



Toxic & Essential Elements; Hair

TOXIC METALS								
		RESULT µg/g	REFERENCE INTERVAL	PERCENTILE				
				68 <sup>th</sup>	95 <sup>th</sup>			
Aluminum	(Al)	1.0	< 7.0	<div><div></div></div>				
Antimony	(Sb)	< 0.01	< 0.050	<div><div></div></div>				
Arsenic	(As)	< 0.01	< 0.060	<div><div></div></div>				
Barium	(Ba)	0.33	< 2.0	<div><div></div></div>				
Beryllium	(Be)	< 0.01	< 0.020	<div><div></div></div>				
Bismuth	(Bi)	< 0.002	< 2.0	<div><div></div></div>				
Cadmium	(Cd)	0.012	< 0.050	<div><div></div></div>				
Lead	(Pb)	1.5	< 0.60	<div><div></div></div>				
Mercury	(Hg)	0.25	< 0.80	<div><div></div></div>				
Platinum	(Pt)	< 0.003	< 0.005	<div><div></div></div>				
Thallium	(Tl)	0.001	< 0.002	<div><div></div></div>				
Thorium	(Th)	< 0.001	< 0.002	<div><div></div></div>				
Uranium	(U)	0.013	< 0.060	<div><div></div></div>				
Nickel	(Ni)	0.08	< 0.30	<div><div></div></div>				
Silver	(Ag)	0.17	< 0.15	<div><div></div></div>				
Tin	(Sn)	0.03	< 0.30	<div><div></div></div>				
Titanium	(Ti)	0.22	< 0.70	<div><div></div></div>				
Total Toxic Representation				<div><div></div></div>				
ESSENTIAL AND OTHER ELEMENTS								
		RESULT µg/g	REFERENCE INTERVAL	PERCENTILE				
				2.5 <sup>th</sup>	16 <sup>th</sup>	50 <sup>th</sup>	84 <sup>th</sup>	97.5 <sup>th</sup>
Calcium	(Ca)	1310	300– 1200	<div><div></div></div>		<div><div></div></div>		
Magnesium	(Mg)	220	35– 120	<div><div></div></div>		<div><div></div></div>		
Sodium	(Na)	37	20– 250	<div><div></div></div>		<div><div></div></div>		
Potassium	(K)	21	8– 75	<div><div></div></div>		<div><div></div></div>		
Copper	(Cu)	66	11– 37	<div><div></div></div>		<div><div></div></div>		
Zinc	(Zn)	180	140– 220	<div><div></div></div>		<div><div></div></div>		
Manganese	(Mn)	0.10	0.08– 0.60	<div><div></div></div>		<div><div></div></div>		
Chromium	(Cr)	0.34	0.40– 0.65	<div><div></div></div>		<div><div></div></div>		
Vanadium	(V)	0.056	0.018– 0.065	<div><div></div></div>		<div><div></div></div>		
Molybdenum	(Mo)	0.031	0.020– 0.050	<div><div></div></div>		<div><div></div></div>		
Boron	(B)	0.55	0.25– 1.5	<div><div></div></div>		<div><div></div></div>		
Iodine	(I)	0.26	0.25– 1.8	<div><div></div></div>		<div><div></div></div>		
Lithium	(Li)	0.007	0.007– 0.020	<div><div></div></div>		<div><div></div></div>		
Phosphorus	(P)	158	150– 220	<div><div></div></div>		<div><div></div></div>		
Selenium	(Se)	0.52	0.55– 1.1	<div><div></div></div>		<div><div></div></div>		
Strontium	(Sr)	3.6	0.50– 7.6	<div><div></div></div>		<div><div></div></div>		
Sulfur	(S)	49100	44000– 50000	<div><div></div></div>		<div><div></div></div>		
Cobalt	(Co)	0.005	0.005– 0.040	<div><div></div></div>		<div><div></div></div>		
Iron	(Fe)	8.0	7.0– 16	<div><div></div></div>		<div><div></div></div>		
Germanium	(Ge)	0.038	0.030– 0.040	<div><div></div></div>		<div><div></div></div>		
Rubidium	(Rb)	0.021	0.007– 0.096	<div><div></div></div>		<div><div></div></div>		
Zirconium	(Zr)	< 0.007	0.020– 0.42	<div><div></div></div>		<div><div></div></div>		
SPECIMEN DATA				RATIOS				
				ELEMENTS	RATIOS		RANGE	
				Ca/Mg	5.95		4– 30	
				Ca/P	8.29		1– 12	
				Na/K	1.76		0.5– 10	
				Zn/Cu	2.73		4– 20	
				Zn/Cd	> 999		> 800	

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## HAIR ELEMENTS REPORT INTRODUCTION

Hair is an excretory tissue for essential, nonessential and potentially toxic elements. In general, the amount of an element that is irreversibly incorporated into growing hair is proportional to the level of the element in other body tissues. Therefore, hair elements analysis provides an indirect screening test for physiological excess, deficiency or maldistribution of elements in the body. Clinical research indicates that hair levels of specific elements, particularly potentially toxic elements such as cadmium, mercury, lead and arsenic, are highly correlated with pathological disorders. For such elements, levels in hair may be more indicative of body stores than the levels in blood and urine.

