The Kidney and Homeostasis

Adapted from BSCS Biology: A Molecular Approach 9th Edition 2006

The cells of the human body are surrounded by liquid that is remarkably constant in its properties. The continuous regulation of the many dissolved compounds and ions in this internal environment is referred to as homeostasis. The kidneys play an important role in homeostasis by regulating blood composition and by regulating the levels of many important chemicals and ions. The production of urine and its elimination from the body are critical functions of the kidneys and the urinary system.

Part A: Blood Versus Urine

The relationship of structure and function in the kidney is illustrated diagram. Use the illustration and the data to answer the analysis questions.

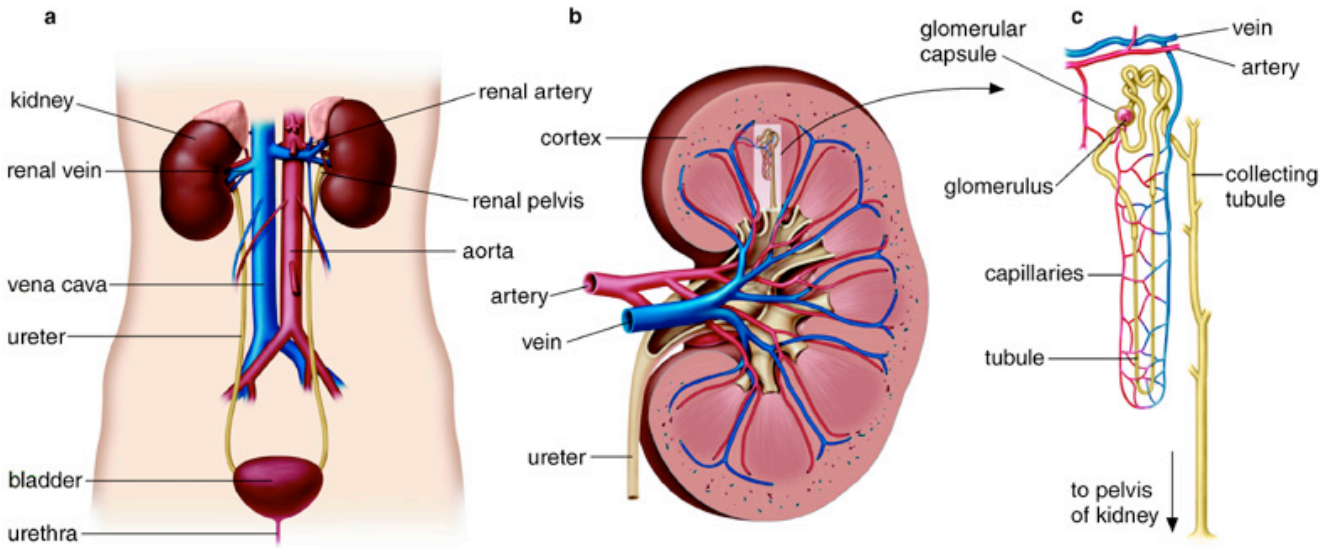


Table 1: Comparison of Substances in Blood and Urine

	% in blood as it enters kidney	% in urine as it leaves kidney
Water	91.5	96.0
Protein	7.0	0.0
Glucose	0.1	0.0
Sodium	0.33	0.29
Potassium	0.02	0.24
Urea	0.03	2.70

1. What do the data for water indicate?
2. Protein molecules are not normally found in the urine. Explain why.
3. The information for glucose is similar to that for protein. Explain these data.
4. Based on what the sodium data indicate, what do you think may happen to the sodium content in the urine of a person who increases his or her intake of sodium chloride?
5. How do the data for potassium differ from those for sodium?
6. How would you interpret the data for urea?
7. Summarize the processes that take place between blood and urine, and identify the structures where they occur.

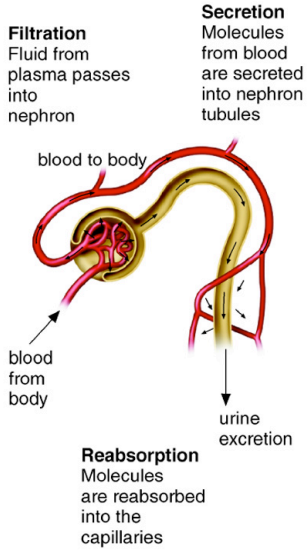
Part B: Filtration, Reabsorption, and Secretion

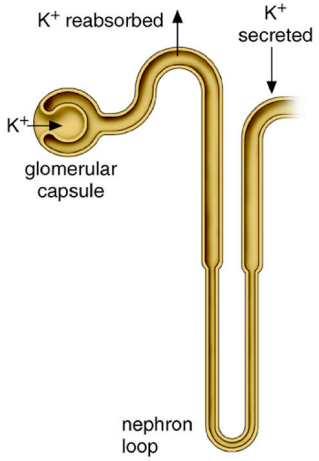
The micropuncture method was used in a second study of the six materials listed in Table 1. Under a microscope, a very fine pipet was used to withdraw samples of fluid at four points along the nephron. Study Table 2, which shows the data that were collected using this technique. Use the data to answer the analysis questions.

Table 2: Proportions of Substances at Four Points Along the Nephron*

	In blood entering glomerulus	In tubule from glomerulus	In urine leaving nephron	In blood leaving nephron
Water	100	30	1	99
Protein	100	0	0	100
Glucose	100	20	0	100
Sodium	100	30	1	99
Potassium	100	23	12	88
Urea	100	50	90	10

The numbers in this table represent proportions, not actual numbers of molecules or ions. For example, for every 100 molecules of water in the blood, 30 will be found in the tubule.





8. Which function, secretion or reabsorption, involves the movement of a greater amount of water in the kidney? Explain your answer.
9. Proteins are involved in which of the three kidney functions?
10. Compare the protein data with the glucose data. What is the difference? Explain the difference.
11. In some samples, glucose is found in the urine. What might cause this condition?
12. Why are excess glucose molecules in the blood excreted?
13. The data tell us that the concentration of sodium in the blood is greater than in the urine yet most of the sodium ions in the urine move back into the blood. What process makes this movement possible?
14. Urea is a by-product of amino acid metabolism. Next to water, urea is the most abundant material found in urine. If urea were allowed to accumulate in the blood, what might happen?
15. Reabsorption accounts for 85% of the salt, water, and other substances processed by the kidney. The remaining 15% is regulated by hormones or nervous system controls. What hormones act on the kidneys and what are their effects?
16. Homeostasis is the maintenance of a relatively stable internal environment in an organism. Summarize how the kidney functions as a homeostatic organ.