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Editorial

pH's influence on microbial growth

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EDITORIAL

A high acid concentration gives yoghurt, pickles, sauerkraut, and lime-seasoned meals their sour flavour. Remember that acidity is a function of hydrogen ion concentration [H+] and is measured in pH. Acidic environments are those with pH values below 7.0, while basic environments have pH values over 7.0. The structure of all macromolecules is affected by extreme pH. At high pH, the hydrogen bonds that hold DNA strands together dissolve. An excessively basic pH hydrolyzes lipids. The proton motive force, which is responsible for ATP generation in cells, is influenced by the H+ concentration gradient across the plasma membrane (see Cellular Respiration). The concentration gradient falls as H+ ions are neutralised by hydroxide ions, reducing energy generation. However, the protein, the cell's workhorse, is the component most sensitive to pH. Moderate pH variations alter the ionisation of amino-acid functional groups and disrupt hydrogen bonding, causing alterations in molecular folding, promoting denaturation and eliminating activity.

The most suitable pH for an organism's growth is the optimum growth pH. The minimum growth pH is the lowest that an organism can tolerate, while the maximum growth pH is the greatest. These values can span a large range, which is critical for food preservation and the survival of bacteria in the stomach. *Salmonella spp*., for example, have an optimum growth pH of 7.0–7.5, but a minimal growth pH of 7.0–7.5.

Most bacteria are neutrophiles, which means they grow best when the pH is within one or two pH units of 7. Most common bacteria, such as *E. coli, staphylococci,* and *Salmonella* spp., are neutrophils that do not thrive in the stomach's acidic pH. Pathogenic strains of *E. coli, S. typhi*, and other intestinal pathogens, on the other hand, are far more resistant to stomach acid. Fungi, on the other hand, like somewhat acidic pH values of 5.0–6.0.

Acidophiles are microorganisms that thrive at a pH of less than 5.55. The sulfur-oxidizing *Sulfolobus sp*p. found in Yellowstone National Park's sulphur mud fields and hot springs, for example, are extreme acidophiles. At pH levels of 2.5–3.5, these archaea can survive. Ferroplasma species exist in acid mine drainage with pH values ranging from 0 to 2.9. *Lactobacillus* bacteria, which are an important element of the normal vaginal microbiota, can endure acidic surroundings with pH values of 3.5–6.8 and, by their metabolic production of lactic acid, contribute to the acidity of the vagina (pH of 4 unless at the commencement of menstruation). The acidity of the vaginal environment has a key function in suppressing other microorganisms that are less acid resistant. Acidophilic microbes have a variety of adaptations that allow them to thrive in harsh acidic conditions. Proteins, for example, have a negative surface charge that stabilises them at low pH. H+ ions are actively ejected from cells by pumps. The alterations in membrane phospholipid composition are most likely due to the necessity to maintain membrane mobility at low pH.

At the other end of the spectrum are alkaliphiles, microorganisms that grow best at pH between 8.0 and 10.5. Vibrio cholerae, the pathogenic agent of cholera, grows best at the slightly basic pH of 8.0; it can survive pH values of 11.0 but is inactivated by the acid of the stomach. When it comes to survival at high pH, the bright pink archaean Natronobacterium, found in the soda lakes of the African Rift Valley, may hold the record at a pH of 10.5. Extreme alkaliphiles have adapted to their harsh environment through evolutionary modification of lipid and protein structure and compensatory mechanisms to maintain the proton motive force in an alkaline environment. For example, the alkaliphile Bacillus firmus derives the energy for transport reactions and motility from a Na+ ion gradient rather than a proton motive force. Many enzymes from alkaliphiles have a higher isoelectric point, due to an increase in the number of basic amino acids, than homologous enzymes from neutrophiles.

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