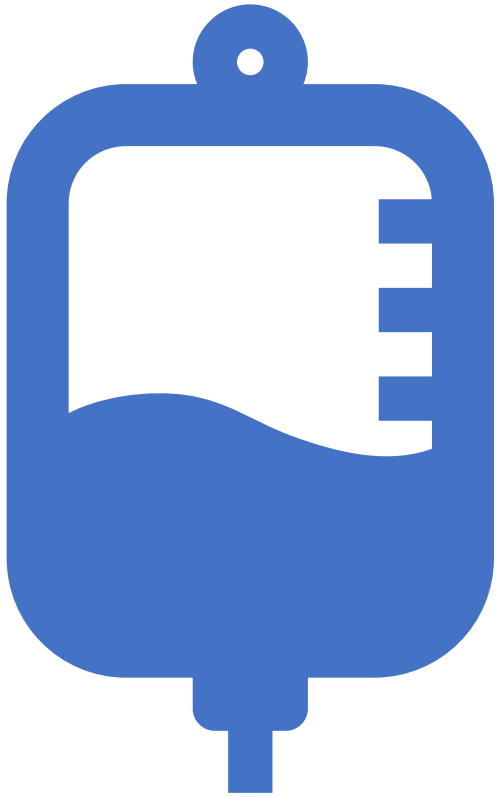


Renal Feedback Loops and Mechanisms Focusing on the Regulation of Blood Volume, Blood Osmolarity, Blood pH, and Blood Glucose. The Effects of Diuretics.

Summary

Urine tests are laboratory analyses performed on urine samples.

Urine analysis can provide useful information about a persons' health.

Urinalysis

- They are routinely used are regular doctor appointments and hospital settings to determine if patients have
  - Infections
  - Diabetes
  - Renal issues
  - Liver issues
  - Metabolic issues
  - Other conditions

Goals

- Physiology students will learn how to analyze urine samples.
- Students will
  - ask a question
  - develop hypotheses
  - research renal feedback loops and renal mechanisms
  - perform an experiment to test the hypotheses
  - analyze data
  - develop a conclusion
  - write a scientific abstract
  - give a scientific presentation.

Multi-day Experimental Design

Groups will choose one person to run a two day experiment

Day 1 the participant will drink the control drink

Day 2 the participant will drink the experimental drink (randomly assigned to the group).

Day 3 students will formally present their findings.

DAY 1: CONTROL DRINKS

- All group members will run urine analysis experiments on their personal urine.
- Groups will choose a participate.
- The participant will empty their bladder and test it.
- Then they will drink the CONTROL DRINK and test their urine at specific time intervals *(don't forget that the participant cannot drink/eat any additional drink/food during the lab meeting)*.
    - The group may want to take pictures along the way to document your experiment.
    - The group will present a quick review of the proper feedback loops and mechanisms that they used to create their hypotheses.

DAY 2: EXPERIMENTAL DRINKS

Urine analysis will only be conducted on the participant.

Before beginning, the participant will empty their bladder and test it.

Then they will drink the EXPERIMENTAL DRINK and test their urine at specific time intervals (don't forget that the participant cannot drink/eat any additional drink/food during the lab meeting).

Take pictures

Take notes

Make observations

DAY 3: SCIENTIFIC ABSTRACTS & PRESENTATIONS

GROUP PROJECT REQUIRES A WRITTEN GROUP ABSTRACT (250 WORDS MAX)

GROUP PROJECT REQUIRED A GROUP SCIENTIFIC PRESENTATION (10 MINUTES MAX).

THE GROUP PROJECT IS DUE ON THE LAST WEEK OF LAB.

PRESENTATION OUTLINE

- SLIDE 1 - Title slide (title and names of group members)
- SLIDES 2-4 – Introduction
  - SLIDE 2 - What is the renal system
  - SLIDE 3 - How is the renal system regulated and controlled
  - SLIDE 4 - Summarize the experiment and the PURPOSE of the experiment
- SLIDE 5 – Hypotheses
- SLIDE 6-8 – Methods
  - SLIDE 6 – Summarize the Experimental Procedure
  - SLIDE 7 – Present data using graphs.
  - SLIDE 8 – Give Interpretation of the data. What did the data show? What does the data mean?
- SLIDE 9 – Conclusions
- SLIDE 10 - Referrences

Abstract

- Write an Abstract to summarize your work. This is due on the day of your presentation. Include the following: (250 words max).
  - Group names and lab section.
  - Title: provide a good title.
  - Introduction: 1-2 sentences
  - Methods: 1-2 sentences
  - Results: 1-2 sentences
  - Discussion: 2-4 sentences.
  - Figures: Attach your final figures and tables at the end of your abstract. Resize appropriately.

