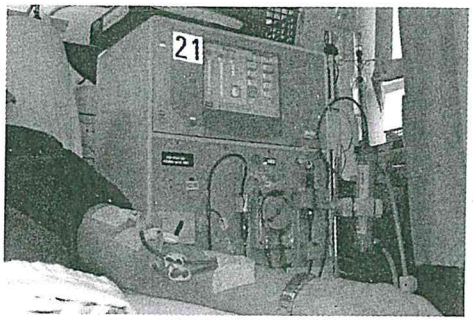
Kidney Dialysis

A dialysis machine is a machine designed to remove wastes from the blood. It is used when the kidneys fail, or when blood acidity, urea, or potassium levels increase much above normal. In kidney dialysis, blood flows through a system of tubes composed of partially permeable membranes. Dialysis fluid (dialysate) has a composition similar to blood except that the concentration of wastes is low. It flows in the opposite direction to the blood on the outside of the dialysis tubes. Consequently, waste products like urea diffuse from the blood into the dialysis fluid, which is constantly replaced. The dialysis fluid flows at a rate of several 100 cm^3 per minute over a large surface area. For some people dialysis is an ongoing procedure, but for others dialysis just allows the kidneys to rest and recover from injury or the effects of drugs or other metabolic disturbance.



A patient undergoing kidney dialysis at a hospital

Principles of Kidney Dialysis

1. In kidney dialysis, explain why the dialyzing solution is constantly replaced rather than being recirculated:

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2. Explain why ions such as potassium and sodium, and small molecules like glucose do not diffuse rapidly from the blood into the dialyzing solution along with the urea:

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3. Explain why the urea passes from the blood into the dialyzing solution: _____

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4. Describe the general transport process involved in dialysis: _____

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5. Give a reason why the dialyzing solution flows in the opposite direction to the blood: _____

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6. Explain why a clot and bubble trap is needed after the blood has been dialyzed but before it re-enters the body:

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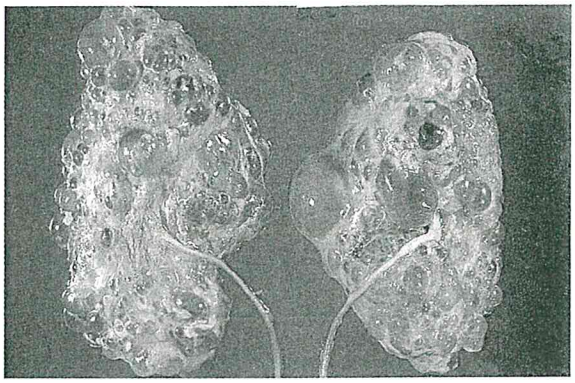
Kidney Transplants

Kidney failure (also called renal failure) arises when the kidneys fail to function adequately and filtrate formation decreases or stops. In cases of renal failure, normal blood volume levels and electrolyte balances are not maintained, and waste products build up in the body. Kidney failure is classified as **acute** (rapid onset) or **chronic** (developing over a period of months or years). There are many causes of kidney failure including decreased blood supply, drug overdose, chemotherapy, infection, and poorly controlled diabetic or hypertensive conditions. Recovery from acute renal failure is possible, but chronic renal damage can not be reversed. If kidney deterioration is ignored, the kidneys will fail completely. In some cases diet and medication can be used to treat kidney failure, but when the damage is extensive, **kidney dialysis** or a **kidney transplant** are required to keep the patient alive.

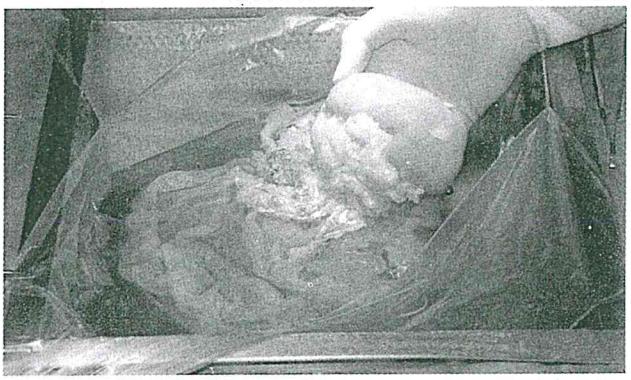
Renal Failure

Kidney (renal) failure is indicated by levels of **serum creatinine**, as well as by kidney size on ultrasound and the presence of anemia (chronic kidney disease generally leads to anemia and small kidney size). Creatinine is a break-down product of creatine phosphate in muscle, and is usually produced at a fairly constant rate by the body (depending on muscle mass). It is chiefly filtered out of the blood by the kidneys, although a small amount is actively secreted by the kidneys into the urine. A rise in blood creatinine levels is observed only with marked damage to functioning nephrons.



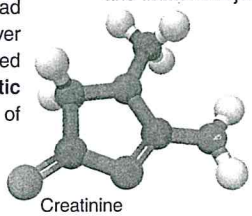
Acute renal failure (ARF) is characterized by decreased urine production (<400mL per day), and commonly arises because of low blood volume (blood loss), dehydration, or widespread infection. In contrast, chronic renal failure, which develops over months or years, is commonly the result of poorly controlled diabetes, poorly controlled high blood pressure, or **polycystic kidney disease**, a genetic disorder characterized by the growth of numerous cysts in the kidneys (above).

Kidney Transplants



Transplantation of a healthy kidney from an organ donor is the preferred treatment for end-stage kidney failure. The organ is usually taken from a person who has just died, although kidneys can also be taken from living donors. The failed organs are left in place and the new kidney transplanted into the lower abdomen. Provided recipients comply with medical requirements (e.g. correct diet and medication) over 85% of kidney transplants are successful.

There are two major problems associated with kidney transplants: lack of donors and tissue rejection. Cells from donor tissue have different antigens to that of the recipient, and are not immunocompatible. Tissue-typing and the use of immunosuppressant drugs helps to decrease organ rejection rates. In the future, xenotransplants of genetically modified organs from other species may help to solve both the problems of supply and immune rejection.



Creatinine

Creatinine levels in both blood and urine is used to calculate the creatinine clearance (CrCl), which reflects the glomerular filtration rate (GFR). The GFR is a clinically important measurement of renal function and more accurate than serum creatinine alone, since serum creatinine only rises when nephron function is very impaired.

1. Distinguish between acute and chronic renal failure and contrast their causes: _____

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2. (a) Explain why a rise in blood (serum) levels of creatinine would indicate a failure of nephron function: _____

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(b) Explain why a creatinine clearance is a more accurate indicator of renal function than a serum creatinine test alone:

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3. Describe some of the advantages and disadvantages of kidney transplantation over a life-time of kidney dialysis:

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