

# Biology 347 General Physiology Lab

## Kidney Function: Urine Analysis and Regulation of Osmolarity

### Objectives

- Students will perform urinalysis using a standard testing procedure.
- Students will collect data under the following experimental conditions:
  - Drinking water
  - Drinking Gatorade
  - Drinking coffee
  - Drinking beer
- Students will analyze their data for trends in differences in volume, specific gravity and pH under the aforementioned conditions as it relates to kidney function.

### Introduction

The kidneys are important regulators of homeostasis in the body. They regulate ions and pH as well as water. In addition, kidneys also serve as the principle organ for the elimination of metabolic waste products. The functional unit of the kidney is the **nephron** and each kidney contains approximately two million of these structures. The nephron is divided into two regions: the **glomerulus** and the **renal tubule**. The heart pumps 7000 l/day (32 55 gal drums), and almost 1/4 (8 55 gal drums) goes through kidneys. Via the glomerulus to the lumen of Bowman's capsule there is 180 l/day of filtrate (**primitive urine**) that passes on to the renal tubule. Finally, there is 1 l urine/day.

How is this volume reduced? The primitive urine is similar to the blood's plasma in composition except that the large molecules (>70,000 MW), such as plasma proteins, are excluded. As the filtrate passes through the renal tubule most of the water is reabsorbed and many of the essential substances are actively or passively reabsorbed into the blood stream. Toxic byproducts of metabolism and substances in excess are retained in the filtrate or are actively secreted into the filtrate and finally excreted as **definitive urine**. Thus the final composition of the urine is very different from that of the glomerular filtrate and reflects the integrity of kidney function and changes in blood composition. An analysis of urine can yield valuable information about the health of the body in general. The volume of urine produced and its specific gravity give information on the state of hydration or dehydration of the body. Several diseases are characterized by abnormal metabolism and the abnormal byproducts can be found in the urine. For example, phenylpyruvic acid appears in the urine of someone suffering from phenylketonuria (PKU), a disease resulting in mental retardation. Type I diabetes mellitus, a disease resulting from a deficient production of insulin by the pancreatic islets, is characterized by the appearance of glucose in the urine, a condition known as glycosuria. Readings above or below the normal range for specific gravity may indicate a pathological condition. For example, a low reading is found in **chronic nephritis** and a high one in **acute nephritis**.

Recent advances in urinalysis techniques have made it possible to perform, in a few seconds, tests which formerly took hours. The Multistix test is a combined test of **pH, proteins, glucose, ketones** and **occult blood**. Alkaline urine is found in many conditions. One example is **cystitis**, a condition in which urine decomposes in the bladder to form ammonia. Typically urine is slightly acidic (around pH 6); however, the pH can be lowered by a diet rich in proteins or citrus fruits. Thus pH by itself is not very informative. An abnormally low pH coupled with high glucose and ketones are characteristics of **diabetes mellitus**. The presence of proteins or blood in the urine is more useful as a diagnostic tool. Blood and proteins in the urine may indicate **nephritis**, a disease characterized by damaged glomeruli that allow plasma proteins and erythrocytes to leak into the urine. However, long distance runners sometimes test positive for blood in their urine.

In the first portion of this exercise, you will analyze your urine for some of the more clinically important constituents. In the second portion of this exercise, the class will be divided into four test groups and the members of each group will drink one of the following beverages:

- Tap water
- Gatorade
- Coffee
- Beer

### Precautions:

Beer - We card! Do not volunteer if you will be driving later.

Coffee - Do not volunteer to take caffeine if you **do not** normally have caffeine in your diet and/or you are known to be sensitive to caffeine.

**Procedure: Urine Analysis**

1. When you come to class, be prepared to micturate. Use the urinalysis jars provided. Conveniently, they have volumes indicated on the sides. Be sure to void completely.
  
2. Note the time: \_\_\_\_\_
  
3. Obtain a Multistix from the front lab bench. Dip the reagent part of the Multistix into the urine so that all reagents are completely covered. Dip quickly for not more than one second! Wipe off the excess urine by dragging the chemstrip across the lip of the urinalysis jar. After the specified number of seconds read the strip by comparing it to the colored scale on the Multistix pages provided. Record your data on class chart on the Blackboard in the front of the lab. This is your initial reading.
  
4. Each group will drink their assigned beverage:
  - Group 1: drinks 710 ml (the equivalent of 2 cans, 12 oz each) of tap water
  - Group 2: drinks 710 ml of Gatorade
  - Group 3: drinks 710 ml of coffee
  - Group 4: drinks 2 cans of beer
  
5. Students should drink their beverages as fast as possible and note the time they are finished: \_\_\_\_\_.
  
6. At thirty minute intervals throughout the lab, students should go to the restroom to empty their bladder and perform the urinalysis as described above.

Note the sample times:

30 minutes: \_\_\_\_\_

60 minutes: \_\_\_\_\_

90 minutes: \_\_\_\_\_

120 minutes: \_\_\_\_\_

7. When finished, please be sure to clean all of your containers that contained urine and throw out your Multistix strips. You are responsible for cleaning-up any mess that was made. Before leaving the lab, wipe down all benches with ethanol.