



SAFER
CONSUMER
PRODUCTS

CALIFORNIA DEPARTMENT OF
TOXIC SUBSTANCES CONTROL

Work Plan Implementation:

Chemicals in Hair Straightening Products Background Document

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Prepared by

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Introduction

The [Safer Consumer Products regulations](#) define the process and criteria used by the Department of Toxic Substances Control (DTSC) to evaluate consumer products for possible designation as Priority Products. A Priority Product is a consumer product identified by DTSC that contains one or more chemicals – known as Chemicals of Concern – with a hazard trait that can cause harm or adverse impacts to people or the environment. As part of the process of evaluating consumer products, DTSC issues a Priority Product Work Plan identifying the product categories to evaluate over a three-year period (Figure 1). DTSC then considers the product categories based on the Work Plan’s stated policy goals.

Since issuing the 2018-2020 and 2021-2023 [Work Plans](#), DTSC has conducted a review of products, chemicals, and chemical classes that align with our policy goals. This document summarizes our preliminary findings on hair straightening products in the Work Plan product category of beauty, personal care, and hygiene products. Publication of this document begins a dialogue with interested stakeholders (including manufacturers, civic and nonprofit organizations, and academia), to inform DTSC’s decisions about which hair straightening products containing one or more Candidate Chemicals should be designated as Priority Products and be subject to the requirements of the Safer Consumer Products regulations.

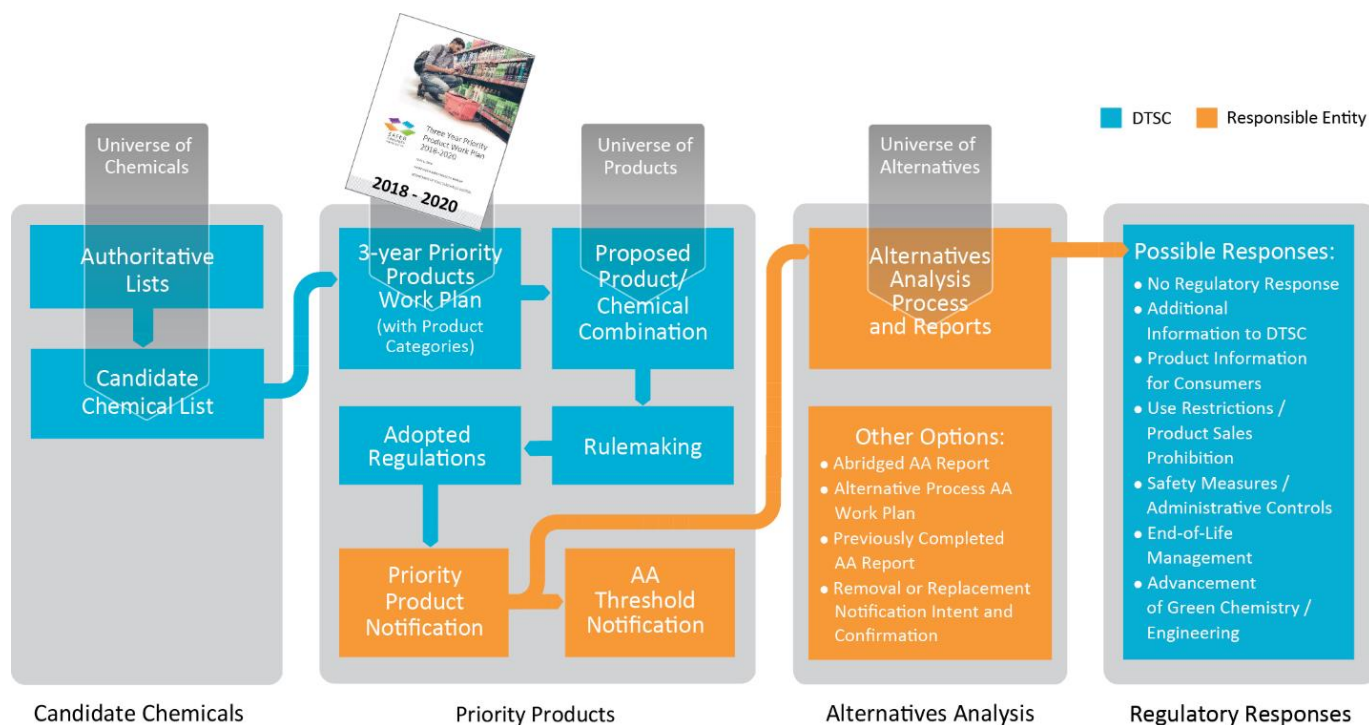


Figure 1. An overview of the Safer Consumer Products regulations.

