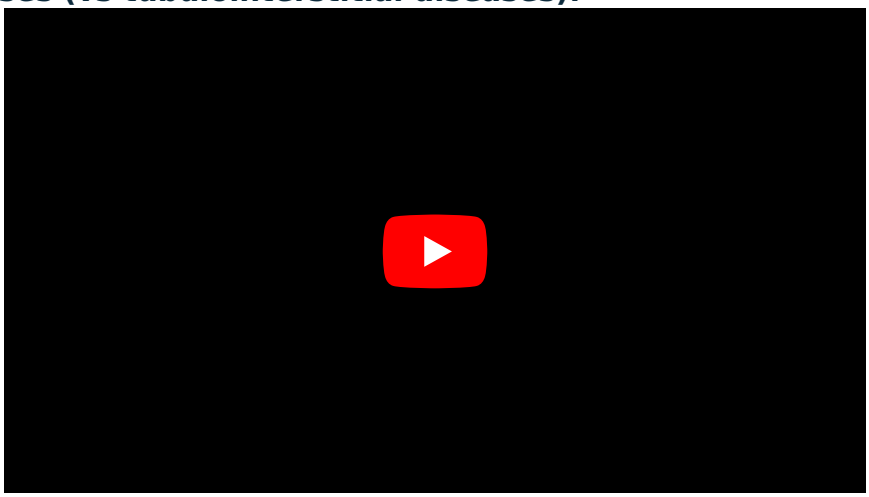
Glomerular barrier

This article has been translated from WikiSkripta; ready for the **editor's review**.

The formation of urinei begins with the filtration of large amounts of fluid through the glomerular capillaries into the Bowman's capsule. Like most capillaries, glomerular capillaries are virtually impermeable to proteins, so the filtered fluid (glomerular filtrate, primary urine) is protein-free and devoid of cellular elements including red blood cells.

Glomerular diseases (vs tubulointerstitial diseases):



The concentration of other components of primary urine, including most salts and organic molecules, is similar to the concentration of these substances in blood plasma. Exceptions are some low molecular weight substances, such as calcium and fatty acids, which are partially bound to plasma proteins (almost half of plasma calcium and most plasma fatty acids) and they are not filtered through the glomerular capillaries.

Glomerular filtration

Glomerular filtration is affected by:

1. Balance of hydrostatic and colloidal osmotic forces,
2. Capillary filtration coefficient (K_f) – the result of permeability and filtration surface area of capillaries.

Glomerular capillaries have a far greater degree of filtration than most other capillaries due to the high glomerular hydrostatic pressure and high K_f value. On average, in an adult, the glomerular filtration rate is approximately 125 ml/min or 180 L/day.
The fraction of plasma flow that is in the kidneys is on average 0.2, so roughly 20% of the plasma is filtered through the glomerular capillaries.

Membrane of glomerular capillaries

The membrane of glomerular capillaries is similar to other capillaries, but there are three main layers:

1. endothelium capillaries
2. basement membrane
3. layer of epithelial cells (podocytes) surrounding the outer surface of the basement membrane of the capillary.

