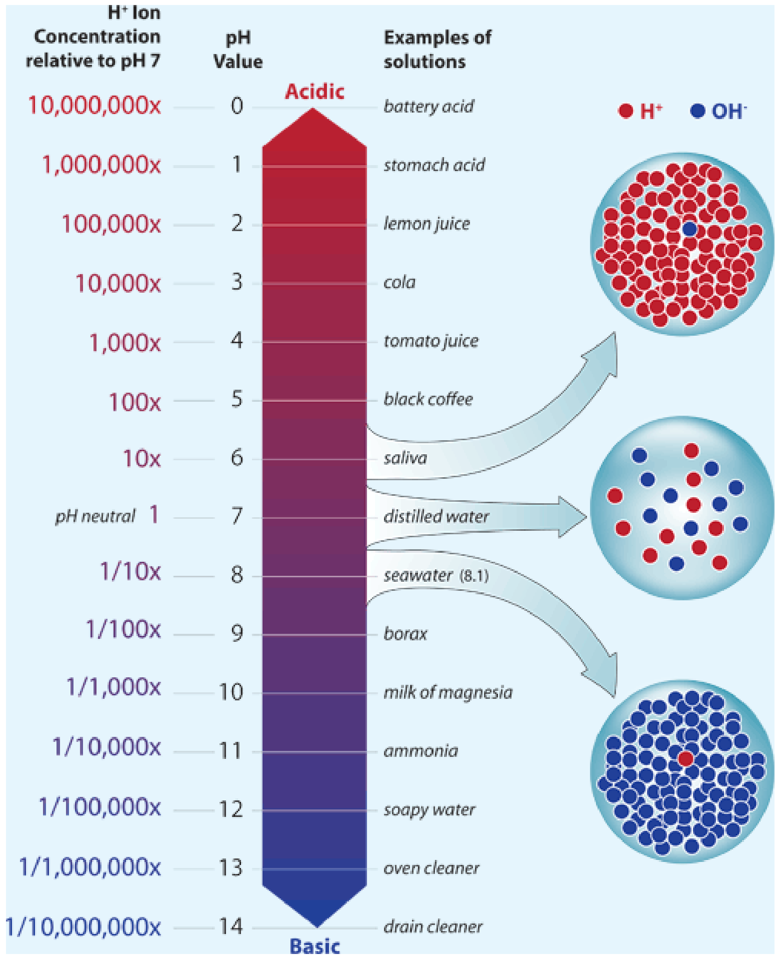
"Buffers and Stomach Acid"

Introduction:

An average adult stomach produces between 2 and 3 Liters of gastric juice daily. Gastric juice is an acidic digestive fluid secreted by the mucous membranes lining the stomach. One of its components is hydrochloric acid (HCl). The pH of gastric juice is 1.5. The pH scale measures how acidic or basic a substance is. An acidic solution has a high concentration of Hydrogen ions (H+) compared to a basic solution that has a high concentration of hydroxide ions (OH-) The pH scale ranges from 0 to 14. A pH of 7 is neutral. A pH less than 7 is acidic. A pH greater than 7 is basic.



The pH scale is logarithmic and as a result, each whole pH value below 7 is ten times more acidic than the next higher value. For example, pH 4 is ten times more acidic than pH 5 and 100 times (10 times 10) more acidic than pH 6. The same holds true for pH values above 7, each of which is ten times more alkaline (another way to say basic) than the next lower whole value. For example, pH 10 is ten times more alkaline than pH 9 and 100 times (10 times 10) more alkaline than pH 8.

The purpose of the acidic stomach contents is to digest food and to activate digestive enzymes. Eating stimulates H^+ secretion. The stomach sheds the mucous lining about every three days. However, if the acid content is excessively high, the H^+ ions move back to the blood and cause muscular contraction, swelling, bleeding, and pain. Ulcers may be another result. This results from the stomach lining breaking down and the acid attacking the stomach wall. One way to temporarily reduce the H^+ in the stomach is to take an antacid. The major function of the antacid is to neutralize excess HCl in gastric juice. Some antacids contain a buffer that maintains the pH of the stomach. Biological buffers can be found in blood and many cells to maintain a stable pH to allow for proper function of proteins and enzymes.

Buffers create a resistance to a change in the pH of a solution when hydrogen ions (protons) or hydroxide ions (OH-) are added or removed. An acid-base buffer typically consists of a **weak acid**, and its **conjugate base**, or substance formed when an acid loses a proton (H+). Buffers work because the concentrations of the weak acid and conjugate base are large compared to the amount of protons or hydroxide ions added or removed. When protons are added to the solution from an external source, some of the base component of the buffer is converted to the weak-acid component (thus using up most of the protons added); when hydroxide ions are added to the solution, protons are dissociated from some of the weak-acid molecules of the buffer, converting them to the base of the buffer (and thus replenishing most of the protons removed). However, the change in acid and base concentrations is small relative to the amounts of these species present in solution. Hence, the **ratio** of acid to base changes only slightly. Thus, the effect on the pH of the solution is small, within certain limitations on the amount of H^+ or OH^- added or removed.

Experimental Question: How does the buffering capacity vary between water, an antacid solution, potato homogenate and liver homogenate?

Hypothesis:

Procedure

1. Pour 25 mL of water into a beaker. Measure the pH (acidity) by dipping a small piece of pH indicator paper in the water with forceps.
2. Test the pH of vinegar by adding a couple drops to piece of indicator paper.
3. Add 30 drops of vinegar to the water measure the pH every 5 drops by dipping the indicator paper into the solution.
4. Discard the solution and rinse thoroughly with tap water.
5. Pour 25 mL of water into a beaker.
6. Dissolve one antacid tablet containing sodium bicarbonate (a biological buffer in our body that maintains a stable pH) into the 25 mL of water.
7. Add 30 drops of vinegar to the solution and measure the pH with the indicator strips every 5 drops.
8. Obtain 25 mL of liver homogenate.
9. Add 30 drops of vinegar to the solution while measuring the pH every 5 drops.
10. Obtain 25 mL of potato homogenate.
11. Add 30 drops of vinegar to the solution while measuring the pH every 5 drops.

Data

Construct a data table and graph to show the buffering capacity of all solutions.

Conclusions

1. Define pH. Give examples of high and low pH levels and interpret the meaning of these values.
2. Explain which solution had the greatest ability to buffer pH changes. Support your response by referring to data from the experiment.
3. Define a buffer and explain how buffer solutions stabilize the pH inside of a solution or cell.
4. Take on the role of a pharmacist to counsel a patient who has ulcers and acid reflux. A patient has acid reflux and ulcers. Recommend foods and drinks to avoid along with explaining why sodium bicarbonate, an active ingredient in antacids, stabilizes acid levels.
5. Describe the role of strong acids in the digestion of proteins within the stomach.
6. Buffers can be found in most cells. Explain the connection between pH buffers and healthy functioning cells that contain hundreds of enzymes to carryout chemical reactions that maintain homeostasis.