Zinc: Uniquely Essential and Efficient

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Zinc (Zn) is one of the most important essential trace elements in biology. Microorganisms, plants and animals all require Zn – it is ubiquitous in cellular metabolism. More than 300 enzymes contain Zn, and more than 50 of these play metabolic roles in animals.

Zinc is also found in many proteins which are not enzymes. For example, special proteins called "zinc fingers" have a single Zn atom at the base of an elongated amino acid structure. Zink fingers link to DNA to initiate the transcription process. They are also found in hormone receptor sites for estrogen, testosterone, and Vitamin D. Since Zn is so critical it's hard to find a system in our bodies that's not affected by Zn deficiency. Immunity, growth, reproduction, taste, smell, eyesight, nervous system function, skin metabolism, and digestion all require adequate Zn.

Zn Chemistry – What makes Zn so Special?

It is agreed that life could not have arisen without Zn. Zinc is in the Periodic Table fourth roll along with the First Transition Series elements. Chromium, manganese, iron, cobalt, nickel, copper, and zinc fall in line from atomic number 24 to 30. All these metals except nickel are essential trace elements. However chromium,manganese, iron, cobalt, and copper have relatively specific or limited metabolic roles, whereas Zn is literally all over the biological map.

The reason for this is that strictly speaking, Zn is not a Transition Metal, but a Representative Metal, Zinc has a complete inner shell of electrons and therefore only gives up its two outer shell electrons to become Zn^{+2}. This makes Zn

stable and reliable in chemical compounds, and allows it to bind with organic molecules such as carbohydrates and proteins without destroying them. Zinc is also able to form compounds with reversible binding, which is absolutely necessary for enzyme and receptor functions. If a metal-organic bond is too strong, then a hormone would bind to a receptor but never be released. Obviously, this one-way street leads to biological disaster!

If you have a Periodic Table handy, look down column IIb underneath Zn and you'll see cadmium (atomic number 48) and mercury (80). Now you can understand why these latter two metals are toxic. They can easily substitute for Zn in enzymes and proteins, but are too large and lazy and won't do Zn's job while they're there.

<u>Zn Requirements – Who is Really Deficient?</u>

The Zn Recommended Daily Allowance for adult and teenage males is 11 mg per day; adult women require 8 mg/d, with an increase to 11-13 mg/d for pregnancy and lactation. Children 1-8 require 3-5 mg/d.

Zinc is found in many foods but is only abundant in animal proteins – especially red meat and shellfish. More than 50% of the Zn in U.S. diets is derived from animal foods, with 25 % coming from beef alone. Diets in industrialized nations are generally considered to provide enough Zn, and therefore Zn deficiency is often demised out-of-hand in North America.

But in the developing world, abut two billion people are Zn-deficient and one billion have iron-deficiency anemia. The combined deficiency of Zn and iron is responsible for significant (and usually irreversible) retardation of physical and intellectual growth in millions of children each year. The added burden of weakened immunity results in further setbacks from diarrhea, pneumonia, tuberculosis, and malaria.

Even in the U.S. and Canada, it's quite possible to be moderately Zn-deficient. One way to do this is consume an unsupplemented vegan or low-protein vegetarian diet. Firstly, such diets have little or no animal protein, so are inherently low in Zn. Secondly, an unfortunate drawback to high-fiber diets is that they inhibit Zn absorption. We already know that Zn binds readily with organic molecules – but this can be a double-edged sword. During the process of digestion, Zn likes to bind with complex carbohydrates and especially certain phosphate compounds called "phytates" or "phytic acid," which are found in whole grains and legumes. This binding can reduce Zn absorption by more than 50%. Phytates are a major cause of Zn, copper, calcium, and iron deficiencies in developing countries where diets are based heavily on grain porridges and beans with very little meat, eggs, or seafood.

Ironically, a refined, low-fiber diet with adequate animal protein has relatively high Zn bioavailability (50 to 55 percent absorption), yet a diet based on unrefined cereal grains and soy protein reduces Zn absorption to about 15%. Over a period of months, a high-fiber vegetarian diet can slowly deplete Zn reserves. Deficiency symptoms may appear, including:

- Reduced resistance to upper respiratory infections;
- Increased incidence of diarrhea and indigestion;
- Dry, scaly skin and scalp; itching or dermatitis:
- Reduced senses of taste and smell,; lack of appetite;
- Poor concentration or memory; and
- Slow healing of minor skin wounds.

According to updated Food and Nutrition Board recommendations, those consuming vegetarian diets may require as much as 50% more zinc than nonvegetarians. Yet unless one is willing to dramatically change one's diet, the only way to increase Zn intake that much is to use a supplement.

Other conditions which cause or contribute to moderate Zn deficiency irrespective of diet include malabsorption, aging, chronic bowel inflammation, and strenuous athletic activity. A significant amount of Zn is lost in sweat, and increased metabolic and tissue/bone repair rates require extra Zn, so athletes should supplement 10-20 mg/d as part of a sports nutrition program.

Why is Zinc Recommended for Men?

Zinc is traditionally a "men's supplement," because it is concentrated in semen and the prostate gland. Each ejaculation removes Zn from the body which must be replaced. Men also need slightly more Zn due to their higher muscle mass.

Zinc's potential role in preventing prostate cancer is controversial. Prostate tumor cells have abnormal Zn metabolism which greatly reduces their ability to concentrate Zn. Research has shown that low blood levels of zinc are associated with increased incidence of prostate cancer, but has not shown that high-dose Zn supplementation prevents prostate cancer. Currently the best advice is that supplementing a complete suite of antioxidant nutrients (including Zn at RDA levels) and choosing a diet similar to that recommended for the prevention of heart disease affords modest protection from prostate cancer.

Another important aspect that pertains to men and women is Zn's role in cardiovascular health. We have already noted that Zn is found in antioxidant enzymes. Zinc also teams up with sulfur amino acids to form the metallothionein proteins, and detoxifiers. Metallothioneins bind heavy metals (including cadmium and mercury) and help safely remove them in urine and feces. They also neutralize oxygen and nitrogen free radicals which can damage artery walls.

Overall, it makes sense to examine one's diet closely and make sure it provides sufficient Zn, but it is rarely necessary to supplement more than 20 mg/d.