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Advancements in Cosmetic Science: A Review of Ingredients and Technologies for Holistic Health and Longevity.

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Abstract

Recent advancements in cosmetic science and personal care represent a fundamental shift from conventional esthetics toward integrative solutions that support both physical health and emotional well-being. This review highlights the latest innovations in ingredients and technologies across skin care, hair care, and dental care, emphasizing their role in enhancing physiological resilience, modulating immune responses, and promoting emotional balance. A key focus is the development of multifunctional personal care products that bridge the gap between external esthetics and internal physiological benefits, reflecting the growing intersection of cosmetic and health sciences. Additionally, this review examines the therapeutic potential of aromatherapy and phytoncides in enhancing mood, reinforcing the critical role of mental well-being in overall health. As the personal care industry continues to evolve, the convergence of chemistry and medical disciplines relevant to cosmetic science—including those focused on skin, hair, oral health, sensory perception, mental well-being, and longevity—is driving a new era of holistic, evidence-based self-care that enhances both esthetic appearance and overall health.(1)

Keywords: holistic health; skin care; reverse aging; well-being; hair care; oral care; mental well-being; aromatherapy

1. Introduction

The interplay between physical health, emotional well-being, and longevity has become an area of increasing scientific interest, shifting the understanding of aging from a purely chronological process to a multifaceted interaction of biological, psychological, and environmental factors [1–3]. This evolving perspective has not only advanced research but has also attracted public and media interest, driving demand for holistic approaches that integrate mind–body interventions into skincare, hair care, and oral care, considering both esthetic and functional benefits [4,5]. Growing recognition of mental health's influence on aging has further reinforced the demand for interventions that support both physiological resilience and emotional well-being [6–8]. This shift has encouraged significant innovations in cosmetic science, leading to the development of bioactive ingredients and advanced technologies that move beyond superficial effects to promote systemic well-being and longevity.

This review provides a comprehensive evaluation of scientifically validated strategies that integrate physical and mental health considerations into modern personal care. By examining bioactive ingredients

and emerging methodologies across skincare, hair care, and dental care, it describes their effects on physiological function and esthetic outcomes (Table 1). Additionally, it explores holistic interventions that promote mental well-being, reinforcing the importance of an evidence-based, longevity-driven approach to personal care and healthy aging. The authors define bioactive peptides as chains of two to ~50 amino acids linked by peptide bonds, smaller than proteins. They emphasise that in cosmetics these peptides are attractive because of their multitarget functional

activities: antioxidant, anti aging, anti inflammatory, antimicrobial. The review argues that peptide based ingredients are part of the broader shift to functional/cosmeceutical formulations (not just appearance, but skin health, repair, etc.).

The interplay between physical health, emotional well being, and longevity has become an area of increasing scientific interest, shifting the understanding of aging from a purely chronological process to a multifaceted interaction of biological, psychological, and environmental factors. This evolving perspective has not only advanced research but has also attracted public and media interest, driving demand for holistic approaches that integrate mind body interventions into skincare, hair care and oral care, considering both esthetic and functional benefits. Growing recognition of mental health's influence on aging has further reinforced the demand for interventions that support both physiological resilience and emotional well being.

This shift has encouraged significant innovations in cosmetic science, leading to the development of bioactive ingredients and advanced technologies that move beyond superficial effects to promote systemic well being and longevity. Among these advancements, the emerging field of neuro cosmetics, particularly aromatherapy based formulations, illustrates how cosmetic science is increasingly leveraging olfactory and neuro endocrine pathways to potentially affect mood, stress and emotional well being while also mitigating physical signs of biological aging. Furthermore, advances in biomimetic materials, adaptogens, antioxidants and microbiome supportive ingredients reflect a growing understanding of the roles of cellular resilience, immune function and neural signaling in the aging process.

The intersection of dermatology, dentistry, neuroscience and longevity research is contributing to recent developments in personal care research. Cosmetic innovations not only enhance skin, hair and oral health, but also serve as integrative tools for influencing health span and life span, highlighting the relevance of a truly interdisciplinary approach in cosmetic science.[2][3]

1. **Skin care :-**

1. Emerging Active Ingredients in Skin Care

1.1 Peptide and synthetic actives

- **Acetyl Tetrapeptide-5**: A small synthetic tetrapeptide targeting the under-eye (periocular) area. It was shown in one small study (~20 subjects) to reduce vascular permeability (≈50%) in vitro and improved edema/dark-circles with topical 0.01% in 35% of participants after 15 days.
- **Copper Tripeptide (GHK-Cu)**: A well-studied peptide–metal complex. It stimulates collagen/glycosaminoglycan synthesis, modulates MMPs and skin fibroblasts, increases dermal density and reduces slack skin in human trials (e.g., a 71-women trial).