BACKGROUND

Hair straightening products change the structure of hair by straightening or relaxing it. They include various gels, creams, sprays, moisturizers, conditioners, shampoos, activators, glosses, and detanglers. Broadly, there are two types of hair straightening products: permanent and temporary.

- Permanent hair straightening products can make hair straight for a few months, even when the hair gets wet.
- Temporary hair straightening products make hair straight until it gets wet or damp, so the effect lasts for only a few days.

The most commonly used permanent hair straightening products are:

- Relaxers,
- Keratin/Brazilian straighteners, and
- Japanese heat straighteners (also known as thermal reconditioning).

Hair relaxers are chemical treatments designed to permanently straighten highly coiled hair by breaking its disulfide bonds and restructuring them. These products are typically sold as kits consisting of multiple components, including a protective gel, a relaxing cream, a liquid activator, and a neutralizing shampoo.

Keratin/Brazilian hair straightening products refer to two types of hair straightening treatments—Brazilian keratin treatments which usually contains formaldehyde and other keratin smoothing treatments. With both, curly or frizzy hair is typically heated after the product is applied, producing a smooth and shiny effect. In formaldehyde-containing hair straighteners, formaldehyde forms cross-links with the keratin amino acids in hair, and the use of a heated flat iron further enhances the cross-linking and makes the hair straight.^[1] Other keratin smoothing treatments do not break the bonds in hair; instead, they use keratin to reduce frizz and smooth hair without permanently changing its structure.

Japanese heat straighteners can be thought of as a hybrid of keratin straighteners and hair relaxers. They use a two-step process that starts with a chemical treatment to break the disulfide bonds in hair, then use of a neutralizing chemical treatment and heat to restructure these bonds as straightened hair. The active ingredient in most Japanese heat straighteners is ammonium thioglycolate (which is not on DTSC's Candidate Chemical's list).

DTSC is concerned about the potential for adverse impacts from exposure to Candidate Chemicals in hair straightening products. DTSC has evaluated several Candidate Chemicals in these products, including formaldehyde, cyclosiloxanes, parabens, sodium hydroxide,

diethanolamine, phthalates, benzophenone-3, and triclosan. Some of these compounds are associated with human health and environmental hazards including respiratory effects, endocrine disruption, developmental and reproductive toxicity, dermal effects, environmental persistence, and bioaccumulation. The findings of these initial evaluations are summarized below.

Use of hair straightening products in salons and homes has the potential to cause or contribute to adverse impacts from exposure to Candidate Chemicals. A recent study tested three hair relaxer kits and detected 35 different endocrine-disrupting or asthma-associated chemicals.^[2] Further, Eberle et al. (2020) found that breast cancer risk increased as the frequency of hair straightener use increased in women who had sisters diagnosed with breast cancer. A higher risk was also evident for hair straightening products applied outside of a professional setting.^[3]

Hair salon workers, pregnant women and their fetuses, and children are particularly vulnerable to harm from toxic chemicals. The use of hair straightening products can begin at an early age. A study has observed that girls of African descent* may begin using chemical hair straightening products as early as 4 years old.^[4] Moreover, chemicals are more readily absorbed through the scalp compared to other areas of skin.^[5] Continuous application of hair straightening products may cause scalp disorders,^[6] which in turn could increase likelihood of exposure to a combination of chemicals in these products (e.g., damage to the scalp may leave the skin more permeable for exposure).

Exposure to harmful chemicals in hair straightening products presents an environmental justice issue. Women of African descent may experience more adverse effects from such exposures, due to higher frequency of use of hair relaxers. Further, low-income communities of color are even more vulnerable, since they frequently encounter multiple environmental and social risk factors and face poorer health outcomes.^[7] The presence of endocrine-disrupting chemicals in hair products used by women of African descent has been linked to hormone-related health complications, such as diabetes, obesity, and an earlier start of menstruation.^[8,9]

The choice of which chemicals in hair straighteners and relaxers DTSC prioritizes under the Safer Consumer Products framework will be informed by a recently enacted law. On September 30, 2020, the Toxic-Free Cosmetics Act was signed into California law (AB 2762). Beginning in January 2025, this law prohibits the use of several chemical ingredients in cosmetic products sold in California, including hair straightening products. The prohibited chemicals include diethylhexylphthalate, formaldehyde, methylene glycol, isobutylparaben, and isopropylparaben.

