UNDERSTANDING THE KIDNEYS

THE FUNCTION, DISEASES AND TREATMENTS FOR THE HUMAN KIDNEY

FRESENIUS MEDICAL CARE

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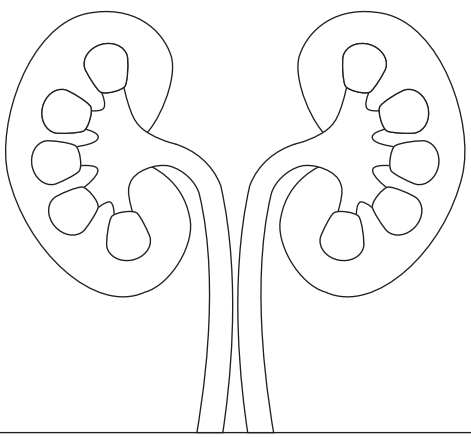
THE KIDNEY – AN ALMOST IRREPLACEABLE ORGAN!

Human kidneys are small, biological marvels with a fascinating design that fulfill a vital function. The failure or inability of the twin organs to function over a significant period can be life-threatening. Treating kidney patients only recently became a success story as hemodialysis became routine in the 1960s. Now, thanks to technical progress, dialysis ensures quality of life and a long life expectancy for an ever increasing number of kidney patients.

This brochure summarizes key information about kidneys and chronic kidney failure and explains how dialysis works.

The kidneys come in pairs.



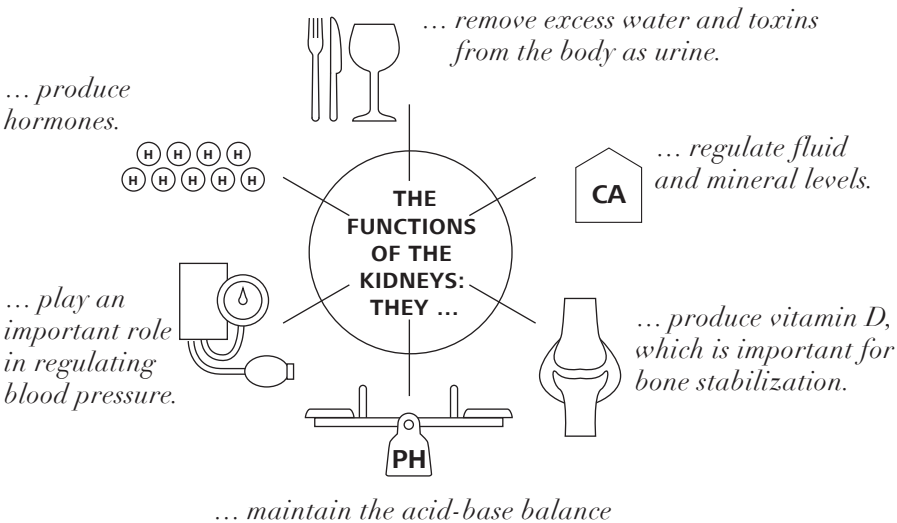
THANKS TO TECHNICAL ADVANCES, KIDNEY PATIENTS ARE ENJOYING INCREASING QUALITY OF LIFE AND LIFE EXPECTANCY.

THE FUNCTIONS OF THE KIDNEYS

The kidneys are located in the abdominal cavity, behind the peritoneum – the lining of the abdomen – and to the right and left of the spinal column. They are about the size of a fist and shaped like a bean.

Our kidneys are essential organs with a wide range of functions: They form urine and route it through the urinary tract. Excess water and toxins from metabolic processes are also removed along with this urine. What's more, the kidneys regulate the body's acid-base balance to prevent excess acidity in the blood.

Through hormone production, the kidneys also play an important part in regulating blood pressure. Hormones from the kidneys, such as erythropoietin, control the production of red blood cells in the bone marrow. Furthermore, the kidneys influence the concentration of minerals such as potassium, sodium and calcium in the blood and the production of vitamin D.



