



ELETE
1990 West 3300 South
Ogden, UT 84401

Phone (800) 669-1297
(801) 731-7040

Fax (801) 731-7985

Mailing Address:
P.O. Box 190
Roy, UT 84067

ELETE

Technical Product Information

Electrolytes and Human Health

Every living being is composed of cells. To sustain life, each cell depends upon a steady, adequate intake of two elements: water and nutrients, especially electrolytes. Electrolytes refer to essential minerals critical to health in a number of ways. Acting independently and cohesively, each these minerals called electrolytes – specifically magnesium, calcium, chloride, sodium and potassium – work with water in maintaining fluid and electrolyte homeostasis, in generating and conducting electrical impulses across cell membranes, in nerve transmission, muscle function and cognition. Our body fluids, i.e., blood, cerebrospinal fluid, perspiration etc., are, in fact, a combination of water and dilute solutions of electrolytes. Any imbalance or inadequacy of these elements can result in impaired or slowed muscle function, nerve transmission, cognition and, in severe cases, death.

ELETE offers two electrolyte formulas that are balanced dietary supplements that replace valuable electrolytes commonly deficient in today's diet. The electrolyte formulas include: *ELETE Electrolyte Add-In*, a concentrated, liquid electrolyte solution, and *Tablytes*, a tableted electrolyte replacement formula.

In addition, these formulations are designed to replenish minerals lost in nutritionally significant amounts in sweat¹ including: magnesium, critical for energy production and cardiovascular function; chloride, necessary for body-water and acid-base balance²; potassium and calcium, necessary for muscle contraction and impulse conduction in the nerves.³ ELETE's electrolyte formulations also capture the perfect balance of micronutrients including boron, zinc and selenium, which are important elements found as part of enzymes or required in many enzymatic functions.³

An important, abiding factor in ensuring an optimal level of electrolytes and trace minerals is the bioavailability of the minerals themselves. The minerals and trace minerals in the electrolyte pre-mix formula are contained in ionic form, which translates to improved absorption and assimilation. Ionic elements are designed to easily dissociate in liquid and move to a positive or negative charge. This ionic form is simply a superior, or more bioavailable form, as the macro and micronutrients are already contained in a form that the body utilizes.

Electrolytes and Their Function Within the Body

Simply defined, electrolytes are certain minerals that, in solution, break apart and become electrolyzed³ (hence the term). In other words, these elements are capable of conducting an electrical current.⁴

In solution, electrolytes, or ions, that separate and carry a positive charge are referred to as cations; ions that carry a negative charge are referred to as anions. Examples of positively-charged ions include: sodium (Na^+), potassium (K^+), calcium (Ca^{2+}) and magnesium (Mg^{2+}). Negatively-charged ions include: chloride (Cl^-), bicarbonate (HCO_3^-), phosphate (PO_4^{3-}) and sulfate (SO_4^{2-}).⁴

Electrolytes, in fact, form the very basis of our being. Within the body, electrolytes are found in both the intracellular and extracellular fluid. Intracellular fluid is the fluid found inside the cells of the body⁵, extracellular fluid, the fluid found outside of the cells and which includes: interstitial fluid (fluid occupying the extracellular space outside blood vessels), plasma (extracellular fluid found within the blood vessels), lymph, cerebrospinal and synovial fluid.

Both intracellular and extracellular fluid contain dilute solutions of electrolyte minerals that cells rely on to perform a number of functions. The primary electrolytes found in plasma, for instance, are sodium, then chloride followed by smaller concentrations of bicarbonate, protein, potassium, calcium, phosphate and magnesium.⁵ Cells (including nerve, heart and muscle cells) utilize electrolytes to carry electrical impulses across cell membranes to other cells and to regulate the activity of the nervous system and of the muscles, including the heart.

The kidneys constantly regulate fluid absorption and secretion in addition to continually calibrating electrolyte levels within the body: they will filter electrolytes such as sodium and potassium, for instance, and either use them according to the body's need at that moment or will excrete them via the urine or feces if there is an excess of that element at that particular moment.

Factors Affecting Electrolyte Balance

Every second of every day, our bodies rely on electrolytes just to support normal physiological functions, and, as a result, we experience small, daily losses of electrolytes. For instance, the average loss of fluids and electrolytes through perspiration can total 600 milliliters (ml). In respiration, this amount is 400 ml; in feces, 200 ml and in urination, 1300 ml.²

Other factors such as pregnancy, poor diet, dehydration, use of diuretics, disease, exertion, vomiting, diarrhea, trauma and excessive perspiration significantly increase one's need for electrolytes.

