2.5 Kidney failure

Problems of living with kidney failure and their solutions, and testing urine

Causes and problems of kidney failure

Kidney failure does not arise from one sole cause. The most common factors which can cause kidney failure are **diabetes**, **hypertension** and infection. When kidneys fail, the body is left unable to remove waste substances and excess water from the blood, which of course includes urea, which is harmful. This will ultimately lead to death, and will not take too long.

Treatment with dialysis

The most common form of treatment for someone with kidney failure is **dialysis**, which performs the same function as a kidney by passing the blood over a **dialysis membrane** to remove excess fluids, wastes and salts. The membrane keeps the blood and **dialysis fluid** separate, but allows for exchange of materials between them. The dialysis fluid contains optimal concentrations of substances, and diffusion across the artificial membrane restores the correct concentrations in the blood: anything in excess flows across the membrane to the fluid, and anything in the blood with too low a concentration flows from the fluid to the blood over the membrane. One issue with dialysis is that a monitored diet must be maintained if someone uses dialysis.

Haemodialysis

Haemodialysis is the most common form, and the oldest form of dialysis. This is where blood from a vein is passed over a dialysis membrane in an external machine. The polysaccharide **heparin** is added to prevent clotting of the blood externally, and all bubbles are removed before the blood is returned to the body. Haemodialysis is a big burden on someone's life and prevents them from doing many things they would otherwise be able to do. It must be undergone in a clinic at least three times a week, although many patients buy their own machines and learn how to perform it at home.

Peritoneal dialysis

In **peritoneal dialysis**, the dialysis is done internally, not via an external machine. A permanent catheter is inserted into the abdomen. In this form of dialysis the filter is the patient's own abdominal membrane, the **peritoneum**. Dialysis fluid is inserted through the catheter into the space between the abdominal wall and surrounding organs. The same substance exchange as with haemodialysis occurs here. After a couple of hours, the fluid is drained from the abdomen, and this process must be performed in several consecutive sessions daily. However, an advantage of peritoneal dialysis is that it has less of an impact on the patient's life, as they are able to walk around whilst the exchange occurs. However, this must begin with surgery in order to permanently implant the catheter into the abdomen.

Kidney transplant

Unless the kidneys have failed due to infection or they are cancerous, there is no reason to remove the kidneys, and so normally when a patient has a kidney transplant, the damaged kidneys are left where they are. A kidney comes from a living relative or someone who has recently died with a healthy kidney. During surgery, the new kidney is placed just underneath the lower abdomen, and is connected both to blood supply and the bladder. Patients must take drugs known as **immunosuppressant drugs** to prevent the risk of *rejection* by the body, as their immune system will recognise the new transplanted kidney as a dangerous foreign object.

The evaluations of undergoing dialysis and having a kidney transplant are outlined below.

Dialysis:

- ✓ No need for major surgery, even the implantation of catheter in peritoneal dialysis is only minor surgery
- ✓ No chance of rejection and no need for immunosuppressants
- × Negative impact on quality of life – constant need for dialysis is a burden
- × Diet is strictly limited if on dialysis
- × Psychological drawback is seeing yourself as chronically ill

Kidney transplant:

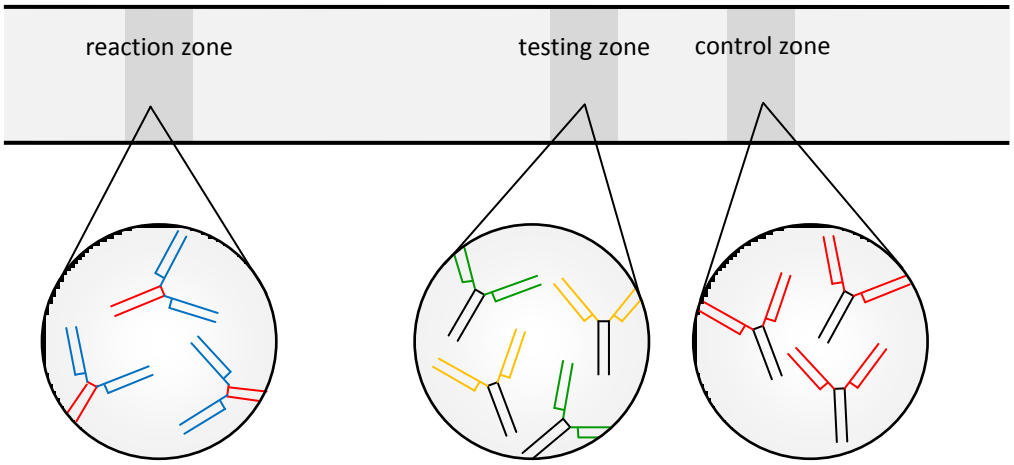
- ✓ Does not affect your life as much – no need for time-consuming dialysis all the time
- ✓ Better quality of life and diet is less limited
- ✓ Psychologically no longer see yourself as ill
- × Requires major surgery including the risk of general anaesthesia and surgery itself
- × Possible risk of rejection and must take immune drugs, there are also side effects of the drugs themselves