Dipeptide Diaminobutyroyl Benzylamide Diacetate (a "tripeptide-3"): Inspired by snake-venom neuropeptides (Waglerin-1), this peptide works by reducing facial muscle contraction (via nAChRs), so is positioned as an anti-wrinkle "muscle-relaxant" for the face. A 4% formulation over 4 weeks in ~57 volunteers showed significant improvement over placebo in glabellar and crow's feet wrinkles. [3]

1.2 Naturally-derived / biomimetic ingredients

- **Ectoin**: A small molecule derived from halophilic bacteria (very drought/UV resistant environments). It forms a "water-shell" around proteins, reduces transepidermal water loss (TEWL), enhances barrier/hydration, and up-regulates heat-shock proteins (HSP70) for cell protection. A randomized controlled study (104 subjects) with 2% ectoin twice daily for 4 weeks showed improved skin hydration, elasticity, and surface structure.
- **Aloe Vera Leaf Extract + Trimethylglycine (TMG)**: A novel combination (1 : 1 mass ratio) was found to increase aquaporin-3 (AQP3) expression in keratinocytes ~2-fold, enhancing hydration and barrier function in vitro; a 60-subject clinical study over 28 days showed immediate hydration boost and improved skin feel.
- **Prunus mume Fruit Extract**: Derived from Japanese plum/ume, especially the seed fraction. It shows skin-whitening, antioxidant, anti-MMP, and SIRT1-promoting effects. In vivo in mice: increased collagen by 38% and reduced skin thickness by 27% after UVB challenge.
- **Andrographolide (from Andrographis paniculata)**: A labdane diterpenoid with anti-inflammatory, antioxidant, and detoxification properties. Studies showed enhanced epidermal stem cell proliferation, upregulated integrin β1, improved dermal density/skin sagging/hydration in a small 32-female subject study (40-50 years old).[4]

1.3 Insights & key takeaways

- Many of these actives (especially peptides, biomimetics) are designed **not just** for superficial appearance but for underlying **cellular resilience**, **barrier function**, **microenvironment**, and **anti-aging mechanisms** (e.g., stem cells, integrins, MMP modulation).
- Evidence bases vary widely: some (e.g., ectoin, Aloe+TMG) have stronger clinical data; others remain largely in vitro/early clinical stages (e.g., acetyl tetrapeptide-5, andrographolide) and are rated as "low strength" in the review.
- Natural/biomimetic ingredients are increasingly prominent — they often carry consumer appeal + biological plausibility.

2. Delivery Systems & Technology Platforms

Advancements are not only in actives but in **how** they're delivered or how skin is "treated" technologically.

2.1 Advanced delivery systems

- Because the skin barrier limits penetration (especially for large, hydrophilic or labile molecules) the review highlights nanoemulsions, solid lipid nanoparticles, nanocapsules, liposomes, and cell-penetrating peptide (CPP) modifications as strategies to enhance permeation.
- Example: Liposomes are biodegradable phospholipid vesicles, commonly used, but their limitations (stability, penetration) are now addressed via surface modification (CPPs) to enhance delivery.

2.2 Technology & diagnostics

- Although the review is more ingredient-centric, some overlapping tech advances include "neurocosmetics" and device/diagnostic tools (to be discussed in next section).
- More broadly (outside the review), there are trends like AI/ML for personalized skincare recommendation, "lab-on-a-chip" skin diagnostics, biomaterials (e.g., hydrogels, smart textiles) for skincare. For instance, research on molecular dynamics & machine learning for beauty design has been published.

2.3 Biomimetic & regenerative strategies

- The review mentions biomimetic materials: e.g., ingredients that mimic natural protective molecules (ectoin water-shell), stem-cell related peptides, matrix modulation etc. These align with "skin rejuvenation" beyond mere coverage of damage.
- Also interdisciplinary crossovers: dermatology, dentistry, neuroscience, longevity science are converging.[3]

3. Holistic, "Beyond Beauty" Dimensions: Mind–Body–Longevity

One of the more interesting aspects of the review is the shift from solely aesthetic outcomes to holistic health, including emotional/psychological well-being, immune/physiological resilience, and longevity.

3.1 Neurocosmetics & sensory/emotional integration

- The review introduces the concept of neurocosmetics — topical or sensory formulations which act not only on skin structure but neurosensory / neuroimmune pathways: e.g., olfactory stimuli (aromatherapy), phytoncides (forest volatile compounds), skin's own neurosensory signalling.
- For example: inhalation of essential oils (e.g., lavender) modulates heart rate, blood pressure, brain activity (EEG/fMRI) and may reduce stress.
- Phytoncides (volatile compounds from trees) inhaled during forest bathing ("shinrin-yoku") may support immune function and reduce stress-mediated immunosuppression. The review notes that studies are small, but the idea is integration of environment/sensory with skin/immune health.

3.2 Longevity / systemic health integration

- The review argues that skin (and hair/oral) care is now overlapping with longevity science: optimizing health span, resilience, stress adaptation, immune function, cellular maintenance.
- Example: Ingredients that support stem cell function, integrin signalling, stress responses (HSPs) etc. These are more typical of longevity research than classical beauty.
- The conceptual shift: health = physical + emotional + social well-being (↔ World Health Organization definition) and cosmetics may play a role in all three.