All screening tests have limitations that must be taken into consideration. The correlation between hair element levels and physiological disorders is determined by numerous factors. Individual variability and compensatory mechanisms are major factors that affect the relationship between the distribution of elements in hair and symptoms and pathological conditions. It is also very important to keep in mind that scalp hair is vulnerable to external contamination of elements by exposure to hair treatments and products. Likewise, some hair treatments (e.g. permanent solutions, dyes, and bleach) can strip hair of endogenously acquired elements and result in false low values. Careful consideration of the limitations must be made in the interpretation of results of hair analysis. The data provided should be considered in conjunction with symptomology, diet analysis, occupation and lifestyle, physical examination and the results of other analytical laboratory tests.

**Caution:** The contents of this report are not intended to be diagnostic and the physician using this information is cautioned against treatment based solely on the results of this screening test. For example, copper supplementation based upon a result of low hair copper is contraindicated in patients afflicted with Wilson's Disease.

### Lead High

This individual's hair Lead (Pb) level is considered to be moderately elevated. Generally, hair is a good indicator of exposure to Pb. However, elevated levels of Pb in head hair can be an artifact of hair darkening agents, or dyes, e.g. lead acetate. Although these agents can cause exogenous contamination some transdermal absorption does occur.

Pb has neurotoxic and nephrotoxic effects in humans as well as interfering with heme biosynthesis. Pb may also affect the body's ability to utilize the essential elements calcium, magnesium, and zinc. At moderate levels of body burden, Pb may have adverse effects on memory, cognitive function, nerve conduction, and metabolism of vitamin D. Children with hair Pb levels greater than 1  $\mu\text{g/g}$  have been reported to have a higher incidence of hyperactivity than those with less than 1  $\mu\text{g/g}$ . Children with hair Pb levels above 3  $\mu\text{g/g}$  have been reported to have more learning problems than those with less than 3  $\mu\text{g/g}$ . Detoxification therapy by means of chelation results in transient increases in hair lead. Eventually, the hair Pb level will normalize after detoxification is complete.

Symptoms associated with excess Pb are somewhat nonspecific, but include: anemia, headaches, fatigue, weight loss, cognitive dysfunction and decreased coordination.

Sources of exposure to Pb include: welding, old leaded paint (chips/dust), drinking water, some

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fertilizers, industrial pollution, lead-glazed pottery, Ayurvedic herbs and use of firearms. Tests for Pb body burden are: urine elements analysis following provocation with intravenous Ca-EDTA, or oral DMSA. Whole blood analysis for Pb reflects recent or ongoing exposures and does not correlate well with total body burden.

#### Silver High

Hair Silver (Ag) levels have been found to reflect environmental exposure to the element. However, hair is commonly contaminated with Ag from hair treatments such as permanents, dyes, and bleaches.

Ag is not an essential element and is of relatively low toxicity. However, some Ag salts are very toxic.

Sources of Ag include seafood, metal and chemical processing industries, photographic processes, jewelry making (especially soldering), effluents from coal fired power plants and colloidal silver products.

The bacteriostatic properties of Ag have been long recognized and Ag has been used extensively for medicinal purposes; particularly in the treatment of burns. There is much controversy over the long term safety of consumption of colloidal silver. Very high intake of colloidal silver has been reported to give rise to tumors in the liver and spleen of animals (Metals in Clinical and Analytical Chemistry, eds. Seiler, Segel and Segel, 1994). However, these data may not have relevance to the effects of chronic, low level consumption by humans.

#### Magnesium High

Magnesium (Mg) is an essential element with both electrolyte and enzyme-activator functions. However, neither of these functions takes place in hair. Body excess of Mg is rare but may occur from excessive oral or parenteral supplementation or as a result of renal damage or insufficiency.

If one rules out external contamination of hair as a result of recent hair treatment, elevated hair Mg is more likely to indicate maldistribution of the element. Physiological Mg dysfunction may or may not be present. Maldistribution of Mg can occur as a result of chronic emotional or physical stress, toxic metal or chemical exposure, physiological imbalance of calcium and phosphorus, bone mineral depletion, and renal insufficiency with poor clearance of Mg (and other metabolites). Elevated hair Mg has been correlated with hypoglycemia and an inappropriately low ratio of dietary Ca : P.

