



LAB #: H210428-2322-1  
 PATIENT: Alex Maclean  
 ID: MACLEAN-A-00139  
 SEX: Male  
 DOB: 09/19/1996 AGE: 24

CLIENT #: 38596  
 DOCTOR:  
 Regenerus Laboratories Ltd  
 Aero 14 Redhill Aerodrome Kings Mill Lane  
 Redhill, Surrey, RH1 5YP UNITED KINGDOM

## Toxic & Essential Elements; Hair

TOXIC METALS			
	RESULT µg/g	REFERENCE INTERVAL	PERCENTILE 68 <sup>th</sup> 95 <sup>th</sup>
Aluminum (Al)	1.3	< 7.0	
Antimony (Sb)	< 0.01	< 0.066	
Arsenic (As)	0.092	< 0.080	
Barium (Ba)	0.04	< 1.0	
Beryllium (Be)	< 0.01	< 0.020	
Bismuth (Bi)	0.004	< 2.0	
Cadmium (Cd)	< 0.009	< 0.065	
Lead (Pb)	0.10	< 0.80	
Mercury (Hg)	0.20	< 0.80	
Platinum (Pt)	< 0.003	< 0.005	
Thallium (Tl)	< 0.001	< 0.002	
Thorium (Th)	< 0.001	< 0.002	
Uranium (U)	0.010	< 0.060	
Nickel (Ni)	0.05	< 0.20	
Silver (Ag)	0.18	< 0.08	
Tin (Sn)	0.02	< 0.30	
Titanium (Ti)	0.22	< 0.60	
Total Toxic Representation			

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)	196	200– 750	
Magnesium (Mg)	36	25– 75	
Sodium (Na)	3	20– 180	
Potassium (K)	< 3	9– 80	
Copper (Cu)	9.9	11– 30	
Zinc (Zn)	190	130– 200	
Manganese (Mn)	0.08	0.08– 0.50	
Chromium (Cr)	0.33	0.40– 0.70	
Vanadium (V)	0.020	0.018– 0.065	
Molybdenum (Mo)	0.025	0.025– 0.060	
Boron (B)	0.15	0.40– 3.0	
Iodine (I)	7.5	0.25– 1.8	
Lithium (Li)	< 0.004	0.007– 0.020	
Phosphorus (P)	149	150– 220	
Selenium (Se)	0.62	0.70– 1.2	
Strontium (Sr)	0.26	0.30– 3.5	
Sulfur (S)	48200	44000– 50000	
Cobalt (Co)	0.003	0.004– 0.020	
Iron (Fe)	4.3	7.0– 16	
Germanium (Ge)	0.037	0.030– 0.040	
Rubidium (Rb)	< 0.003	0.011– 0.12	
Zirconium (Zr)	0.014	0.020– 0.44	

SPECIMEN DATA		RATIOS		
COMMENTS:		ELEMENTS	RATIOS	RANGE
Date Collected: 04/20/2021		Ca/Mg	5.44	4– 30
Date Received: 04/28/2021		Ca/P	1.32	0.8– 8
Date Reported: 04/30/2021		Na/K	1	0.5– 10
Methodology: ICP/MS		Zn/Cu	19.2	4– 20
Sample Size: 0.197 g		Zn/Cd	> 999	> 800
Sample Type: Head				
Hair Color: Brown				
Treatment:				
Shampoo:				

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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.

Arsenic High

In general, hair provides a rough estimate of exposure to Arsenic (As) absorbed from food and water. However, hair can be contaminated externally with As from air, water, dust, shampoos and soap. Inorganic As, and some organic As compounds, can be associated with toxicity. Inorganic As accumulates in hair, nails, skin, thyroid gland, bone and the gastrointestinal tract. Organic As, such as that derived from shellfish, is rapidly excreted in the urine.

As can cause malaise, muscle weakness, vomiting, diarrhea, dermatitis, and skin cancer. Long-term exposure may affect the peripheral nervous, cardiovascular and hematopoietic systems. As is a major biological antagonist to selenium.

Common sources of As are insecticides (calcium and lead arsenate), drinking water, smog, shellfish (arsenobetaine), and industrial exposure, particularly in the manufacture of electronic components (gallium arsenide).

As burden can be confirmed by urine elements analysis. Comparison of urine As levels pre and post provocation (DMPS, DMSA, D-penicillamine) permit differentiation between recent uptake and body stores.

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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.

Calcium Low

Hair Calcium (Ca) levels have been correlated with nutritional intake, several disease syndromes, and metabolic disorders. Interpretation of low hair Ca levels is difficult and other variables need to be considered.

Ca is the most abundant element in the body. Although most Ca is contained in the skeletal system, Ca is actively involved in muscle contraction, the nervous system, hormone secretion, and immunological responses.

Causes of Ca deficiency include but are not limited to inadequate dietary Ca, protein or vitamin D, excess dietary phosphorus and malabsorption. Malabsorption is likely if other essential elements such as magnesium, cobalt, manganese, and chromium are also at low levels in hair. Other factors associated with poor Ca status include physical inactivity, chronic stress, hormonal imbalance, aluminum containing antacids, chronic use of diuretics or laxatives, high alcohol intake, and exposure to toxic elements (e.g. lead, cadmium).

Symptoms of Ca deficiency include: muscle cramps or tetany, myalgia, and skeletal pain. Chronic Ca deficiency (or negative balance) results in osteoporosis.

Hair is vulnerable to external contamination by Ca as a result of hair treatments (permanent solutions, dyes, bleach). Other means to assess Ca status include: dietary assessment, whole blood elements analysis, and measurement of bone density, serum vitamin D-3, and parathyroid hormone.

