Key Concepts

Water compartments inside and outside cells maintain a balanced distribution of total body water.

The concentration of various solute particles in water determines internal shifts and movement of water.

Key Concepts, cont’d

A state of dynamic equilibrium among all parts of the body’s water balance system sustains life.

Basic Principles

A unified whole

Virtually every space inside and outside the cells is filled with water-based fluids

Body water compartments

Dynamic systems within the body

Intracellular or extracellular

Particles in the water solution

Determine all internal shifts and balances between compartments

Homeostasis

Body’s state of dynamic balance
• Capacity of the body to maintain life systems despite what enters the system from outside

• Homeostatic mechanisms protect the body’s water supply

• Body Water Functions

• Solvent
  — Basic liquid solvent for all chemical processes within the body

• Transport
  — Nutrients carried through the body in water-based fluids (e.g., blood, secretions)

• Thermoregulation
  — Maintains stable body temperature

• Body lubricant

• Body Water Requirements

• Surrounding environment
  — Body water is lost as sweat and must be replaced

• Activity level
  — Water is lost as sweat
  — More water is needed for increased metabolic demand in physical activity

• Functional losses
  — Disease process affects water requirements

• Body Water Requirements, cont’d

• Metabolic needs
— 1000 ml of water necessary for every 1000 kcal in the diet

• Age
  — Infants need 700 to 800 ml of water per day

• Fluid Compartments

• Adequate Intake of Water

• Other Dietary Factors

• Dehydration
  — >2% total body weight loss
  — Special concern in the elderly

• Water intoxication
  — Those at risk:
    • Infants
    • Psychiatric patients
    • Patients on psychotropic drugs
    • Endurance athletes

• Percentage of Body Weight Loss

• Body Water Amount and Distribution

• Extracellular fluid
  — Total body water outside cells
  — One quarter of extracellular fluid is blood plasma
  — Three quarters is water surrounding cells and bathing tissues, water in dense tissue, and water moving through the body as secretions
  — Interstitial fluid
Fluid surrounding cells in tissues

Body Water Amount and Distribution, cont’d

Intracellular fluid
  - Total body water inside the cells
  - Twice the volume of that outside the cells

Overall water balance
  - Average adult metabolizes 2.5 to 3 L of water/day

Distribution of Total Body Water

Body Water Amount and Distribution, cont’d

Water intake
  - Preformed water in liquids that are consumed
  - Preformed water in foods that are eaten
  - Product of cell oxidation
  - Older adults must maintain proper intake of water because of the tendency for dehydration

Body Water Amount and Distribution, cont’d

Water output
  - Obligatory water loss
    - Leaves the body through kidneys, skin, lungs, and feces
  - Optional water loss
    - Varies according to climate and physical activity

Sources of Fluid Intake and Output
• Electrolytes
  • Small, inorganic substances that break apart in a solution and carry an electrical charge (ions)
  • Balance between cation and anion concentration maintains chemical neutrality necessary for life

• Balance of Cation and Anion Concentrations

• Plasma Proteins
  • Mainly albumin and globulin
  • Organic compounds of large molecular size
  • Retained in blood vessels
  • Control water movement
  • Colloids guard blood volume (colloidal osmotic pressure)

• Chapter 9
  Lesson 9.2

• Key Concepts
  • The concentration of various solute particles in water determines internal shifts and movement of water.

• Key Concepts, cont’d
  • A state of dynamic equilibrium among all parts of the body’s water balance system sustains life.

• Separating Membranes

• Capillary membrane
Thin and porous

Water molecules move freely across them

Cell membrane

- Thicker membranes
- Constructed to protect and nourish cell contents

Moving Water and Solutes Across Membranes

Osmosis

- Process or force that impels water molecules to move throughout body
- Moves water molecules from an area of greater concentration to an area of lesser concentration

Diffusion

- Force by which particles in solution move outward in all directions from an area of greater concentration to an area of lesser concentration

Diffusion Through a Membrane

Moving Water and Solutes Across Membranes

Filtration

- Water is forced through membrane pores when pressure outside the membrane is different

Active transport

- Necessary to carry particles “upstream” across separating membranes

Pinocytosis

- Larger molecules attach to thicker cell membrane, then are engulfed by cell

Movement of Molecules, Water, and Solutes by Osmosis and Diffusion
• Pinocytosis

• Capillary Fluid Shift Mechanism

• Cells’ water and nutrients must move from capillaries to cells.

• Water and cell metabolites must return to capillaries.

• Uses opposing fluid pressures:
  — Hydrostatic pressure
  — Colloidal osmotic pressure

• Fluid Shift Mechanism

• Organ Systems Involved in Body Water Balance

• Gastrointestinal circulation
  — Water from blood plasma is continually secreted into the gastrointestinal tract.
  — In the latter portion of the intestine, most water and electrolytes are reabsorbed into the blood.
  — Is maintained in isotonicity.

• Organ Systems Involved in Body Water Balance, cont’d

• Renal circulation
  — Kidney “laundering” of the blood helps maintain water balance and proper solution of blood

• Hormonal controls:
  — Antidiuretic hormone mechanism
  — Aldosterone mechanism
Approximate Total Volume of Digestive Secretions

Approximate Concentration of Certain Electrolytes in Digestive Fluids

Acids and Bases

Optimal degree of acidity or alkalinity must be maintained in body water solutions and secretions

More or less acid according to degree of concentration of hydrogen ions

Acidity expressed in terms of pH

Acid-Base Buffer System

Handles an excess of acid or base

Mixture of acid and base that protects a solution from wide variations in pH

Main buffer system: carbonic acid/base bicarbonate

Physiologic Buffer Systems

Respiratory control

Carbon dioxide leaves the body

Urinary control

Kidney monitors hydrogen ions

Summary

The human body is approximately 50% to 60% water

Primary functions of water are to give form and structure to body tissue, provide a water environment for cell to work, and control body temperature

Body water is distributed within the intracellular and extracellular compartments

Summary, cont’d
• Overall water balance is maintained by fluid intake and output

• Two types of solute particles control the distribution of body water
  — Electrolytes
  — Plasma protein

• The acid-base buffer system uses electrolytes and hydrogen ions to maintain a normal extracellular fluid pH of approximately 7.4