

Chromium (Cr) — HMTc analyte

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THE ANALYTE

24 · Cr · Total; Cr(VI) on trigger

Trivalent chromium is a low-toxicity form assumed to dominate in food and long treated as an essential trace element, whereas hexavalent chromium is an IARC Group 1 carcinogen (established on occupational-inhalation evidence and assessed by US EPA as likely carcinogenic by the oral route), so chromium is limited only where a credible hexavalent-chromium pathway exists.

Why it is limited

The government and expert-body assessments that underpin limiting chromium in food, and what each concluded. The maximum levels in force apply these findings; this page is the rationale, not the certification threshold.

BODY	YEAR	ASSESSMENT	WHAT IT CONCLUDED
IARC	1990	IARC Monographs Vol. 49 — Chromium, Nickel and Welding	Hexavalent chromium compounds (as encountered in chromate production, chromate-pigment production, and chromium plating) classified Group 1 (carcinogenic to humans) on sufficient human evidence for lung and nasal/nasal-sinus cancer via occupational inhalation. Metallic chromium and Cr(III) are Group 3 (not classifiable). This is the foundational carcinogenicity classification later authorities cite.
EFSA	2014	CONTAM Panel Scientific Opinion on the risks to public health related to the presence of chromium in food and drinking water (EFSA Journal 2014;12(3):3595)	Set a Cr(III) TDI of 300 µg Cr(III)/kg b.w. per day (NOAEL 286 mg/kg b.w./day, UF 100 × 10). Applied a margin-of-exposure approach for Cr(VI) using three NTP reference points: BMDL10 1.0 mg Cr(VI)/kg b.w./day (neoplastic — combined adenomas/carcinomas, mouse small intestine), BMDL10 0.11 mg/kg b.w./day (non-neoplastic — diffuse epithelial hyperplasia of the duodenum, male mice per EFSA Table 22), and BMDL05 0.2 mg/kg b.w./day (haematotoxic — decreased haematocrit, male rats). Because no food Cr(VI) occurrence data existed and food is largely a reducing medium, the Panel assumed all food chromium is Cr(III) and all water chromium is Cr(VI); it found low concern for average consumers but a potential concern at upper-bound 95th-percentile Cr(VI) exposure via drinking water in 'Infants', 'Toddlers' and 'Other children', and recommended generating speciated Cr(III)/Cr(VI) occurrence data.

BODY	YEAR	ASSESSMENT	WHAT IT CONCLUDED
US EPA	2024	IRIS Toxicological Review of Hexavalent Chromium [Cr(VI)] (EPA/635/R-24/164Fa)	Derived a chronic oral reference dose (RfD) of 9×10^{-4} mg/kg-day anchored on gastrointestinal (duodenal) diffuse epithelial hyperplasia in female mice (NTP 2008), an adult oral cancer slope factor of $0.16 \text{ (mg/kg-day)}^{-1}$ (0.27 with age-dependent adjustment factors) based on oral-cavity squamous-cell tumors, plus inhalation RfC $3 \times 10^{-5} \text{ mg/m}^3$ and inhalation unit risk $1.1 \times 10^{-2} \text{ (}\mu\text{g/m}^3\text{)}^{-1}$. Classified Cr(VI) 'likely to be carcinogenic to humans' by the oral route and 'carcinogenic to humans' by inhalation. Named neonates and infants under 30 months, individuals with chronically elevated stomach pH, DNA-repair-deficient/CFTR-mutated populations, the developing fetus, and the elderly as susceptible groups for whom the standard values may under-protect.
OEHHA	1987/2008	California Proposition 65 chemical listing — Chromium (hexavalent compounds), with safe-harbor levels	Listed as a carcinogen (27 Feb 1987, via the authoritative-bodies/IARC mechanism) and separately as a developmental and male/female reproductive toxicant (19 Dec 2008). Associated safe-harbor levels: cancer No Significant Risk Level (NSRL) of $0.001 \text{ }\mu\text{g/day}$ by inhalation and reproductive Maximum Allowable Dose Level (MADL) of $8.2 \text{ }\mu\text{g/day}$ by the oral route. These are hazard-identification and warning thresholds, not food maximum levels.