Goals:

- • Students should understand
  - renal feedback loops
  - renal regulation of –
    - blood volume
    - blood osmolarity
    - blood pH
    - blood glucose
  - the effects of diuretics on the body

Goals:

- Students will work safely and follow precise protocols to run urine analysis experiments.

- Students will properly handle all waste materials, equipment, and chemicals.

- Students will work together to design a good experiment, take and analyze data, create conclusion, write an abstract, create a scientific presentation, and participate in their group scientific presentation.

- Students will listen attentively during group presentations and ask good questions.

A. Personal Urinalysis Test SUPPLIES

- Gloves
- Placemat
- 500mL of DI water as your control
- 500mL of your assigned experimental drink
- Urine analysis reagent strips
- Urinometer
- Graduated cylinder/Urine cup (urine volume)
- Chloride ion testing station
- Transfer pipets
- Test tubes
- 20% potassium chromate
- 3% silver nitrate

A. Personal Urinalysis Test - INSTRUCTIONS

Measure the Volume of Urine –

Use a urine cup/graduated cylinder to determine the urine volume.

Take a sample of urine in a transfer pipet

Add one drop to each test pad.

Allow to sit for the allotted time

Check results. **To prevent contamination, DO NOT touch the test strip to the bottle.*

Use the urine analysis reagent strip to determine the following

- the pH
- glucose concentration
- specific gravity
- protein concentration

Measure the volume of urine at the meniscus.

This shows a volume of 20 ml.

Measuring Urine pH

According to the American Association for Clinical Chemistry, the average value for **urine pH** is 6.0.

Safe pH range is from 4.5 to 8.0.

Urine under 5.0 is acidic

Urine higher than 8.0 is alkaline, or basic.

High Urine pH – Alkaline

- **Urine** higher than 8.0 is alkaline, or basic.
- If a person has a high urine pH, meaning that it is more alkaline, it might signal a medical condition such as:
  - kidney stones
  - urinary tract infections (UTIs)
  - kidney-related disorders
  - prolonged vomiting
  - kidney stone formation

Low Urine pH – Acidic

- **Urine** under 5.0 is acidic
- If a person has low urine pH, meaning that it is more acidic, it might indicate a medical condition such as:
  - diabetic ketoacidosis
  - diarrhea
  - starvation

