Name _____ Date _____

Background

Urinalysis is used by doctors to assess various factors of urine, including color and pH, that could indicate disease. These factors are normally kept in balance by the **kidneys** as they filter blood and produce urine but may change under certain conditions like disease or medication use, or even with certain foods.

Table 1. Urine Color and Possible Causes

Color	Diet	Drugs	Disease
light yellow to amber	normal	none	none
clear to light yellow	increased fluid intake	alcohol	uncontrolled diabetes mellitus
yellow orange to orange	carrots	antibiotics, pyridium	bilirubin from obstructive jaundice
green	green food dyes, asparagus	diuretics	bacterial infection
red to red brown	beets	senna laxatives	hemoglobin in urine (various causes)
dark wine	beets	anti-inflammatory drugs	hemolytic jaundice
brown	rhubarb (large quantity), fava beans, severe dehydration	barbiturates	hemolytic anemia or liver disease; extremely strenuous exercise or muscle injury
brown-black	rhubarb (huge quantity), excessive sorbitol consumption	antidepressants	melanin pigment from melanoma (rare)

Normal urine colors range from light yellow to amber, depending upon the concentration of **urobilin**, the urinary pigment. Certain foods, drugs, diseases, and amount of water intake can cause lighter or darker urine.

Table 2. Abnormal Urinalysis Results and Possible Causes

	Possible Causes	
Test Result	**Diet**	**Disease**
Low pH (<6)	high protein diet; cranberry juice	uncontrolled diabetes mellitus
High pH (>8)	diet rich in vegetables; dairy products	severe anemia
Low Specific Gravity (<1.010)	increased fluid intake	severe renal damage
High Specific Gravity (>1.026)	decreased fluid intake; loss of fluids	uncontrolled diabetes mellitus; severe anemia
Glucose Present	large meal	uncontrolled diabetes mellitus
Protein Present	high protein diet	severe anemia

The **pH** of a solution is a measure of its free hydrogen ion (H^+) concentration, which indicates acidity or alkalinity. A solution with a pH of 7.0 is neutral. A solution with a pH less than 7.0 is acidic, and a solution with a pH greater than 7.0 is basic. Typically, the pH of normal urine is between 6.0, which is slightly acidic, to 8.0, which is slightly basic. Again, this normal balance can be upset by certain foods or disease.

Specific gravity is the density of a solution relative to water, which has a specific gravity of 1.000. The specific gravity of normal urine ranges from 1.010 to 1.026. Specific gravity varies according to fluid intake but can also affected by disease.

Glucose (sugar) should not be detected in normal urine; its presence usually indicates **diabetes mellitus**, a severe metabolic disorder caused by defective carbohydrate utilization. The kidneys play a key role in glucose homeostasis and are able to reabsorb practically all glucose in their proximal convoluted tubules under normal conditions. If blood glucose is too high, as in diabetes, the kidneys will be unable to reabsorb all glucose, resulting in glucose presence in urine. Glucose may also be present in the urine after a big meal or during times of emotional stress.

A very small amount of **protein** is normally present in the urine. Any change in the color of a protein test strip indicates an elevated level of protein in urine. Diet and disease can affect protein levels in urine. For example, patients with severe **anemia**, a condition where the blood lacks an adequate number of red blood cells, usually excrete protein in their urine.

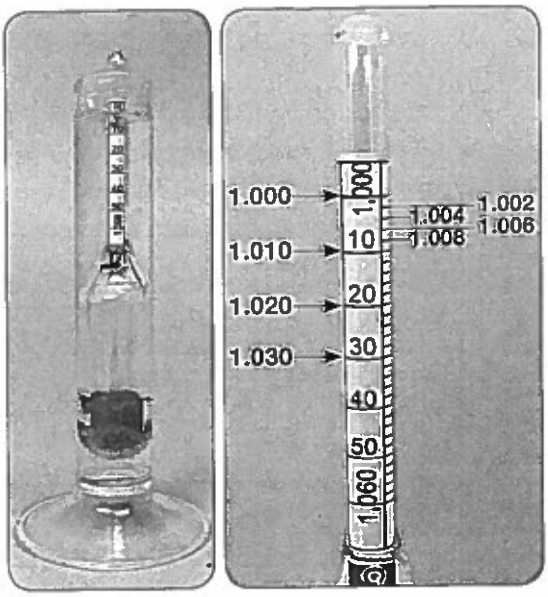

Figure 1.
(a) The specific gravity of a liquid can be determined using a hydrometer.
(b) The hydrometer you will be using in this investigation has a scale as seen here. Be sure to take readings at the bottom of the meniscus. The specific gravity of normal urine ranges from 1.010 to about 1.026.

Prelab Questions

1. What are the normal results for urine tests in regards to:
   a. color:
   b. pH:
   c. specific gravity:
   d. glucose:
   e. protein:

2. What test results would you expect from a person with diabetes mellitus?
   a. color:
   b. pH:
   c. specific gravity:
   d. glucose:
   e. protein:

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Materials

At the lab station:

plastic urine specimen containers, 5
disposable pipets, 5
Urine Reagent strips, 5
pH test strips, 5
absorbent paper towel

At the central materials station:

hydrometer and jar
pH color chart
marking pens, 2
simulated urine specimens, 5
10-mL graduated cylinders, 5

Safety

Simulated urine can irritate skin or eyes. Avoid contact with these chemicals, and flush the affected area with water if contact does occur. Simulated urine also can stain clothing; avoid contact.