AVERAGE LENGTH OF A KIDNEY:

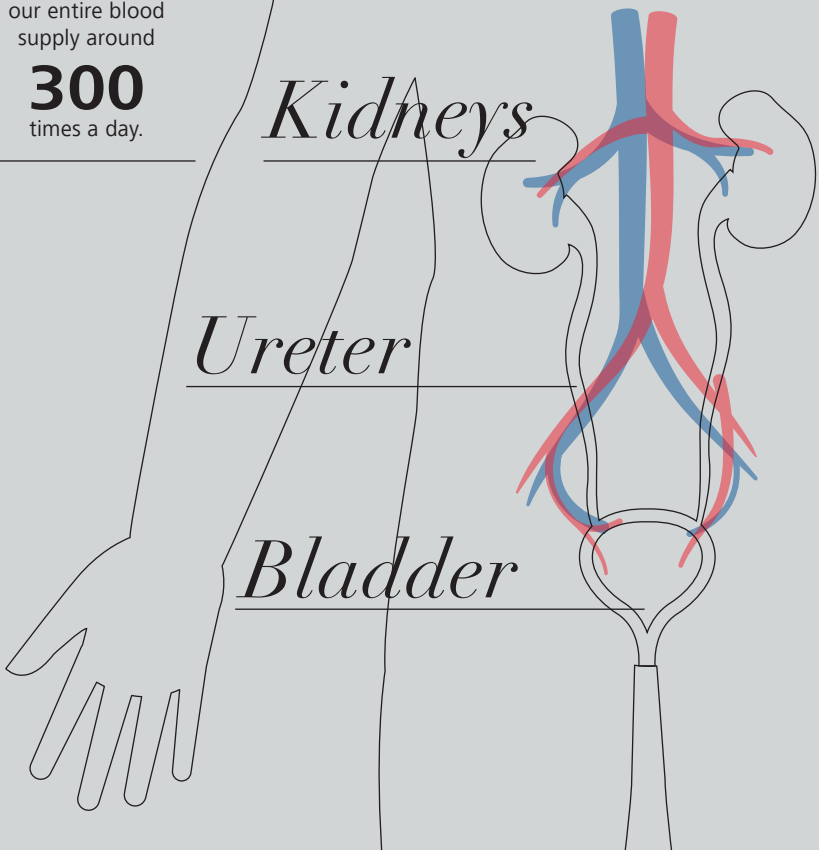
11 CM
(4.3 IN)

A kidney weighs about

120–200 g
(4–7 OZ)

Healthy kidneys clean our entire blood supply around

300
times a day.

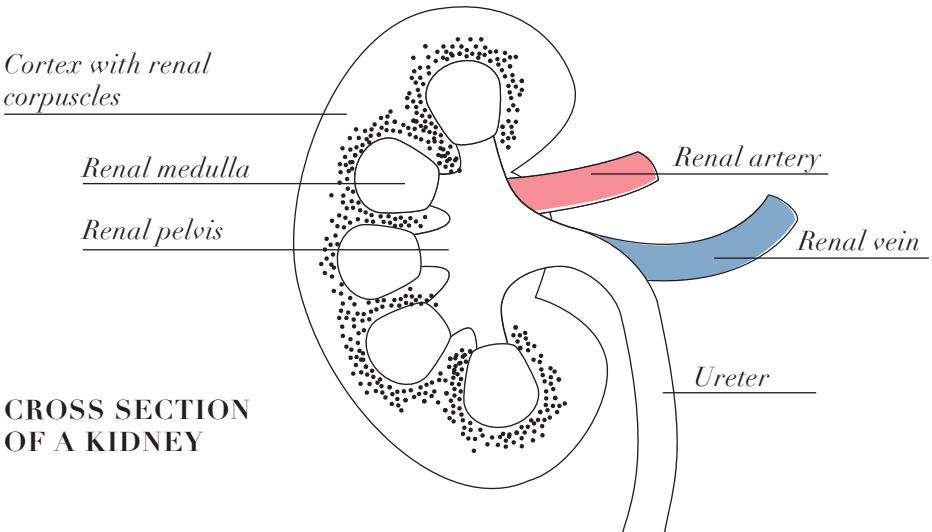


THE CAUSES OF KIDNEY DISEASE

Kidney diseases can have different causes. Various forms of infection in kidney tissue often leave lasting damage. Even high blood pressure, a common ailment, can damage the kidneys. Underlying diabetes is often the cause of kidney disease and an excessive intake of certain medications can also reduce kidney function in the long term. Various other, sometimes congenital, causes exist, such as polycystic kidney disease.

