ALBION MINERALS
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RESEARCH NOTES

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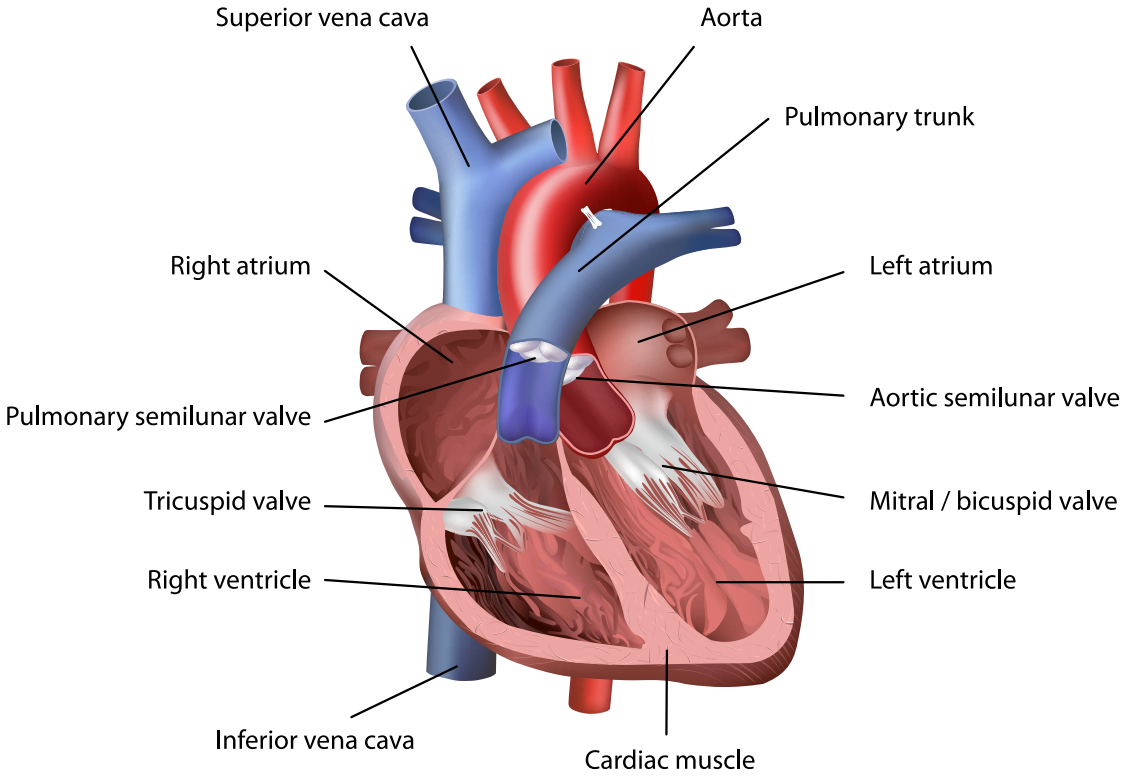
Minerals for the Heart
Impact on Cardiac Rhythm

The importance of a proper performing heart to one's health is unquestioned. There are a number of things that can go wrong with the heart that can be life threatening. According to the Mayo Clinic, there are more than 3 million cases of arrhythmias in the USA per year. In normal adults, the heart will beat at a rate of 60 to 100 times per minute. Arrhythmia is a set of conditions in which the heart beat is irregular, too slow or too fast. If the heart beats too slow *(less than 60 beats per minute)*, the conditions is a bradycardia. If it is too fast *(over 100 beats per minute)*, the conditions is called a tachycardia. The symptoms of a cardiac arrhythmia may include palpitations, dizziness, fainting spells, fatigue, shortness of breath and chest pain.

As seen in figure 1, the heart's upper two chambers are the atria, and the two lower chambers are the ventricles. Normally, the signal for the heart to beat comes from heart's sinus node,

Figure 1.



which works as the pacemaker, seen in the upper portion of the right atrium. The heartbeat signal travels from the sinus node to the atrioventricular node *(A-V node)*, which is found between the atria, through the bundle of HIS *(a sequence of modified heart muscle fibers found between the ventricles)* to the muscles of the ventricles. This stimulates the ventricles to contract resulting in a heartbeat[1].

Minerals of Note

Cardiac muscle or heart muscle makes up the bulk of the heart's mass. It is one of the body's three muscle groups: skeletal, smooth and cardiac muscle. Cardiac muscle is an extremely specialized form of muscle that pumps blood throughout the body. Cardiac muscle is only found in the heart. Calcium and magnesium work together to control muscle contraction, while sodium and potassium help the nerve cells send electrical signals *(called action potentials)* that signal the muscles to contract. One can argue that iron is also needed for muscle contraction, due to its role in providing energy for muscle contraction. However, calcium, magnesium, sodium, and potassium play very specific roles in the generation of a proper heartbeat.

