

## The pH value in the human body

Manufacturers of body care products advertise that their products have a pH value that is “gentle on the skin,” while nutrition experts recommend an “alkaline diet” and warn that stress and environmental pollution can “acidify” the body in the truest sense of the word.

Suddenly in everyday life, we’re confronted with some key terms from chemistry class: acids, bases, pH value. What lies behind these terms?

### Acids and bases

Acids are substances that give up protons ( $\text{H}^+$  ions), while bases absorb protons. (For comparison: The basic processes of redox reactions are based on the absorption and release of electrons.)

If you mix an acid and a base, the base can fully absorb the acid’s protons. This process is called neutralization.

In an aqueous solution, the protons given up by an acid are bound by water molecules (water molecules are dipoles). The reaction results in oxonium ions (more specifically: hydronium ions,  $\text{H}_3\text{O}^+$ ). Conversely, in aqueous solutions bases can absorb protons from water molecules, resulting in the formation of hydroxide ions ( $\text{OH}^-$ ).

The pH value is used in chemistry to classify substances with respect to their ability to give up or absorb protons.

### Definition of pH value

The abbreviation “pH” stands for “potentia hydrogenii” (Latin for power of hydrogen). The pH value is a measure of the concentration of oxonium ions or protons in an aqueous solution. The concentration for pure water at 22°C is  $10^{-7}$  mol/l;  $10^{-7}$  is one tenth of a millionth. To eliminate the need for people to work with such small numbers in practice, the pH value is defined as the negative decimal logarithm of the oxonium ion or proton concentration (c):

$$\text{pH} = -\log (c[\text{H}_3\text{O}^+]) = -\log (c[\text{H}^+])$$

Pure water thus has a pH value of 7 and is neutral. The more oxonium ions or protons there are in a solution, the lower the pH value is. Acidic solutions have a pH value of 0 to 7, basic solutions of 7 to 14.

You can detect acids and bases in solution very easily using color indicators. For example, if you add blue litmus to an acidic solution high in oxonium ions or protons, the color will turn to red. Phenolphthalein, a colorless compound, is suitable as a color indicator for basic solutions, in which it turns purple. (The color changes as molecules are modified due to proton transfers.) In practice, we use pH test strips with a combination of several pH-sensitive dyes so that we can measure a large continuous range of pH values. For really precise measurements, though, we must use electronic pH meters with a pH measuring electrode.

## The pH value in the human body

Knowledge of the acid-base reaction is a prerequisite for being able to understand the chemical processes in body cells and fluids, e.g., in breathing and digestion.

A pH value that makes it possible for internal organs to function in the body is in the slightly basic range, at about 7.4 in the blood. The body also has areas where the environment is more acidic,

e.g., in the stomach (pH 1 to 2) or on the skin (pH 5.5). Hyperacidity throughout the entire body (pH < 6.8) or a value that is too alkaline (pH > 7.8) can lead to death.

The body thus constantly tries to maintain its ideal pH value. To do so, the blood has various buffer systems that neutralize excess acids with basic substances. However, excess acids are also eliminated, for example, by being filtered out via the kidneys and excreted as part of urine.

Note: The pH value in the human body can be measured in urine or on the skin, for example.

However, the values measured vary fairly significantly. Factors that influence the values include the time of day, food or drink consumed (for measurement in the urine), and the effect of soap (for measurement on the skin).

### **The pH value of skin**

The skin has a protective acid mantle. This mantle is an acidic film consisting of water and oils that protects the skin from drying out and from pathogens. The pH value of healthy skin is about 5.5 in most regions of the body. This protective acid mantle can be destroyed through excessive use of soap, which has a pH value of 9 to 10. However, if you use cleansers with pH values gentle on the skin and possibly containing moisturizing additives, there is no risk to the protective acid mantle.

### **The pH value in nutrition**

People in industrialized societies tend to eat a very acidic diet including, for example, sweets and carbonated beverages like cola or other soft drinks. Practitioners of alternative medicine therefore recommend an “alkaline diet,” which consists primarily of so-called alkaline foods (most kinds of fruits and vegetables). Other foods such as meat, coffee, and nuts are categorized as acidogenic and harmful, and should therefore be consumed only in small amounts. However, if you eat a reasonably balanced diet, all acidic or alkaline foods and all acidogenic or alkalogenic foods in the body are broken down and neutralized or excreted. Therefore, there is no reason for you to worry about hyperacidity. This is probably also the reason why the therapeutic effect of a primarily alkaline diet has not yet been proven scientifically.