3.3 Multi-functional / integrative formulations

- Modern products are moving away from single-target (e.g., just wrinkle reduction) to multifunctional: barrier/hydration + anti-aging + neuro-stress + emotional/sensory support. The merging of skin/hair/oral care into integrated lifestyle and wellness interventions. [(4)]

4. Practical Implications & Considerations

For formulators / skincare professionals

- Choosing actives: Balance between strong clinical evidence vs hype. E.g., ectoin and Aloe+TMG have stronger data; many peptides still need larger trials.
- Delivery matters: Even potent actives won't work if they can't reach target site (e.g., dermis). Nanocarriers, CPPs etc add complexity/cost but may enhance efficacy.
- Holistic branding: There's a demand for formulations that speak to "wellness", "mind-body", "resilience" – but claims must be substantiated.
- Personalisation and diagnostics: As technologies (AI/ML, skin age calculators, lab-on-a-chip) grow, skincare may become more tailored rather than one-size-fits-all.

For consumers / user perspective

- Seek evidence: Look for clinical data (number of subjects, duration, endpoints).
- Don't expect miracles: Many innovations are early-stage and "low strength" evidence.
- Mind–body matters: Stress, sleep, diet, lifestyle impact skin health. Products that aim to influence sensory/emotional state (neurocosmetics) add value but are adjuncts, not replacements.
- Consistency counts: Barrier protection, hydration, sun protection remain foundational. New actives add incremental benefit.

5. Challenges & Future Directions

- Evidence gaps: Many novel actives have small-scale studies or are still in vitro/animal. Larger randomized, long-term human trials are needed. The review highlights this.
- Regulation & claims: Especially when moving into "health" or "longevity" claims, regulatory frameworks (cosmetic vs drug) matter.

- Delivery/penetration hurdles: Skin remains a formidable barrier. Ensuring stability, bioavailability, safety of new delivery systems is essential.
- Sustainability & biotech: As the industry uses biotech, synthetic biology, biomimetics, attention to sustainability (resource usage, environmental impact) grows. (See broader biotech in beauty industry coverage).
- Personalisation & diagnostics: Tools like AI, skin-age calculators, wearables/patches may enable better customization of skincare interventions.
- Integration of lifestyle/holistic factors: Because skin is impacted by systemic health (immune, metabolic, neurological), future cosmetic science may increasingly coordinate with nutraceuticals, lifestyle medicine, digital health etc.
- Ethics & safety: Especially for sensory/neuro actives, exposure to novel bio-active compounds, long-term effects, robust safety data need to keep up with marketing.

1. The New Paradigm in Skin Care

Modern cosmetic science is shifting from *surface-level aesthetics* (wrinkle reduction, pigmentation) to integrated health and longevity, where *skin is viewed as a biomarker and regulator of systemic well-being*.
Key scientific drivers:

- Neurocosmetic research → exploring skin–brain communication.
- Regenerative & stem-cell biology → targeting the dermal extracellular matrix (ECM) and stem cell niches.
- Systems biology & AI → creating personalized formulations.
- Biotechnology & biomimetics → producing sustainable and functional bioactives.

Skin is now considered a *"mirror organ"* reflecting oxidative stress, inflammation, and metabolic health—making dermatocosmetic interventions a potential gateway to improved systemic resilience.[13][14]

2. Advanced Active Ingredients

2.1 Bioactive Peptides

Peptides are short amino acid sequences that signal, relax muscles, or repair the ECM.

Peptide	Mechanism of Action	Evidence / Efficacy	Key Benefits
Acetyl Tetrapeptide-5	Reduces vascular permeability, enhances lymphatic drainage, and reduces puffiness.	*In vivo* study (20 subjects): ↓ under-eye edema in 35% within 15 days.	Eye contour firming, anti-fatigue.

GHK-Cu (Copper Tripeptide-1)	Stimulates collagen, elastin, glycosaminoglycans; reduces oxidative damage.	Clinical: 71 women, 12 wks → ↑ dermal density, ↓ wrinkles.	Regeneration, wound healing, anti-aging.
Palmitoyl Pentapeptide-4 (Matrixyl)	Stimulates ECM synthesis; biomimetic of collagen fragment.	Multiple clinical trials: visible wrinkle reduction in 4–8 weeks.	Fine line reduction, dermal repair.
Dipeptide Diaminobutyroyl Benzylamide Diacetate	Inhibits nicotinic acetylcholine receptors → muscle relaxation.	Placebo-controlled (57 subjects): ↓ wrinkle depth after 4 weeks.	"Botox-like" smoothing effect.

Peptide Trends:

- Combinations (e.g., *Matrixyl 3000*, multi-peptide complexes).
- "Smart peptides" designed via AI-driven molecular modeling.
- Incorporation into nano-liposomes for deeper delivery.[3]

2.2 Biomimetic & Natural Molecules

Ingredient	Source & Function	Mechanistic Insights	Clinical Evidence
Ectoin	Extremolyte from halophilic bacteria.	Forms hydration shell around proteins, induces HSP70, stabilizes membranes.	2% ectoin → ↑ hydration, ↓ TEWL, ↑ elasticity (104 subjects, 4 wks).
Aloe Vera + Trimethylglycine (TMG)	Plant polysaccharides + osmolyte.	↑ Aquaporin-3 expression, enhances water transport.	60 subjects: significant ↑ skin hydration & softness.
Prunus mume Extract	Japanese plum extract rich in polyphenols.	Anti-MMP, antioxidant, ↑ SIRT1 (longevity enzyme).	*In vivo*: ↑ collagen 38%, ↓ UVB-induced damage.
Andrographolide	From *Andrographis paniculata* herb.	Anti-inflammatory, activates integrin β1, promotes stem cell renewal.	32 middle-aged women: ↑ dermal density, hydration.

