

Chapter 7

Inside the Artificial Kidney Machine

Real World BioApplications

One of the most important organs in vertebrates is the kidney. Kidneys, which occur in pairs, help maintain homeostasis by regulating the concentrations of dissolved substances in the blood. Without this constant monitoring by the kidneys, the nitrogenous waste products of cellular activity can build to toxic concentrations. It is

possible to live with only one kidney; however, if both kidneys fail, people must have their blood filtered by an artificial kidney machine in a process called hemodialysis. In this activity, you will investigate how artificial kidney machines duplicate the important functions of kidneys.

Part A: Nephron Structure and Function

Each kidney is composed of nearly one million tiny filtering units called nephrons (Figure 1). Through a complex process involving both active and passive transport of substances, nephrons filter out excess water, waste molecules, and excess ions from the blood, and ensure that critical nutrients such as glucose and proteins remain in the blood. The table in Figure 1 shows how the concentrations of substances dissolved in the blood change as they pass through the kidney. Study the table and diagram of the nephron in Figure 1, and then answer the following questions.

Concentrations of Dissolved Substances (mg/100 mL of fluid)			
Dissolved Substances	Arterial Blood (A)	Filtrate (B)	Urine (C)
Urea	30	30	2000
Uric Acid	2	2	30
Glucose	100	100	0
Salts	900	900	2300
Protein	8500	0	0

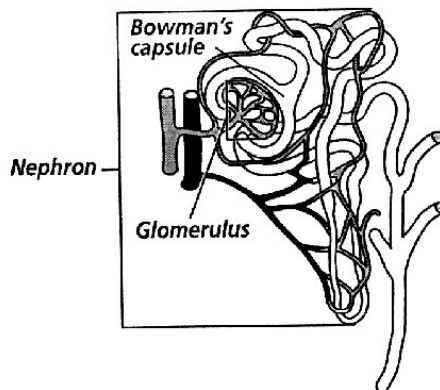
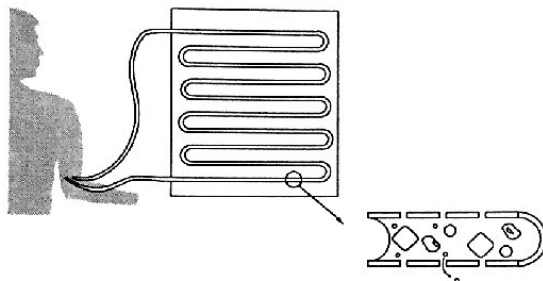


Figure 1

- Bowman's capsule is a selectively permeable structure. According to the table, which substances pass through Bowman's capsule into the tubule to become filtrate?
- Which parts of the nephron actually filter the blood?
- Using your understanding of diffusion, how might you account for the increases in concentration of urea, uric acid, and salts in urine?
- What happened to the glucose in the filtrate? What process was involved?

Part B: How Do Artificial Kidney Machines Work?

Artificial kidney machines, like kidneys, work by the process of diffusion. During dialysis, blood is pumped from a person's artery through selectively permeable tubing that is bathed in a solution similar to actual blood plasma. As the blood circulates through the tubing, waste materials diffuse from the tubing into the surrounding solution and are washed away. The cleaned blood left behind is then returned to a vein.

**Figure 2**

Study the diagram in Figure 2 and answer the following questions.

1. Using your knowledge of diffusion, explain what happens to the waste materials as the blood circulates through the machine.

2. Explain what would happen to the diffusion process if the solution surrounding the tubing were not regularly cleaned and discarded.

3. Which molecules would you expect to find in the tube leading back from the machine to the person's vein?

4. Explain why blood cells, glucose, protein, salts, and water don't leave the tubing.

