

RESEARCH ON ACID-BASE BALANCE: MERCK CORPORATION

The Merck Manual- Second Edition Chapter 159

Acid-Base Balance

An important property of blood is its degree of acidity or alkalinity. Body acidity increases when the level of acidic compounds in the body rises (through increased intake or production, or decreased elimination) or when the level of basic (alkaline) compounds in the body falls (through decreased intake or production, or increased elimination). Body alkalinity increases with the reverse of these processes. The body's balance between acidity and alkalinity is referred to as acid-base balance.

The blood's acid-base balance is precisely controlled, because even a minor deviation from the normal range can severely affect many organs. The body uses different mechanisms to control the blood's acid-base balance.

One mechanism the body uses to control blood pH involves the release of carbon dioxide from the lungs. Carbon dioxide, which is mildly acidic, is a waste product of the metabolism of oxygen (which all cells need) and, as such, is constantly produced by cells. As with all waste products, carbon dioxide gets excreted into the blood. The blood carries carbon dioxide to the lungs, where it is exhaled. As carbon dioxide accumulates in the blood, the pH of the blood decreases. The brain regulates the amount of carbon dioxide that is exhaled by controlling the speed and depth of breathing. The amount of carbon dioxide exhaled, and consequently the pH of the blood, increases as breathing becomes faster and deeper. By adjusting the speed and depth of breathing, the brain and lungs are able to regulate the blood pH minute by minute.

The kidneys are also able to affect blood pH by excreting excess acids or bases. The kidneys have some ability to alter the amount of acid or base that is excreted, but because the kidneys make these adjustments more slowly than the lungs do, this compensation generally takes several days.

Yet another mechanism for controlling blood pH involves the use of buffer systems, which guard against sudden shifts in acidity and alkalinity. The pH buffer systems are combinations of a weak acid and weak base that exist in balance under normal pH conditions. The pH buffer systems work chemically to minimize changes in the pH of a solution by adjusting the proportion of acid and base. The most important pH buffer system in the blood involves carbonic acid (a weak acid formed from the carbon dioxide dissolved in blood) and bicarbonate ions (the corresponding weak base).

Acidosis and alkalosis are the two abnormalities of acid-base balance. In acidosis, the blood has too much acid (or too little base), resulting in a decrease in blood pH. In alkalosis, the blood has too much base (or too little acid), resulting in an increase in blood pH. Acidosis and alkalosis

are not diseases, but rather are the result of a wide variety of disorders. The presence of acidosis or alkalosis provides an important clue to doctors that a serious problem exists.

Acidosis and alkalosis are categorized as metabolic or respiratory, depending on their primary cause. Metabolic acidosis and metabolic alkalosis are caused by an imbalance in the production of acids or bases and their excretion by the kidneys. Respiratory acidosis and respiratory alkalosis are caused primarily by lung or breathing disorders.

What Is the Blood pH?

Acidity and alkalinity are expressed on the pH scale, which ranges from 0 (strongly acidic) to 14 (strongly basic, or alkaline). A pH of 7.0, in the middle of this scale, is neutral. Blood is normally slightly basic, with a pH range of 7.35 to 7.45. To function properly, the body maintains the pH of blood close to 7.4.