Niacinamide (Vitamin B3)	Classic vitamin with rejuvenated importance.	Supports barrier lipids, ↓ hyperpigmentation, ↑ NAD^+ metabolism.	Numerous RCTs: broad benefits on barrier and tone.

Key Innovation:
These compounds aim not just for cosmetic effect but for *cellular homeostasis*—balancing oxidative stress, inflammation, hydration, and cellular turnover.[15][16]

2.3 Adaptogens & Phytochemicals

Class	Representative Actives	Mechanisms & Pathways
Adaptogenic herbs	*Rhodiola rosea*, *Panax ginseng*, *Ashwagandha*	Modulate cortisol, enhance mitochondrial function, improve dermal energy metabolism.
Polyphenols	Resveratrol, EGCG (green tea), ferulic acid	Activate Nrf2 and SIRT1 → antioxidant, DNA repair, longevity-linked effects.
Marine actives	Algae polysaccharides, fucoidan	Provide hydration, antioxidant and UV-protective biofilms.
Probiotics & postbiotics	*Lactobacillus ferment*, *Bifida lysate*	Modulate skin microbiome, barrier integrity, and inflammation.

3. Delivery Systems & Formulation Technology

3.1 Nanotechnology in Cosmetics

System	Function	Example Ingredients
Liposomes / Niosomes	Enhance solubility and skin penetration of actives.	Peptides, CoQ10, retinol.
Solid Lipid Nanoparticles (SLN)	Protect sensitive actives, slow release.	Vitamin E, retinol, coenzymes.
Nanoemulsions	Stable dispersion of oil/water, improves texture and absorption.	Sunscreens, botanical extracts.
Cell-Penetrating Peptides (CPPs)	Facilitate transdermal delivery of macromolecules.	Growth factors, DNA repair enzymes.

Emerging Concepts:

Smart nanocarriers: triggered by pH, temperature, or light.Exosome-like vesicles from plant or yeast origin as biomimetic carriers.3D skin models used for in-vitro penetration and efficacy testing.

3.2 Biotechnology & Green Manufacturing

- Fermentation technology for peptides, ceramides, and collagen analogs → sustainable and scalable.
- Synthetic biology to produce rare natural actives (e.g., vegan squalene, bio-retinol).

- Microbial biosynthesis reduces environmental impact and ensures ingredient consistency.[17][18]

4. Neurocosmetics and Emotional Well-Being

4.1 Skin–Brain Axis

Skin communicates with the central nervous system via neuropeptides (substance P, CGRP), hormones (cortisol), and immune cytokines.

Neurocosmetic agents modulate this interface:

- Fragrances & essential oils (e.g., lavender, bergamot) affect EEG patterns, inducing relaxation.
- β-endorphin-releasing peptides (from marine proteins or plant extracts) promote mood and "comfort skin" sensation.
- Phytoncides (tree volatiles) shown to lower cortisol and enhance NK cell activity.

4.2 Sensory Skin Care

Multisensory formulations now consider:

- Texture & temperature perception (gel-to-water, transforming creams).
- Aromachology – scent-based psychological modulation.
- Colour therapy & packaging cues – affect consumer stress and satisfaction.[18][19][20]

5. Longevity-Oriented Skin Science

5.1 Molecular Pathways Linked to Longevity

- Sirtuins (SIRT1–7): regulate mitochondrial metabolism, DNA repair. Activated by resveratrol, niacinamide, Prunus mume.
- AMPK & mTOR: nutrient-sensing pathways controlling cellular renewal; modulated by peptides and plant polyphenols.
- Senolytics & anti-inflammaging: ingredients targeting senescent cells or chronic inflammation (quercetin, curcumin).

5.2 Integration with Internal Health

Holistic skincare now overlaps with:

- Nutraceuticals: collagen peptides, hyaluronic acid supplements, antioxidants.
- Lifestyle medicine: stress reduction, sleep hygiene, diet rich in phytonutrients.
- Digital longevity tracking: skin age biomarkers measured by imaging and AI.[6]

6. Personalized and Diagnostic Technologies

Technology	Application	Example
AI-based skin analyzers	Use deep learning to assess texture, pigmentation, wrinkles.	L'Oréal's Modiface, SkinVision apps.
Lab-on-a-chip diagnostics	Microfluidic devices that measure sebum, hydration, microbiome.	Portable dermatologist tools.
Wearable sensors	Track pH, moisture, UV exposure in real time.	Smart patches, biosensing textiles.
Digital twins of skin	Simulated 3D models for virtual ingredient testing.	Used in R&D to predict efficacy.

These technologies enable precise formulation matching to a person's genotype, lifestyle, and environmental exposure.