Urine glucose concentration

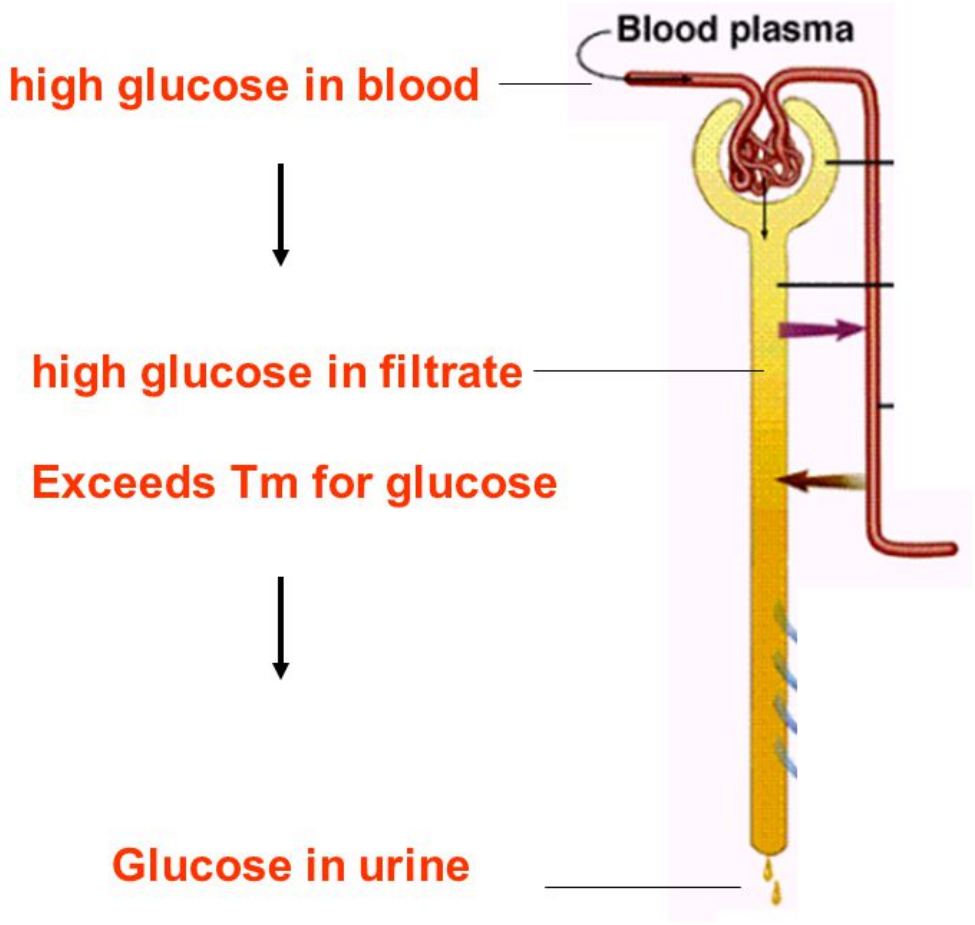
The normal amount of **glucose** in **urine** is 0 to 0.8 mmol/L (millimoles per liter).

A higher measurement could be a sign of a health problem.

Diabetes is the most common cause of elevated **glucose** levels.

Renal glycosuria can cause **urine glucose** levels to be high even if blood **glucose** levels are normal.

Urine glucose concentration

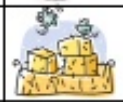


Urine glucose concentration - renal glycosuria

- in those with renal glycosuria, glucose is abnormally elevated in the urine due to improper functioning of the renal tubules, which are primary components of nephrons, the filtering units of the kidneys.

Urine specific gravity

TABLE 18-3 CHARACTERISTICS OF NORMAL URINE

	CHARACTERISTIC	DESCRIPTION
	AMOUNT	 1-2 liters, depending on intake
	COLOR	 Straw/amber (darker, more concentrated)
	SPECIFIC GRAVITY	**1.010-1.025** MEASURE OF DISSOLVED MATERIAL IN URINE. LOWER VALUE = MORE DILUTED URINE
pH	pH	DIET HAS BIGGEST EFFECT ON URINE pH 4.6 6 8.0
	COMPOSITION (MAKEUP)	95%  5%  & 
	NITROGENOUS WASTES	UREA – AMINO ACID METABOLISM CREATINE – FROM MUSCLE METABOLISM URIC ACID – FROM NUCLEIC ACID METABOLISM

Urine specific gravity

Ideally, **urine specific gravity** results will fall between 1.002 and 1.030 if your kidneys are functioning normally.

Specific gravity results above 1.010 can indicate mild dehydration.

The higher the number, the more dehydrated you may be.

Urine Protein Concentration

Normal values are 0 to 20 mg/dL.

For a 24-hour **urine** collection, the normal value is less than 80 mg per 24 hours.

The protein urine dipstick test measures the presence of proteins, such as albumin, in a urine sample.

Urine Protein Concentration

- Larger amounts of protein in the urine may be due to:
  - Heart failure
  - Kidney problems, such as
    - kidney damage
    - diabetic kidney disease
    - Kidney cysts
  - Loss of body fluids (dehydration)
  - Problems during pregnancy, such as
    - seizures due to eclampsia
    - high blood pressure caused by preeclampsia
  - Urinary tract problems, such as a bladder tumor or infection
  - Multiple myeloma