Toxicological basis

What the assessment bodies found when they examined chromium, why the answer depends entirely on which chromium they meant, and why that species distinction is what governs whether a dietary limit applies at all.

Chromium is two toxicologically different substances sharing a name, and regulation turns on which one is present. Trivalent chromium (Cr(III)), the form that dominates food, produced no adverse effect even at the highest doses tested in chronic animal studies; EFSA derived a tolerable daily intake of $300 \text{ }\mu\text{g Cr(III)/kg body weight per day}$ and concluded that current dietary Cr(III) exposure does not raise a public-health concern. Hexavalent chromium (Cr(VI)) is the species of concern. It enters cells through sulfate and phosphate transporters and is reduced intracellularly through Cr(V) and Cr(IV) intermediates, generating reactive oxygen species and DNA damage in a mutagenic mode of action. When Cr(VI) is ingested the gastrointestinal tract is the critical oral target: the pivotal NTP drinking-water bioassay produced small-intestinal adenomas and carcinomas and diffuse epithelial hyperplasia of the duodenum, and the US EPA's 2024 IRIS assessment anchored a chronic oral reference dose of $9 \times 10^{-4} \text{ mg/kg-day}$ on that duodenal lesion. Chromium is not regulated in food the way [lead](#) or [cadmium](#) are because the two species are not interchangeable, and the dose that reaches tissue depends on how much ingested Cr(VI) survives reduction to Cr(III) before absorption.

The populations that carry the most risk are defined by that reduction chemistry. Ingested Cr(VI) is partially reduced to Cr(III) in saliva and gastric fluid before systemic absorption, so anything that lowers gastric reducing capacity raises the internal Cr(VI) dose per unit ingested. EPA's IRIS assessment names neonates and infants under 30 months, individuals with chronically elevated stomach pH, people with DNA-repair-deficient or CFTR-mutated backgrounds, the developing fetus, and the elderly as groups for whom the standard reference values may under-protect. Infants are doubly exposed: their gastric pH is higher and less acidic than an adult's, which reduces the efficiency of Cr(VI)-to-Cr(III) conversion and elevates the systemically available dose per unit of Cr(VI) ingested. EFSA's 2014 opinion reached a parallel conclusion from the exposure side, finding low concern for

average consumers but a potential concern at upper-bound 95th-percentile Cr(VI) exposure through drinking water for infants, toddlers, and other children. That concern was framed around water rather than food, because food is largely a reducing medium in which Cr(VI) does not persist.

The carcinogenicity classification is where imprecision does the most damage, so it must be stated by route. IARC classifies hexavalent chromium compounds as Group 1, carcinogenic to humans, but that classification rests on sufficient human evidence for lung and nasal or nasal-sinus cancer in workers who inhaled chromate dust and fume in chromate production, pigment production, and chromium plating; metallic chromium and trivalent chromium are Group 3, not classifiable. The canonical Group 1 tumour sites are therefore inhalation-route occupational cancers, not dietary ones. By the oral route the evidence is weaker and species-specific: the US EPA's 2024 IRIS review assessed Cr(VI) as likely to be carcinogenic to humans by ingestion, a lower weight-of-evidence descriptor than the carcinogenic to humans it applies to inhalation, and derived an oral cancer slope factor of $0.16 \text{ (mg/kg-day)}^{-1}$ (0.27 with age-dependent adjustment factors) from oral-cavity squamous-cell tumours in the animal bioassay. EFSA's margin-of-exposure calculation used the same animal record, with a neoplastic BMDL10 of $1.0 \text{ mg Cr(VI)/kg body weight per day}$ for combined small-intestinal adenomas and carcinomas and a non-neoplastic BMDL10 of $0.11 \text{ mg/kg body weight per day}$ for duodenal epithelial hyperplasia. The honest summary is that Cr(VI) is a confirmed human carcinogen by inhalation and a plausible oral carcinogen on animal data, and that trivalent chromium carries neither classification.