* See Appendix 1 for rationale for use of terms.

The **Preliminary Screening Results** section below provides a brief summary of the findings from DTSC’s evaluation of chemicals used in hair straightening products. This section describes the exposure pathways, environmental impact, hazard traits, product use and market trends, and possible alternatives for each Candidate Chemical evaluated.

DTSC is requesting additional information from stakeholders about Candidate Chemicals in hair straightening products, including exposure data, and market and sales information. Please see the **Questions to Stakeholders** section for specific questions.

PRELIMINARY SCREENING RESULTS

Market and Use Information

Mintel’s Global New Product Database lists the ingredients of 185 hair straightening products introduced to the U.S. market from 1996 to 2020; 114 of these products (62 percent) contain one or more Candidate Chemicals.^[10]

Hair straightening products are used in many homes and workplaces throughout California. Barbers and hair salon workers use a wide variety of such products. These sectors in California employed nearly 70,000 workers in 2018, and analysts project this figure will rise approximately 6.5 percent by 2028.^[11] In addition to salon use, many people also use hair straightening products at home. However, at-home use of these products has been declining since 1990.^[12]

Candidate Chemical Screening Summary

Formaldehyde

In keratin/Brazilian hair straightening products, formaldehyde[†] restructures curly hair to form new bonds with added keratin protein and natural keratin proteins in the hair, resulting in straight hair. A formaldehyde-containing solution is first applied to the hair, followed by a heating their hair with a blow dryer, which enhances the reactivity of formaldehyde with the added keratin and the keratin present in hair. When the hair is further heated with a flat iron, formaldehyde reactivity is further enhanced, and seals the cuticle.^[1]

The concentration of formaldehyde in formaldehyde-containing straightening formulations varies by manufacturer, but typically is found to be at percent levels. Pierce et al. (2011) detected formaldehyde at concentrations of 11.5 percent in Brazilian Blowout, 8.3 percent in Global Keratin, and 3 percent in Coppola Keratin/Brazilian straighteners.^[13] In a 2011 report, the Environmental Working Group (EWG) reported that keratin hair straightening products being marketed by Peter Coppola contained formaldehyde, despite claims by the

[†]When it is in solution, formaldehyde is also known as formalin or methylene glycol.

manufacturer that the chemical had been replaced with timonacic acid; eight different organizations detected formaldehyde in these products, according to EWG.^[14] A recent Safety Data Sheet shows that a Brazilian Blowout hair straightening product contains formaldehyde at concentrations of three to seven percent.^[15]

There is potential for significant inhalation exposure to formaldehyde in hair salons that use formaldehyde-containing hair straightening products. The U.S. Occupational Safety and Health Administration (OSHA) and Oregon OSHA sampled for formaldehyde in hair salons' indoor air and detected it in excess of threshold exposure levels established by U.S. and Oregon OSHA, the World Health Organization (WHO), and the California Office of Environmental Health Hazard Assessment (OEHHA).^[16-20]

The key hazards from formaldehyde exposure for users of hair straightening products and hair salon workers are ocular and respiratory effects from short-term inhalation exposure.^[20] Salon workers also face a potential increase in cancer risk from long-term exposure.^[21] Formaldehyde exposure can also result in allergic sensitization. Previously sensitized individuals are more sensitive to formaldehyde exposure and may more readily develop health effects, such as respiratory distress, when they are re-exposed.^[22]

State and federal authorities have established health-based exposure limits for formaldehyde. The Formaldehyde Standard, enforced by both the U.S. and Oregon OSHAs, applies to formaldehyde in all of its forms and specifically includes several other terms, including "methylene glycol" and "formalin."^[16,23] The hazards posed are the same regardless of the name used to describe them.^[16,23]

Alternatives to formaldehyde-containing keratin hair straightening products exist, such as hot irons; keratin products formulated with other aldehydes (e.g., glutaraldehyde, citral); and glyoxal (liquid keratin) straighteners.^[14] Glycolic acid, hydrogen peroxide, alkaline sulfites, and urea-based conjugates are other alternatives to formaldehyde-based products.^[14]

Sodium Hydroxide

Sodium hydroxide, also known as lye, is used in personal care products as a pH adjuster and cleansing agent.^[24] In hair relaxers, it is used to break the disulfide bonds in hair and alter its curl pattern. Elevated concentrations of sodium hydroxide are associated with skin, eye, and lung irritation and burns, along with temporary loss of hair.^[25,26] During the application of lye hair relaxers in a salon, acute dermal and inhalation exposures to sodium hydroxide have the potential to cause significant adverse impacts to both the client and other people in the vicinity, especially salon workers.^[27]