URINE COLOR CHART

NO COLOR. TRANSPARENT
You're drinking a lot of water

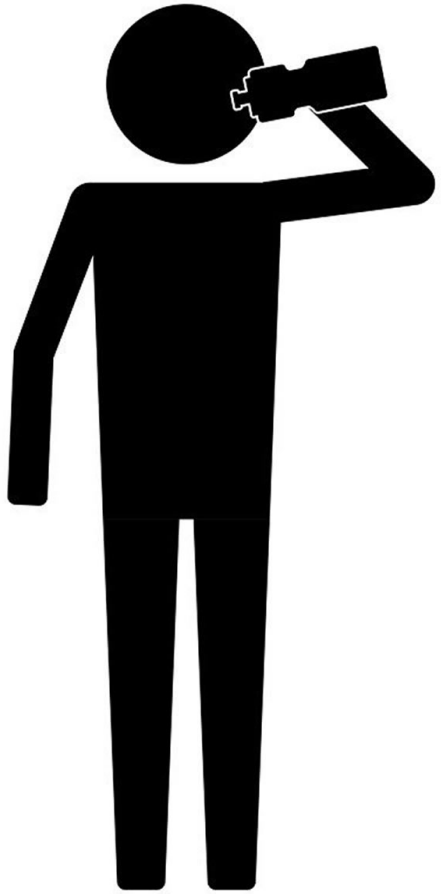
PALE STRAW COLOR
You're normal & well hydrated

TRANSPARENT YELLOW
Normal

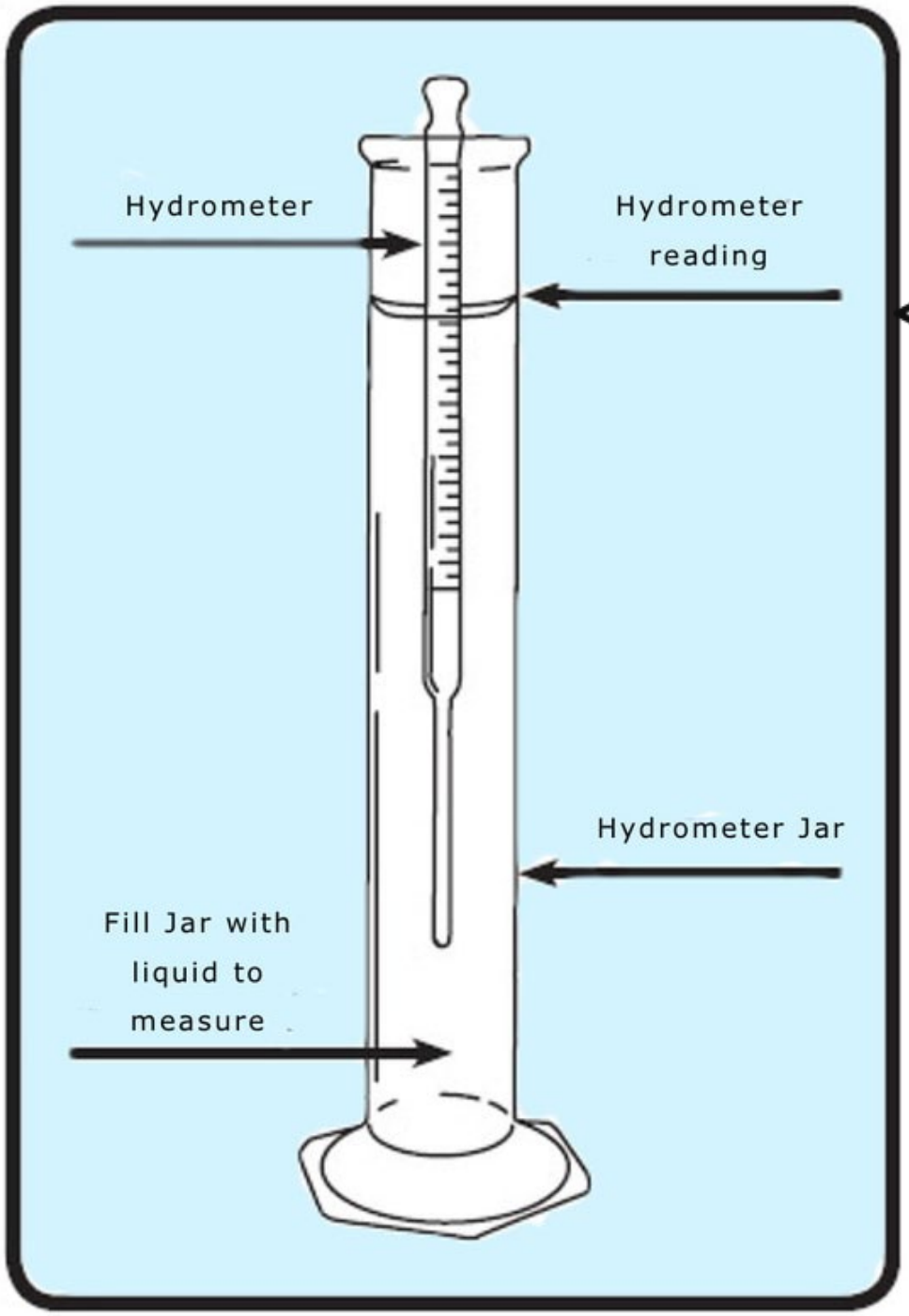
DARK YELLOW
You need to drink some water soon