To ascertain the degree of electrolyte loss occurring as a result of strenuous physical activity, Mao et al measured electrolyte loss from thirteen soccer-team players and 100 sedentary students from the same high school for a period of eight days. Mean electrolyte losses gathered from sweat and urine samples following a one-hour game measured: sodium, 1,896 milligrams (mg); potassium, 248 mg; and calcium, 20 mg.⁶ These results demonstrate that the loss of electrolytes through excessive perspiration is

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significant and, over time (with the exception of sodium, levels of which are luxuriantly provided within the American diet), these losses can have a negative impact.

Prominent signs of an electrolyte imbalance include: muscular weakness, slowed nerve conduction and muscle function, general weakness and apathy.

Diet As An Unreliable Source of Electrolytes:

The importance of electrolyte replacement formulas stem from the fact that unfortunately, modern diets are no longer a reliable source for the replenishment of valuable electrolytes. Large-scale dietary surveys consistently corroborate the fact that with the exception of sodium, many important minerals including magnesium, calcium, chloride, potassium and important trace elements are not replaced.

In the case of magnesium, for instance, a survey conducted by Gallup revealed that 72 percent of adult Americans are falling short of the Recommended Dietary Allowance (RDA). The survey further revealed that 55 percent of all adults are consuming three-quarters or less of the RDA, while 30 percent are eating less than half the required amount of the mineral.⁷ Several studies have also supported this finding in self-selected diets in Europe and Asia as well.⁸ There are several factors that account for this suboptimal intake including the use of synthetic fertilizers that only replace two or three minerals (primarily nitrogen and phosphate) rather than a comprehensive balance of minerals; the use of synthetic pesticides; food refining techniques that strip minerals, vitamins and nutrients from foods (e.g., heat processing, grinding, removal of nutritionally dense components); use of artificial colors, flavors, preservatives and municipal water supplies that are soft, i.e., poor in magnesium, calcium, etc. Another factor accounting for this suboptimal intake is the presence of certain metabolic conditions in individuals such as hypertension, pregnancy, osteoporosis, stress and trauma that also increase one's requirements for specific elements.⁹

Therefore, based on how micronutrients affect fluid balance, muscle contraction and nerve conduction, supplementation of ionic electrolytes—magnesium, calcium, chloride, potassium and some sodium—as is found in ELETE's line of dietary supplement may be warranted.

Magnesium

An essential mineral, magnesium(Mg) is the fourth most abundant cation in the body and is an intracellular ion.¹⁰ Nearly half the Mg found in the body is contained within the bone.¹¹

Mg is an element needed to activate enzymes that are important for protein, electrolyte and carbohydrate metabolism, in DNA production and function and in the utilization of other essential minerals including calcium.⁸ Mg modulates the electrical potential across cell membranes, which allows nutrients to pass back and forth. It helps in the production of energy by transferring the key phosphate molecule to adenosine triphosphate (ATP), a high energy source generated by the cytochrome system¹¹, in muscle contraction and relaxation, in nerve conduction, in protein synthesis, and in many biochemical reactions as a cofactor to enzymes.⁸

Mg is important in maintaining resistance to infection, in protecting against cardiovascular, kidney and bone disease and in assisting in meeting additional needs as a result of emotional and/or physical stress.⁸ There are over 200 published clinical studies showing the need for Mg.¹² These studies have shown Mg to be helpful in migraines, high blood pressure, asthma, angina pectoris, coronary artery disease, cardiac arrhythmias, certain types of musculoskeletal disorders, epilepsy, chronic fatigue syndrome, mitral valve prolapse, anxiety, panic disorder, pre-menstrual syndrome, pre-eclampsia as well as many other medical and psychiatric conditions.¹²

Several studies have been conducted examining the effect of Mg supplementation on muscular work performance.¹³ Studies have demonstrated a sustained fall in Mg plasma concentration following strenuous physical exercise.¹³ Whereas decreased endurance capacity has been observed in animals fed Mg deficient diets, Mg repletion has been shown to have a significant effect in athletic performance.¹³ In moderately-trained athletes, Mg supplementation resulted in a significant decrease in blood pressure, heart rate and oxygen consumption indicating that Mg supplementation effectuates an improvement in cardiorespiratory performance.¹³ Another study found that triathletes taking 390 mg of Mg per day demonstrated reduced swimming, cycling and running times.¹⁴ It has been hypothesized that this effect is due to Mg increasing glycogen synthesis or sparing glycogen in muscle, thereby conserving energy more efficiently.¹⁵