7. Sustainability and Ethical Beauty

Future cosmetic development integrates:

- Circular formulation design: biodegradable and refillable packaging.
- Carbon-neutral ingredient sourcing.
- Vegan, cruelty-free biotechnology production.
- Transparent data and ingredient traceability (blockchain labeling).[7][8]

8. Challenges and Future Perspectives

Challenge	Description	Potential Solutions
Evidence quality	Many cosmetic trials are small, short, or industry-sponsored.	Larger RCTs, standardized biomarkers, independent replication.
Penetration limits	Stratum corneum blocks large actives.	Nanocarriers, microneedles, bioadhesive systems.
Regulatory ambiguity	Longevity/health claims blur cosmetic-drug boundaries.	Clearer FDA/EU definitions and claim substantiation.
Safety of nano-materials	Possible long-term toxicity or bioaccumulation.	Biodegradable nanomaterials, risk assessment studies.
Consumer education	Hype around "anti-aging" ingredients.	Transparent evidence-based communication.

9. Summary Table: The Future of Skin Health & Longevity

Dimension	Innovation Example	Outcome
Cellular repair	GHK-Cu, Matrixyl peptides	Collagen, ECM renewal
Barrier & hydration	Ectoin, Aloe + TMG	TEWL reduction, elasticity
Stress resilience	Adaptogens, phytoncides	Cortisol modulation
Microbiome modulation	Probiotic ferments	Balanced inflammation
Longevity signaling	Resveratrol, SIRT1 activators	Mitochondrial efficiency
Personalized care	AI diagnostics, nanotech	Optimized efficacy
Sensory wellness	Neurocosmetics, aromatherapy	Mood enhancement

10. Key Takeaways

Cosmetic science ≠ superficial beauty. It now embraces well-being, emotional balance, and longevity biology.Ingredient innovation (peptides, biomimetics, adaptogens) merges with technological innovation (AI, nanotech, green biotech).Holistic health implies mind–skin–body integration; the *skin* is a sensor and regulator of internal health.The field moves toward evidence-based, sustainable, personalized skincare for resilience, not just youth.[12][21][22][23][24]

1. Hair care:

1. Emerging Active Ingredients for Hair Care

1.1 Peptide-based and biomimetic actives

The copper-tripeptide complex GHK-Cu is highlighted for hair care: It "enhances hair growth and thickness, enlarges hair follicle size, and improves hair transplant success rates". Mechanism: stimulation of dermal fibroblasts in the hair-follicle dermal papilla, increased VEGF expression, decreased TGF-β1 secretion, reduced apoptosis of dermal papilla cells. Example: In vivo mouse studies: intradermal GHK-Cu injections led to enlargement of follicles (transition from vellus to terminal type) around wound areas. While promising, the evidence level is marked "Low" (i.e., preliminary) for hair application in that review.

1.2 Naturally derived hair-targeting ingredients

- **Biotin**: A water-soluble B-vitamin, important in fatty acid/amino acid metabolism and keratin production. The review states: "Aside from conditions like alopecia and uncombable hair syndrome, there is no scientific validation of biotin's efficacy in enhancing hair quality or quantity in individuals without a deficiency."
- **Wasabi-derived 6-MSITC (6-methylsulfinylhexyl isothiocyanate)**: In vitro human dermal papilla cell studies (2 μM) showed increased DPC proliferation and up-regulated VEGF mRNA → suggests potential hair growth stimulant.
- **Vanillyl butyl ether**: A warming agent (sensory stimulator) that via sensory neuron/vanilloid receptor (VR-1) activation triggers CGRP release → stimulates microcirculation around follicles and IGF-2 production (important for hair stem cell proliferation).

- **Shikimic acid**: From plant sources, acts as a "mannose bioisostere". In vivo/organ-culture hair follicle studies showed induction of IGF-1, KGF, VEGF in follicles → potential promotion of anagen phase.
- **Tetrahydroxystilbene-2-O-β-D-glucoside (TSG)**: Derived from Polygonum multiflorum root. In double-blind, placebo-controlled studies (26 pre-/post-menopausal women): 97% reported reduced hair loss; 77% noted increased hair thickness after 3-6 months. Marked as "Strong" in review for hair care, though still early.

1.3 Key take-aways for ingredient selection

- There's a move from purely cosmetic hair care (shine, softness) to scalp health, follicle regeneration, hair-cycle modulation, and even pigment/aging aspects (grey hair) in hair science.
- Many ingredients are still in early evidence stages (in vitro, small trials), especially for hair-follicle/dermal-papilla modulation.
- Multi-mechanistic ingredients (vascular, stem cell niche, sensory microcirculation) are increasingly relevant for hair longevity (i.e., sustained thickness/density over time, reduced thinning with aging).[25][26]

2. Delivery Systems & Formulation Technologies for Hair / Scalp

While the review focuses more on skin, several concepts apply to hair & scalp.

2.1 Advanced delivery & targeting

- Hair-care formulations now target scalp microenvironment: beyond hair shaft, focusing on the dermal papilla, bulb region, follicle niche. Delivery systems must penetrate scalp skin, reach follicular reservoirs, and maintain activity over hair-cycle time spans.
- Nanocarriers, liposomes, solid lipid nanoparticles developed for dermal/skin delivery may adapt for scalp applications (e.g., peptide carriers, enhanced permeability).
- Sensory-activated delivery: Agents like vanillyl butyl ether that stimulate receptor pathways (VR-1) in the scalp to enhance microcirculation and delivery of nutrients/growth factors to follicles (see above).

