CHAPTER 27
WATER, ELECTROLYTES, AND ACID-BASE BALANCE

CHAPTER OVERVIEW: This chapter continues the discussion of water balance begun in the previous chapter (The Urinary System). The detailed interactions between the endocrine and local controls for maintaining concentrations of individual electrolytes and the water content of the body fluids are discussed. The regulation of pH is explained in terms of electrolytes, water and the buffer systems of the body fluids.

OUTLINE (two or three fifty-minute lectures):
Seeley, A&P, 5/e

ıapt. ɔject.	**Topic Outline, Chapter 27**	**Figures & Tables**	**Transparen Acetates**
1	I. Body Fluids., p. 901		
	A. Proportion of Body Weight that is Water	Table 27.1, p.902	
	1. Decreases with Age		
	2. Decreases with Increased Fat Content		
	B. Fluid Compartments	Table 27.2, p.902	
	1. Intracellular Fluid is 40 % of the Total Body Weight		
	2. Extracellular Fluid is 20 % of the Total Body Weight		
	a. Interstitial Fluid		
	b. Blood Plasma		
	II. Regulation of Intracellular Fluid Composition, p. 901		
	A. Continuous Exchange Among Compartments	Fig. 27.1, p.902	TA-556
	1. Separated by Semipermeable Membranes		
	2. Water Moves Freely by Osmosis		
2	3. Difference in Actual Composition		
	4. Osmotic Equivalence		
	III. Regulation of Extracellular Fluid Composition. P. 901		
	A. Balance Between Intake and Elimination of Electrolytes		
3, 4	IV. Regulation of Ion Concentrations, p. 901		
	A. Sodium Ions	Clinical Note, p.903	
	1. Responsible ofr 90-95 % of Osmotic Pressure		
	2. Ingestion Usually Greater than Need		
	3. Kidneys Major Route of Na^+ Ion Excretion		
	a. Rate of Sodium Transport Under Control of Aldosterone		
	b. Presence of Aldosterone Leads to Sodium Retention		
	4. Na^+ also found in Sweat		

5. Sodium Transport Mechanisms Controlled by Osmolality and BP	Fig. 27.2, p.904 Table 27.3, pp.905-906	TA-557
a. Increased Osmolality Leads to Small volume of Concentrated Urine		
b. Increased BP Leads to Increased Salt and Water Excretion	Predict Quest. 1	
6. Atrial Natriuretic Hormone	Table 27.4, p.906	
a. Secreted in Response to Increased BP in Right Atrium		
b. Actions		

1). Inhibits Reabsorption of Sodium Ions in Kidney
2). Inhibits Effect of ADH on Distal convoluted Tubules and Collecting Ducts

7. Lack of Control of Na^+ Concentration has Severe Consequences	Predict Quest. 2	
B. Chloride Ions		
1. Predominant Anion of Extracellular Fluid		
2. Follow the Movement of Cations (Na^+, K^+, Ca^{2+})		
C. Potassium Ions		
1. Extracellular K^+ Concentration Kept within Narrow Range		
2. Profound Effects on Membrane Potentials if Concentration Moved Outside Normal Range	Table 27.5, p.907	
a. Hyperkalemia and Depolarization of Membranes		
b. Hypokalemia and Hyperpolarization of Membranes		
3. Regulation Primarily through Altering Rate of Secretion in Distal Convoluted Tubule		
a. Aldosterone Increases Rate of Secretion	Fig. 27.3, p.908	TA-558
b. Lowers Plasma K^+ Concentration		
D. Calcium Ions		
1. Normal Concentration of 9.4 mg/100 ml		
2. Effects of Derangement	Table 27.6, p. 909	
a. Hypercalcemia ($ 12 mg/100 ml)		
b. Hypocalcemia (# 6 mg/100 ml)		
3. Kidneys, Bone and Intestinal Tract all Involved in Ca^{2+} Regulation	Fig. 27.4, p.910	TA-559
4. Parathyroid Hormone		
a. Secretion from Parathyroid	Fig. 27.4, p. 910	TA-559

Glands Stimulated by Decreased Blood Ca^{2+}
b. Actions

5. Calcitonin
a. Secretion from C Cells of Thyroid Stimulated by Increased blood Calcium Levels
b. Actions

1). No Effect on Kidney

E. Phosphate Ions (Regulated Through Rates of Kidney Transport)

5, 6 V. Regulation of Water Content, p. 909 — Fig. 27.5, p.911

A. Water Intake — Table 27.7, p.912

1. Intake 1500 to 3000 ml
2. Thirst Center in Hypothalamus
a. Supraoptic Nucleus
b. Sensitive to Changes in Osmolality
c. Baroreceptor Reflex Stimulates Thirst Center

B. Three Routes of Water Loss
1. Surface Evaporation
a. Insensible Perspiration (100-150 ml)
b. Sweat or Sensible Perspiration — Table 27.8, p.913; Predict Quest. 3

2. Feces - Minor Volume
3. Urine - Variable Amount in Response to Blood Osmolality Changes

7 VI. Regulation of Acid-Base Balance, p. 913

A. Acids and Bases
1. Increased H^+ = Lower pH — Appendix D; Fig. 27.6, p.913 — TA-560
2. pH < 7 = Acidic Condition; pH >7 = Basic Condition

8 B. Buffer Systems — Table 27.9, p.914

1. Buffers Resist Changes in pH
2. Chemical Equilibrium of Weak Acid and its Salt

9 C. Mechanisms of Acid-Base Balance — Fig. 27.7, p.915 — TA-561

1. Respiratory Regulation of Acid-Base Balance
a. Carbonic Acid - Bicarbonate Buffer System — Fig. 27.8, p.916 — TA-562
b. Reversible Reaction

		c. Carbonic Anhydrase Enzyme System d. Increased CO_2 at Lungs Leads to Decreased H^+		
	2. Renal Regulation of Acid-Base Balance		Fig. 27.9, p.917	TA-563
		a. Active Transport of Hydrogen Ions into Filtrate	Clinical Note, p.916 Predict Quest. 4	
		b. Tubular Carbonic Anhydrase System c. Filtration of Bicarbonate Ions d. Presence of Phosphate Buffers pH of Urine e. Secretion of Ammonia		
10	Clinical Focus: Acidosis and Alkalosis		Clinical Focus, pp.918-919 Table 27-A, p.918	

IMPORTANT CONSIDERATIONS: If there are only two lecture sessions for these topics, split them into composition, distribution and ion exchanges of body fluids and compartments; followed by regulation of water concentration and acid-base balance. If there is a third session available use this to review, summarize and collate all the various mechanisms discussed here and in previous chapters. This chapter provides an excellent opportunity for students to draw together the functions of all of the organ systems and appreciate the interactive relationships and compensating mechanisms that provide the functional links. Unfortunately students often become overwhelmed by the detail and do not see the larger points to be made. Help students make the functional connections before they worry about the fine details.

SEE INSTRUCTOR'S MANUAL AND COURSE SOLUTIONS MANUAL FOR ADDITIONAL RESOURCES.