These are not the finding of a single body. EFSA, the US EPA, IARC, and California's OEHHA independently characterise chromium along the same species line and converge: the hazard lives in the hexavalent form, the trivalent form does not warrant a dietary limit, and the oral Cr(VI) hazard is real but bounded by the chemistry of the gut. California adds a right-to-know mark of concern without setting a food standard: [Proposition 65](#) lists hexavalent chromium as a carcinogen (1987) and as a developmental and male and female reproductive toxicant (2008), with an oral Maximum Allowable Dose Level of $8.2 \text{ }\mu\text{g/day}$ and an inhalation cancer No Significant Risk Level of $0.001 \text{ }\mu\text{g/day}$, both warning thresholds rather than maximum permitted concentrations, and trivalent chromium is not listed at all. The practical consequence explains why no government sets a chromium maximum level in any food: measured chromium in finished food is overwhelmingly trivalent, EFSA found no food Cr(VI) occurrence data and assumed all food chromium was Cr(III), and reported food Cr(VI) is frequently a method artifact of digestion rather than a real exposure. The certification program follows that evidence rather than inventing a number, limiting chromium only where a credible hexavalent pathway exists, through reflex Cr(VI) speciation above a total-chromium trigger. The science drew the species line first; the limits, where they exist, follow it, and where food is concerned the gap is that there is no food limit to follow, a gap the evidence supports leaving visible.

Occurrence & exposure

How much chromium food actually carries, and why the number needs a caveat before it can be read. The occurrence data below are total chromium, not hexavalent chromium; the two must not be conflated, and the certification program treats the total value as a screen rather than a hazard measurement.

Total chromium by food — US FDA Total Diet Study FY2018–2020 elemental-analysis summary. Values are $\mu\text{g/kg}$ (ppb) on a prepared, ready-to-eat composite basis: the median (P50), the 95th percentile, and the single highest sample. Reporting limits are $25\text{--}50 \text{ }\mu\text{g/kg}$, so a median shown as <50 is a non-

detect; n is small (3 subsamples) for several items. These are TOTAL chromium (metal species Cr), not Cr(VI), and are population occurrence values, not safety thresholds.

FOOD (FDA TDS COMPOSITE)	MEDIAN P50 MG/KG	95TH PCT MG/KG	HIGHEST SAMPLE MG/KG
Cheese, American, processed	300	390	400
Cake, chocolate with chocolate icing	300	300	300
Fish sticks / patties, frozen, oven-cooked	200	380	400
Cereal, bran with raisins	100	280	300
Cereal, oat ring	50	275	300
Cereal, corn flakes	67	75.1	76
Cereal, crisped rice	54	95.4	100
Raisins	56	95.6	100
Milk, chocolate, reduced fat, fluid	29	39.5	43
Tortilla, flour	<50	92.8	200
Beef, ground, pan-cooked	<50	100	600
Cauliflower, fresh/frozen, boiled	<50	<50	600

Health-based guidance values and safe-harbor levels for chromium, by species and route. These are reference points regulators derived, not occurrence and not food maximum levels; the trivalent and hexavalent values are not interchangeable, and the route (oral vs inhalation) is load-bearing. Sources: EFSA (2014), US EPA IRIS (2024), and California OEHHA Proposition 65 as compiled on the Heavy Metal Index.

REFERENCE VALUE / LIMIT	VALUE	ROUTE / SPECIES	BASIS
EFSA tolerable daily intake, Cr(III)	300 µg/kg bw/day	oral, trivalent	NOAEL 286 mg/kg bw/day; no health concern from food
US EPA chronic oral RfD, Cr(VI)	9 × 10 ⁻⁴ mg/kg-day	oral, hexavalent	duodenal diffuse epithelial hyperplasia, female mice (NTP 2008)
US EPA oral cancer slope factor, Cr(VI)	0.16 (mg/kg-day) ⁻¹	oral, hexavalent	oral-cavity squamous-cell tumours; 0.27 with age adjustment
EFSA BMDL10, neoplastic, Cr(VI)	1.0 mg/kg bw/day	oral, hexavalent	small-intestinal adenomas / carcinomas, mice
EFSA BMDL10, non-neoplastic, Cr(VI)	0.11 mg/kg bw/day	oral, hexavalent	duodenal epithelial hyperplasia, male mice
Prop 65 MADL, reproductive	8.2 µg/day	oral, hexavalent	warning threshold, not a food maximum level
Prop 65 NSRL, cancer	0.001 µg/day	inhalation, hexavalent	warning threshold, not a food maximum level

