**Fluid and Electrolyte Balance**

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**Interrelation of Fluid and Electrolyte Balance**

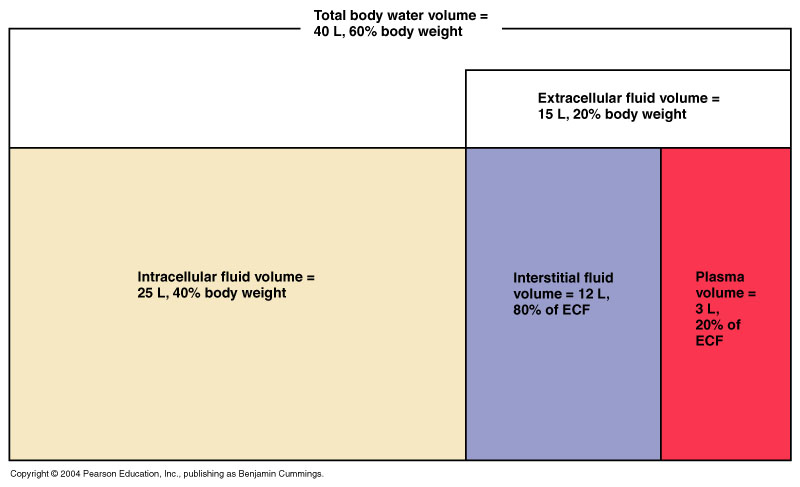
* Fluid and electrolyte balance: implies homeostasis
* Electrolytes have chemical bonds that allow dissociation into ions, which carry an electrical charge; of critical importance in fluid balance
* Fluid balance and electrolyte balance are interdependent

**Body Water Content**

* Infants have low body fat, low bone mass, and are 73% or more water
* Total water content declines throughout life
* Healthy males are about 60% water; healthy females are around 50%
* This difference reflects females:
  + Higher body fat
  + Smaller amount of skeletal muscle
* In old age, only about 45% of body weight is water

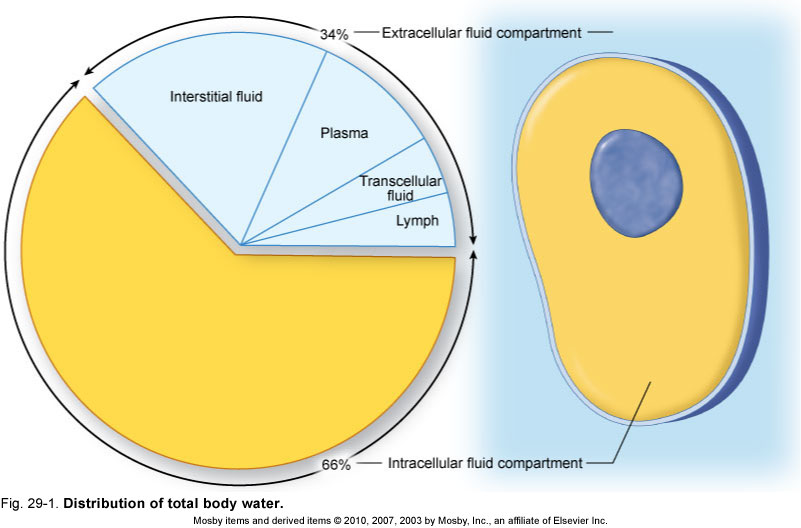
**Body Fluid Compartments**

* Two major fluid compartments
* Extracellular fluid (ECF) makes up the internal environment of the body
  + Consists mainly of plasma and interstitial fluid (IF)
  + Lymph, cerebrospinal fluid, and joint fluids are considered ECF
  + Functions of ECF are to provide a relatively constant environment for cells and transport substances to and from the cells
* Intracellular fluid (ICF): water inside the cells
  + Function is to facilitate intracellular chemical reactions that maintain life
  + By volume, ICF is the largest body fluid compartment

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**Water Compartments**

* The fluid sites of the body where water is stored is called water compartments
  + Heart and circulatory system is an example of one compartment and the fluid is plasma
  + Joint capsules is an example and the water is synovial fluid
* Although water and ions are constantly moving, their proportion in the compartments remain constant
* This balance is called fluid-electrolyte homeostasis and it is essential for life

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**How Water Enters & Leaves the Body**

* Water enters the body in the digestive tract; also added to the total fluid volume from each cell as it catabolizes food, with the resulting water entering the bloodstream
* Water leaves the body by four exits
  + As urine through the kidney
  + As water in expired air through the lungs
  + As sweat through the skin
  + As feces from the intestine

