# CHROMIUM

## Introduction

Chromium is a transition metal, with valencies of 2, 3, and 6. Hexavalent chromium ($Cr^{6+}$) is highly toxic to mammals, while trivalent chromium ($Cr^{3+}$) is an essential nutrient. Normally, no detectable $Cr^{6+}$ is found in human clinical samples. We measure total chromium (which includes Cr of each valency) in clinical specimens and in water by ICPMS.

Chromium was recognized as an essential trace element when its role in glucose tolerance was described in 1959 [1]. "Glucose tolerance factor" (GTF or chromodulin) binding is required for insulin uptake on to cell receptors. GTF, which has not been fully characterized, is thought to be a Cr-amino acid complex and is deficient in many diabetic subjects. Cr supplementation in such patients has been reported to improve insulin binding, the number of insulin receptors, beta cell sensitivity, and insulin receptor enzymes [2]. This is the only known biological function of chromium.

Capacity for Cr storage in the body decreases with age and gastro-intestinal absorption of chromium is compromised with age [3] and in insulin-dependent diabetes mellitus. In contrast, the gastro-intestinal absorption of Cr may increase in zinc deficiency.

## Physiological role of chromium

Chromium deficiency is characterised by an impaired glucose tolerance, altered plasma lipids and peripheral neuropathy. Chromium in the plasma is transported on transferrin, which, being a negative acute phase reactant, falls in concentration in the plasma in inflammatory diseases such as diabetes mellitus. The possibility is therefore that diabetics, who suffer from prolonged inflammation, are only apparently chromium deficient because of their low transferrin levels: however, utilisation of insulin by diabetics is greatly increased by chromium supplementation (the recommended daily dose for Cr is 200 microgrammes), which suggests that they are truly chromium deficient (since their requirement for insulin falls when chromium is administered) [4].

Chromium supplementation has also been used to treat the carbohydrate cravings of depression, with the results suggesting that chromium picolinate is beneficial for patients with atypical depression and severe carbohydrate craving [5]. This suggests a link between depression, decreased insulin sensitivity, and subsequent diabetes. Chromium picolinate's insulin enhancing effect has been also been shown to attenuate simple weight gain, but by an unknown mechanism [6].

## Toxic effects of chromium

In general trivalent $Cr^{3+}$ enters the cells poorly (including the absorptive enterocytes of the GI tract) because it has no dedicated ion transport channels and in the trivalent state does not resemble other essential ions. Hexavalent chromium ($Cr^{6+}$), which is carcinogenic to humans, is better absorbed than $Cr^{3+}$ because at physiological pH it resembles phosphate [7] and is more readily taken up by cells. An important source of hexavalent chromium ($Cr^{6+}$) is chromate production waste sites, from which it passes into household dust in adjacent residences.

Chromium from stainless steel cookware can leach into acidic food (e.g. rhubarb) on cooking; inorganic chromium absorbed in this way is scavenged by the haemoglobin in erythrocytes and is not thought to exchange with plasma chromium or act as a glucose tolerance factor. Skin exposure to all forms of chromium is a potential source of contact allergic dermatitis, while chronic excess chromium intake predisposes to bronchial carcinoma [7].

## Chromium in clinical samples

Reference intervals for chromium are as follows:



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| | |
|---|---|
| Urine Cr | <2.5 μmol/mol of creatinine |
| Plasma Cr | 6.2 – 33.4 nmol/L |
| Whole blood Cr | 3.6 – 23.1 nmol/L |
| Hair Cr | 0.10 – 1.50 μg/gm of hair |

Blood chromium at lower levels can vary somewhat in the short term according to dietary intake and thus may not reflect long-term intake or exposure. In contrast, the chromium content of hair will reflect the average metal uptake over the duration of follicle formation.

High levels of chromium (and cobalt) are found in the blood of patients with metal-on-metal prosthetic joints. Patients with well functioning metal-on-metal joints may have somewhat elevated blood levels of chromium and cobalt without apparent adverse health effects [e.g. Cr 45 nmol/L or Co 30 nmol/L]. The Medical Device Agency alert (MDA/2010/033) states that, for patients implanted with metal-on-metal replacements, cobalt and chromium levels in the blood should be measured in high risk patient groups, and if either cobalt or chromium levels are elevated above 7 ppb [i.e. Cr >135 nmol/L or Co >119 nmol/L], then a second measurement should be performed three months after the first test.

Apart from patients with leaking metal-on-metal prosthetic joints, the highest concentration of chromium in humans is found in hair, making it an excellent tissue for Cr analysis [7].

**Patient preparation:**

The patient should discontinue nutritional supplements for 48 hours before the collection of blood or urine for chromium determination.

**Specimen requirements**

For blood or plasma chromium measurement, blood should be collected into an 8 ml trace element-free potassium EDTA tube. Collection tubes are available on request. If a number of blood tubes are being taken at the same collection, the trace element-free tube should be filled first to avoid cross-contamination. Postal samples (overnight delivery) are acceptable.

A 24 hour urine collection is preferred for urine chromium determination, but a 6 hour urine collection is acceptable. The total volume of urine collected should be recorded and, after mixing, 15 mL of urine should be sent to submitted in a plastic, screw cap container. A postal sample kit can be supplied.

For hair analysis, hair should be cut from the nape of the neck, as close to the scalp as possible. At least 0.5gm of hair is required, which is about one heaped tablespoon full. Only hair up to 1½“ (4cm) from scalp can be used. Please allow for this when the hair is long by sending in a larger total sample, for example 2 tablespoons-full of hair.

**Turnaround time:** 5 working days.

**References:**


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