back into the tissues, depending on its solubility in the tubular liquid and its permeability with respect to the tubule tissues. Any of the drug that remained in the tubule would become more concentrated as more water was removed from the tubule during its passage to the collecting ducts. Eventually, the drug would enter the urinary bladder and be excreted in the urine.

Applying Inquiry Skills
5. A possible experimental design follows:
   1. Set up a control and experimental group. Care should be taken to ensure that control and experimental groups are similar in age, gender, health, and so on.
   2. Provide all members of the control group with 100 mL of water.
   3. Provide the experimental group with 100 mL of caffeine drink.
   4. Collect and compare urine output over the next 5 hours. All members of both groups should be placed under similar conditions (e.g., no exercise, no additional food or drink).
   5. Analyze and graph urine output over time.

7.5 FORMATION OF URINE

Section 7.5 Questions

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Understanding Concepts
1. See Figure 1, page 346 of Student Text.
   • The kidneys filter waste from the blood and regulate water and pH balance.
   • The renal artery carries blood to the kidneys.
   • The renal vein carries filtered blood away from the kidneys.
   • The ureter transports urine from the kidneys to the bladder.
   • The urinary bladder stores urine.
   • The urethra carries urine from the bladder outside the body.

2. • Bowman’s capsule receives filtered blood from the glomerulus.
   • The proximal tubule is the site of active transport of glucose, amino acids, and Na⁺ ions.
   • The loop of Henle carries filtrate from the proximal tubule to the distal tubule.
   • The distal tubule conducts urine from the loop of Henle to the collecting duct.
   • The collecting duct is a tube that carries urine from nephrons to the pelvis of a kidney.

3. Filtration involves the movement of fluids from the glomerulus into the Bowman’s capsule. Reabsorption involves the movement of fluids from the nephron into the extracellular fluid and eventually the capillary net. Secretion involves the selective transport of fluids from the capillary net into the nephron (the distal tubule, precisely).

4. (a) When people consume excess amounts of sugars, the glucose in the blood exceeds the threshold level. The ability to actively transport glucose from the nephron is limited by the number of glucose carrier molecules. Once the number of glucose molecules exceeds the numbers of carrier molecules, excess glucose is excreted as waste.
   (b) Excess glucose remains in the nephron and creates a strong osmotic force, drawing water into the nephron. This causes water to remain in the nephron and be excreted in the urine.

5. (a) afferent arteriole: C
efferent arteriole: A
   (b) It would increase filtration.
   (c) The glomerulus is not permeable to larger molecules, such as proteins or cells.
   (d) Areas B (glomerulus) or D (proximal tubule). Glucose is reabsorbed in the proximal tubule.
   (e) D (the proximal tubule) and G (the distal tubule)
   (f) G: the distal tubule
   (g) All areas of the nephron but it would be most concentrated in G.
   (h) Area D, the proximal tubule. This area is involved in active transport, which requires ATP. ATP is provided by cellular respiration, which partially occurs in the mitochondria.


7. (a) Salts in the ocean are more concentrated than electrolytes found in the extracellular fluid of the fish. By taking in ocean water, the extracellular fluid would become hypertonic to tissues causing dehydration.
   (b) Marine fish in a hypertonic environment excrete very high volumes of dilute urine (small quantity of solutes).
Making Connections

8. Renal hypertension is high blood pressure caused by a narrowing of the arteries that carry blood to the kidneys. Salt increases the movement of fluids from cells into capillaries, thereby raising the volume of body fluids. The increase in body fluids increases blood pressure. People with renal hypertension have to avoid high levels of salts to avoid a further increase in blood pressure.

7.6 WATER BALANCE

Section 7.6 Questions

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Understanding Concepts

1. ADH is antidiuretic hormone, a hormone that regulates water balance. ADH is produced in the hypothalamus and stored in the pituitary.

2. As solute concentration in the blood increases (when water intake is decreased or increase water loss), osmotic pressure changes, and the cells of the hypothalamus shrink. This stimulates osmoregulators, which send a nerve message to the pituitary to release ADH.

3. The thirst centre is located in the hypothalamus.

4. When osmotic pressure increases, the cells of the hypothalamus shrink, osmoregulators are stimulated, and the pituitary releases ADH. ADH is carried in the blood to the kidney. ADH enters the kidney and acts on the collecting duct and upper regions of the distal tubule, making them permeable to water. Greater volumes of water are reabsorbed. This helps prevent additional water loss. The shrinking of the cells of the hypothalamus also initiate a thirst response and you begin drinking.

5. In humans, the shrinking of the cells of the hypothalamus also initiates a thirst response and you begin drinking.

6. Low blood pressure in the kidneys or reduced blood flow to the kidneys causes the release of renin from the glomerulus area of the kidney. Renin activates angiotensinogen and converts it into angiotensin, which in turn causes the release of aldosterone from the adrenal cortex. Aldosterone is released into the blood and causes an increased Na+ reabsorption from the nephron. The Na+ will increase osmotic pressure of the extracellular fluid and, therefore, increase water reabsorption. Angiotensin also causes constriction of blood vessels, increasing blood pressure.

7. An acid–base balance is maintained by buffer systems that absorb excess H+ ions or ions that act as bases. Excess H+ ions from metabolism are buffered by bicarbonate ions in the blood. Carbonic acid, a weak acid, is produced. In turn, the carbonic acid breaks down to form carbon dioxide and water. The carbon dioxide is then transported to the lung, where much of it is exhaled.

The buffer system removes the H+ ions, but the system must be restored to protect the body. The kidneys restore the buffer by reversing the reaction. CO2 is actively transported from the peritubular capillaries into the cells that surround the nephron. CO2 combines with water to produce bicarbonate and H+ ions. The bicarbonate diffuses into the blood, restoring the buffer, and the H+ combines either phosphate or ammonia ions and is excreted.

The kidney restores the buffer system of the blood by reversing the buffer system reaction. CO2 is transported from the peritubular capillaries to the cells of the nephron, where the CO2 combines with water to form bicarbonate and H+ ions. The bicarbonate ions go back into the blood, restoring the buffer. If the H+ remained in the blood, the pH would increase. Fluctuations in pH can lead to death. Instead, the H+ combines with either phosphate ions or ammonia ions and is excreted with the filtrate from the nephron.

\[ \text{H}^+ + \text{HCO}_3^- \rightarrow \text{H}_2\text{CO}_3 \rightarrow \text{H}_2\text{O} + \text{CO}_2 \]

bicarbonate ion  →  carbonic acid  →  water + carbon dioxide

The kidney restores the buffer system of the blood by reversing the buffer system reaction. CO2 is transported from the peritubular capillaries to the cells of the nephron, where the CO2 combines with water to form bicarbonate and H+ ions. The bicarbonate ions go back into the blood, restoring the buffer. If the H+ remained in the blood, the pH would increase. Fluctuations in pH can lead to death. Instead, the H+ combines with either phosphate ions or ammonia ions and is excreted with the filtrate from the nephron.