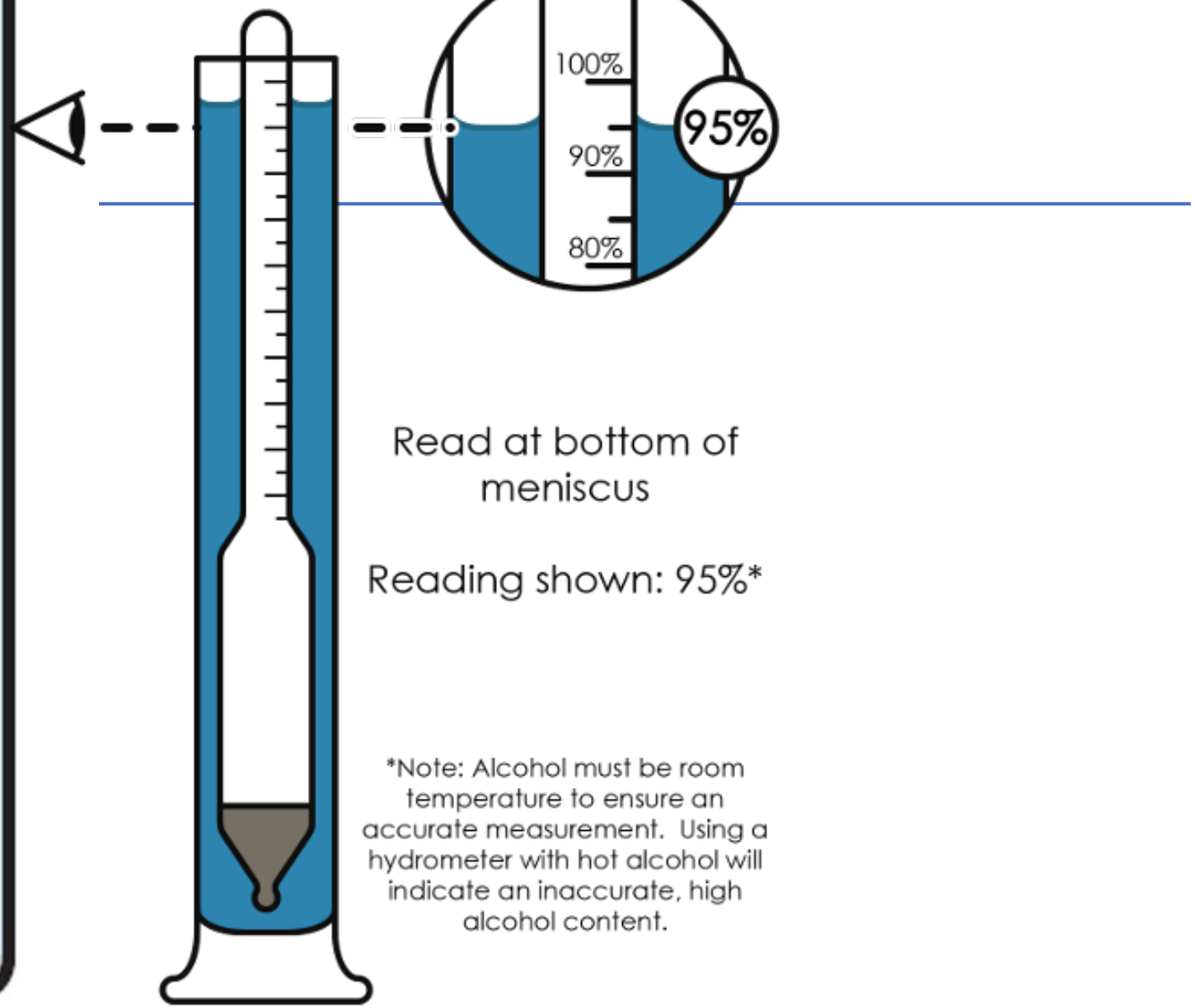
AMBER OR HONEY
Your body isn't getting enough water.

