uBEATS Teacher's Guide:

Measuring & Transferring Liquids in the Laboratory

This teacher guide is a supplementary text to support the use of the uBEATS "Measuring and Transferring Liquids in the Pediatric Cancer Research Group (PCRG) Laboratory" module for grades 9-12.

To help students develop the knowledge necessary for an incredible future in health care, we created UNMC Building Excellence in Academics Through STEM (uBEATS), an online health science resource for Nebraska students.

UNMC uBEATS modules are short (15 minutes or less), interactive online health science modules to supplement the curriculum taught in grades 6 – 12. These do not replace curriculum, but they are a supplement for teachers and students incorporating evidence-based information and UNMC expert-guided material. Each module is chunked into sections with formative and summative assessments with immediate feedback provided.

Tips on how to utilize uBEATS modules:

- Internet access is required to view uBEATS modules.
    - For those who have access to one-to-one technology, modules can be used in or outside of the classroom as a topic introduction, extension, or review. For classrooms without individual student devices, modules can be used in whole-group instruction. Formative assessment questions can use the teacher's preferred call-and-response method and summative assessment questions can be displayed on the board and answered individually by students or printed and distributed to students after viewing the module.

Objectives

- Describe the process of transferring solutions with a serological pipet.
- Describe the process of transferring solutions with a micropipette.
- Apply solution transfer through serial dilution.

Introduction

When you make your favorite cake, you need specific tools: a measuring cup for the milk, a tablespoon for the oil, and a teaspoon for the vanilla. Inaccurate volumes can lead to disastrous or inedible results. Just like in your kitchen, in the PCRG laboratory, you need an assortment of devices designed to measure and transfer liquids for a successful experiment, such as flasks, beakers, and graduated cylinders. These examples are useful for large volumes, but what do you use when you need to transfer a small amount of solution? In the PCRG laboratory, we frequently measure small volumes when mixing drugs, setting up experiments, or during cell culture. The metric unit of volume used to measure liquids is the liter, abbreviated with (L). We primarily work with milliliters (mL) and microliters (µL). 1L is 1000mL, and 1mL is 1000µL. Since the volumes are so small, we use specialized measuring tools called serological pipets and micropipettes. Serological pipets are appropriate when you need to work with volumes greater than 1 milliliter. Micropipettes are the tool of choice when you need to precisely transfer liquids in the microliter range.

Prior Knowledge

Before beginning this module, the teacher should understand the Next Generation Science Standards (NGSS) featuring Three-Dimensional Learning.

Dimension 3: Disciplinary Core Ideas—Physical Sciences. A Framework for K-12 Science Education

Within matter, atoms and their constituents are constantly in motion. The arrangement and motion of atoms vary in characteristic ways, depending on the substance and its current state (e.g., solid, liquid). Chemical composition, temperature, and pressure affect such arrangements and motions of atoms, as well as how they interact. Under a given set of conditions, the state and some properties (e.g., density, elasticity, viscosity) are the same for different bulk quantities of a substance, whereas other properties (e.g., volume, mass) provide measures of the size of the sample at hand.

National Academies of Sciences, Engineering, and Medicine. 2012. A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press. https://doi.org/10.17226/13165.

Science and Engineering Practices NGSS

4. Analyzing and interpreting data

5. Using mathematics and computational thinking

8. Obtaining, evaluating, and communicating information

Crosscutting Concepts NGSS

3. Scale, proportion, and quantity

Key Terms/Vocabulary

Measurement, volume, liquid, flask, beaker, graduated cylinder, serological pipet, micropipette, pipette aid, pipette tip, solution transfer, serial dilution, metric units, liter (L), milliliter (mL), microliter (µL), aspirate, dispense, filter plug, over-aspirate, hydrophobic filter, power display, speed adjustment button, control button, tip ejector button, volume dial, volume display, accuracy, precision, sterile, diameter, horizontal, vertical, syringe, piston, plunger, resting position, first stop, second stop, viscous, evacuate, concentration, percentage, ratio, dilution, solution, range, sharps box, microtube, microtube rack, stock solution.

Science Standards

National Consortium for Health Science Education **NCHSE**

Foundation Standard 1: Academic Foundation

- 1.3.1 Demonstrate competency using basic math skills and mathematical conversions as they relate to healthcare.
    - a. Metric system
        - Milli-
        - Micro
    - b. Mathematical
        - Percentages
        - Ratios
    - c. Conversions
        - Volume (ml/cc)

Extensions of the lesson

To help students become more familiar with the Key Terms of this module, the teacher can use the vocabulary list for a classroom Word Wall or integrate the vocabulary into review sessions.

As student misconceptions become apparent, the teacher may need to reinforce these concepts:

- Flasks, beakers, and graduated cylinders are commonly used to measure the volume of liquids. However, small volumes need specialized measuring tools.
    - A serological pipet measures volumes in milliliters (mL).
    - A micropipette is needed when the volume is less than 1 milliliter. A micropipette measures volumes in microliters (µL).
- The serological pipet gets its name from procedures carried out on samples of blood serum.
- "Pipet" and "pipette" are both correct spellings of the same word, both referring to a laboratory tool used to transfer liquids. In British English "pipette" is more commonly used, and in American English, you will see "pipet" more often. The two spellings are interchangeable, with one exception: a "**micropipette**" is never called a "**micropipet**."
- A sharps box is a special container for disposal of used hypodermic needles, syringes, and other sharps. Pipette tips are never discarded in regular trash—they are dropped immediately into a sharps box for safe storage until the box is disposed of according to community guidelines.

Enrichment

- To learn more about laboratory techniques, search for videos about pipettes. For example, How do you use a micropipette?

- For a video explanation of serological pipettes, see How to Use a Serological Pipette.

- For a fun classroom activity demonstrating serial dilution, students can experience One in a Million.