Chronic kidney disease ultimately leading to kidney failure is a long and usually creeping process that sees the kidneys slowly lose their ability to function. It can often go unnoticed for several years, as the early signs are usually not especially pronounced. As a result, some patients do not visit a kidney specialist until a late stage of the illness.

Though rare, some acute cases can develop quickly in a matter of days or weeks, thus requiring immediate renal replacement therapy. In such cases, unlike that of chronic kidney disease, there is a good chance that the kidneys will start working again and that renal replacement therapy can be stopped.



CROSS SECTION OF A KIDNEY

THE CONSEQUENCES OF KIDNEY DISEASE

When kidneys are no longer able to do their job properly, there are significant consequences for the functional efficiency of the entire organism. Water can utilize in the legs or even in the lungs, for example, and often too few toxins and too many proteins are removed. The body is damaged and the patient's physical and mental capacity can be compromised.

Further consequences are anemia caused by the dysfunction of blood cell production and the onset of decalcification of the bones.

As it may be possible to slow the progress of the disease in its early stages, it is important to diagnose chronic kidney disease early on and work with a physician to find the right treatment.

POSSIBLE WARNING SIGNS:

* *Reduced urine production*
* *Swelling in the hands, face and legs*
* *Shortness of breath*
* *Problems sleeping*
* *Loss of appetite*
* *Nausea*
* *Feeling cold*
* *Tiredness*

THE GOALS IN TREATING KIDNEY FAILURE

If the performance of the kidneys, also known as **clearance,** falls below 10 to 15 percent of normal levels, complications are to be expected. Water and waste materials build up in the body, causing **uremia.** If left untreated over a longer period, this can prove fatal to the patient.

CLEARANCE
the ability of the kidneys to remove toxins

UREMIA
an excess of substances containing urea in the blood

Severely damaged kidneys can only be treated by replacing the organ's vital functions with an appropriate treatment (renal replacement therapy).

Blood sugar and blood pressure have a significant influence on the development and progression of chronic kidney weakness.

PREVENTING CHRONIC KIDNEY FAILURE

** Eat a healthy diet*
** Drink sufficient fluids*
** Exercise regularly*
** Avoid excess weight*
** Don't smoke*

TREATMENT OPTIONS AT A GLANCE

There are three basic treatment options:

- **Hemodialysis**
- **Peritoneal dialysis**
- **Kidney transplant**

Hemodialysis and peritoneal dialysis take over the key tasks of the kidneys, removing waste materials, excess salt and fluids from the body. In a kidney transplant, a healthy donor kidney replaces the functions of the damaged kidneys. Which treatment is the most suitable for a patient depend on a whole range of medical, social and psychological factors.