Since 1996, sodium hydroxide has been listed as an ingredient in over 100 hair straightening products on the market.^[28] Published Safety Data Sheets show that hair straightening products typically have sodium hydroxide concentrations at or below 2.5 percent.^[29] Lithium hydroxide, potassium hydroxide, calcium hydroxide, magnesium hydroxide, ammonium thioglycolate, and guanidine hydroxide are examples of alternative bases used in hair straightening products. These chemicals have similar functional uses as sodium hydroxide.^[24] Additionally, no-lye alternatives are strong bases and, as such, may have similar potential to cause adverse health impacts.^[14]

Parabens

Parabens are manmade chemicals often used as preservatives in personal care products.^[30] Since personal care products contain ingredients that can spoil, parabens are added to prevent and reduce the growth of harmful bacteria and mold, thus increasing the shelf life of the product.^[31] Common parabens are methylparaben, ethylparaben, propylparaben, and butylparaben.^[31] Often, more than one paraben is used in a single product.^[32]

Helm et al. (2018) detected three parabens—methylparaben, ethylparaben, and butylparaben—in hair relaxer kits; methylparaben was measured at higher concentrations (approximately 2,000 ppm) and ethyl- and butylparaben below 100 ppm.^[2] A product ingredient search revealed widespread use of parabens in Personal care products, with propylparaben being by far the most common, followed by butylparaben, isobutylparaben, and isopropylparaben. Mintel's Global New Product Database lists more than 76 paraben-containing retail hair straightening products that entered the U.S. market from 1996 to 2020.^[32]

Users of personal care products can be exposed to parabens through skin contact and inhalation of dust.^[33,34] All commercially used parabens are regarded as endocrine disrupting chemicals.^[35] *In vitro* and animal *in vivo* evidence demonstrates that parabens are endocrine disruptors.^[36–38] Additionally, *in vivo* and *in vitro* studies show evidence for reproductive effects.^[39–45] Recent *in vitro* studies show parabens may be involved in the proliferation of breast cancer cells.^[46,47]

Alternatives to parabens are widely available and have been evaluated by the European Union.^[48] In the U.S., many manufacturers and retailers have initiated voluntary phaseouts of parabens.

Cyclosiloxanes

Cyclosiloxanes, most commonly cyclotetrasiloxane (D4), cyclopentasiloxane (D5), and dodecamethylcyclohexylsiloxane (D6), are used in a variety of personal care products, including multi-component hair relaxer kits. These chemicals provide antistatic, emollient, humectant,

solvent, viscosity-controlling, and hair conditioning properties.^[49] In hair relaxer kits, cyclosiloxanes are commonly found in the shampoo and conditioner components.^[2] Mintel's Global New Product Database includes more than 100 siloxane-containing retail hair straightening products that were introduced into the U.S. market from 1996 to 2019.^[50] Cyclosiloxanes exhibit several exposure potential and toxicological hazard traits including environmental persistence, bioaccumulation, and reproductive toxicity.^[51–55] Exposure pathways to people include direct contact with skin, ingestion of breast milk during nursing, and inhalation via indoor air due to the chemicals' volatility.^[52,56,57]

Several plant-based alternatives for cyclosiloxanes have been identified. Isodecylneopentanoate, hydrogenated polydecen, and glycol distereate are common chemical replacements of cyclomethicone used in creams and leave-in products.^[58] Hydrogenated olive oil unsaponifiables, polyglyceryl-4 oleate, and tridecane can replace D5.^[59]

Diethanolamine

Diethanolamine (DEA) itself is rarely an intentionally added ingredient in hair straightening products; however, it is a known contaminant of ingredients used in these products. In hair relaxer kits, DEA-related ingredients are most commonly used to make the shampoo component thicker, creamier, and more sudsy.^[60,61] Since 1996, about half of hair relaxer kits contain a shampoo with DEA-related ingredients, with cocamide DEA being the most common.^[50,62] Exposure to these chemicals occurs through dermal contact during use.^[63]

DEA and some DEA-related ingredients have been shown to cause cancer in mice, leading authoritative bodies to classify them as possibly carcinogenic to humans.^[63] DEA can also react with impurities in the product to form highly carcinogenic chemicals called nitrosamines.^[64] This led the European Union to ban DEA in 2013 as an intentional ingredient in cosmetics and place strong restrictions on DEA-related ingredients to limit the amount of free DEA and the potential for nitrosamine formation.^[65–68]