Activity 1

Key Question

How do we perform urinalysis and interpret the results?

In this activity, you will perform five important component tests of clinical urinalysis: color, pH, specific gravity, glucose, and protein. The Low, Normal, and High simulated urine samples are designed to produce results indicative of those characteristics. You will also be provided with two unknown simulated urine samples for urinalysis, and you will be asked to report and interpret the results.

Procedure

1. Take three plastic urine specimen containers to the central materials station. Use a marking pen to label the containers *Low*, *Normal*, and *High*. Use the labeled graduated cylinders at the central materials station to transfer 10 milliliters of Low, Normal, and High Simulated Urine to the appropriate labeled containers.
2. Return to your lab station. Place the containers of simulated urine on the absorbent paper towel. Observe the samples, and record the color of each sample in your Laboratory Data table.
3. Use a pen or pencil to label one end of three of the pH test strips *L*, *N*, and *H*.
4. Holding the labeled end, dip the *L* strip into the Low sample. Shake off any excess liquid. Lay the pH strip in front of the Low sample on the absorbent paper towel. Repeat the process with the Normal (*N* strip) and High (*H* strip) samples.
5. Compare the color of the test trip to the pH color chart at the central materials station. In your Laboratory Data table, record the pH of each sample.
6. Label the plastic portion of three Urine Reagent strips *L*, *N*, and *H*, respectively.
7. Test each sample for glucose and protein using a Urine Reagent strip, as follows:
   a. Observe the color of the test squares that are attached at one end of the Urine Reagent strip. The greenish square nearest the tip will be used for testing the glucose in the sample; the yellow square will detect protein in the sample.
   b. Dip the end of the strip with the test squares into the urine sample, and then withdraw it. Run the end of the strip against the rim of the urine container to remove excess urine.

c. Wait 30 seconds, then observe and record the color of the test squares.
   - *Green square:* A negative result produces no color change, indicating normal or low urine glucose. A darkening of the square indicates a higher than normal urine glucose level; the darker the color, the higher the glucose level.
   - *Yellow square:* A negative result produces no color change, indicating the absence of protein in the urine. A green or blue color indicates the presence of protein in the urine sample.

8. Measure the specific gravity of Simulated Urine Low. Do not forget to consider the calibration factor from your teacher's calibration demonstration.
   a. Rinse the urine hydrometer and jar thoroughly.
   b. Use a clean pipet to fill the jar to the fill line with the sample.
   c. Insert the hydrometer into the jar as shown in Figure 1 of the Prelab.
   d. Read the fluid level on the hydrometer scale, and record the value in your Laboratory Data table.
   e. Add or subtract the calibration factor from your measurement. Record the adjusted value in your Laboratory Data table.
9. Repeat the specific gravity test for the Normal and High samples, and record the results in your Laboratory Data table. Be sure to carefully rinse the urine hydrometer and jar thoroughly between each sample.
10. Repeat the procedure for samples Unknown A and Unknown B. Analyze the color, pH, glucose, protein, and specific gravity of these samples, and record the results in your Laboratory Data table.

Laboratory Data

	Simulated Urine Samples				
Urine Test	**Low**	**Normal**	**High**	**Unknown A**	**Unknown B**
Color					
pH					
Specific Gravity					
Glucose					
Protein					

Name _____ Date _____

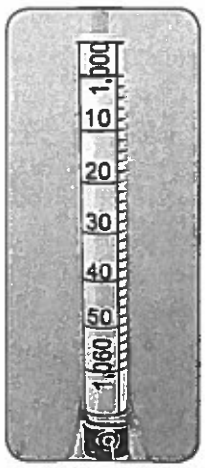
Activity 1

Questions

1. Using Table 1 and Table 2 of the Prelab, determine which disease(s), if any, may be indicated by the urine test results for Unknown A and Unknown B and why.
2. Place an asterisk next to all abnormal results in the Laboratory Data table.
3. In a clinical setting, urine is often examined under a microscope. What information about a patient's health might be gained through this type of examination?
4. Clinical Application: What urinalysis results would you expect for someone being treated for a bacterial infection like strep throat, assuming he or she follows the doctor's orders? What is your reasoning for each factor? Doctor's orders: amoxicillin, 2×/day; lots of bed rest; drink lots of fluids.

Factor	Result	Reasoning
Color		
pH		
Specific Gravity		
Glucose		
Protein		

5. As a pharmacist, what side effect warning might you give someone starting a new medication to treat the signs and symptoms of arthritis?
6. Can any of these urine tests definitively diagnose diabetes? Why or why not? If not, why would a doctor ever order a urinalysis?
7. Using this hydrometer scale, mark and label the upper and lower boundaries of the normal range of the specific gravity of urine.