Calcium

Calcium is known for its essential involvement in the building and maintenance of bones. However, it plays critical roles in the function of the heart. The body has three types of muscle: skeletal, smooth and cardiac muscle. Calcium plays a different role in each of them. The heart is formed from specialized muscles cells called cardiomyocytes that when functioning properly work automatically without the heart skipping a beat. The stimulation for the contraction of the cardiac muscle is a bit different from the stimulation of skeletal muscle contraction. We can willingly stimulate skeletal muscle contraction, which is not so for the cardiac muscle, as mentioned, the cardiac muscles work automatically, at a rate of about 70 beats or contractions per minute. Meaning that the heart muscles must contract and relax about 100,000 times per day[2]. Calcium is critical to the regulation of the contraction and relaxation of the cardiac muscle. Cardiac muscles, unlike skeletal or smooth muscles, contract from the stimulation of a unique group of cardiac cells known as the sinoatrial node *(SA node)*. These node cells do not have a true resting state, but spontaneously and rhythmically change their polarization in order to begin a contraction. When a node cell reaches a threshold of -40 millivolts, fast calcium channels begin to flood the SA nodes with positively charged calcium. It has been shown that intracellular calcium from the sarcoplasmic reticulum is required for cardiac muscle contraction. With each heart beat the calcium concentration in the cytosol is elevated ten-fold from its resting level. The contractility of the cardiac muscle is directly determined by the level of calcium elevation during systole[3]. The calcium fires the SA node, which stimulates the rest of the cardiac cells to contract and the heart beat is made. A defect in the removal of the calcium from the cytosol during diastole would impair cardiac relaxation, which is needed to allow the heart chambers to refill with blood needed for the next contraction.

Magnesium

The heart has the highest magnesium requirement of any organ in the human body, especially the left ventricle. Magnesium is important for coordinating the activity of the cardiac muscles *(myocytes)*. It has been shown that low magnesium increases one's risk for cardiac arrhythmias and heart palpitations. All of magnesium's roles in maintaining a regular heart beat are not totally known. Since magnesium is a cofactor of the membrane sodium- potassium pump *(Na-K pump)*, its deficiency can reduce the pumps activity, resulting in a partial depolarization and changes in the activity of many potential-dependent membrane channels[4]. Magnesium has been reported to increase the sinus node recovery time, atrioventricular node *(AVN)* conduction time during sinus rhythm, atrial paced cycle length, AV node refractory period and effective refractory period[5]. This allows the heart to relax longer and allow for more effective refilling. It is believed that magnesium deficiency

is an important pathogenic factor resulting in supraventricular and ventricular arrhythmias. Magnesium's many electrophysiological effects have been reported to help maintain healthy heart rates. Intravenous infusion of magnesium during an attack of supraventricular tachycardia effectively prolongs the relative refractory period *(heart muscle relaxation time)*, slowing down the atrioventricular conduction, leading to a restoration of sinus rhythm. Low magnesium levels have been seen to result in a variety of cardiac arrhythmias, such as atrial fibrillation and atrial flutter. Magnesium's electrophysiological actions have been shown to help prevent premature ventricular contractions.

Potassium

The electrolytes, like sodium and potassium, working together, both play critical roles in the maintenance of proper heart rhythm. The rhythmic contractions of the heart is controlled by periodic changes in the membrane potential of the cardiac myocytes. The SA node initiates the start of the heart beat *(it maintains its own automaticity)*. Once the SA node fires, the myocytes cause their rhythmic contraction/relaxation waves. The rhythmic contraction of the heart are controlled by periodic changes of the membrane potential of the cardiac myocytes, called action potentials[6]. The cardiac action potentials consist of 5 phases. Phase 0, which lasts only a few milliseconds, is the time of rapid depolarization, in which sodium flows into the cell. This is followed by a short and small repolarization *(phase 1)*, which is followed by a long *(between 100 and 400 milliseconds)* plateau at a depolarized level *(phase 2)*. The repolarization of the plateau potential is called phase 3. The final phase 4 continues to the next rapid depolarization. The action potential is the result of a concerted action of inward *(depolarizing)* and outward *(hyperpolarizing)* ionic currents. The outward component if carried by potassium *(K+)* ions through potassium-permeable transmembrane proteins, the potassium channels.

So, the control of the contraction and relaxation of the myocytes requires a proper quantitative relation of extracellular sodium and intracellular potassium. If these are out of balance, the heart rhythm is disrupted - leading to different types of arrhythmias.

Summary

Proper heart rhythm is reliant on the adequate dietary intake of four minerals: calcium, magnesium, potassium and sodium. Low magnesium and low potassium are the two minerals that have been seen to be occur more frequently. Balchem's Albion minerals can provide one with bioavailable forms of calcium, magnesium, and potassium. These minerals can be used as a dietary supplement to ensure adequate intake in the diet. The calcium and magnesium ingredients can come in a variety of forms, including Taste-Free forms, as well.

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