?

32 Why is it not possible to create large concentration differences for water and small ions between the lumen of the proximal tubules and the peritubular capillaries?

33 List the steps in tubular reabsorption (see Fig. 13.11).

34 Differentiate between *primary* and *secondary* active reabsorption.

35 What is the energy source for the secondary active reabsorption of glucose and amino acids?

36 Where are the Na^+-K^+ pumps located in the tubular epithelial cells?

37 Define the terms antiport and symport.

pump in the basolateral membrane. By utilizing energy that, in any case, would be released during Na^+ transport through the apical membrane, glucose can be transported into the epithelial cells without extra energy expenditure.

In the kidneys, the co-transported substances generally move in the same direction across the membrane, as described above for Na^+ and glucose (symport). However, some substances, for example H^+, leave the cell in exchange for the Na^+ entering (antiport, Fig. 13.13). In addition to glucose, amino acids and several other organic molecules are reabsorbed from the renal tubules by secondary active transport. Glucose, amino acids, and other organic substances that have been co-transported with Na^+ into the epithelial cells are subsequently transported across the basolateral cell membrane and into the interstitial fluid by facilitated diffusion (Fig. 13.13).

Glucose in Urine (Glycosuria)

If glucose can be detected in the urine of an animal that has fasted for 10–13 hours, the cause is usually an abnormally high glucose concentration in plasma due to diabetes mellitus.

Diabetes mellitus is due either to lack of insulin or to reduced sensitivity of target tissues to insulin (insulin resistant diabetes, p. 256). In diabetes, the transport of glucose into most cells is reduced (p. 256) and the plasma concentration of glucose increases. When the amount of glucose filtered exceeds the renal transport maximum for glucose, glucose can be detected in the urine.

Some dogs, as well as some humans, have a genetic defect in the transport mechanism for glucose in the kidneys (low T_{max}). Glucose then appears in the urine even when the concentration of glucose in plasma is normal.

Passive reabsorption

When solutes are transported out of the tubular lumen by primary or secondary active transport, the osmolarity in the tubular lumen becomes slightly lower than inside the epithelial cells and in the intercellular spaces. Water is then reabsorbed by osmosis (Fig. 13.14). The reabsorption of water increases the tubular concentrations of substances that are not actively reabsorbed, such as various anions, urea, and many drugs and environmental toxins. If the epithelial cell membranes are permeable to a specific substance, it can then be reabsorbed by diffusion due to concentration differences. When positively charged sub-

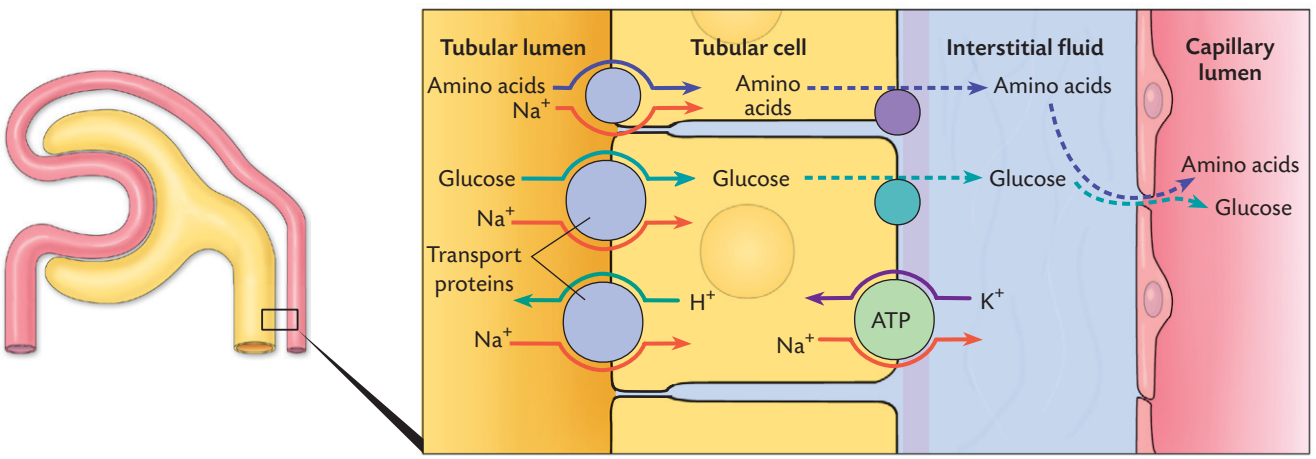

Figure 13.13 Reabsorption of glucose and amino acids. Glucose and amino acids are transported through the apical membrane of the epithelial cell by secondary active transport, coupled to Na^+ transport. The secondary active transport through the apical membrane increases the intracellular glucose and amino acids concentrations to levels higher than those in the interstitial fluid, causing the substances to be transported out of the cell by means of facilitated diffusion. Transport of H^+ from the epithelial cells and into the tubular lumen in exchange for Na^+ is also shown in the figure.