**Water Intake and Output**

* The total intake of daily water is about 2.5 liters
  + 1600 mL from drinking liquids
  + 700 mL from food
  + 200 mL from cell respiration
* The total water output is about 2.5 liters
  + 1500 mL from the urine
  + 500 mL from sweat
  + 300 mL from exhaled water vapor
  + 200 mL from feces



**Regulation of Water Intake**

* The hypothalamic thirst center contains osmoreceptors that detect changes in the osmolarity of body fluids
* Osmolarity is the concentration of dissolved materials in fluid
* Dehydration raises osmolarity
  + There is less water in proportion to the dissloved materials
* Thirst is quenched as soon as we begin to drink water
* Feedback signals that inhibit the thirst centers include:
  + Moistening of the mucosa of the mouth and throat
  + Activation of stomach and intestinal stretch receptors

**Influence and Regulation of ADH**

* Water reabsorption in collecting ducts is proportional to ADH release
* Low ADH levels produce dilute urine and reduced volume of body fluids
* High ADH levels produce concentrated urine
* Hypothalamic osmoreceptors trigger or inhibit ADH release
* Factors that specifically trigger ADH release include prolonged fever; excessive sweating, vomiting, or diarrhea; severe blood loss; and traumatic burns

**Disorders of Water Balance: Dehydration**

* Water loss exceeds water intake and the body is in negative fluid balance
* Causes include: hemorrhage, severe burns, prolonged vomiting or diarrhea, profuse sweating, water deprivation, and diuretic abuse
* Signs and symptoms: cottonmouth, thirst, dry flushed skin, and oliguria
* Prolonged dehydration may lead to weight loss, fever, and mental confusion
* Other consequences include hypovolemic shock and loss of electrolytes

**Disorders of Water Balance: Edema**

* Atypical accumulation of fluid in the interstitial space, leading to tissue swelling
* Caused by anything that increases flow of fluids out of the bloodstream or hinders their return
* Factors that accelerate fluid loss include:
  + Increased blood pressure, capillary permeability
  + Incompetent venous valves, localized blood vessel blockage
  + Congestive heart failure, hypertension, high blood volume
* May be localized or systemic
* Localized edema follows injury and inflammation
* Systemic edema is the result of an imbalance between the movement of water out of and into capillaries
* Edema is a symptom and not a disease
* Treatment is aimed at correcting the specific cause
  + If this is not possible then the volume of tissue fluid can be reduced my a low salt diet and the use of diuretics



**Mechanisms That Maintain Homeostasis of Total Fluid Volume**

* Under normal conditions, homeostasis of total volume of water is maintained or restored primarily by adjusting urine volume and secondarily by fluid intake
* Regulation of fluid intake: decrease in fluid intake causes osmoreceptors in “thirst center” of hypothalamus to increase secretion of antidiuretic hormone
* Regulation: two factors determine urine volume
  + Glomerular filtration rate, except under abnormal conditions, remains fairly constant
  + Rate of tubular reabsorption of water fluctuates considerably; normally adjusts urine volume to fluid intake; influenced by amount of antidiuretic hormone and aldosterone
* Factors that alter fluid loss under abnormal conditions: rate of respiration and volume of sweat secreted may alter fluid output under certain abnormal conditions
  + Vomiting, diarrhea, or intestinal drainage can produce fluid and electrolyte imbalances
  + Symptoms range from simple thirst to muscle weakness and kidney failure

**Electrolyte Balance**

* Electrolytes are salts, acids, and bases, but electrolyte balance usually refers only to salt balance
* Salts are important for:
  + Neuromuscular excitability
  + Secretory activity
  + Membrane permeability
  + Controlling fluid movements
* Salts enter the body by ingestion and are lost via perspiration, feces, and urine

**Regulation of Sodium and Potassium Levels in Body Fluids**

* Normal sodium concentration in IF and potassium concentration in ICF depend on various factors, especially the amount of ADH and aldosterone secreted
  + ADH regulates ECF electrolyte concentration and colloid osmotic pressure by regulating amount of water reabsorbed into blood by renal tubules
  + Aldosterone regulates ECF volume by regulating the amount of sodium reabsorbed into blood by renal tubules
* Regulation of Sodium and Potassium Levels in Body Fluids
* When conservation of body sodium is required, the kidneys excrete essentially sodium-free urine; kidneys are considered the chief regulator of sodium levels
* Chloride: most important extracellular anion and almost always linked to sodium; chloride ions are generally excreted in urine in association with potassium; thus hypochloremia is often associated with cases of potassium loss
* Hypokalemia occurs in cell breakdown; as cells disintegrate, potassium enters the ECF and is rapidly excreted because it is not reabsorbed efficiently by the kidney

