Excretory Physiology

Background Information:

The excretory system functions to get rid of the body’s waste products and is comprised of two separate organ components: the skin and the urinary system (kidney/bladder). Skin, which also functions as the primary line of defense for the body, is organized for protection, self repair, and replacement as well as excretion. Sweat is comprised of a watery solution of sodium chloride into which traces of urea, sulfates, and phosphates have been dissolved. Along with waste excretion, sweating also enables the body to regulate temperature. The amount of sweat secreted depends on such factors as environmental temperature and humidity, amount of muscular activity, and various stress conditions.

The primary function of the urinary system is to excrete wastes with the purpose of homeostatic maintenance of bodily fluid volume and composition. This function is performed by the functional unit in the kidney, the nephron. Blood travels through the kidney and using the processes of filtration, reabsorption and secretion the nephron produces urine. Urine travels from the nephrons to the renal pelvis and then is drained by peristaltic action to the urinary bladder via the ureters. The urinary bladder is emptied to the outside via the urethra.

The composition of urine varies. The pH of urine is usually slightly acidic (pH = 6), however normally ranges from pH 5-9. Random urine samples may vary in specific gravity (i.e., density) from 1.003-1.04+. Twenty four hour urine collections from normal adults with normal diets and normal fluid intake will have a specific gravity of approximately 1.02. Small amounts of glucose (glucosuria) and protein are normally excreted by the kidney however these amounts are not able to be detected by usual laboratory methods. Detectable amounts of either glucose or protein could indicate the presence of a pathologic condition such as diabetes mellitus (glucose). Abnormally colored also urine indicates possible problems, particularly problems of metabolism. The normal yellow color of urine comes from the heme portion of hemoglobin when it is broken down. The metabolite from this breakdown is a urochrome pigment. Normal urine specimens ordinarily yield negative results when testing for ketones, however detectable levels may occur in normal urine when the patient has recently undergone or is experiencing physiological stress conditions such as fasting, pregnancy and frequent strenuous exercise. The significance of trace amounts of blood (hematuria) may vary among patients, normally being absent but possibly being found in the urine of menstruating females.

Urinary output also varies. On average, 1 - 1.8 liters of urine are produced each day, although volumes vary with fluid intake as well as in different seasons of the year. Various fluid volumes are secreted or retained by the kidney in order to maintain body fluid osmolarity (ion concentrations).

The following exercise was designed to demonstrate the kidney’s ability to regulate body fluid osmolarity by its secretion or retention of fluid and/or solutes when various amounts of ions are consumed.
**Experimental Protocol:**

**Activity A**

1.) In this activity you will investigate the effects of salt intake on the volume of urine produced, as well as urine solute concentration. In this experiment, solute concentration will be measured using specific gravity, or solution density. Pure water has a specific gravity of 1.0; the presence of solutes in a solution cause its specific gravity to increase >1.0g/ml.

2.) Limit fluid intake on the day or lab. Empty your bladder 1-2 hours prior to the beginning of the laboratory session and record the exact time. Do not save this urine sample.

3.) Upon entering the laboratory, take a urine collection vessel to the restroom and void, emptying the bladder completely. Record the exact time. The samples from all students will be mixed to generate the “control” urine.

4.) Return to the laboratory and immediately drink the solution assigned to you by your laboratory instructor. Drink as quickly as possible—no longer than 10 minutes. Your laboratory instructor will divide the class into three groups as follows:  
   a. Group 1: 800 mls water.
   b. Group 2: 80 mls water + 7 grams NaCl quickly followed by 720 mls water.
   c. Group 3: 80 mls water + 7 grams NaCl.  
   **Note:** Students with health problems or who are on specific medications should not be in group c. Notify your laboratory instructor if this is the case.

5.) Empty your bladder into the same collection vessel every 30 minutes after drinking the solution. Continue for 90 minutes (3 total collections after the control urine collection). If you are unable to void, retain the urine until the next 30-minute collection time.

6.) Analyze the urine from each group for the following parameters:  
   a.) Volume. Measure the total volume of each group (combined) with a graduated cylinder and express it as milliliters excreted per minute.
   b.) Specific gravity. Use a Combistick or a refractometer (the use of which will be demonstrated by your laboratory instructor) to test this parameter.