Science Education Collection

Making Solutions in the Laboratory

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Abstract

The ability to successfully make solutions is a basic laboratory skill performed in virtually all biological and chemical experiments. A solution is a homogenous mixture of solute dissolved in bulk liquid known as the solvent. Solutions can be described by their solute concentration, a measure of how much solute is present per unit of solution. In this video, a step-by-step procedure for how to make a water-based, or aqueous, solution for biological applications is presented. The video discusses how to calculate and measure the amount of solute needed for a given volume of solution. Methods for dissolving the solute in purified water and adjusting the pH of the solution are shown. Proper addition of the quantity sufficient (QS) to reach the desired volume is demonstrated with respect to the meniscus before discussing methods for sterilizing the solution. Applications of making solutions are presented through the discussion of several commonly used biological solutions, such as phosphate buffered saline (PBS), and their uses in biological research. These solutions are buffers that mimic physiological pH and osmolarity of cellular fluids.

Transcript

Making solutions is an essential procedure involved in virtually all biological and chemical experiments performed across the globe.

A solution is made up of a substance dissolved in liquid. The dissolved substance is known as the solute, and the bulk fluid as the solvent. The resulting homogenous mixture is referred to as the solution.

Solutions can be described by their solute concentration, a measure of how much solute is present per unit of solution.

Making solutions may be a basic laboratory skill, but poor technique can mean the difference between a successful or failed experiment.

The first consideration when making solutions is safety. It is important to take appropriate precautions, such as wearing gloves and a lab coat, depending on the type of chemicals you are working with.

There are many different ways to go about making a solution. This video will demonstrate the most common way to make a water-based, or aqueous, solution.

First determine the moles of solute you will need to achieve the desired concentration in a given volume of solution. Then covert this value to grams using the molecular weight, or the number of grams per mole, of the chemical.

The chemicals can be weighed out using a digital balance and a weigh boat.

A graduated cylinder can then be used to measure out a volume of purified water that is roughly three quarters of the final volume of solution.

It is imperative that aqueous solutions be prepared with purified water rather than tap water. Failure to do so can compromise the quality of not only the solution, but potentially multiple experiments down the line.

At this point, the purified water should be transferred into a beaker containing a stir bar on a magnetic stir plate.

The measured solutes can then be added to the stirring purified water. Stirring the mixture helps the solute to dissolve. Applying heat can also be used for this purpose.

Once all of the solutes have been dissolved in solvent, the pH of the solution can be adjusted using a pH meter. To bring the pH up, add dilute sodium hydroxide to the stirring solution. To bring the pH down, add dilute hydrochloric acid. Be sure to slowly add the acid or base, as the pH can change rapidly.

pH paper can also be used to measure the pH of a solution, however use of a calibrated pH meter results in a more accurate measurement.

The solution is then poured into a volumetric flask using a funnel so that it can be brought up to its final volume. Adding the quantity sufficient to reach this volume is known as Q.S.'ing the solution.

Be sure that the meniscus lines up with the mark on the volumetric flask. In an aqueous solution, the meniscus is concave, and should be read at the lowest point of the curve.

When performing biological research, specifically those involving living cells, solutions may need to be sterilized before use. This can be done by autoclaving, which subjects the solution to high temperature steam under high pressure.

Alternatively, the solution can be sterilized by running over a 0.22 micron filter, which will exclude any bacterial cells.

Now that you have a fundamental understanding of how to make solutions, it's time to take a look at some commonly used solutions in the laboratory and their applications.

In biological research, numerous solutions are designed to mimic physiological fluids. These solutions are buffered, which means they resist change in pH in a specific range; usually, pH is maintained at about 7.4 to simulate intracellular and extracellular fluids.

Phosphate buffered saline, or PBS, is a commonly used buffer in biological research that mimics physiological pH and osmolarity. Osmolarity refers to the total moles of solute in a solution. For example, a solution containing 1 mole of NaCl has 2 osmoles of solute, because the sodium and cloride ions dissociate in solution. PBS has ion concentrations which closely match those of cells, making it an isotonic solution, meaning that the amount of solute outside of the cell is equivalent to what's found inside the cell. PBS is made up of several different salts in water, including salts with phosphate groups that maintain a constant pH in the range of 7.2 to 7.6.

Common uses for PBS in the lab include washing cells, and diluting biomolecules such as protein.

Artificial cerebrospinal fluid, or ACSF mimics the electrolyte concentrations of cerebrospinal fluid. This solution must be freshly prepared, and the pH, osmolarity, and ionic composition should be carefully monitored to match in vivo conditions.

ACSF is generally used in electrophysiological studies to prepare brain slices and to perfuse them during experiments. It can also serve as the extracellular solution during patch clamp measurement.

Ringer's solution is an isotonic saline solution with a balanced pH used in biological research. It is commonly used in in vitro experiments with organs and tissues.

You've just watched JoVE's introduction to making solutions. In this video we reviewed how to make a solution from start to finish… including how to determine the required amount of solute (A), how to properly QS a solution (B), and methods of sterilization (C). We also reviewed some common solutions as well as their applications in biological research (D).

Thanks for watching, and remember to always use proper technique when making solutions.