Glossary

adhesion: the attraction between water molecules and molecules of a different substance

cohesion: the intermolecular forces between water molecules caused by the polar nature of water; creates surface tension

evaporation: the release of water molecules from liquid water to form water vapor

hydrophilic: describes a substance that dissolves in water; water-loving

hydrophobic: describes a substance that does not dissolve in water; water-fearing

solution: a homogeneous mixture made of two or more components

solute: the substance being dissolved

solvent: a substance capable of dissolving another substance

surface tension: the cohesive force at the surface of a body of liquid that prevents the molecules from separating

temperature: a measure of molecular motion

Footnotes

1 Humphrey, W., Dalke, A., and Schulten, K., "VMD—Visual Molecular Dynamics," *J. Molec. Graphics*, 1996, vol. 14, pp. 33-38. http://www.ks.uiuc.edu/Research/vmd/

2.4 pH and Buffers

Learning objectives

By the end of this section, you will be able to:

- *Explain what pH is and why it is vital to living cells*
- *Understand what a logarithmic scale is*
- *Know which numbers on the pH scale represent acids and bases*
- *Explain what buffers are and why they are important*
- *Be able to define and explain all bolded terms*

pH

The pH of a solution is a measure of its acidity or alkalinity. You may have used **litmus paper**, a paper that can be used as a pH indicator, to test how much acid or base exists in a solution. You might have even used litmus paper to make sure the water in an outdoor swimming pool is treated correctly. In both cases, this pH test measures the amount of hydrogen ions that exist in a given solution.

$$\mathbf{H_2O(l) \leftrightarrow H^+(aq) + OH^-(aq)}$$

*(aq) means water is the solvent that dissolves the ions

Hydrogen ions spontaneously generate in pure water by the dissociation, ionization, of a small percentage of water molecules. While the hydroxide ions (OH^-) are kept in solution by their hydrogen bonding with other water molecules, the hydrogen ions (H^+), consisting of only a single proton, immediately bond to water molecules forming hydronium ions. For simplicity, scientists still refer to hydrogen ions and their concentration as if they were free in liquid water and not as being bound to water.

Acids

An acid is a substance that releases hydrogen ions (H^+) in solution (Figure 2.31a). Because an atom of hydrogen has just one proton and one electron, a positively charged hydrogen ion is simply a proton. This solitary proton is highly likely to participate in chemical reactions. Strong acids are compounds that release all their H^+ in solution; that is, they ionize completely. Hydrochloric acid (HCl), which is released from cells in the lining of the stomach, is a strong acid because it releases all its H^+ ions in the stomach's watery environment. This strong acid aids in digestion and kills ingested microbes. Weak acids do not ionize completely; that is, some of their hydrogen ions remain bonded within a compound in solution. An example of a weak acid is vinegar or acetic acid.

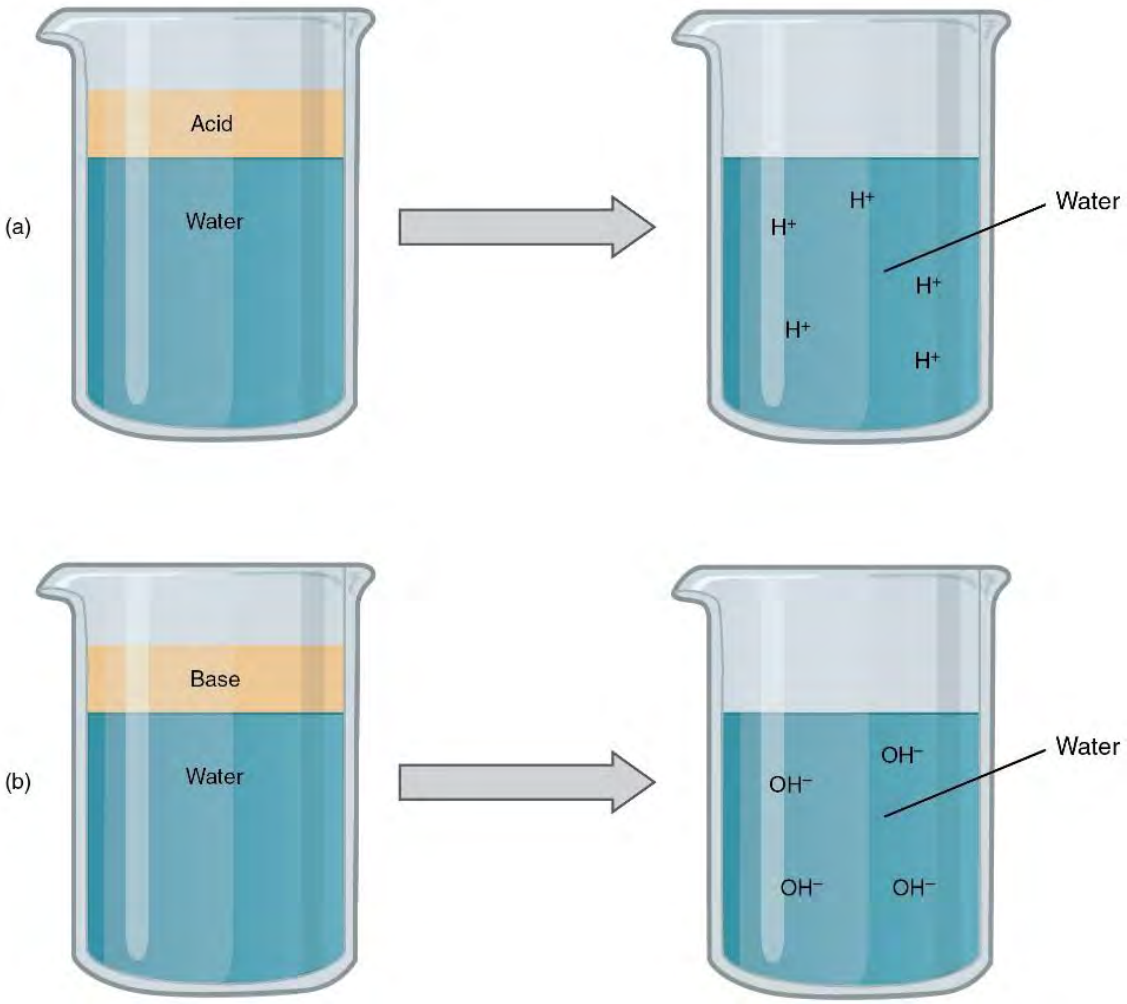

Figure 2.31 Acids and Bases (a) In aqueous solution, an acid dissociates into hydrogen ions (H+) and anions. (b) In aqueous solution, a base dissociates into hydroxyl ions (OH^-) and cations. (credit: Betts et al./Anatomy and Physiology OpenStax)[/caption]

Bases

A base is a substance that releases hydroxide ions (OH^-) in solution, or one that accepts H^+ already present in solution (Figure 2.31b). The hydroxide ions combine with H^+ present to form water molecules, thereby removing H^+ and reducing the solution's acidity. Strong bases release most or all their hydroxide ions; weak bases release only some hydroxide ions or absorb only a few H^+. Food mixed with hydrochloric acid (HCl) from the stomach would burn the cells that make up the small intestine if it were not for the release of bicarbonate (HCO_3^-), a weak base that attracts H^+. Bicarbonate accepts some of the H^+, thereby reducing the acidity of the solution.