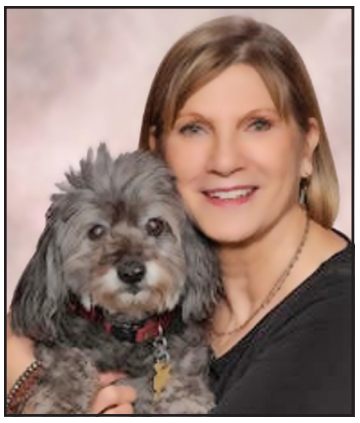
IRON – Friend or Foe?



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The Earth was formed from universal elements about 4.6 billion years ago. Iron is the most abundant element on our planet. It forms much of the Earth's inner and outer core. Spinning solid iron composes the inner core. The outer core is liquid iron, an excellent electrical conductor. As the liquid iron moves, it sets up currents and a planetary magnetic field. The Earth's magnetic field protects the planet from space radiation caused by the sun's solar wind. The many primordial elements and a shielding magnetic field contributed to the conditions allowing life to emerge about 3.5 billion years ago. But this was anaerobic life – no oxygen was yet present. It is theorized that iron, by transferring its electrons, helped atoms of carbon and oxygen get together. Then cyanobacteria developed. This type of bacteria uses iron - based photosynthesis for energy, like plants. They release oxygen as a by-product. Over time, a billion or so years later, the Earth's atmosphere contained 21% oxygen and developing life forms had to adapt to this. Organisms have been exploiting the delicate relationship between iron and oxygen ever since.

Iron's capacity to easily donate or accept electrons makes it a biologically useful element for every living organism. Our blood looks red because there is so much iron in it. (Iron has the property of reflecting red light.) Hemoglobin, packed into red blood cells, is composed of heme proteins with 4 iron atoms—each of which is capable of holding an atom of oxygen. The more oxygen that is carried, the brighter the blood gets. The iron rich hemoglobin picks up oxygen from the lungs, transports it throughout the body and then releases the oxygen to the cells. This iron and oxygen relationship is clearly vital to our health as it is to the health of all vertebrates.

Despite being so important, iron has toxic properties when presented in its free form. Oxygen also has toxic forms and when iron and oxygen get together in the wrong forms there is a lot of free radical damage to DNA, to cells, and to fatty cell membranes. Organisms have had to evolve many different strategies to prevent this toxicity, while still being able to benefit from the safe interaction of iron and oxygen. There seems to be a need for a "middle man", allowing iron and oxygen to influence each other but preventing them from having direct contact. These "middle men" are the proteins that safely transport iron, bind up and store iron, and allow or prevent the passage of iron, and they rarely ever leave iron alone.

Almost two-thirds of the iron in our body is found in the hemoglobin present in circulating red blood cells. 25% is contained in a readily available storage form. The remaining 15% of body iron is bound to muscle and various enzymes involved different cell functions.

The average daily diet provides 10 – 20mg of iron. Stomach acid is needed to change dietary iron into a form that can be absorbed. Iron absorption into the blood occurs in the upper small intestine (duodenum) in an amount determined by the body's current needs. Typically only 1 – 2 mg of iron is absorbed per day because most of our iron is recycled. A transporter molecule, transferrin, shuttles iron around in the blood. About 30 grams per day is taken out of storage and delivered to the bone marrow for the production of hemoglobin for 200 billion red blood cells. Ferritin, a giant molecule that can hold 4,500 iron atoms, is the storage form of iron. Ferritin is found in liver cells and white blood cells called macrophages.

This recycling of iron appears to protect against the scenario of unavailable dietary iron. There is no physiological mechanism for excretion of excess iron from the body other than blood loss through pregnancy, menstruation, or other bleeding. So dietary needs are typically low unless one is pregnant, bleeding, or on a low or iron restricted diet.