Mg status can be difficult to assess; whole blood and packed blood red cell Mg levels are more indicative than serum/plasma levels. Amino acid analysis can be helpful in showing rate-limited steps that are Mg-dependent (e.g. phosphorylations).

#### Copper High

The high level of Copper (Cu) in hair may be indicative of excess Cu in the body. However, it is important first to rule out exogenous contamination sources: permanent solutions, dyes, bleaches, swimming pool/hot tub water, and washing hair in acidic water carried through Cu pipes. In the case of contamination from hair preparations, other elements (aluminum, silver, nickel, titanium) are usually also

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elevated.

Sources of excessive Cu include contaminated food or drinking water, excessive Cu supplementation, and occupational or environmental exposures. Insufficient intake of competitively absorbed elements such as zinc or molybdenum can lead to, or worsen Cu excess.

Medical conditions that may be associated with excess Cu include: biliary obstruction (reduced ability to excrete Cu), liver disease (hepatitis or cirrhosis), and renal dysfunction. Symptoms associated with excess Cu accumulation are muscle and joint pain, depression, irritability, tremor, hemolytic anemia, learning disabilities, and behavioral disorders.

Confirmatory tests for Cu excess are a comparison of Cu in pre vs. post provocation (D-penicillamine, DMPS) urine elements tests and a whole blood elements analysis.

#### Chromium Low

Hair Chromium (Cr) is a good indicator of tissue levels and may provide a better indication of status than do urine or blood plasma/serum (Nielsen, F.H. In Modern Nutrition on Health and Disease; 8th Edition, 1994. Ed. Shils, Olson and Shike. Lea and Febiger, Philadelphia). Hair Cr is seldom affected by permanent solutions, dyes and bleaches.

Cr (trivalent) is generally accepted as an essential trace element that is required for maintenance of normal glucose and cholesterol levels; it potentiates insulin function, i.e., as a part of "glucose tolerance factor". Deficiency conditions may include hyperglycemia, transient hyper/hypoglycemia, fatigue, accelerated atherosclerogenesis, elevated LDL cholesterol, increased need for insulin and diabetes-like symptoms, and impaired stress responses. Marginal or insufficient Cr is common in the U.S., where average tissue levels are low compared to those found in many other countries. Low hair Cr appears to be associated with increased risk of cardiovascular disease and an atherogenic lipoprotein profile (low HDL, high LDL). Common causes of deficiency are ingestion of highly processed foods, inadequate soil levels of Cr, gastrointestinal dysfunction, and insufficient vitamin B-6. Cr status is also compromised in patients with iron overload/high transferrin saturation because transferrin is a major transport protein for Cr.

Confirmatory tests for Cr adequacy include glucose tolerance and packed red blood cell elements analysis.

#### Selenium Low

Selenium (Se) is normally found in hair at very low levels, and several studies provide evidence that low hair Se is reflective of dietary intake and associated with cardiovascular disorders. Utilization of hair Se levels to assess nutritional status, however, is complicated by the fact that use of Se- or sulfur-containing shampoo markedly increases hair Se (externally) and can give a false high value.

Se is an extremely important essential element due to its antioxidative function as an obligatory component of the enzyme glutathione peroxidase. Se is also protective in its capacity to bind and "inactivate" mercury, and Se is an essential cofactor in the deiodination of T-4 to active T-3 (thyroid hormone). Some conditions of functional hypothyroidism therefore may be due to Se deficiency (Nature; 349:438-440, 1991); this is of particular concern with mercury exposure. Studies have also indicated significant inverse correlations between Se and heart disease,

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cancer, and asthma.

Selenium deficiency is common and can result from low dietary intake of Se or vitamin E, and exposure to toxic metals, pesticides/herbicides and chemical solvents.

Symptoms of Se deficiency are similar to that of vitamin E deficiency and include muscle aches, increased inflammatory response, loss of body weight, alopecia, listlessness, skeletal and muscular degeneration, growth stunting, and depressed immune function.

Confirmatory tests for Se deficiency are Se content of packed red blood cells, and activity of glutathione peroxidase in red blood cells.

#### Total Toxic Element Indication

The potentially toxic elements vary considerably with respect to their relative toxicities. The accumulation of more than one of the most toxic elements may have synergistic adverse effects, even if the level of each individual element is not strikingly high. Therefore, we present a total toxic element "score" which is estimated using a weighted average based upon relative toxicity. For example, the combined presence of lead and mercury will give a higher total score than that of the combination of silver and beryllium.