2.2 Biomimetic & green formulation support

- Use of botanical stem-cell-derived extracts (e.g., shikimic acid from plant callus) for regeneration support.
- Use of microcirculation-enhancing agents, adaptogens (in hair-care context), biomimetic peptides to mimic endogenous hair-growth signals (VEGF, IGF, KGF).
- Formulation trends towards **scalp health** (barrier, microbiome, inflammation) as foundational to hair longevity — rather than simply hair shaft treatment.[27]

3. Holistic Health, Longevity & Hair Care

3.1 Hair as a longevity biomarker

- Hair thinning, miniaturization, greying are visible signs of aging (chronological + biological). The review emphasises hair care interventions geared toward *longevity* (maintenance of hair density, pigment retention, follicle health) rather than temporary cosmetic effect.
- For example, the TSG from P. multiflorum is aimed at early greying and thinning — addressing aging hair.

3.2 Mind–body & scalp connection

- The scalp is innervated richly; microcirculatory and neural regulation (e.g., sensory peptides, vanilloid receptors) affect hair follicles. The review's shift to "neuro-cosmetics" (skin/hair/neuro interface) implies hair care that also addresses stress, microvascular health, immune/hormonal regulation.
- Example: Vanillyl butyl ether stimulating VR-1 in scalp implies sensory/neuro modulation to support hair roots (IGF-2 release, microcirculation) — linking physiological health and hair longevity.

3.3 Integrative lifestyle & hair longevity

- Hair-care for longevity isn't just topical: Nutrition (e.g., biotin & micronutrients), systemic health (hormonal, immune, circulatory) influence hair follicle cycle. The article emphasises nutrients rich in vitamins/minerals for hair-cycle support.
- Preventive mindset: Strategies to preserve hair follicle reservoir, delay miniaturization, maintain pigment production, support scalp environment (reduce inflammation, oxidative stress) are emerging.[28]

4. Challenges & Future Directions in Hair-Care Science

4.1 Evidence and translation

- Many promising ingredients for hair are supported by in vitro or small-scale clinical studies; robust long-term trials in diverse populations are lacking. The review flags this ("Low" evidence strength for many hair actives).
- Heterogeneity: Hair loss etiologies vary (androgenetic, diffuse thinning, telogen effluvium, aging, nutrition, autoimmune) — treatments need to be stratified and evidence may not extrapolate.
- Translating scalp delivery: The hair follicle niche is complex (bulge, DP, bulbar region); effective penetration and sustained release remain technical hurdles.

4.2 Personalisation & diagnostics

- Hair-care for longevity will increasingly demand diagnostics: scalp imaging, follicle density measurements, hair-cycle tracking, biomarkers (microcirculation, oxidative stress) to tailor treatments.

- Integration with digital health: AI/ML tools to design or recommend peptides/bioactives based on scalp phenotype/hair-history.

4.3 Sustainability & formulation ethics

- As with skin care, hair-care science is moving toward biotechnology (fermented peptides, plant-cell extracts, green chemistry) for sustainability.
- Ethical and safe production of high-potency actives (e.g., GHK-Cu analogues, novel peptide scaffolds) must meet regulatory checkpoints.

4.4 Multi-modal & combined therapies

- Combining topical actives with device-based therapies (microneedling scalp, low-level laser therapy, micro-circulation enhancers) may enhance hair-longevity outcomes.
- Holistic approach: Addressing lifestyle (nutrition, sleep/stress, systemic health) + topical/scalp treatments for maximum impact on hair longevity.

1. The New Paradigm: Hair as a Longevity Organ

Hair follicles are mini-organs that undergo cyclical regeneration — anagen (growth), catagen (regression), telogen (rest), and exogen (shedding).
Aging, stress, inflammation, oxidative damage, and microvascular dysfunction shorten anagen and trigger premature follicular senescence.
The new generation of hair-care products aims to:

- Re-activate follicle stem cells in the *bulge* region.
- Support dermal papilla fibroblasts (DPF) for sustained signaling.
- Enhance microcirculation and oxygen/nutrient supply.
- Modulate hormones and neuro-signals influencing hair growth.
- Maintain pigment synthesis and delay greying.[29]

2. Bioactive Ingredients for Hair Growth and Longevity

2.1 Peptide-Based and Biomimetic Molecules

Active	Mechanism of Action	Evidence & Data	Outcome
Copper Tripeptide-1 (GHK-Cu)	Stimulates dermal papilla fibroblast proliferation, upregulates VEGF, suppresses TGF-β1, enhances ECM & angiogenesis.	In vivo studies: promotes anagen phase transition, increases follicle size.	Hair growth, improved density, scalp rejuvenation.
Palmitoyl Tetrapeptide-20	Mimics thymopoietin-stimulating peptides; improves	Ex vivo hair follicle culture: increased	Strengthens follicle structure,

	follicular vitality and reduces oxidative stress.	keratin gene expression.	improves resilience.
Acetyl Tetrapeptide-3 + Trifolium pratense (Red Clover) extract	Blocks DHT via inhibition of 5α-reductase and strengthens ECM at follicular anchor.	Human trial (n=30): +13% hair density, −29% hair loss after 4 months.	Anti-hair loss, scalp thickening.
Oligopeptide-41	Stimulates IGF-1 expression and Wnt/β-catenin activation.	In vitro DPC culture: +60% proliferation rate vs control.	Follicle renewal and anti-aging.