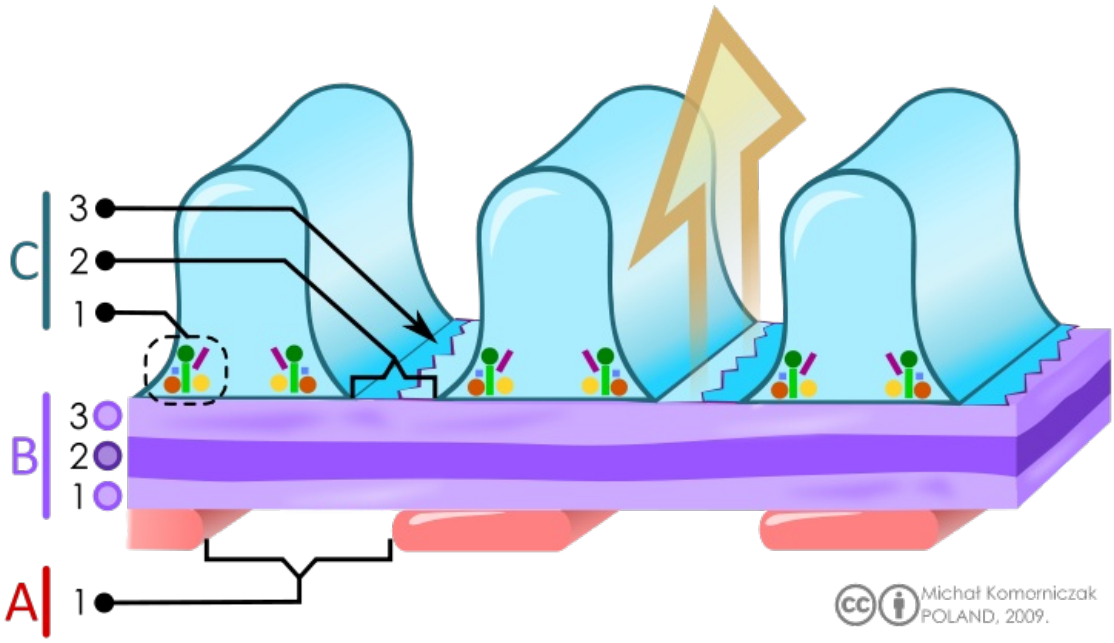
In this way, it forms a *filtration barrier* which, despite its 3 layers, filters several hundred times more water and dissolved substances than a normal capillary membrane. Even with this high degree of filtration, the membrane normally prevents the filtration of plasma proteins.

Filtering degree

A high degree of filtration through the membrane is possible thanks to its special properties.
Capillary endothelium has **pores**. Although relatively large, endothelial cells have a permanent negative charge that prevents the passage of plasma proteins.

Surrounding the endothelium is the **basement membrane**, which contains a network of collagen fibers and proteoglycans with large gaps between which large amounts of water and small solutes can filter. The basement membrane also prevents the filtration of plasma proteins, thanks to the strong negative charge on the proteoglycans.

The last part of the glomerular membrane is a layer of epithelial cells that line the outer surface of the glomerulus. The cells do not form a continuous layer, but have long finger-like projections (**podocytes**') that surround the outer surface of the capillaries. The finger-like processes are separated by slit-like pores through which the glomerular filtrate moves. Podocytes also have a negative charge, preventing further filtration of plasma proteins.



Membrane selectivity

The glomerular capillary membrane is thicker than most other capillaries, but has many more pores and therefore filters more fluid. Despite the high degree of filtration, the filter barrier is selective; when deciding which molecules will be filtered, their size and electrical charge are the determining properties.

Effect of molecular weight of different molecules.

Fabric	Molecular Weight	Throughput
Water	18	1.0
Sodium	23	1.0
Glucose	180	1.0
Inulin	5,500	1.0
Myoglobin	17,000	0.75
Albumin	69,000	0.005

A permeability of 1.0 means that the substance is filtered freely like water; a permeability value of 0.75 means that the filtration rate is 75% of the water filtration rate. Electrolytes (such as sodium) and small organic compounds (such as glucose) are freely permeable. As the molecular weight approaches that of albumin, the permeability across the membrane decreases rapidly and approaches zero.

Large, negatively charged molecules are more difficult to filter than positively charged molecules of the same weight.

The diameter of the plasma protein albumin molecule is approximately 6 nm, the pore size in the glomerular membrane is approximately 8 nm. However, albumin does not pass through the membrane due to its negative charge and the electrostatic resistance of the negatively charged proteoglycans in the wall of the glomerular capillary.

Disease

At u in certain kidney diseases, the negative charge of the basement membrane is lost (even if there is no histological change in the structure of the kidney). This condition is known as minimal change nephropathy. The consequence of this loss of the negative charge of the basement membrane is the possibility of some low molecular weight proteins, mainly albumin, passing through and appearing in the urine (proteinuria or albuminuria).

Links

Related Articles

- Glomerular filtration
- Glomerular filtration test

- Kidneys

Reference

- HALL, John E. a Arthur C. GUYTON. Guyton and Hall textbook of medical physiology. 12th ed. vydání. Saunders/Elsevier : Philadelphia, Pa., c2011. ISBN 9781416045748.