

Copper

Physiological Functions

Copper is a component of prolyl and lysyl hydroxylases, enzymes involved in collagen synthesis. Because of this, connective tissue-rich tissues such as capillaries, scar tissue, and bone matrix are most sensitive to copper status. Copper also functions at the catalytic site of the antioxidant enzyme superoxide dismutase. Additionally, the copper-containing plasma protein ceruloplasmin is integral to iron metabolism since it catalyzes oxidation of the mineral, which is required for its binding to proteins involved in absorption, transport, and storage. The redox potential of copper ions gives it a key role in energy metabolism as a component of the cytochromes that participate in electron transport.

Factors Affecting Availability

Approximately one third of the total body pool of copper is localized in skeletal muscle. Another third is found in brain and liver. The remaining amount of total body copper is found in bone and other tissues. Since copper is excreted primarily in the bile, diseases of the liver and gall bladder may affect copper balance.

Copper absorption is regulated by changes in the total body pool. The increase in absorptive efficiency observed when total body copper decreases is mediated by an intestinal copper-binding protein that is also involved with mucosal storage of zinc. Consequently, high dose zinc supplements (150 mg/day) can dramatically contribute to copper deficiency by decreasing the amount of protein available to bind copper. High dose vitamin C supplements (1500 mg/day) may also decrease copper absorption because the reduced form of the mineral, which is increased in the presence of vitamin C, is less well-absorbed than the oxidized form.

Deficiency

Although severe copper deficiency is rarely observed, marginal copper status is not uncommon. High dose supplements of zinc, vitamin C, and iron are contributing causes of marginal copper deficiency. Microcytic hypochromic anemia in the presence of normal serum ferritin is the primary clinical feature of marginal copper deficiency. This anemia, which is hematologically identical to iron-deficiency anemia, develops as a result of abnormalities in iron utilization. Skeletal abnormalities, reproductive difficulties, impaired nervous tissue function,

and changes in hair and skin pigmentation have been observed in severe copper deficiency. A role for copper in the maintenance of bone mass has been determined from observations of osteoporosis in preterm infants born with inadequate copper reserves.

Toxicity

Copper toxicity is unlikely unless exposure to large amounts occurs as a result of industrial contamination or inappropriate use of supplements. Large dose copper supplements (10-20 mg/day) may contribute to liver damage, abnormalities in red blood cell formation, weakness, and nausea.

Copper toxicity is the primary abnormality associated with Wilson's Disease. This inborn error of metabolism initially impacts the central nervous system causing tremors, dystonia, dysarthria, dysphagia, chorea, drooling, mental retardation and lack of coordination. Treatment involves a copper-restricted diet and long-term oral penicillamine therapy. Penicillamine binds copper and reduces its absorption

- ❖ *The upper limit of safety established for copper by the Food and Nutrition Board of the Institute of Medicine is approximately 10,500 mg daily for adults. See table below for age- and gender specific guidelines.*

Copper Tolerable Upper Intake Levels	
Life Stage	Copper mcg/d
Infants	
0-6 mo	N/A
7-12 mo	N/A
Children	
1-3 y	1000
4-8 y	3000
Males, Females	
9-13 y	5000
14-18 y	8000
19-70 y	10000
70 y	10000
Pregnancy	
≤ 18 y	8000
19-50 y	10000
Lactation	
≤ 18 y	8000
19-50 y	10000

Requirements

The Daily Reference Intakes (DRI) for copper are shown in the table below.

Life Stage	Copper mcg
Infants	
0 – 6 months	200
7 – 12 months	220
Children	
1 – 3 years	340
4 – 8 years	440
Males	
9 – 13 years	700
14 – 18 years	890
19 – 30 years	900
31 – 50 years	900
51 – 70 years	900
> 70 years	900
Females	
9 – 13 years	700
14 – 18 years	890
19 – 30 years	900
31 – 50 years	900
51 – 70 years	900
> 70 years	900
Pregnancy	
< 18 years	1,000
19 – 30 years	1,000
31 – 50 years	1,000
Lactation	
< 18 years	1,300
19 – 30 years	1,300
31 – 50 years	1,300

Dietary Sources

Copper is found in foods such as organ meats, seafood, nuts, seeds, whole grains, legumes, chocolate, cherries, dried fruits, milk, tea, chicken, and potatoes. Other foods that are good sources of copper are listed below.

Copper Content of Food	
Food	Copper (mg)
Beef liver, 3.5 oz.	4.5
Oysters, cooked 3.5 oz	2.0
Oysters, raw, 3.5 oz	1.10
Cashews, dry roasted, _ cup	0.80
Molasses, blackstrap, 2 T.	0.84
Pumpkin seeds, roasted, _ cup	0.78
Black-eyed peas, cooked, _ cup	0.70
Clams, steamed, 3.5 oz	0.69
Sunflower seeds, _ cup	0.60
Unsweetened chocolate, 1 oz	0.62
Brewer's yeast, 2 Tbl	0.52
Beans, refried, _ cup	0.50
Instant breakfast, fortified, 1 pkt	0.50
V-8 juice, 1 cup	0.48
Tofu, firm, _ cup	0.24
Prunes, dried, 10	0.40
Salmon, baked, 3 oz.	0.30