The amount of free DEA in ingredients can vary widely. For example, products containing cocamide monoethanolamine (MEA) have been shown to contain hundreds of times less residual DEA than similar products containing cocamide DEA.^[69–71] DEA and cocamide DEA are listed as Prop 65 carcinogens, and it appears that DEA and DEA-related ingredients are being used much less frequently than in the past.^[72,73]

Phthalates: Diethyl Phthalate and Diethylhexyl Phthalate

Diethyl phthalate (DEP) and diethylhexyl phthalate (DEHP) are used as plasticizers, solvents, and fragrance carriers in a wide variety of products.^[74,75]

Phthalates are not listed as intentionally added ingredients in hair straightening products. Helm et al. (2018) measured the short-chain phthalate DEP in hair straightening products at concentrations higher than the longer-chain phthalates DEHP.^[2] The exposure routes of concern for DEP in hair relaxers include inhalation and dermal absorption. Hazard traits of DEP and DEHP include developmental toxicity, reproductive toxicity, endocrine toxicity,^[74] and carcinogenicity (only for DEHP).^[76]

The evidence for DEP's toxicity is still inconclusive. While it is structurally similar to the longer-chain phthalates, which have clearly demonstrated developmental effects on the male reproductive system, multiple studies in rats and mice, including multigeneration studies, have observed no effects from DEP on fertility (although limited reproductive effects have been seen at high doses).^[77-81] Early research showed associations between increased maternal urinary concentrations of DEP and reduction in anogenital distance (i.e., distance between the anus and the base of the penis) in male infants (this is a common indicator of abnormal male reproductive tract masculinization).^[82,83] However, a recent systematic review of the anogenital distance epidemiological data found only "slight evidence" of this association, which suggests that DEP does not have as strong an anti-androgenic effect (e.g., blocking the effects of androgens such as testosterone) as other phthalates.^[84] A separate systematic review of female reproductive and developmental outcomes found moderate evidence of preterm birth associated with DEP exposure but inadequate evidence of effects on pubertal development in females.^[85]

Essential oils are one potential alternative to phthalates used as fragrance carriers.

Benzophenone-3

Benzophenone-3 (BP-3), also known as oxybenzone, is an ultraviolet (UV) filter commonly used in sunscreens. BP-3 is used as a sunscreen in lotions, conditioners, and cosmetics; it protects these products from the damaging effects of UV light.^[86] A recent product database search indicates that BP-3 is used in the conditioner component of hair relaxer kits and is also an added ingredient in temporary hair straightening products.^[87] BP-3 was also detected by Helm et al. (2018) in one hair relaxer kit.^[2]

Concerns over widespread BP-3 exposure led to efforts by the National Toxicology Program and the U.S. Food and Drug Administration (FDA) to assess the potential adverse effects of BP-3.^[88] The U.S. Centers for Disease Control and Prevention (CDC) National Biomonitoring Program detected BP-3 in 97 percent of approximately 2,500 urine samples taken from individuals in the U.S., thus indicating widespread use of personal care products containing BP-3.^[89] BP-3 is absorbed by the skin and has been found to be a photoallergen in some people^[86] In addition, even though BP-3 has weak estrogenic (e.g., mimicking the effects of estrogen) and anti-

androgenic effects,^[90] it is a suspected endocrine disruptor based on evidence in cell-based assays, experimental animals, and ecotoxicity data.^[91] In the aquatic environment, BP-3 is a reproductive toxicant in fish^[92] and causes bleaching and ossification in the larval form of coral.^[93] BP-3 may enter the aquatic environment through recreational swimming in lakes and rivers and when BP-3 containing products are washed down the drain.^[94]

Triclosan

Triclosan is a chemical with antibacterial properties historically used in products such as detergents, soaps, skin cleansers, deodorants, lotions, creams, toothpastes, and dishwashing liquids.^[95]

Helm et al. (2018a) detected triclosan in one of three hair relaxer kits tested; however, the source in this product is unknown as triclosan is not a listed ingredient for the hair relaxer kits tested in this study.^[2] Market data suggests that triclosan is rarely used in hair products.^[96]

Several studies show triclosan is an endocrine-disrupting chemical in multiple animal species. Triclosan may also affect immune responses, cellular metabolism, and cardiovascular functions.^[97] Potential exposures to triclosan are through contact with skin. Biomonitoring studies have detected triclosan in the urine of nearly 75 percent of the people tested.^[95]

The FDA issued a final rule banning triclosan from antiseptic soap products in December 2017, and in 2019 it issued a final rule banning triclosan from being used in hand sanitizers.^[98] As a result of these regulatory actions, it appears that manufacturers have voluntarily removed triclosan from virtually all personal care products.

