Acids, Bases, and Cells

Enzymes are essential to chemical reactions in cells, but they are also sensitive to environmental factors, such as heat. The pH (how acidic or basic something is) of tissues can affect enzymes' activity. Remember from your chemistry, a pH of 7 is neutral. 1-6 is acidic. And 8-14 is basic. Most cells maintain a pH close to neutral.

Biochemical activities of living tissues frequently tend to change the pH. Yet life depends upon maintaining a pH that will not inactivate the enzymes working in that tissue. Can living tissues maintain a certain pH under normal conditions?

Materials:

pH paper or meter
0.1N HCl
0.1N NaOH
Commercial Buffer solution, pH 7
Liver and potato homogenates, 10g per 100 ml of water
50 mL beaker

Procedure:

Pour 25 ml of tap water into a 50 mL beaker. Record its initial pH. The pH paper is expensive and should be used in small pieces. Discard your paper in a can as you use it. Add 0.1N HCl a drop at a time and record the pH after each drop until 10 drops have been added. Thereafter, record the pH after each 5 drops until 10 more drops have been added. Prepare a data table and be sure to record your results after each drop.

Rinse the beaker and pour into it another 25 ml of tap water. Record the initial pH and add 0.1N NaOH drop by drop, recording the pH in exactly the same way as for the 0.1N HCl. After 10 drops, proceed 5 drops at a time until 30 drops have been added (total of 30 drops).

Observations:

1. Make a simple graph, plotting two lines for the change of pH in tap water against the drop of acid and base solutions added. Put pH on the vertical and number of drops on the horizontal. Use the same color pencil for these two lines. At the end of the line write tap water. Be sure to allow spaces on the bottom for the jump from one drop to five drops.

2. Summarize the effects of HCl and NaOH on tap water. Does there seem to be a steady increase or a sudden jump? Is there any correlation between the number of drops and the change in pH?

Procedure:

Now try tissue -- living -- from a living system. Rinse your beaker and pour 25 ml of liver homogenate into it. Record the initial pH. Add 0.1N HCl one drop at a time and record the pH for 10 drops. Thereafter, record the pH after each 5 drops until 30 drops have been added.

Rinse the beaker. Measure out another 25 ml of liver homogenate. Repeat the procedure above except use 0.1N NaOH instead of the acid.

Observations:

3. Graph the results for the liver on the same graph as for the tap water, using a different colored pencil. Label the lines on the graph.

4. What was the total pH change for the 30 drops of acid added to the liver?

5. What was the total pH change for the 30 drops of base added?

6. How do these differ from the tap water?

7. How do account for the difference in the liver and tap water?

Procedure:

Try plant tissues -- potato homogenate -- to see if plant tissues react the same way as animal tissues. Rinse your beaker, pour 25 ml of potato homogenate into it. Record the initial pH. Add drops of HCl as you did before until 30 drops have been reached. Repeat the whole procedure using the NaOH.

Observations:

8. Graph this data on the same graph with the liver and the tap water. Use a different color pencil and label your lines.

9. Does the potato react more like the liver or the tap water?

10. How do you account for this?

Chemists can purchase buffers to control pH during certain lab tests. Rinse your beaker and add 25 ml of the commercial buffer on the front table. Test this with the HCl as you did the water, liver and potato. Repeat the procedure using the NaOH.

11. Add these figures to your graph. Use a different colored pencil and label the lines.

12. Is the action of the buffer more like the tap water or the liver and potato?

13. Do you think that living cells have built in buffers?

14. What do you think would be the advantage of having organic buffers in cells?