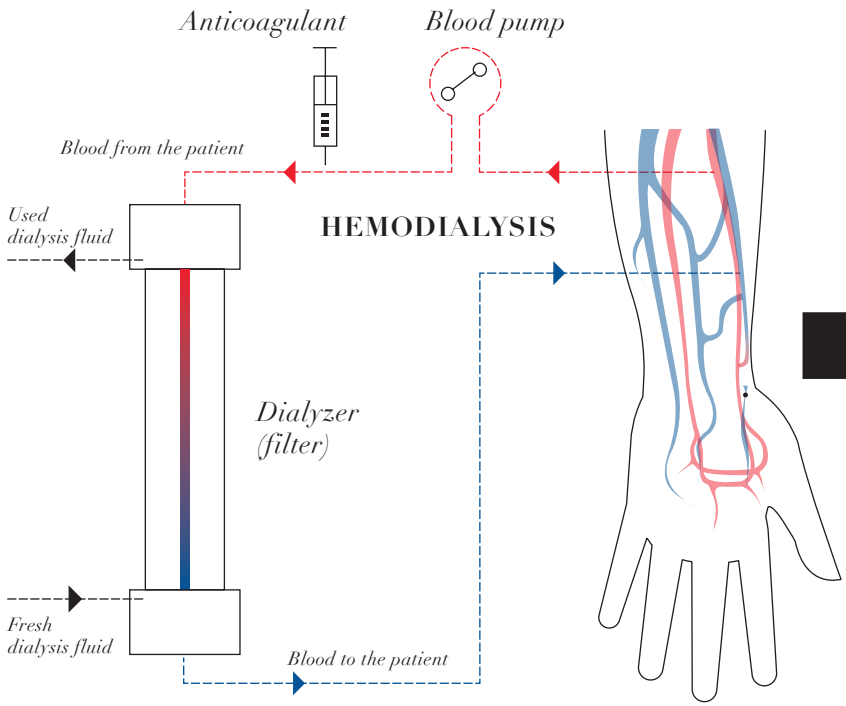
Dialysis treatment does not entirely replace all the functions of the kidneys, meaning that patients almost always need to take certain medications regularly. These include antihypertensive treatments, drugs for lowering phosphate levels in the blood, vitamins and drugs that boost the production of red blood cells to prevent anemia.

DIALYSIS

Dialysis largely replicates the functions of the kidneys in patients with chronic kidney failure.

HEMODIALYSIS

Hemodialysis is the process of cleaning blood outside the body. During hemodialysis, blood is taken from a blood vessel and passed through a filter, known as a **dialyzer.** The blood is cleaned in the dialyzer before being returned to the body, which is why the dialyzer is also referred to as an "artificial kidney". The process is controlled by a hemodialysis machine, which pumps the blood around the circuit, adds in an anticoagulant, removes excess fluid and regulates the entire cleaning process, amongst other things. Hemodialysis usually takes three to six hours and is performed at least three times a week, usually in a dialysis center.



Instead of being treated in a dialysis center, patients may be offered the option of receiving treatment in their own home environment. Various types of home dialysis give patients the opportunity to make their treatment part of their everyday life.

For hemodialysis blood is usually taken from a vein in the arm that has been specially prepared for the purpose in an operation. This operation involves creating a connection (known as a **"shunt"**) between an artery and the vein to ensure the vein can carry enough blood. If no appropriate blood vessels can be found for the shunt procedure, a catheter can be used for the treatment.

USUALLY

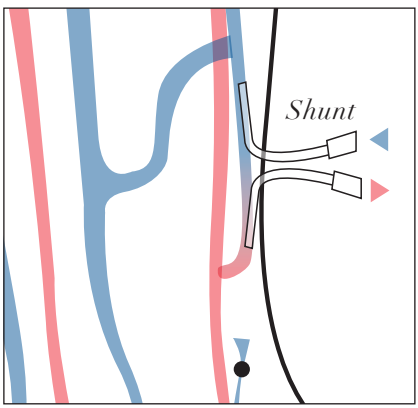
3

TREATMENTS PER WEEK

AT LEAST

3–6

HOURS PER TREATMENT



SHUNT

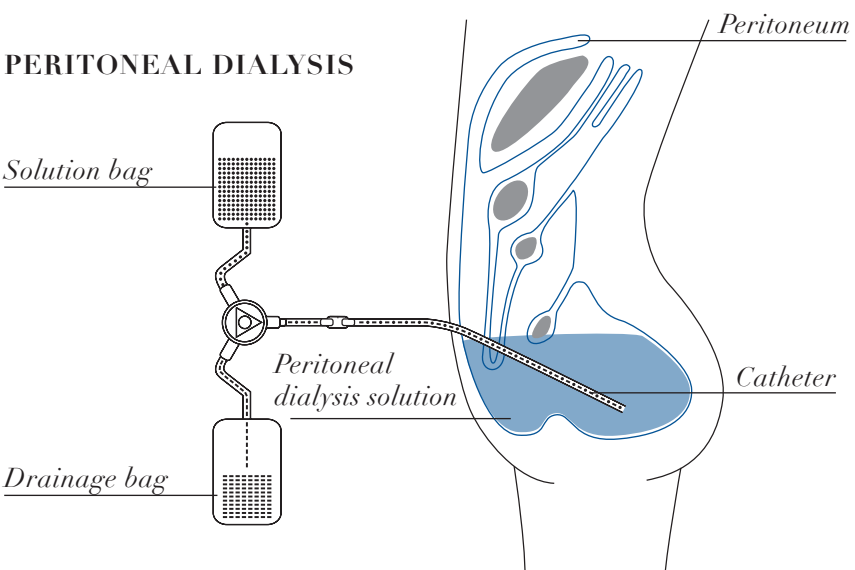
A connection between an artery and a vein that facilitates hemodialysis and is preferably located in the forearm of the dialysis patient.