Conditions of Iron Deficiency

Anemia is a condition in which the number of red blood cells in the blood is low or, the blood cells have less than the normal amount of hemoglobin. There are many causes of anemia but in this article we are only going to review iron deficiency anemia. The primary causes of iron deficiency are increased demand and decreased absorption. Increased demand occurs during periods of rapid growth, pregnancy, menstruation and excess blood loss (gastrointestinal bleeding, trauma, surgery, lead poisoning, toxic chemicals, alcohol abuse, medications like ibuprofen and aspirin...) Decreased absorption of iron occurs with: low intake of bioavailable iron, decreased stomach acid, lack of intrinsic factor, celiac disease, inflammatory conditions like Crohn's disease, autoimmune diseases, vegetarian diets and hormone imbalances.

Iron deficiency anemia can manifest many symptoms including chronic fatigue, weakness, dizziness, headaches, depression, sore tongue, feeling cold, shortness of breath with exertion, restless leg syndrome, pica (the desire to chew on ice or other non - foods) and that "blah" feeling. Iron deficiency in pregnancy can create many bad outcomes for mother and baby. Even mild iron deficiency can be felt in less than optimal mental performance in school or work.

Dietary iron has two forms: heme iron found in meat and shellfish and non - heme iron found in plants and most dietary supplements. Heme iron is absorbed more efficiently. Absorption of non - heme iron can be enhanced by supplying Vitamin C, B12, folate and zinc. Certain foods can interfere with the absorption of iron like dairy products, coffee, tea, chocolate, eggs and fiber. So can stomach acid blocking medications and taking calcium supplements at the same time as iron.

Strategies for replacing iron depend on the severity of the iron deficiency anemia and include: iron injections, IV infusions, blood transfusions, dietary supplements and iron fortified foods.

Conditions of Iron Overload

Because of the limited ability to excrete iron, the body should not get overloaded with iron. This can happen with prolonged hyperabsorption of iron or excess blood transfusions. Hereditary hemochromatosis is a condition of iron overload caused by the cells over - absorbing iron. Excessive amounts of iron can accumulate in the liver, pancreas and the heart causing cirrhosis, diabetes and heart dysfunction. Pituitary, thyroid, joints, and bone marrow can also be affected. There are several types of hemochromatosis. The treatment is to "unload" iron by donating blood or repeated phlebotomies.

There are genetic conditions that produce abnormal hemoglobin, red blood cells, iron transporters, and iron receptors. Some are easily recognized by doctors and some not. Comprehensive DNA testing can elucidate all the ways iron is being handled in the body and determine whether iron overload is an issue. Using this testing I have seen the recommended blood donation resolve symptoms and blood test results that I never would have imagined!

Conditions of Iron Sequestration

All living things depend on iron to sustain life. When the body is threatened with an infection, iron is shuttled to ferritin storage. "Hiding the iron" limits it's availability as "food" for the pathogens circulating in the blood. What develops is a condition that looks like anemia but isn't. This is called anemia of chronic disease, or more appropriately, anemia of inflammatory response. Infection, tissue injury, inflammation or cancer can set up this acute phase response by the innate immune system. It is so important to determine if this is happening because recommending iron for these people is giving food to the invader!

Too much iron inside the cells can be harmful in another way. There are conditions where iron can react with oxygen and create free radicals. When this happens, there is damage to the DNA, proteins and fats in the cells. This may cause symptoms of inflammation or it may be a silent process that will cause its consequences later on. Standard blood tests do not find this but the comprehensive DNA testing does. Unloading iron here is critical and unknowingly adding iron is adding fuel to the fire!

40-50 years ago we heard television commercials selling iron supplements for "iron poor blood". We all had iron in our "One-A-Day" multivitamins back then. We are much more judicious in our use of supplemental iron now. Iron is essential for life. Too much or too little iron changes the way we grow, develop and function. Genetic and environmental influences determine our iron balance. So, is iron our friend or foe? It's all in the context. Don't guess. Test.

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