Tissue fluid

Interstitial fluid, or **tissue fluid**, is a fluid that permeates all tissues and fills the space between cells. Along with plasma and transcellular fluid, it belongs to the so-called extracellular fluids. Because the wall of the capillaries allows water to pass through, tissue fluid is **produced by filtering blood plasma** through the wall of blood capillaries. The main **function** of tissue fluid is the **transport of nutrients** and O_2 to the cells and the **return transport of waste materials.**

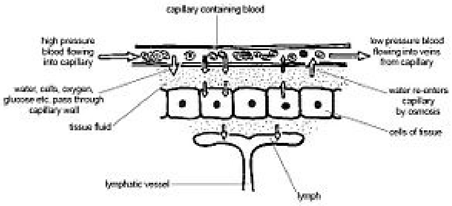
The composition of tissue fluid is almost identical to the composition of blood plasma. It is a water solution that contains AMK, sugars, fatty acids, hormones, salts, cell metabolites and other substances. The biggest difference between it and plasma is the **minimal protein content**. If tissue fluid begins to accumulate in one place, edema occurs.

The human body contains an average of about **11 liters of tissue fluid**.

Formation of tissue fluid

The formation of tissue fluid is a continuous process that takes place at the level of blood capillaries. It is formed by a mixture of water, substances and gases. The mechanisms involved in the exchange of water, substances and gases between the plasma and the interstitium are: diffusion, filtration and reabsorption

Diffusion



Diffusion plays the most important role in the exchange of respiratory gases (**oxygen** and **carbon dioxide**), **water** and other substances. It takes place along the entire length of the capillary in both directions according to the **concentration gradients** of individual substances. Thanks to diffusion, mixing of intravascular and interstitial fluid is ensured. By this mechanism, about 50[1] times more substances are moved across the capillary endothelial barrier than by the other mechanism. But for the clean resulting fluid movement it is filtration and reabsorption that are decisive .

Filtration and reabsorption

Each capillary has an arterial and a venous end, which differ mainly in pressure conditions.

- **Arterial end** - blood pressure exceeds oncotic pressure, so blood is **filtered** through capillary walls to produce about 20 L of fluid/24 h[1].
- Venous end – oncotic pressure exceeds blood pressure, and therefore about 18 l of fluid/24 h is reabsorbed[1] back into the blood.

The **two liters** of liquid that are created by passing through the arterial and venous end of the capillary make up the basis of **lymph** (lymphatic) fluid.

Under normal conditions, there is a **dynamic balance** between filtration and reabsorption. The fluid that exits at the arterial end is reabsorbed back at the venous end, or is drained away by lymphatic vessels.

At the **arteriolar end** of the capillaries, the blood pressure is **30-35 mmHg**[1] (4.0-4.7 kPa). This pressure acts as the main driving force for filtration against the negligible interstitial fluid pressure. The oncotic pressure in the plasma (25 mmHg[1], i.e. 3.3 kPa) tries to keep fluids in the individual capillaries. At the beginning of the capillaries, **filtration** predominates and **tissue fluid is formed** here.

At the **venous end** of the capillaries, the blood pressure drops to **15–20 mmHg**[1] (2.0–2.66 kPa). The other values hardly change here and **reabsorption** prevails here. The tissue fluid is absorbed back into the blood along with the metabolites, which are thus removed from the tissues.

The resulting **filtration pressure exceeds the reabsorption pressure**, so filtration slightly prevails over reabsorption.

Starling's force

The movement of fluid through the capillary wall is ensured by four forces, which are called **Starling forces** according to their discoverer. Filtration and reabsorption are primarily determined by the ratio between the hydrostatic pressure in the capillaries and the oncotic pressure of plasma proteins. Interstitial fluid pressure and oncotic pressure in this fluid are also involved in filtration and reabsorption, only to a lesser extent. The role of Starling forces in fluid motion is represe by the relation:

$$V = K * (P_k - P_i + \Pi_i - \Pi_k)$$

In this relation, the individual letters mean:

- **V** – the volume of fluid that moves across the capillary wall;
- **K** – a constant determined by the permeability of the capillary wall;
- **P_k** – hydrostatic pressure in the capillary;
- **P_i** – hydrostatic pressure of the interstitial fluid;
- **Π_i** – oncotic pressure of interstitial fluid;
- **Π_k** – plasma oncotic pressure.

If the value of V is **positive**, it is **filtering**. If the value of "V" were in **negative** values, it would be **reabsorption**.

Hydrostatic pressure in capillaries

Hydrostatic pressure in capillaries is identical to blood pressure. This pressure is not constant – its value depends on the pressure in the blood vessels and the resistance ratio of the resistance vessels. Capillary hydrostatic pressure will increase if both arterial and venous pressures increase, or if postcapillary resistance increases. The hydrostatic pressure in the capillaries **decreases** if the pre-capillary resistance increases.

Hydrostatic pressure of interstitial fluid

The hydrostatic pressure of the interstitial fluid represents the pressure around the capillary and **prevents filtration**. Under normal conditions, this pressure is zero, but it is of great importance among the Starling forces in pathological conditions (e.g. in edema).

Oncotic pressure of plasma proteins

Like the hydrostatic pressure of interstitial fluid, the oncotic pressure of plasma proteins also **prevents filtration**. In humans, the proportion of protein osmotic pressure represents only a small part of the osmotic pressure in plasma. The osmotic pressure of proteins is 25 mmHg, whereas the osmotic pressure in plasma is 240 times more (6,000 mmHg)[1].

This pressure is particularly important for fluid exchange between the capillary and the interstitium. The capillary wall is practically impermeable to proteins, while the electrolytes responsible for the osmotic pressure pass through the capillary completely freely.

Oncotic pressure of the interstitium

The oncotic pressure of the interstitium is determined by those proteins that pass through the capillary wall during the filtration of tissue fluid. The value of this pressure is negligible, since the amount of proteins, especially albumins, is very small (usually less than 1 mmHg[1]).

Mechanism of tissue fluid exchange

In the arterial part of the capillary, the blood fluid penetrates from the blood into the tissue thanks to the action of hydrodynamic pressure. In the venous part, this pressure begins to decrease until it reaches a value of 0. At the same time, the osmotic pressure rises and therefore the fluid is sucked back. Only a small amount of fluid remains in the tissue, which is drained away by the **lymphatic vessels**.

Links

Related articles

- Extracellular fluid
- Lymphatic system
- Blood plasma
- Resistance vessels

Sources

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1. KITTNAR, Otomar – ET AL.,. *Lékařská fyziologie.* 1. edition. Praha : Grada, 2011. 790 pp. pp. 230. ISBN 978-80-247-3068-4.