PERITONEAL DIALYSIS

The **peritoneum** lines the walls of the abdomen and covers the internal organs. It has similar attributes to the artificial filter used in hemodialysis – its pores allow the passage of certain substances while retaining others. Peritoneal dialysis utilizes this naturally filtering organ.

PERITONEUM
The lining of the abdomen. It is used as a natural replacement filter in peritoneal dialysis.

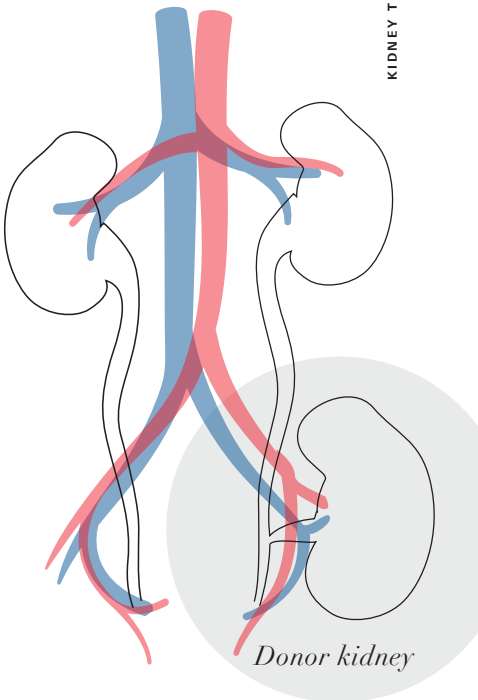
An operation is first carried out to implant a catheter, which is then used to feed sterile dialysis fluid into the abdominal cavity to collect toxins and remove them along with excess water. After a few hours, the dialysis solution is removed and replaced immediately with fresh solution. Patients usually change their dialysis solution like this independently, carrying out the procedure manually several times a day at home or at work and using a machine, a so-called cycler, at night.



KIDNEY TRANSPLANT

Many patients with chronic kidney failure hope for a "new" kidney, i.e. a kidney transplant. For many, that means getting back to a life that is not dependent on machines. However, there are not enough donor organs available in the world, and sometimes there can be important medical and personal reasons why a kidney transplant is not an option. Moreover, when donor kidneys are being allocated, it is important to consider whether the donor and recipient share similar tissue types. This reduces the risk that the recipient's body could quickly reject the transplanted kidney.

The donor kidney is implanted in the groin area of the patient and connected to the patient's blood vessels. The patient's own kidneys are usually left in the body. The ureter of the donor kidney is connected to the patient's bladder. A donor kidney that functions well will take over the work of the damaged kidneys.



KIDNEY TRANSPLANT

Every transplant carries the risk that the recipient's immune system will reject the donor organ. Consequently, transplants are followed by a lifetime of treatment with drugs designed to prevent the body rejecting the new kidney. Regular exams carried out by a specialist are also essential after a kidney transplant.