Insight:
Peptide actives represent the "next generation" of hair bio-signals, mimicking growth factors (VEGF, IGF-1) without systemic hormone effects.[31]

2.2 Plant-Derived & Natural Bioactives

Ingredient	Source / Type	Mechanistic Pathways	Evidence	Effect
6-MSITC (6-Methylsulfinylhexyl Isothiocyanate)	Extracted from *Wasabia japonica*	Activates dermal papilla cell proliferation, ↑ VEGF mRNA	In vitro DPC study	Follicle stimulation & microcirculation
Shikimic Acid	Plant-derived hydroxy acid	Induces growth factors (IGF-1, KGF, VEGF), enhances keratinocyte activity	In vivo/organ culture	Promotes anagen phase & scalp renewal
Tetrahydroxystilbene-2-O-β-D-glucoside (TSG)	From *Polygonum multiflorum*	Antioxidant, SIRT1 activator, melanin synthesis modulator	Clinical: 26 women, 97% ↓ hair loss, 77% ↑ thickness (3–6 mo)	Strong hair growth, anti-grey effect
Vanillyl Butyl Ether (VBE)	Sensory active (capsaicin analog)	Activates TRPV1 (vanilloid receptor), ↑ CGRP & IGF-2 → vasodilation & neuro-growth	Topical use increases scalp perfusion (thermal imaging)	Enhanced follicle perfusion, hair density
Caffeine	Natural alkaloid	Inhibits phosphodiesterase → ↑ cAMP → counteracts DHT effect	Multiple RCTs	Promotes anagen, reduces telogen phase duration

Biotin (Vitamin B7)	Vitamin cofactor	Supports keratin synthesis, fatty acid metabolism	Effective only in deficiency	Maintains strength, prevents brittleness

Trend:
Biomimetic molecules like TSG and shikimic acid align with *longevity biology* (SIRT1 activation, antioxidant repair), linking hair preservation with anti-aging.[31]

2.3 Microbiome and Scalp Health Ingredients

Emerging research shows the scalp microbiome (balance of *Cutibacterium*, *Staphylococcus*, *Malassezia*) affects follicle inflammation, dandruff, and sebum balance.

Active	Mechanism	Outcome
Lactobacillus ferment lysates	Modulate immune response, reduce *Malassezia* overgrowth	Improves scalp comfort and reduces itch
Prebiotic fibers (inulin, α-glucan oligosaccharide)	Feed beneficial microbes, rebalance scalp microbiota	Enhances barrier, reduces irritation
Postbiotics (fermented peptides)	Deliver microbial metabolites (short-chain fatty acids, lactic acid)	Strengthen scalp homeostasis, mild antimicrobial

3. Delivery Systems and Formulation Technologies

Technology	Function & Advantage	Example / Application
Nanoemulsions	Enhance solubility and penetration of oils/extracts into scalp	Caffeine, red clover, 6-MSITC formulations
Liposomal encapsulation	Protects peptides, provides controlled release into follicular ducts	GHK-Cu, palmitoyl tetrapeptides
Solid Lipid Nanoparticles (SLN)	Stabilize sensitive actives (vitamins, polyphenols)	For leave-on scalp serums
Hydrogel systems	Moisture-retentive delivery for sensitive scalp	Aloe + peptides combinations
Cell-penetrating peptides (CPPs)	Facilitate macromolecule delivery to follicle bulb	Growth factors, biomimetic peptides

New frontiers:
"Smart" nanocarriers that release actives in response to scalp temperature, pH, or mechanical massage.

4. Neurocosmetics and the Scalp–Brain Axis

Hair and scalp are highly innervated — stress, emotion, and neuroendocrine imbalance can disrupt growth cycles.
Emerging neurocosmetic strategies aim to modulate this axis.

Mechanism	Example Compound	Effect
↓ Cortisol & stress response	Adaptogens: *Rhodiola*, *Ashwagandha*	Reduces stress-induced hair loss

Activate sensory nerves for circulation	Vanillyl Butyl Ether, Menthol	Enhances perfusion, "energy" sensation
Increase endorphin release	β-endorphin mimetic peptides	Improves scalp comfort & subjective wellness
Aromatherapy synergy	Lavender, rosemary oils	Modulate brain alpha waves → relaxation & circulation

This mind–scalp connection supports both mental well-being and follicular longevity — bridging neurobiology and trichology.[32]

5. Longevity Biology in Hair Care

Hair-aging is characterized by:

- Decline in stem-cell activity (bulge stem cells senesce).
- Reduced angiogenesis in dermal papilla.
- Accumulation of oxidative damage to melanocytes (greying).
- Inflammaging (chronic micro-inflammation in follicles).[31]