Inadequate Mg status (both with and without symptoms) has been associated with several symptoms including gastrointestinal tract abnormalities associated with malabsorption or excessive fluid and electrolyte losses and renal dysfunction with defects in cation reabsorption.¹⁶ Other symptoms of inadequate Mg status include: nausea, muscle weakness, constipation, urinary spasms, menstrual cramps, sensitivity to loud noise, anxiety, insomnia, premenstrual irritability, heart palpitations, arrhythmias, angina due to spasms of the coronary arteries, high blood pressure and mitral valve prolapse.^{12,16} Because certain minerals and trace minerals work in a cohesive fashion (i.e., certain elements increase the efficacy of others), a deficiency in Mg, according to Whang, can also lead to a disruption in the reuptake of potassium once dehydration has occurred¹⁷ – an effect that can have very negative health implications (i.e., cardiac function, acid-base and body-water balance) and as it relates to athletic performance (i.e., energy, endurance, muscle performance).

Many commercially available sports drinks do not contain Mg, thereby making the common purpose of these sports drink products, which is rehydration, completely obsolete.¹⁷ ELETE's line of electrolyte formulations are designed to replenish the body's concentration of Mg plus other macro and micro minerals in a highly available and assimilable form. This formulation provides Mg in sufficient levels to assist individuals in meeting the recommended daily allowance (RDA) for Mg (280 mg/day for women, 350 mg/day for men).

Chloride

Chloride (Cl) is a naturally-occurring element found abundantly in nature.¹⁸ Within the body, though, it is an inorganic ion that is contained in extracellular fluid along with sodium.¹⁹ Cl makes up about .15 percent of our body weight¹⁹ and is mainly found in the extracellular fluid along with sodium.²⁰ It occurs in plasma in concentrations of 96 to 106 mEq/liter (1mEq of chloride is 35.5 mg).¹⁶ The highest amount of Cl can be found within

the red blood cells and, in a more concentrated form, in cerebrospinal fluid and gastrointestinal secretions.¹⁸

As one scientist observed many years ago, our cells contain the same elements and concentration of elements nearly identical to those found in early Precambrian seas.¹⁸ Science clearly demonstrates that early life forms developed their structure and catalytic abilities using minerals and trace minerals found in these ancient seas.²¹ In his paper, "Evolutionary Events Culminating In Specific Minerals Becoming Essential for Life," Nielsen states, "The mineral elements incorporated in the first primitive organisms, therefore, most likely reflected the mineral element concentrations in the sea water where they evolved."²¹ The average concentration of Cl contained in sea water is 18.98%¹⁸. This recalls the earlier fact that Cl is the most abundant anion found in plasma⁵ and that concentrations of this element is closely regulated by the kidneys.

According to the National Academies of Science, Cl "is essential in maintaining fluid and electrolyte balance."¹⁶ It is involved in body water balance and acid-base balance.² Cl is intricately involved in the exchange of oxygen and carbon dioxide within the red blood cells. Referred to as the chloride shift, when red blood cells are properly oxygenated, Cl will circulate from the red blood cells to the plasma where bicarbonate will leave the plasma and shift to the red blood cells.² This shift is essential in maintaining homeostasis or equilibrium within the body.² Cl also helps generate the osmotic pressure of body fluids²⁰ and works with the other electrolytes in maintaining nerve transmission and normal muscle contraction and relaxation; in stimulating the liver to act as a filter, separating waste and then eliminating it from the body; in assisting in bone and joint support and in distributing hormones.¹⁹

Cl is also critical for digestion. It combines with the hydrogen ion in the stomach to form hydrochloric acid (HCl), or gastric juice.² As we age, our bodies can secrete less HCl which can impair the absorption and assimilation of many of the nutrients such as magnesium and calcium. Supplementary forms of Cl, though, can stimulate the production of HCl, necessary for the absorption and assimilation of minerals and nutrients found in the foods we eat and the supplements we consume.