Name _____ Date _____

Activity 2

Materials

At the lab station:

paper urine specimen container
glass vial
disposable pipets, 2
Urine Reagent strip
pH test strip
absorbent paper towel

At the central materials station:

hydrometer and jar, 2
pH color chart
marking pens, 2
antibacterial soap

Safety

Urine contains bacteria, and is not sterile. Handle only your own urine. Wash your hands thoroughly before and immediately after this activity.

Key Question

What are your urinalysis results, and what do they mean?

In this activity, you will perform five important tests routinely done in clinical urinalysis: color, pH, specific gravity, glucose, and protein. You will use your own urine for testing and then report and interpret the urinalysis results.

Procedure

1. Following your teacher's instructions, collect a fresh urine sample of approximately 25 mL in the paper urine specimen container. Place the sample cup on the absorbent paper towel at your lab station.
   Note: You should avoid handling any other urine samples. Only test your own sample.
2. Label one pipet *T* for "tests," and the other *H* for "hydrometer."
3. Use the *T* pipet to transfer about 2 mL of the urine to the glass vial. Observe the color of the urine, and record your observation in the Laboratory Data table.
4. Dip the end of the pH strip into the urine sample. Run the end of the strip against the rim of the container, and then lay the pH strip on the absorbent paper towel for a moment to remove any excess liquid.
5. Compare the color of the test trip to the pH color chart at the central materials station. Record the pH of your sample in the Laboratory Data table.
6. Test the sample for glucose and protein using a Urine Reagent strip, as follows:
   a. Observe the color of the test squares that are attached at one end of the Urine Reagent strip. The greenish square nearest the tip will be used for testing the glucose in the sample; the yellow square will detect protein in the sample.
   b. Dip the end of the strip with the test squares into the urine sample, and then withdraw it. Run the end of the strip against the rim of the urine container to remove excess urine.
   c. Wait 30 seconds, then observe and record the color of the test squares.
      - *Green square:* A negative result produces no color change, indicating normal or low urine glucose. A darkening of the square indicates a higher than normal urine glucose level; the darker the color, the higher the glucose level.
      - *Yellow square:* A negative result produces no color change, indicating the absence of protein in the urine. A green or blue color indicates the presence of protein in the urine sample.

7. Measure the specific gravity of your urine sample. Do not forget to consider the calibration factor from your teacher's calibration demonstration.
   a. Rinse the urine hydrometer and jar thoroughly.
   b. Use the clean *H* pipet to fill the jar to the fill line with the sample.
   c. Insert the hydrometer into the jar as shown in Figure 1 of the Prelab.
   d. Read the fluid level on the hydrometer scale, and record the value in your Laboratory Data table.
   e. Add or subtract the calibration factor from your measurement. Record the adjusted value in your Laboratory Data table.
8. Return the urine from the hydrometer to your sample cup.
9. Clean the urine hydrometer and jar thoroughly with antibacterial soap and water so it is ready for use by the next person.
10. Dispose of the urine in the sample cup in accordance with your teacher's instructions (e.g., in a toilet, etc.).
11. Discard the cup, glass vial, used test strips, and paper towel according to your teacher's instructions.
12. Wash your hands thoroughly with soap and water.

Laboratory Data

Urine Test	Urine Sample Observations
Color	
pH	
Glucose	
Protein	
Specific Gravity	

Name _____ Date _____

Activity 2

Questions

1. Are there any abnormal test results in your urinalysis? If so, indicate any possible causes. If results were normal, can you name any healthy practices that you follow which may have contributed to these results?
2. How might the results of a urinalysis change for a single patient over the course of a day? Consider your daily activities and how the results of your urinalysis might have differed if it were performed on urine collected earlier or later in the day.
3. The following abnormal results were obtained from a patient's urinalysis. Name a disease that could cause these results.

Color	very light yellow
pH	3.0
Specific Gravity	1.040
Glucose	positive
Protein	negative

4. Diabetes is a disease that often goes undetected for a while, sometimes even years. In fact, some studies suggest that half of all people with diabetes do not realize they have it. Based on urine alone, what are some reasons you think people do not realize they are diabetic?
5. Clinical application: Imagine you are a sports medicine physician and the following clinical case is presented to you:
   An otherwise healthy 24-year-old male has presented at your office with recent symptoms of a burning pain when urinating. The subject has recently decided to begin bodybuilding as a way to lose some of the weight he gained eating a poor diet in college. The subject weight trains 6 days each week, a drastic change from his previous exercise habit of a 1-hour jog or run once a week. His intense weight training requires careful monitoring of food and liquid intake. The subject describes his new diet as healthy, with a large focus on lean chicken breast, hard-boiled eggs, and beans. He is careful not to overeat. He also says that he closely monitors his water intake and forces himself to drink the recommended eight glasses of water each day, no more and no less.

   a. What would you expect this subject's urinalysis results to look like, and why?

Factor	Result (circle one)	Reasoning
pH	LOW / NEUTRAL / HIGH	
Specific Gravity	LOW / HIGH	
Glucose	ABSENT / PRESENT	
Protein	ABSENT / PRESENT	

   b. What do you think could be the cause of the burning sensation during urination?

   c. What would you recommend as a treatment?