9.11: Dialysis

Learning Objectives

- Understand the difference between dialysis and osmosis.

As introduced in a previous section, osmosis is the process by which *solvent* particles can pass through a semipermeable membrane. **Dialysis** is similar to osmosis with the difference being that the pores in the semipermeable membranes are larger, thus allowing *both* solvent and small solute molecules to pass through. Larger solute particles, such as colloids and proteins, that cannot pass through the pores in the membrane are left behind. The size of the pores in the semipermeable membranes can be varied to allow for separation (or purification) of specific solute molecules from a solution based on their size. Biochemists and molecular biologists use dialysis to purify proteins from mixtures or to change the concentration of solute particles for different types of experiments, as illustrated in Figure 9.11.1.

Figure 9.11.1: Dialysis separates colloidal particles like protein and starch from water, small molecules, and ions. Source: Potcherboy at English Wikipedia / CC BY (https://creativecommons.org/licenses/by/3.0)

Role of dialysis in the human body

Kidneys filter the blood by dialysis, which occurs in tubular structures called nephrons (Figure 9.11.2 The nephrons filter the water, and small molecules, like glucose, amino acids, urea, and ions from the blood. Useful products and most of the water reabsorb later on, but urea and other waste products are excreted through urine. (You can read more about kidney structure and function here.)

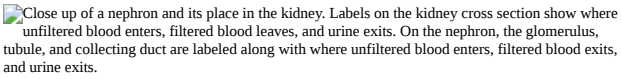

Figure 9.11.2: Image of a close up nephron and its place in the kidney. Labels on the kidney cross section show where unfiltered blood enters, filtered blood leaves, and urine exits. On the nephron, the glomerulus, tubule, and collecting duct are labeled along with where unfiltered blood enters, filtered blood exits, and urine exits. (National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health. CC0 1.0)

The main function of the kidneys is to filter the blood to remove wastes and extra water, which are then expelled from the body as urine. Some diseases rob the kidneys of their ability to perform this function, causing a buildup of waste materials in the bloodstream. If a kidney transplant is not available or desirable, a procedure called dialysis can be used to remove waste materials and excess water from the blood.

In one form of dialysis, called **hemodialysis**, (see Figure 9.11.3), a patient's blood is passed though a length of tubing that travels through an *artificial kidney machine* (also called a *dialysis machine*). In the dialyser, a section of tubing composed of cellophane (a semipermeable membrane) is immersed in dialysate, a solution of sterile water, glucose, amino acids, and certain electrolytes. The osmotic pressure of the blood forces waste molecules, such as urea, and excess water through the membrane into the dialysate. Red and white blood cells are too large to pass through the membrane, so they remain in the blood. After being cleansed in this way, the blood is returned to the body.

Dialysis is a continuous process, as the osmosis of waste materials and excess water takes time. Typically, 5–10 lb of waste-containing fluid is removed in each dialysis session, which can last 2–8 hours and must be performed several times a week. Although some patients have been on dialysis for 30 or more years, dialysis is always a temporary solution because waste materials are constantly building up in the bloodstream. A more permanent solution is a kidney transplant.

Figure 9.11.3: Simplified hemodialysis circuit. (Yassine Mrabet, CC BY 3.0)

Career Connection: Dialysis Technician

Dialysis is a medical process of removing wastes and excess water from the blood by diffusion and ultrafiltration. When kidney function fails, dialysis must be done to artificially rid the body of wastes. This is a vital process to keep patients alive. In some cases, the patients undergo artificial dialysis until they are eligible for a kidney transplant. In others who are not candidates for kidney transplants, dialysis is a life-long necessity.

Dialysis technicians typically work in hospitals and clinics. While some roles in this field include equipment development and maintenance, most dialysis technicians work in direct patient care. Their on-the-job duties, which typically occur under the direct supervision of a registered nurse, focus on providing dialysis treatments. This can include reviewing patient history and current condition, assessing and responding to patient needs before and during treatment, and monitoring the dialysis process. Treatment may include taking and reporting a patient's vital signs and preparing solutions and equipment to ensure accurate and sterile procedures.

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