SYRUP OR BROWN ALE
You need to drink water. NOW & A LOT!



•hydrometer





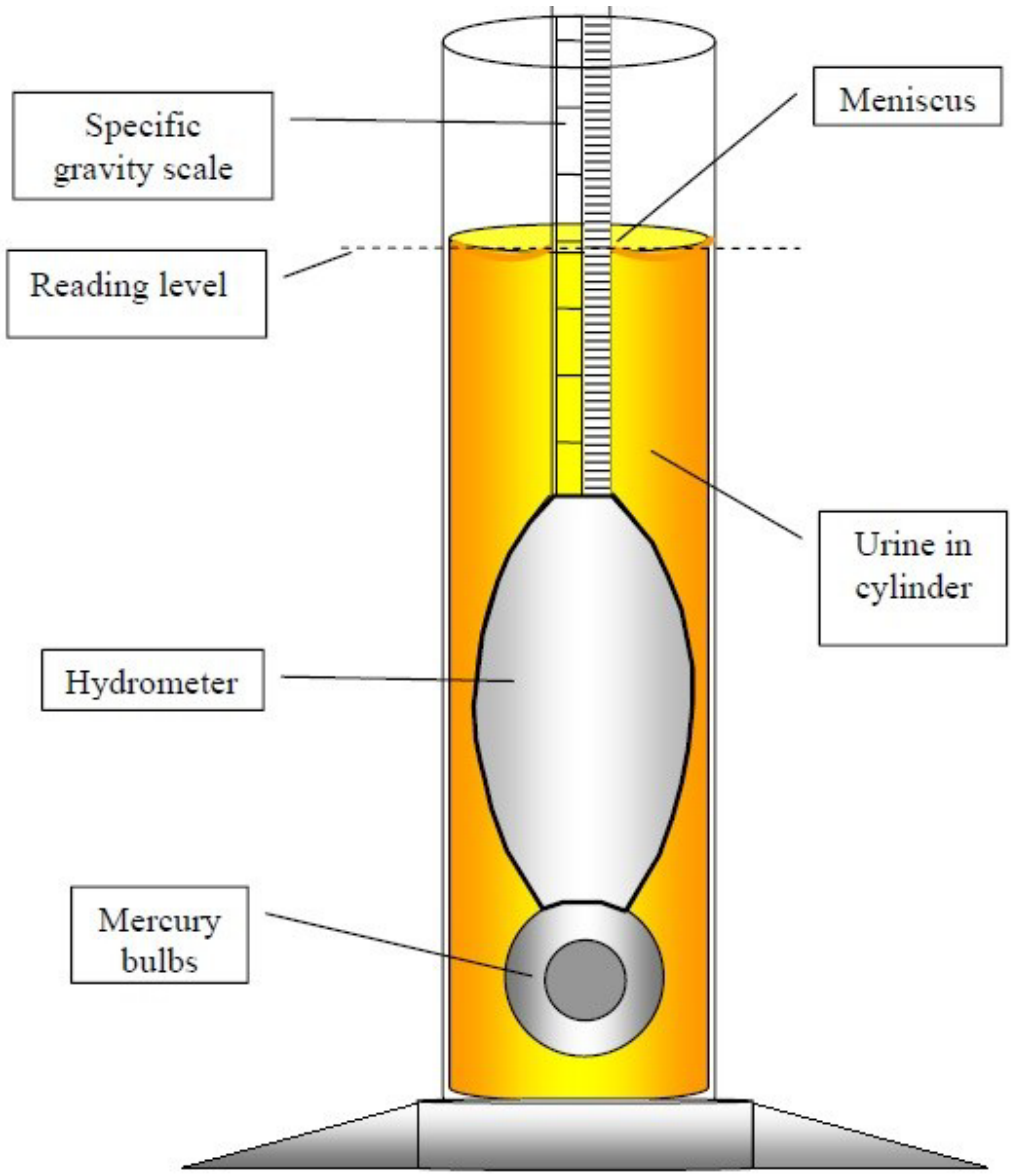
Read at bottom of meniscus

Reading shown: 95%*

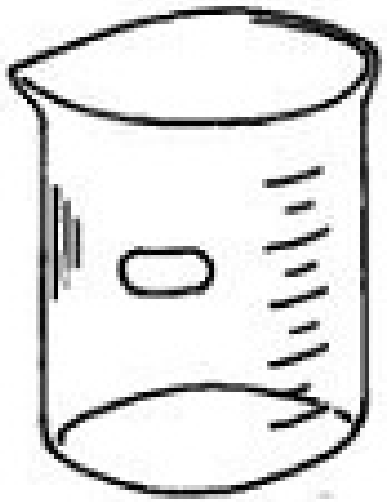
*Note: Alcohol must be room temperature to ensure an accurate measurement. Using a hydrometer with hot alcohol will indicate an inaccurate, high alcohol content.

Urinometer

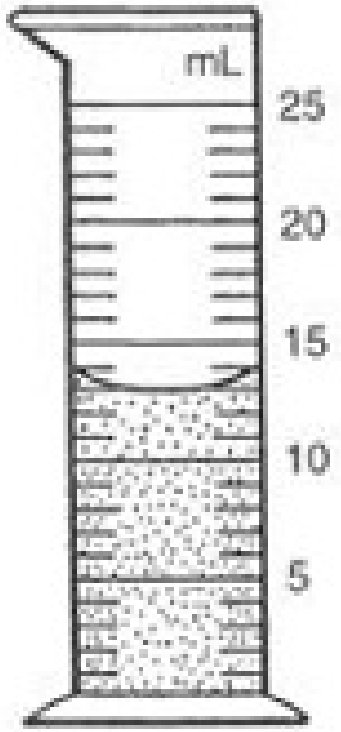
- A **Urinometer** is a simple piece of equipment for determining urine specific gravity.
- A typical **urinometer** is composed of a float, a weight, and a stem.
- The float is an air-filled glass tube, ending in the weight on the left and the stem on the right.



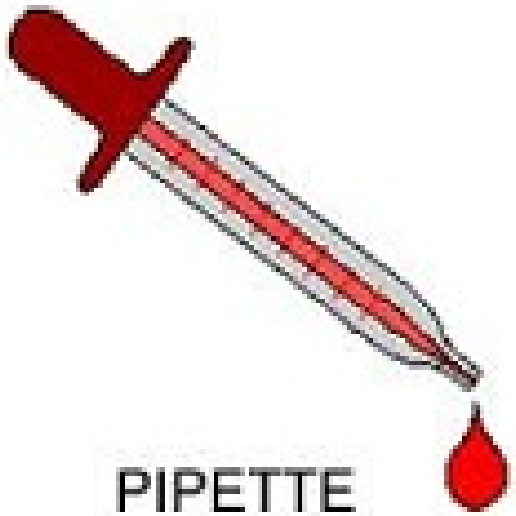
Know Your equipment



BEAKER



GRADUATED CYLINDER



PIPETTE

Hyperchloremia

dehydration

Cushing syndrome → minerocorticoid increased → reabsorption of Chloride at renal tubule decreases

Severe diarrhea → loss of bicarbonate→ compensatory retention of chloride

Respiratory acidosis → shallow breathing → CO_2 conc increases → H_2CO_3 conc increases → HCO_3^- decreases → Cl^- conc increases

Renal tubular acidosis

Urine Chloride Concentration

Increased levels of Urinary Chloride (hyperchloremia) may be produced by conditions, such as:

- Consumption of increased amounts of salt
- Addison disease
- Salt loss in urine due to inflamed kidneys; a condition known as salt-wasting nephropathy
- Passing increased amounts of urine (polyuria)

Hypochloremia

Excessive vomiting HCl lost→ increase plasma bicarbonate " Hyperchloremia alkalosis "