Sodium Low

The level of Sodium (Na) in hair has not been documented to be indicative of dietary adequacy or nutritional status. Na is an essential element with extracellular electrolyte functions, but these functions do not occur in hair. Low hair Na may have no clinical significance or it may be

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consistent with electrolyte imbalance associated with adrenal insufficiency. In this condition, blood Na would be low, blood potassium would be high, and urinary levels of Na would be expected to be high. Observations at DDI indicate that Na and potassium levels in hair are commonly low in association with emotional stress. The low levels of Na and potassium are frequently concomitant with high levels of calcium and magnesium in hair. This apparent "emotional stress pattern" requires further investigation.

Appropriate tests for Na status as an electrolyte are measurements of Na in whole blood and urine, and measurements of adrenocortical function.

#### Potassium Low

The level of Potassium (K) in hair does not reflect nutritional status or dietary intake. However, hair K levels may provide clinically relevant information pertaining to adrenal function and/or electrolyte balance.

K is an electrolyte and a potentiator of enzyme functions in cells, but neither of these functions takes place in hair. K can be low in the body as the result of gastrointestinal or renal dysfunction, or as a side effect of some diuretics. In adrenocortical hyperactivity, blood levels of K are depressed, while urinary K is increased. Low hair K should be viewed as a screening test. Observations at DDI indicate that hair levels of sodium and K are commonly low in association with emotional stress. The low levels of sodium and K are frequently concomitant with high levels of calcium and magnesium in hair. This apparent "emotional stress pattern" requires further investigation.

Symptoms of true K deficiency include: muscle weakness, fatigue, and tachycardia. Diabetic acidosis can result in severe K loss.

Confirmatory tests for K deficiency include measurements of packed red blood cell K; whole blood K and the sodium/K ratio; urine K and the sodium/K ratio. An electrocardiogram may show abnormalities when K is low in serum/plasma or whole blood.

#### Copper Low

Hair Copper (Cu) levels are usually indicative of body status with two exceptions: (1) addition of exogenous Cu (occasionally found in hair preparations or algicides in swimming pools/hot tubs), and (2) low hair Cu in Wilson's or Menkes' diseases. In Wilson's disease, Cu transport is defective and Cu accumulates, sometimes to toxic levels, in intestinal mucosa, liver and kidneys. At the same time, it is low in hair and deficient in other peripheral tissues. In Menkes' disease, the activity of Cu dependent enzymes is very low. Cu supplementation is contraindicated in these diseases.

Cu is an essential element that is required for the activity of certain enzymes. Erythrocyte superoxide dismutase (SOD) is a Cu (and zinc) dependent enzyme; lysyl oxidase which catalyzes crosslinking of collagen is another Cu dependent enzyme. Adrenal catecholamine synthesis is Cu dependent, because the enzyme dopamine beta-hydroxylase, which catalyzes formation of norepinephrine from dopamine, requires Cu.

Symptoms of Cu deficiency include: elevated cholesterol, increased inflammatory responses, anemia, bone and collagen disorders, reproductive failure, and impaired immunity. Possible reasons for a Cu deficiency include: intestinal malabsorption, insufficient dietary intake, molybdenum excess, zinc excess,

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and chelation therapy. Cu status is adversely affected by excess of antagonistic metals such as mercury, lead, cadmium, and manganese.

Confirmatory tests for Cu deficiency are serum ceruloplasmin to rule out Wilson's disease (ceruloplasmin is deficient in Wilson's disease), a whole blood or packed red blood cell elements analysis, and a functional test for Cu (barring zinc deficiency) is measurement of erythrocytes SOD activity. Erythrocyte SOD activity is subnormal with Cu deficiency.

#### 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.

#### Boron Low

Boron (B) is normally found in hair, but the correlations among dietary B intake, and tissue and hair levels of B have yet to be established. Recent studies clearly indicate that B has an important role in normal bone metabolism/density and may be needed for normal membrane function. In post-menopausal women consuming a very low B diet, B supplementation significantly lowered urinary excretion of calcium and magnesium and increased serum levels of estrogen (Environ. Health Perspect.; 102 Supl.7: 59-63, 1994). Further research is in process to determine the clinical significance of hair B levels.

#### Lithium Low

Lithium (Li) is normally found in hair at very low levels. Hair Li correlates with high dosage of Li carbonate in patients treated for Affective Disorders. However, the clinical significance of low hair Li levels is not certain at this time. Thus, hair Li is measured primarily for research purposes. Anecdotally, clinical feedback to DDI consultants suggests that low level Li supplementation may have some beneficial effects in patients with behavioral/emotional disorders. Li occurs almost universally in water and in the diet; excess Li is rapidly excreted in urine.

Li at low levels may have essential functions in humans. Intracellularly, Li inhibits the conversion

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of phosphorylated inositol to free inositol. In the nervous system this moderates neuronal excitability. Li also influences monamine neurotransmitter concentrations at the synapse (this function is increased when Li is used therapeutically for mania or bipolar illness).

A confirmatory test for low Li is measurement of Li in blood serum/plasma.

#### 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, 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.

#### Rubidium Low

Hair Rubidium (Rb) levels may correlate with exposure and with Rb levels in other tissues. Rubidium is not considered to have a biological function; due to its chemical similarity to potassium, it may be taken up by plants and animals (Comp. Biochem. Physiol.; 73: 223, 1982, Haematologica 75: 27, 1990). Daily intake varies from 1-5 mg depending on geography and diet.

The Hair Toxic and Essential Elements test is a screen for element exposures over the last 3-4 months.

#### 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

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Patient: **Alex Maclean**

**Hair Head**

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than that of the combination of silver and beryllium.