Total chromium in the FDA Total Diet Study is broadly but modestly distributed, and the pattern tracks processing and contact more than any single ingredient. The highest and most consistent central values fall on processed and cooked items — processed cheese, baked goods and confectionery, fish portions, and fortified cereals — consistent with chromium's ubiquity and with contact from chromated stainless steel and other chromate-bearing materials in equipment, packaging, and storage. Fresh produce sits largely below the study's reporting limit, punctuated by occasional high single samples that pull maxima well above the typical central value without moving the median. Every one of these values is total chromium, overwhelmingly trivalent, because hexavalent chromium is oxidatively unstable in most food matrices and the routine digestion methods behind occurrence surveys reduce any Cr(VI) to Cr(III) before it is counted.

This is why total-chromium occurrence, however complete, cannot be read as a hexavalent-chromium exposure signal, and why the program does not set a limit off it. The monitoring question that matters is narrower: in which matrices, and under which processing or water-contact conditions, can hexavalent chromium survive to reach the consumer. The program answers that by holding total chromium as a first-pass screen and triggering reflex hexavalent-chromium speciation above a defined total-chromium threshold, so effort concentrates where a credible Cr(VI) pathway exists rather than being spent treating an essential trace element as a contaminant. Occurrence data anchor the screen; speciation, not the total number, anchors the hazard call.

Anchor occurrence dataset: US FDA Total Diet Study FY2018–2020 elemental-analysis summary (analyte 'Chromium' = total Cr, A-tier US government survey), prepared/ready-to-eat composites at a 25–50 µg/kg reporting limit. Corroborated by the Heavy Metal Index chromium and hexavalent-chromium metal pages, which catalog the total-Cr occurrence corpus and note that reported food Cr(VI) is largely a method artifact. The full occurrence corpus is on the [Heavy Metal Index](#).

How it is regulated

No government sets a chromium maximum level — total or hexavalent — in any food matrix. In the infant-and-child-foods derivation every sovereign column (EU, UK, Codex, Health Canada, China [GB 2762](#), India [FSSAI](#), Brazil ANVISA, [FSANZ](#), US FDA) is blank for chromium, and direct inspection confirms neither Commission [Regulation \(EU\) 2023/915](#) ([/regulations/eu-2023-915](#)) nor US FDA [Closer to Zero](#) ([/regulations/us-fda-c2z](#)) carries a chromium entry. The only enforceable Cr(VI)-specific instruments sit in adjacent domains — California's drinking-water Maximum Contaminant Level of 10 µg/L for hexavalent chromium (SWRCB, adopted 2024, effective 1 Oct 2024; an earlier 2014 MCL at the same value was invalidated in 2017 on an inadequate economic-feasibility record before this re-adoption) and the Prop 65 safe-harbor levels above — alongside non-specified total-chromium drinking-water MCLs (US EPA 100 µg/L; California 50 µg/L); none is a food limit. Because a government-limit lookup returns nothing for food, the standard does not adopt or invent a number: chromium is a no-ML, controlled cell, and the literature baseline is reported one-way at the Heavy Metal Index metal page rather than derived on the certification site.

How the HMTc program treats it

Total chromium is a claim analyte, equal at the gate with every other published limit; no metal has an allowed overage. In infant-and-child-food matrices it is registered 'not material' (n/m) — no standalone numeric ceiling, because no government regulates it and finished food chromium is overwhelmingly trivalent. Instead of an invented number, chromium is controlled by reflex hexavalent-chromium speciation: total chromium is reported, and mandatory Cr(VI) speciation is triggered on any total-chromium result above 100 µg/kg (ppb), with any quantifiable Cr(VI) a hard fail. This control language is confirmed verbatim in `tools/standards/cat1-config.json` and the compiled Cat-1 standards; it treats the carcinogenic species as a pathway hard fail while treating trivalent chromium as the low-toxicity, essentially-assumed form.

Literature baseline

The complete peer-reviewed and regulatory literature for chromium is maintained independently at the [Heavy Metal Index](#)^[2]. That reference reports what the literature says; this certification site applies it. The two are kept editorially separate by design.