Water comprises over 60% of all body matter in the adult and close to 80% in the neonate. Water serves as the vehicle to carry nutrients to the body's cells and to remove its waste materials. The distribution of water determines the size of the body fluid compartments, and with water concentration it establishes the physiochemical milieu that allows cellular work to occur. Water metabolism is integral to all life functions. A comprehensive review of water metabolism in the neonate encompasses cellular regulation, cardiac and vascular physiology, and renal, neurological, and hormonal functions.

Total body water volume (TBW) is usually expressed as a percent of total body weight. The plasma membranes of all of the body's cells establish two large divisions of the TBW: intracellular water (ICW), which is contained within the cells, and that in the surrounding extracellular water (ECW). This chapter begins with a presentation of the popular notion of the evolution of higher life forms that provides the construct for understanding this distribution of TBW and the relation of TBW to energy metabolism. In subsequent sections the discussion includes, in sequence: cell volume regulation and the interface between the intracellular-extracellular body fluid compartments; control of the extracellular water through the interactions between the neonatal heart and kidney; and hormonal modulation of these systems. The following sections emphasize the neonatal changes in water distribution during transition from fetal to extrauterine life, and the premature neonate's adaptation to water loss upon exposure to a hostile environment.

Five common patient scenarios are presented in the final section to illustrate clinical manifestations of the basic principles developed in previous sections: the neonate with respiratory distress syndrome; the subsequent development of chronic pulmonary dysfunction; the critically ill premature infant with shock and massive edema; the very low birth weight neonate less than 26 weeks' gestation; and the growing premature infant recovering from these conditions who manifests hyponatremia and edema.

Body Water Compartment Regulation

It is widely assumed that primitive, single cell life forms first appeared in an ocean environment that was similar in composition to the ECW of modern mammals. As these organisms evolved into more complicated multicellular, multitissue beings, they surrounded their cells with an internalized version of the primitive ocean, allowing them to thrive in less constant external environments. The famous physiologist Claude Bernard (1813–1878), called this the *milieu interior*. With such an organization the intracellular compartment is shielded from direct interface with the harsh modern environment and can continue its primitive methods of regulating cell size and composition because it is buffered from sudden changes in solute and water content by the extracellular compartment. This arrangement demands that the organism has a system to monitor the composition of the ECW and has physiological strategies to correct water and solute losses and gains resulting from its contact with the outside world.

Losses and gains of water and solute due to this interaction with the environment are coupled to the metabolic rate of an organism in a predictable way (Fig. 32.1). This interaction demands less than half the usual amount of energy a growing infant produces by metabolism. The fuels oxidized to produce this metabolic energy are the carbon skeletons of carbohydrates, lipids, and proteins. The by-products of energy production are carbon dioxide (CO₂), water, nitrogen waste, fixed acids, and heat. The fuels are carried into the organism with water, and the elimination of the waste products of metabolism results in water loss. Water is evaporated passively from the upper respiratory tract as CO₂ is exhaled during respiration. Excess heat is dissipated from the skin actively through sweating and passively through insensible evaporation of interstitial water. Nitrogen wastes and fixed acids are eliminated in the urine, necessitating renal water loss; a small amount of water is lost from the gastrointestinal tract, and a...
Osmolality and Osmotic Pressure
As all chemicals, water spontaneously moves from a region of high concentration to one of low concentration. Such movement occurring through a semi-permeable membrane, like the cell membrane, is called osmosis (from the Greek word for impulsion). The same Greek root provides the term osmolality (quantity of water in solution) and osmotic pressure (the force that drives the movement of water between areas of different concentration).

Osmolality is the number of discrete particles of solute per kilogram of solvent. The unit of measure of osmolality is the osmole. One osmole is the number of particles (Avogadro's number) in one gram molecular weight of a substance that does not dissociate in solution. If a solute dissociates into two ions when in solution, one gram molecular weight of that substance contains two osmoles. In physiological solutions the amount of solute is small, so solute concentration is expressed in milliosmoles (mOsm) per kilogram.

Expressing the water concentration of a solution is confusing because water is the solvent in all body fluids. Although the same principle of osmolar concentration outlined above for the solute applies to the solvent water particles, we are in the habit of describing Solute concentration in body fluids is commonly measured by freezing point osmometry (one gram mole of solute per kilogram of water lowers its freezing point by 1.858°C).8 The concentration of solute particles when expressed as the number of discrete particles per kilogram of solvent, is properly termed osmolality. In physiological studies it is often more useful to know the number of discrete particles per liter of solution. The precise term for this quantity is osmolarity. Because the difference between osmolality and osmolarity is small in physiological solutions, the measured value for osmolality is commonly used as if it were the osmolarity, and the term osmolality is used for either case.

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