Testing urine

Pregnancy testing

A women's urine can be used to test for pregnancy, using commercially prepared testing strips. The number of coloured bands which appear on a strip are used to categorise as either pregnant or not pregnant.

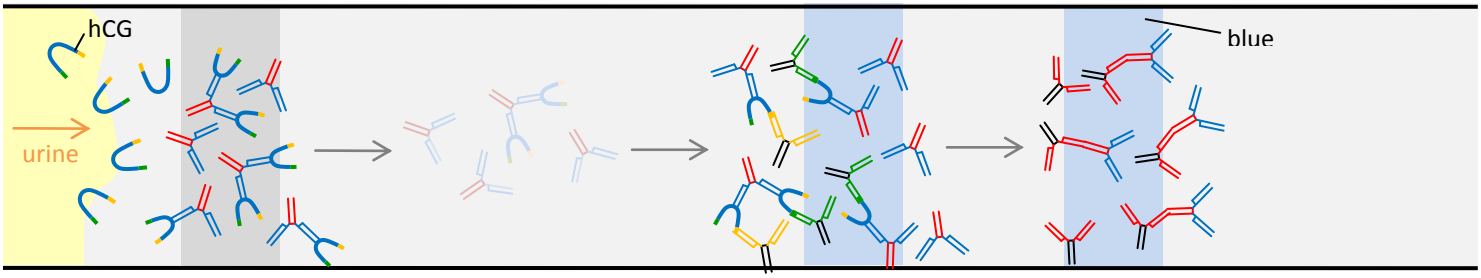
It is the hormone **human chorionic gonadotrophin** (hCG) which is pivotal here. hCG is produced by the developing placenta, and has important roles during pregnancy. However, some of it is lost to the urine, which is why it can be detected. Women who are not pregnant do *not* product hCG. An hCG test strip can detect even low levels of the hormone when present in the urine. Urine is drawn along the testing strip across three 'bands'. These represent three zones, which are often known as the *reaction zone*, the *testing zone* and the *control zone*.



The reaction zone contains a type of antibody which recognises a single molecular feature of the hCG molecule. These are called **monoclonal antibodies** and only will bind to hCG. These antibodies have **blue beads** attached to them, which always remain on the antibodies.

The blue beads will later become visible, which will give an indication of pregnancy or no pregnancy. The testing zone contains a group of antibodies called **polyclonal antibodies** which can bind to numerous molecular parts of hCG. The control zone contains antibodies which can recognise and bind to the antibodies which are currently in the reaction zone.

A pregnancy test strip is either urinated on or dipped in a urinary test sample. This is on the end closest to the reaction zone. A pregnant woman will yield a *positive* test result. This woman will have hCG in her urine, and so hCG will be on the testing strip. As the urine moves along the strip, the following processes take place:



urine passes into the reaction zone and some of the monoclonal antibodies bind to the hCG, though some do not and carry on down the strip also

when the urine carrying the monoclonal antibodies (some bound to hCG and others not) reaches the testing zone, the hCG binds from a separate area to the polyclonal antibodies immobilised here, so that the blue beads on the original anditbodies are fixed – this zone goes blue

those monoclonal antibodies without hCG attached continue to move along the strip with the urine when they reach the control antibodies and bind to them, likewise here turning this zone blue

By this method, when there is hCG present in the urine (i.e. in pregnant women), there will be two blue strips. However, when the woman is not pregnant there is no hCG so the monoclonal antibodies will not attach to the hormone and therefore will not bind to the testing zone, so there is only one blue strip (the control zone at the end).

Testing for anabolic steroids

Urinary testing can also be used to test for **anabolic steroids** which can be used to enhance physical performance. This is done using **gaseous chromatography**. This is a method which separates different gases, so that various substances can be identified within the urine sample.