Bio 3B Laboratory
Human Osmoregulation

Objectives

- To understand the concept of homeostasis and its relationship to water balance in living organisms
- To understand the basic mechanisms of regulation of body fluid concentrations
- To investigate the effect of hyper and hypo-osmotic solutions on urine concentration and production

Introduction

Homeostasis is the maintenance of equilibrium, or constant conditions. In biological systems this is accomplished feedback mechanisms that counteract changes that lead toward disequilibrium. In the 19th century, French physiologist Claude Bernard observed that the chemical and physical properties of blood were very nearly constant. He called this the "constancy of the interior milieu," and argued that it was essential to the vertebrate life. The term homeostasis was coined by Harvard physiologist Walter B. Cannon in the early 1900's. Homeostatic mechanisms operate at all levels of organization in living systems, including the molecular, cellular, organismal, and even population levels. In complex organisms, such as humans, it involves constant regulation of such things as oxygen and carbon dioxide, nutrients, hormones, and organic and inorganic solutes. Despite changes in the external environment, homeostatic mechanisms work to keep the concentrations of these substances in body fluid remain basically unchanged.

Osmoregulation is the homeostatic regulation of solute concentrations in the blood. In mammals, the system of regulation relies upon osmoreceptors in the hypothalamus. A change in plasma concentration will cause neurons of the supra-optic nucleus to release antidiuretic hormone (ADH, or vasopressin) into the general circulation. The actual site of release is at the posterior pititary (neurohyphysis). The axons from the supra-optic region connect to the capillaries in the posterior pituitary, releasing their neurohormone directly into the blood. Anti-diuretic hormone alters the permeability of collecting ducts in the kidney, allowing for more or less water to be reabsorbed at that site. If plasma osmotic concentration is low (too much water) a decrease in ADH makes tubules less permeable and more water will be lost in the urine. Conversely, if plasma concentration increases (not enough water) ADH will increase making tubules more permeable, allowing for water to be reabsorbed rather than lost in the urine.

Thus, in humans, the kidneys are the primary osmoregulatory organs. Waste water and ions are removed from the body by the kidneys in the form of urine. Human kidneys produce approximately 1ml of urine per minute and the typical osmolarity of extracellular fluid is 300 mOSM/L. In this lab we will investigate the effect of solute consumption on human urine concentration and output.

Procedure
Each group must have at least four members. The group is responsible for mixing the salt solutions and procuring a can of Coke. Each of the four subjects will complete the following protocol.

1. Visit the restroom, void all urine, collecting the complete sample in a beaker
2. Each subject will drink one of the following:
    - 800 ml of water
    - 800 ml of 0.9 % NaCl
    - 80 ml of 9 % NaCl
    - 800 ml of a Coke

3. At 40 and 80 minute intervals after consuming the drink, each person will visit the restroom and collect all of their urine in a beaker.

Urine analysis
After each collection, you should record the total volume and the osmolarity (osmolality). Use a graduated cylinder to determine volume. The osmolarity will be determined using the Wescor vapor pressure osmometer. Vapor pressure is one of the colligative properties, and thus directly convertible into osmotic concentration. You should calculate the rate of urine production at the 40 and 80 minute intervals. The entire class data set will be posted on the class website.

Write-up
You should create at least one figure and write an abstract for this lab, using mean values and appropriate statistics.

Data Table for Osmoregulation Lab

Treatment	Initial		40 minute		80 minute	
	volume (ml)	concentration (mOSM)	volume (ml)	concentration (mOSM)	volume (ml)	concentration (mOSM)
water						
0.9% NaCl						
9.0% NaCl						
Coke						