it branches out into smaller **arterioles**, then into a network of capillaries which eventually link up with **venules** to carry blood back to the veins. So blood flowing into an organ or tissue is contained in the capillaries. At the arterial end of the capillaries, the blood is under high pressure due to the contraction of the heart muscle – this is called **hydrostatic pressure**. It tends to push blood fluid out of the capillaries. The fluid leaves via the tiny gaps in capillary walls.

The fluid which leaves the blood consists of plasma with dissolved nutrients and oxygen. Red blood cells, platelets, plasma proteins and most white blood cells remain in the blood – they are too large to be pushed through the gaps. The resultant fluid is **tissue fluid**. This fluid surrounds body cells, so exchange of gases and nutrients can occur across the cell surface membranes. This exchange occurs via **diffusion** and **facilitated diffusion** (see 1.8 Movement Across Cell Membranes).



The hydrostatic pressure of the blood is not the only force acting on the fluid. The tissue fluid itself has some hydrostatic pressure which will push the fluid back into the capillaries. Both the blood and tissue fluid contain solutes, giving them a negative **water potential** (see 2.11 Water Potential). The water potential of the tissue fluid is *less negative* than that of the blood. This means that water tends to move back into the blood from the tissue fluid via **osmosis**, down the water potential gradient.



The diagram on the previous page shows the hydrostatic and osmotic pressures acting on a single capillary. At the venous end, the blood has lost its hydrostatic pressure. The combined effect of the hydrostatic pressure in the tissue fluid and the osmotic force of the plasma proteins are sufficient to move fluid back into the capillary. It carries with it any waste substances such as carbon dioxide that have left the cells.

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Not all tissue fluid returns to capillaries. Some is drained away into the **lymphatic system**. This consists of a number of vessels (tubes) that are like capillaries. They start in the tissues and drain the excess fluid into larger vessels, which eventually rejoin the blood system in the chest cavity.

Lymph fluid is similar to tissue fluid and contains the same solutes. There will be less oxygen and fewer nutrients, as they have been absorbed by body cells. There will therefore be more carbon dioxide and other wastes from the body cells. Lymph also has a more fatty material that has been absorbed from the intestines. The main difference between tissue fluid and lymph is that lymph contains many **lymphocytes** produced in the **lymph nodes**. The lymph nodes are swellings found along the lymphatic system. They filter any bacteria and foreign material from the fluid. The lymphocytes engulf and destroy these bacteria and foreign particles. This is part of the immune system.

The table below outlines the differences between blood, tissue fluid and lymph:

Feature	Blood	Tissue fluid	Lymph
Cells	Erythrocytes, leucocytes and platelets	Some leucocytes	Lymphocytes
Proteins	Hormones and plasma proteins	Some hormones, proteins secreted by body cells	Few proteins
Glucose	More (80-120mg per 100cm ³)	None	Less
Amino acids	More	Less (absorbed by body cells)	Less
Oxygen	More	Less (absorbed by body cells)	Less
Carbon dioxide	Less	More (released by body cells)	More