COPPER AND THE BRAIN

Copper is also a critical component in the formation and maintenance of the brain and spinal cord, and it is especially significant in babies. This has been known for decades, and it is the reason why most infant formulas are fortified with copper. A mothers' milk has it's own natural level of copper but some infant formulas like soy formulas and cows milk lack this important ingredient. Pre-term infants and especially low birth weight babies are particularly susceptible to copper deficiencies due to minimal copper stores in the organs and tissues at birth. Most of the newborns' copper levels are obtained during the last weeks of gestation. Human milk has also been found to enhance the absorption of copper, but cow's milk does not.

Infants in developing countries are also prone to low dietary copper levels due to a higher conception of cow's milk and refined carbohydrates. The role that copper plays in nervous tissue is integrally linked to its preservation and maintenance of the cell membrane. The cellular membrane structure and its function are at the very foundation of life. Without its integrity, animal life would cease.

Myelin is a fatty insulating layer found wrapped around nerves. It is composed primarily of phospholipids and its functions consist of protection, insulation, and to aid in the conduction of electrical nerve impulses. If the myelin sheath breaks down or is faulty in function or formation, the nerve impulse cannot be efficiently carried. This can lead to developmental disorders in a growing child with incoordination and ultimately paralysis. Lambs fed a low copper diet lose their coordination and sway while standing. In severe cases, the hindquarters become paralyzed and in the lambs' brain, severe lesions are present, and the normal healthy tissue is replaced by pulpy masses of tissue. Copper deficiencies depress phospholipid synthesis.

In man, Multiple Sclerosis is linked to a progressive deterioration of the myelin sheath and the body's inability to properly conduct nervous impulses to muscles. Parkinson's disease has also shown abnormalities in copper metabolism.

The copper deficient symptoms in lambs, rats, and man are very interesting because they mimic the symptoms found in dairy cattle, dogs, guinea pigs, mice, and rats fed fluorine compounds. In the chronic administration of fluorine, the animals developed "in-coordination and the inability to use their hind quarters to walk or to stand. Cows that were fed a diet that contained 93 ppm fluoride first developed signs of lameness at 2 years of age. After a little over 3 years, 2 of the cows could only get along on their knees.

Copper is a major component of different catalytic centers of enzymes and many of these enzymes are essential for normal physiological function such as cellular respiration and free radical defense. Cu/Zn super oxide dismutase (SOD) **is another copper regulated enzyme that provides the cells with a major defense barrier against oxygen toxicity. It is oxygen, the second strongest "electron thief," that is believed to be responsible for multiple cellular pathologic conditions. Oxygen alone is a very strong free radical and Cu/Zn super oxide dismutase acts as a very strong antioxidant to inactivate this potentially harmful free radical.**

Oxidative damage can be another mechanism in which copper deficiencies can indirectly cause brain pathologies. Brain Cu/Zn SOD activity has been reported to be low in young rats fed a copper deficient diet. Reductions in the activity of the free-radical oxidant defense enzyme have been shown to be associated with excessive lipid and protein oxidative damage and death.

Other enzymes that contain copper are catechol oxidase, which can be found in the mitochondria and catalyzes the joining of molecular oxygen to hydrogen to form water and the enzyme: *cytochrome-C-oxidase*,

which is essential for proper brain and spinal cord development. Ceruloplasmin also has copper as a vital component and is used in the formation of hemoglobin.