The Basic Skills of the Biotechnology Workplace

Key Concepts

- Liquid volumes are measured using graduated cylinders for liters and milliliters, pipets for milliliters, and micropipets for microliters.
- A µL is 0.001 mL, and 1 mL is 0.001 L.
- To convert between metric units of measure, move the decimal point left (to go to bigger units) or right (to go to smaller units) the number of zeros in the conversion factor.
- To make an accurate measurement with a graduated cylinder or pipet, make sure the bottom of the meniscus is touching the graduation.
- If you have a choice of pipets for measuring a volume, a smaller volume pipet is more likely to give an accurate measurement or reading.
- To use a micropipet correctly, you must master setting the volume and using the plunger.
- Some common micropipets and their ranges of measurement are the P-1000 (100-1000 µL), P-200 (20-200 µL), P-100 (10-100 µL), P-20 (2-20 µL), and P-10 (0.5-10 µL).
- A multichannel pipet can measure and dispense several identical volumes at the same time.
- In a solution, a solute is what is dissolved in the solvent. In most solutions, water or a water-based solution (buffer) is the solvent.
- Most solutes are measured on a balance in grams or milligrams (0.001 g).
- Concentration is the amount of solute dissolved in the solvent.
- The three most common ways concentration is measured in a biotech lab are by mass/volume, % mass/volume, molarity, or by some amount "X."
- To calculate the amount of solute to use in a particular mass volume solution, use the Concentration in Mass/Volume Units equation:

_____ g/mL	x	_____ mL	=	_____ g of solute
concentration		volume		to be weighed out, then dissolved in the solvent

- To calculate the amount of solute to use in a particular % mass/volume solution, use the Concentration in % Mass/Volume Units equation:

_____ %	=	_____		
percent value		decimal value of the g/mL		
_____	x	_____	=	_____ g of solute to be measured and added
decimal (g/mL)		volume (mL)		to be weighed out, then dissolved in the solvent

- In biotechnology work, a mole is equal to 6.02×10^{23} atoms of molecules. A mole weighs, in grams, the molecular weight of the molecule.
- Knowing the molecular weight of compound is important in calculating the amount of a substance to use as a solute in a molar solution. Molecular weight is reported in atomic mass units (amu). A molecule's molecular weight equals the sum of the atomic weights of the atoms that makeup the molecule.
- To calculate the amount of solute to use in a particular molar solution, use the Molarity Concentration equation:

volume in	x	molarity	x	molecular weight	=	grams of solute to be dissolved
wanted (L)		desired (mol/L)		of the solute (g/mol)		solvent until the final volume

- A solution gets more concentrated as solvent is removed or as solute is added. A sample gets more diluted as solvent is added or solute is removed.
- To calculate how to make a specific dilution, use the equation, $C_1 V_1 = C_2 V_2$

Lab Practices

- Volume and mass measurements are made in metric units. You can easily convert by using the B← →S rule, moving the decimal point to the left or right depending on the units being converted.

- 10-, 5-, 2-, and 1-mL pipets are common in biotechnology labs. Before using each pipet, determine the maximum volume of the pipet and the value of its smallest graduations.
- Never mouth pipet. Use an appropriate pipet pump or pipet aid with each pipet.
- Pipet at eye-level. The bottom of the sample meniscus is where the volume is read.
- Although micropipets differ from one manufacturer to another, they are similar in that they measure in microliters (µL).
- Micropipets are named based on the maximum volume they will measure. For example, a P-1000 will measure a maximum of 1000 µL. Each pipet has a minimum and maximum volume it will measure.
- Most micropipets have a plunger apparatus for measuring and dispensing specified volumes. The technician must learn how each plunger works, where the first and second stops are, and how to control, fill, and dispense samples. Large errors in volume can occur if the plunger is not used correctly.
- A micropipet must be used with a micropipet tip. Tips should be discarded after each use to prevent contamination.
- A microcentrifuge is used to pool samples in the bottom of a microcentrifuge tube. Tubes placed into any centrifuge must be balanced in mass and volume to other tubes in the centrifuge.
- Mass or weight is measured in the laboratory using an electronic balance. For masses above 0.1 g, a tabletop balance is usually used. For milligram masses, an analytical balance is used.
- A weigh boat or weigh paper is always used on a balance. Samples are never placed on an unprotected weighing pan.
- Level and zero the balance with nothing on it. Then add a weigh boat or weigh paper and rezero the balance before weighing a sample.
- A micropipet's accuracy can be checked by measuring water samples on a balance. For example, 1 mL of water weighs 1 g, and 1 µL of water weighs 1 mg.
- A solution is composed of one or more solutes dissolved in a solvent. When making a solution, measure the solute and then slowly mix solvent into the solute.
- The concentration of a solution is the amount of solute in a particular volume.

Concentration is reported in different ways depending on the solute. Common units of concentration include mass/volume, % mass/volume, molarity, and "X" concentration.

- Indicator strips and indicator solutions can be used to measure the concentration of solute in solvent. Biuret solution (a mixture of NaOH and CuSO4) indicates the presence of protein.
- To determine how to prepare a certain volume of a solution at a certain mass/volume concentration, use the equation:

concentration desired (m/v) x total volume desired = mass of solute in the volume desired

- A spectrophotometer can be used to quantify the difference in colored solutions.
- To make a solution of a specific % mass in a specific volume, multiply the decimal value of the concentration desired by the total volume desired:

decimal value of
concentration desired x total volume desired = mass of solute to add to desired volume of solvent

- A one molar (1 mol/L) solution is 1 mole (1 mol) of solute dissolved in a volume of solvent to a total of 1 L. A one molar solution is reported as 1 *M*. A mole is 6.02 x 10^{23} molecules.
- To determine how to prepare a molar solution, use this equation:

Volume (L) x Molarity (mol/L) x molecular weight (g/mol) = grams of solute in final volume

- Dilutions of concentrated solutions are made by adding some volume of solvent to some volume of concentrated solution. Use the equation $C_1 V_1 = C_2 V_2$ to calculate the volume of concentrated solution to use in the dilution.
- To cancel units in the solution equations, you may need to convert units, for example, grams to milligrams, or milliliters to liters.