



7. Magnesium Bicarbonate

Magnesium bicarbonate is a complex hydrated salt that exists only in water under specific conditions. It does not occur in a solid form. Water containing magnesium bicarbonate is considered to be appropriately mineralised. Indeed, medical research from many countries has demonstrated that people live longer when they drink water that is appropriately mineralised. When consumed, magnesium bicarbonate rapidly enters body cells. This occurs because magnesium is an intracellular element and magnesium functions as a bicarbonate co-transporter into cells:



Magnesium bicarbonate in water

When magnesium bicarbonate enters body cells, the concentrations of bicarbonate ions inside body cells are increased. The bicarbonate derived from magnesium bicarbonate produces hydroxide ions (OH^-) inside body cells which neutralise the acid (H^+) from carbon dioxide concentrations, ATP hydrolysis and other sources. This occurs via a series of sequential and simultaneous reactions:

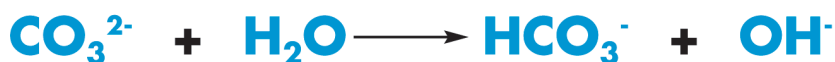
- i. Magnesium bicarbonate enters body cells and dissociates to increase bicarbonate ion concentrations inside body cells.



- ii. The principal acid-base reaction involving bicarbonate ions produces carbonate (CO_3^{2-}) ions.



- iii. Some carbonate ions react with water to produce hydroxide ions and more bicarbonate ions.



- iv. Hydroxide ions neutralise the acid produced from carbon dioxide concentrations and ATP hydrolysis (and neutralise acid derived from other sources) to form water.





Note: The carbon dioxide molecules (CO_2) produced in reaction (ii) above only produce one acid group (H^+) in five hundred molecules whereas the carbonate groups (CO_3^{2-}) produced in reaction (ii) above produce many more hydroxide ions. Hence, there is a net production of hydroxide ions relative to acid in body cells (by a factor of about one hundred) despite the presence of carbon dioxide.

In addition to the above reactions, some hydroxide ions react with carbon dioxide directly to produce bicarbonate ions without acid:



This direct reaction of hydroxide ions with carbon dioxide is considered to occur also at the active site of an intracellular enzyme called carbonic anhydrase. This direct reaction is very important in slowing of the ageing process.

In the body, the intracellular enzyme carbonic anhydrase is the enzyme that greatly accelerates the production of acid (strictly, protons) from carbon dioxide and water:



Carbonic anhydrase enzyme

Carbonic anhydrase enzyme is ubiquitous in body cells and constitutes up to ten percent of the soluble protein in most body cells. It is one of the fastest enzymes known: each carbonic anhydrase enzyme produces from ten thousand to one million acid groups (H^+) per second.

The acid (H^+) produced by carbonic anhydrase enzyme is pumped by proton pump enzymes into cell organelles such as lysosomes, phagosomes, endosomes and ruffled membranes. In the presence of magnesium bicarbonate, less acid is produced by carbonic anhydrase enzyme. This occurs because magnesium bicarbonate increases the concentrations of bicarbonate ions inside body cells. Bicarbonate ion concentrations decrease the formation of acid by carbonic anhydrase enzyme (Le Chatelier's principle) and also produce hydroxide ions as described above. Hydroxide ions react with carbon dioxide directly at the active site of the carbonic anhydrase enzyme to form bicarbonate ions without acid:



Carbonic anhydrase enzyme



Irrespective of the kinetic mechanism, in the presence of magnesium bicarbonate less acid (fewer protons) is produced in the carbonic anhydrase enzyme reaction. As a consequence, less acid (fewer protons) is pumped into lysosomes and ruffled membranes by proton pump enzymes.

It is to be emphasised that magnesium bicarbonate assists in the maintenance of cell homeostasis. As stated previously, intracellular homeostasis is very dependent on the "here and now": it is very dependent on the immediate maintenance of ideal biochemical conditions. Because magnesium bicarbonate decreases the production of acid from carbon dioxide in body cells, when magnesium bicarbonate is present in body cells then the time dependency for carbon dioxide elimination from the lungs and the time-dependency for acid elimination by the kidneys do not operate as adversely on the homeostasis of body cells. Ageing is greatly delayed.

Magnesium bicarbonate increases considerably the energy production in body cells. This energy increase occurs in several ways. First, magnesium bicarbonate protects the natural organic and inorganic phosphate buffers in the cytoplasm of cells. This is important, particularly in muscle cells and brain cells (neurons). Second, magnesium bicarbonate neutralises the acid produced as a result of metabolic processes and ATP hydrolysis. This allows more ATP to be hydrolysed; that is, more energy can be utilised. Third, magnesium bicarbonate buffers the mitochondria in body cells from excess acid concentrations which improves mitochondrial function and allows more ATP to be produced. When more ATP can be hydrolysed and more ATP can be produced, body cells have sufficient energy for optimum function. When body cells have optimum function, the energy levels and the physical performance of the body are enhanced. See Appendix for details of magnesium bicarbonate and mitochondrial function.

During strenuous types of exercise, muscle metabolism can increase to sixty times normal. This increase is higher than the corresponding increase in blood flow which increases to twenty times normal. As a result, carbon dioxide concentrations increase greatly in muscle cells and tissues during strenuous exercise and add to the acid load in the muscles. Normally, muscle cells contain concentrations of organic and inorganic phosphates that are able to buffer the acid load in exercising muscles. Indeed, there are about twenty times the concentrations of phosphates inside cells than there are outside cells. However, during strenuous exercise the phosphate buffers are overwhelmed and the muscles become acidic. Muscle acidity results in poor performance and fatigue.

When strenuous physical activities are undertaken, the consumption of magnesium bicarbonate protects the natural organic and inorganic phosphate buffers inside muscle cells. This minimises fatigue caused by acidity. Energy and physical performance are enhanced. In addition, magnesium



bicarbonate neutralises the acidity produced from the high calorie intake needed for strenuous physical activity such as competitive sport.

It should be noted that magnesium ions are coupled with ATP in biochemical reactions involving ATP in body cells. In addition, magnesium ions are required as cofactors in many enzymes involved in the metabolism of food to energy. Therefore, adequate magnesium ion concentrations per se in body cells are crucial for proper cell energy production and utilisation. Magnesium bicarbonate in water is the ideal product to supply magnesium ions to body cells.

All experiments with mammals have shown that the consumption of magnesium bicarbonate increases life span (strictly, life expectation). In sheep, cattle and horses life span is increased by about thirty percent. An increase in life span of thirty percent is similar to the increase in life span achieved in mammals by calorie restriction; that is, an increase in life span due to low carbon dioxide concentrations in body cells. In humans, data available from many government and institutional surveys on death rates show that people who consume hard water containing carbonate and bicarbonate ions live longer.