Cl is easily absorbed in the small intestine and is excreted via the urine and in perspiration.¹⁹ Cl loss mirrors that of sodium loss, therefore, conditions that deplete Cl include: chronic diarrhea and/or vomiting, excessive perspiration, trauma and renal disease¹⁶. Symptoms of a Cl deficit include: hair and tooth loss, poor muscular contraction and impaired digestion.¹⁹ In the case of a severe Cl deficiency, hypochloremic metabolic alkalosis can result, which is the state of the body fluids becoming too alkaline, characterized by nerve and muscle hyperexcitability and slow and shallow breathing.² A potassium deficiency will also occur in conjunction with Cl loss.²

Calcium

Calcium (Ca) is an essential nutrient that is primarily stored in the bone (approximately 99 percent).¹¹ The lion's share of attention this mineral receives is in conjunction with its role in bone density, which is, in fact, the major function of Ca. It, together with phosphorous and other minerals and trace minerals, helps to build and maintain bone.²² However, Ca also serves in several important intracellular functions as well.

Less than one percent of the body's Ca is contained in extracellular fluid and this minute concentration is carefully regulated by calcitonin and parathyroid hormone.² Ca is present in three different forms in the body: ionized, bound and complexed.² Nearly half of the plasma Ca is free, ionized Ca. Slightly less than half the plasma Ca is bound to protein, primarily albumin, and the remaining percentage is combined with other elements such as phosphate, citrate and carbonate.² Only the ionized Ca is physiologically important. For the body to utilize Ca to perform its physiologic functions, the Ca must be in its free, ionized form.² The Ca and other elements in this product, as well as other ELETE products, are contained in ionic form, thus resulting in improved absorption and assimilation.

Maintaining Ca homeostasis is essential to life. Levels of intracellular Ca will be maintained at the expense of bone Ca. If there is not enough dietary calcium to support Ca blood levels, the parathyroid gland will release parathyroid hormone, which will increase the intestinal absorption of Ca and leach Ca and phosphorous from the bones. So, although the majority of Ca is contained in the bones, blood and cellular concentrations of this mineral are maintained first.²³

Among Ca's intracellular functions are: protein and fat digestion, energy production, normal nerve conduction and muscle contraction and membrane permeability.^{11,16} Ca is keenly involved in the contraction of heart muscle² and it affects the absorption of other nutrients including B-12¹¹ and iron.¹⁹ It also plays an important role in blood clotting process by converting prothrombin into thrombin.² Ca also wards off an accumulation of excess acid or alkali in the blood.¹⁹ It is also involved in the activation of several enzymes including lipase, which breaks down fats for utilization by the body and exerts a sedative effect on nerve cells.²

As we age, the ability to absorb and assimilate Ca decreases. During infancy and childhood, up to 75 percent of the Ca ingested may be absorbed, whereas an adult might use only 20-40 percent of dietary calcium in his or her body.¹⁶ According to the National Academies of Science, the average adult excretes 100 to 250 mg/day of Ca through urine, however, this amount can vary among persons eating self-selected diets.¹⁶ Gastric hydrochloric acid assists in Ca absorption as the duodenum is the site for absorption of calcium(see *Cl*).²⁰

Prominent signs of Ca deficiency include: brittle nails, aching joints, elevated blood cholesterol, heart palpitations, insomnia, muscle cramps, nervousness, rickets, tooth decay, rheumatoid arthritis, cognitive impairment, depression and in severe cases, convulsions and delusions.¹⁹

Considering Mao et al's earlier findings measuring Ca losses that occurred through strenuous activity,⁶ it is important to note that ELETE's electrolyte formulations (see above) provide small amounts of Ca, in its ionic form, to assist and support the body in numerous skeletal and extrasketal functions. However, the amounts of Ca vary from product to product. Please refer to the product's label for the exact amount of calcium.

Potassium

Potassium (K) is the primary cation found within the cells. Ninety-seven percent is found in the intracellular fluid and 2 to 3 percent is found in the extracellular fluid (e.g., intravascular and interstitial fluids).² The normal concentration of K in cell water is 145 mEq/liter (1 mEq of K is 39 mg)¹⁶ while the normal serum K range is 3.5 to 5.3 mEq/L.² This range is carefully regulated by the kidneys.

Within the body, K regulates fluid balance within the cells, contributes to nerve impulse transmission, skeletal and smooth muscle contraction and the maintenance of normal blood pressure.^{11,16} Research has demonstrated that a low potassium intake, which is quite common in the United States, tends to elevate blood pressure.²⁴ In conjunction with sodium, K regulates water balance and acid-base balance within the blood and tissues.²⁴ It is able to enter the cells more easily than sodium and will instigate the brief sodium-K exchange across the cell membrane.²⁴ During muscle contraction, sodium and K are exchanged.¹¹ K is also very important for contraction of the myocardium.¹⁶ Too little K changes the conduction rate of the nerve impulses and can weaken heart muscle, thereby causing it to beat irregularly.² It is a catalyst for protein and carbohydrate metabolism,¹¹ is involved in cellular energy production, deposits glycogen (the body's main fuel source) in liver cells, regulates the osmolality of intracellular fluids and is also important for normal growth and to build muscle.^{16,24}