Next Steps

Public Engagement

DTSC is asking stakeholders to address the questions listed in Themes 1-4 below. A public comment period will begin on May 24, 2021. Written comments can be submitted via the online information management system [CalSAFER](#). The comment period will close on July 23, 2021 at 11:59 p.m. In addition, DTSC will hold a public workshop with stakeholders and invited participants on June 22-23, 2021. Further details about this workshop will be available on our [Workshops and Events Webpage](#). This stakeholder engagement process will help inform additional research that may result in the proposal of one or more Priority Products. Please monitor our [Priority Products Work Plan Implementation webpage](#) for updates on this topic.

QUESTIONS TO STAKEHOLDERS

Theme 1. Chemicals in Hair Straightening Products

- Are there additional chemicals in hair straightening products that SCP should evaluate?

- Are there studies that show detection of Candidate Chemicals in hair straightening products that are not listed on product labels that DTSC should be aware of?
- Are there studies on safer chemical alternatives used in hair straightening products not identified in this document?

Theme 2. Exposure to Chemicals from Hair Straightening Products

- Are there studies on environmental fate, ecological impacts, and air or water impacts from use and disposal of hair straightening products DTSC should be aware of?
- Are there personal exposure monitoring studies for hair straightening products DTSC should be aware of?
- How frequently are hair straightening products applied in the home versus salons? Any research data you are aware of?

Theme 3. Toxicity of Chemicals in Hair Straightening Products

- For any Candidate Chemicals in hair straightening products, can you provide information of ongoing toxicological studies?
- Are there any ongoing studies regarding adverse impacts related to parabens in hair straightening products?
- For sodium hydroxide-free relaxers, are you aware of any adverse risks associated with the use of non-lye relaxers?
- Are there any ongoing studies regarding potential impacts of benzophenone-3 in hair straightening products?
- What methods can be used to minimize DEA related nitrosamine formation in personal care products?
- What would be an appropriate Alternatives Analysis Threshold (AAT) for DEA in personal care products?

Theme 4. Market Presence

- How many retail and professional hair straightening products are used or sold annually in California? Please provide data or sales reports.
- Do salons typically buy a significant portion of their chemical hair straightening supplies from large-scale retailers such as Costco or Walmart?
- What percentage of all hair straightening products are sold exclusively by online retailers (e.g., Amazon)?

Appendix 1 – Terms Used to Describe Racial and Ethnic Groups

- Although race and ethnicity are often used interchangeably, they are distinct terms. Race is a social construct that is not universal and is usually associated with physical characteristics such as skin color or hair texture. Ethnicity refers to shared cultural characteristics such as language, ancestry, practices, and beliefs.
- For inclusivity and to ensure consistency in the background document, we identified potential affected populations by ancestry or place of origin. The table below provides the terms used in the background document.
- *Table 1. Background Document Reference Language*

Terminology	Place of Ancestral Origin
*African Descent	Sub-Saharan Africa
Asian Descent	Asia
European Descent	Europe
Latin/Hispanic Descent	European (Spain) and indigenous American countries that speak Spanish
Middle Eastern/ *North African Descent	Middle East or North Africa
Native American Tribal Ancestry or Alaska Native	The Americas (Indigenous North, Central, and South Americas)
Native Hawaiian or Pacific Islander	Hawaii, Guam, Samoa, and other Pacific Islands

** Individuals from North or Sub-Saharan Africa may consider themselves of African descent.*

- Hair is a defining characteristic of our physical appearance. It is a physical feature that is modified in terms of length, color, or shape. The cosmetic industry considers three primary geo-racial hair types—African, Asian, and European—with distinct hair fiber shape characteristics (diameter and curvature) that control much of the cosmetic and physical behavior of human hair. The cosmetic industry generally considers Asian hair straight, African hair curly or tightly coiled, and European hair as somewhere in between [99]. For the purpose of this background document, hair type will generally be analyzed based on these three primary geo-racial hair types.
- Marketing data and statistics were also researched and analyzed. Marketing resources use descriptive language that differs from Table 1 above. Cosmetic industry marketing refers to consumers as Asian, Black, Latinx, or White. Our documents will also use this terminology to distinguish consumers when discussing market and sales data.

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