Addison's disease (Aldosterone decreases ,renal reabsorption of chloride ion decreases ,excretion of chloride ions increases) Chloride ion concentration decreases

Respiratory alkalosis → Hyperventilation → elimination of CO_2 increases → increase in concentration of blood bicarbonate → Chloride ion concentration decreases

Urine Chloride Concentration

Decreased levels of Urinary Chloride (hypochloremia) may be caused by conditions, such as:

- Consumption of decreased amounts of salt
- Cushing syndrome
- Conn syndrome
- Vomiting, diarrhea, excess sweating, leading to loss of fluids from the body

A. Personal Urinalysis Test - INSTRUCTIONS

3. Use the urinometer to measure the specific gravity.
   - Use a transfer pipet to fill the glass graduated cylinder about 75% full.
   - Gently add the hydrometer and make sure it is floating freely in the middle of the graduated cylinder.
   - Take your reading at the meniscus.

A. Personal Urinalysis Test - INSTRUCTIONS

4. Use the chloride testing station to determine the chloride ion concentration.
   - Add 10 drops of urine into a test tube.
   - Add one drop of 20% potassium chromate and mix.
   - Add 3% silver nitrate and mix.
   - COUNT the drops as you add them one drop at a time of 3% silver nitrate at a time until the solution turns brown.
   - Calculate the chloride ion concentration using the following formula
     - $\frac{(\#\ drops) \times (0.061\ g\ Cl^-)}{0.1\ L}$ = X grams per liter (this is MOLARITY)

CLEAN-UP

- Return your urine to your urine cup.
- **Dispose of the urine by flushing it down the toilet**.
- All items that have or may have urine on them must go in the **biohazard softs**.
- Chloride testing liquids should go in the **chemical waste container**
- Test tubes should go in the **test tube collecting bucket**.

B. Group Project:

- **Control Drink (Day 1) &. Experimental Drink (Day 2)**
- **Tests** • Same as section A
- Choose one student per group to be the participant.
  - On Day 1 they will drink the control.
  - On Day 2 they will drink the experimental.
- DAY ONE • Control drink: 500mL of drinking water
- DAY TWO • Experimental drink: 500mL of an **assigned experimental drink**
  - **A lot of water (NOTE: 1000mL)**
  - **½ teaspoon Baking Soda**
  - **Orange juice**
  - **0.9% NaCl**
  - **1.5% NaCl**
  - **5% glucose**
  - **Gatorade**
  - **Caffeine/Black coffee**

Protocol:

- Time = 0min: Have the students empty their bladder as soon as the lab begins. They should measure their urine volume and bring back a sample. When they return, have them “chug” their assigned drink and begin the timer (20min interval). STUDENTS CANNOT EAT NOR DRINK ANYTHING FROM THIS POINT ON. Run a complete urine analysis on their time 0min urine.
- Time = 20min: When the timer rings, have the student empty their bladder. They should measure their urine volume and bring back a sample. When they return begin the timer (20min interval). Run a complete urine analysis on their time 20min urine.
- Time = 40min: When the timer rings, have the student empty their bladder. They should measure their urine volume and bring back a sample. When they return begin the timer (20min interval). Run a complete urine analysis on their time 40min urine.
- Time = 60min: When the timer rings, have the student empty their bladder. They should measure their urine volume and bring back a sample. When they return begin the timer (20min interval). Run a complete urine analysis on their time 60min urine.
- Time = 80min: When the timer rings, have the student empty their bladder. They should measure their urine volume and bring back a sample. When they return begin the timer (20min interval). Run a complete urine analysis on their time 80min urine.
- Time =100min: When the timer rings, have the student empty their bladder. They should measure their urine volume and bring back a sample. When they return begin the timer (20min interval). Run a complete urine analysis on their time 100min urine.
- OPTIONAL Time =120min: When the timer rings, have the student empty their bladder. They should measure their urine volume and bring back a sample. When they return begin the timer (20min interval). Run a complete urine analysis on their time 120min urine.
- 8. STUDENTS MAY NOW EAT & DRINK WHATEVER THEY WISH OUTSIDE OF THE LAB.
- 9. CLEAN-UP: dispose of urine and waste appropriately. Points will be lost if waste is mismanaged.