Studies have demonstrated that K reduces mean systolic blood pressure. Diets high in K correspond with a decreased risk in stroke mortality. It also been reported that K reduces vascular and plasma lipids and can be of benefit in the protection against cardiovascular disease.²⁵

In muscle performance, contracting skeletal muscle cells release K. Ongoing muscular contraction, followed by an accompanying release of K can lead to muscular fatigue.²⁶ Diuretic drugs, illness (e.g., vomiting, diarrhea) and abuse of laxatives can further exacerbate a K imbalance in certain individuals. Supplemental amounts of K, however, may alleviate weakness and fatigue in elderly persons or persons following weight-loss programs.²⁴ Repletion of this mineral may also be required after an individual has experienced heavy fluid losses, such as in perspiration, for example. During perspiration, as water, sodium and other electrolytes are lost from the body, the ultimate damage, reports Schauss, results when K moves out of the cells with cell water.¹¹

The minimum requirement for K as set by the National Academies of Science is 1,600 to 2,000 mg (40 to 50 mEq) per day.¹⁶

Sodium

Sodium (Na) is the primary cation found in extracellular or intravascular fluid and is the main regulator of extracellular fluid volume.¹⁶ In addition to this, Na maintains acid-base balance, regulates the osmolality of vascular fluids and maintains the membrane potential of cells.¹⁶ The normal concentration of sodium in the extracellular fluid is 135 to 146 mEq/L; in perspiration, it is 50 to 100 mEq.²

The shifting of Na and K across cell membranes helps to create an electrical potential that enables the muscles to contract and nerve impulses to be transmitted: Na shifts into cells as K is shifted out in order to maintain water balance and neuromuscular activity.²

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Another important function of Na is that it influences the solubility of the other blood minerals, thus preventing a build-up of certain deposits within the bloodstream.¹⁹

Some Na is stored in the bones and is made available as it is needed. Na can be lost with excessive perspiration and with vomiting and diarrhea. Thirst is activated by Na and occurs after the total level of body water is reduced.²⁷ Even slight dehydration can reduce the blood volume thereby triggering the thirst response.²⁷ It is for this reason that thirst is a poor indicator of fluid replacement.²⁷ Thirst can result in the replenishment of water, but not of Na, which is important for osmolality.² Drinking water alone can lead to “water intoxication.” In such a situation, water goes into the cells and causes swelling, which is characterized by headaches, weakness, loss of appetite and poor memory.

During strenuous exercise or competition, hyponatremia, which is measured as a blood Na concentration below 136 mmol/L, can occur.²⁷ Hyponatremia can sometimes be diagnosed in persons at rest. However, individuals with low Na levels do not necessarily have the symptoms of hyponatremia. Hyponatremia is characterized by weakness and/or disorientation. In very serious cases, it can result in rapid neurological deterioration, cardiovascular instability and seizures.²⁷

The use of Na during and/or following strenuous exercise or competition, especially in long-endurance events, may be warranted. Hyponatremia can occur if too much water and too little sodium is consumed (see above). By adding a small amount of Na to water, it can speed gastric emptying and water absorption.²⁷

Conclusion

Electrolytes lost as a result of profuse sweating, illness, diuretic use, etc. must be replaced in the diet. Unfortunately, most sports electrolyte drinks found in today’s marketplace are comprised mainly of sugar and sodium and lack the comprehensive balance of other valuable minerals and trace minerals, which the body uses for a variety of physiologic functions.

The ELETE line of electrolyte formulations supplement the diet with critical electrolytes including magnesium, chloride, calcium and potassium balanced with other important micronutrients lacking in most sports drinks and gels. To further enhance the efficacy of these products and the elements and trace elements contained therein, all of these formulas contain the natural balance of micronutrients as found in Utah’s Great Salt Lake. Some of the natural micronutrients contained in this formulation include: zinc (associated with maintaining normal taste and smell, helps synthesize DNA and RNA), selenium (acts as a powerful antioxidant), and boron (important for brain function and bone density), to name only a few. The combined effect in terms of micronutrient content and electrolytes will support a healthier electrolyte ratio, which, in turn, can positively impact overall health and well-being.

In addition, the elements and trace elements in this formulation are ionic, i.e., the minerals will easily become ions in liquid form, thus allowing for optimal absorption and assimilation within the body.

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