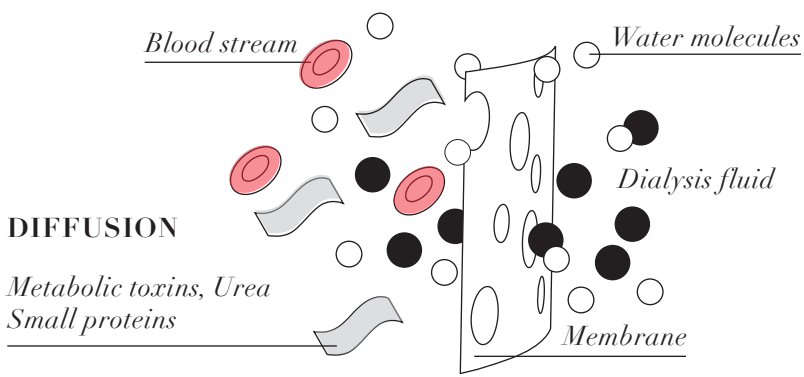
HOW METABOLIC TOXINS ARE REMOVED FROM THE BODY

A dialyzer is an artificial filter containing fine dialysis fibers with microscopic pores. They are also known as **dialysis membranes** and are hollow with semi-permeable walls. To remove toxins during hemodialysis, a special dialysis fluid (dialysate) is introduced into the dialysis filter, which bathes the membranes from the outside. Due to the semi-permeable nature of the dialysis membrane, metabolic toxins, urea and other small particles pass through the membrane. Vital substances and blood cells, however, remain in the blood stream because the pores are too small for them to pass through.

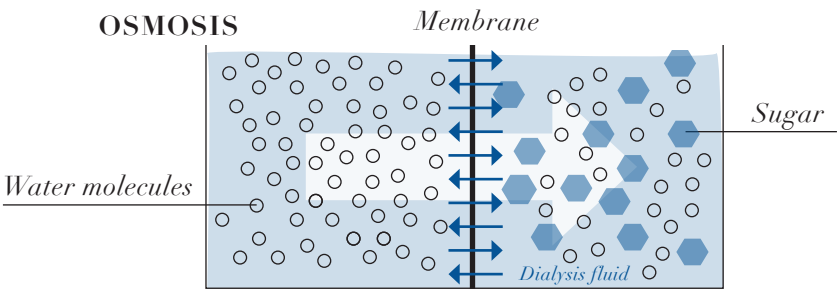
One dialyzer can contain up to
20,000
dialysis membranes

The walls of the dialysis membranes measure just
0.035 mm
or 35 µm

The transfer of metabolic toxins through the membrane into the dialysate is based on physical transport laws. When two liquids (in this case blood and dialysate) with differing concentrations of substances are separated by a semi-permeable membrane, molecules attempt to offset the concentration difference. They therefore migrate towards the liquid with the lower concentration. This process is known as **diffusion.** However, proteins and blood cells cannot pass through the small pores of the membrane, as their molecules are comparatively large. As a result, they remain in the blood.



To remove excess water from the body during peritoneal dialysis, sugar is added to the dialysis fluid. The concentration of the sugar in the dialysis fluid is higher than in the blood. Since the sugar molecules cannot pass through the membrane, the only way of balancing out the difference in concentration is for water to pass from the blood, through the filter membrane and into the "high-percentage" sugar solution. This process is known as **osmosis.** By continuously introducing fresh dialysis fluid, excess water that the kidneys cannot remove and that would otherwise collect in the body, can be removed from the blood.



Both hemodialysis and peritoneal dialysis are based on these two principles – diffusion and osmosis. In hemodialysis, an artificial filter is used while, in peritoneal dialysis, the patient's peritoneum is used as a dialysis membrane.

Another process that can be used in hemodialysis is convection. In this process, solvents and the substances they contain are transported from one side of a semi-permeable membrane to the other due to a difference in pressure. Convection plays an important part in hemodiafiltration, a particularly effective type of hemodialysis.

Fresenius Medical Care is the world's leading provider of products and services for patients with kidney disease, millions of whom are undergoing dialysis treatment. We look after hundreds of thousands of dialysis patients in our global network of dialysis centers. Fresenius Medical Care is also the leading provider of dialysis products such as dialysis equipment and dialysis filters. Additionally, in the field of Care Coordination, the company is expanding its portfolio of supplementary medical services related to dialysis.

Further information about our company and the history of dialysis can be found online at:

www.freseniusmedicalcare.com

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