Modern ingredients target these cellular mechanisms:

Longevity Pathway	Representative Actives	Mode of Action
Sirtuin activation (SIRT1)	TSG, resveratrol, niacinamide	Enhances mitochondrial efficiency, DNA repair
Nrf2 antioxidant response	Polyphenols, green-tea catechins	Detoxifies ROS, maintains follicular redox balance
mTOR/AMPK modulation	Caffeine, adaptogens	Supports energy metabolism, prevents senescence
Anti-inflammaging	Ectoin, probiotics, β-glucans	Stabilizes scalp immune tone, reduces cytokine stress

6. Holistic & Integrative Hair Longevity Strategies

6.1 Internal–External Synergy

- Nutraceuticals: Collagen peptides, marine proteins, zinc, iron, omega-3s, biotin (only if deficient).
- Lifestyle: Sleep optimization, stress management, balanced diet, UV protection.
- Adjunct therapies: Microneedling, low-level laser therapy (LLLT), PRP for enhancing topical efficacy.

6.2 Personalized Hair-Care Technologies

- AI scalp analyzers: Assess density, follicle size, dandruff severity.
- Tricho-diagnostic imaging: Optical coherence tomography for follicular mapping.
- Digital twins of scalp: Simulation models to predict ingredient performance.

These tools enable *precision trichology* — customizing products to individual scalp biology and lifestyle.

7. Sustainability & Green Innovation

Future hair-care formulations must align with:

- Biotechnological production: Fermentation of peptides, recombinant proteins, vegan keratin.
- Circular design: Biodegradable surfactants, refillable packaging.
- Ethical sourcing: Replacement of animal-derived collagen and keratin with plant or yeast analogs.[33]

8. Challenges and Future Research Directions

Challenge	Description	Needed Research
Low evidence quality	Most hair actives have small or in vitro studies only.	Large RCTs, histological and molecular markers.
Barrier penetration	Difficult to deliver actives to follicle bulb.	Nanocarriers, microneedle-assisted delivery.
Variability in alopecia types	Androgenetic vs telogen vs stress-related.	Personalized ingredient mapping.
Regulatory ambiguity	Overlap between cosmetic and therapeutic claims.	Global harmonization (EU, FDA, ISO).
Consumer education	Misleading "miracle growth" claims.	Transparent efficacy grading systems.

9. Summary Table — Top Hair-Longevity Ingredients (2025)

Category	Ingredient	Mechanism	Evidence Level	Outcome
Peptide	GHK-Cu	VEGF↑, ECM repair	Moderate	Growth & density
Peptide + Botanical	Acetyl Tetrapeptide-3 + Red Clover	5α-reductase↓	Strong	Anti-hair loss
Polyphenol	TSG (Polygonum multiflorum)	SIRT1↑, antioxidation	Strong	Growth, anti-grey
Phytoactive	Shikimic acid	IGF-1, KGF↑	Moderate	Anagen prolongation
Sensory active	Vanillyl butyl ether	VR-1 activation	Moderate	Circulation & vitality
Nutrient	Biotin	Keratin metabolism	Low (if non-deficient)	Strengthening
Alkaloid	Caffeine	PDE inhibition, cAMP↑	Strong	Growth stimulation

Microbiome	Probiotics/Postbiotics	Immune modulation	Emerging	Scalp balance
Adaptogen	Ashwagandha	Cortisol↓, AMPK↑	Moderate	Stress-related hair preservation
Longevity molecule	Niacinamide	NAD^+, SIRT↑	Strong	Follicular resilience

3.Oral Care

1. Paradigm Shift: Oral Care as an Entry Point to Longevity

- The oral cavity is now understood not just in isolation (teeth/gum hygiene), but as a system-wide gateway linking oral tissue integrity, microbial biofilms, inflammation, and systemic health (cardiovascular, metabolic, immune).
- Maintaining healthy enamel, dentine, gingiva and mucosa contributes to reducing chronic low-grade inflammation (inflamm-aging) which accelerates ageing processes.
- Oral care formulations are evolving from purely cosmetic/maintenance (whiteness, fresh breath) to tissue resilience, barrier integrity, microbiome modulation, and regenerative capacity.
- Longevity angle: preserved oral tissue = fewer losses, fewer invasive interventions, reduced systemic burden (e.g., periodontitis linked to cardiovascular risk) = improved healthspan.

2. Key Active Ingredients & Mechanisms in Oral Care

2.1 Biomimetic Minerals & Remineralisation

**Hydroxyapatite (HAP) / Zinc-carbonate HAP

- HAP mimics the mineral phase of enamel and dentin. It is biocompatible, safe when ingested accidentally (particularly relevant for children).
- Mechanisms:
    - HAP particles deposit in demineralised enamel/dentin micro-pores, gradually replacing lost mineral and restoring matrix integrity.
    - In dentin hypersensitivity: HAP occludes exposed dentinal tubules, reducing fluid movement (which triggers nerve responses) and thereby reducing pain.
    - In biofilm control: HAP can bind to bacterial adhesins, blocking bacterial attachment to enamel surfaces and reducing plaque accumulation.
- Evidence:
    - A systematic review/meta-analysis found that HAP in oral care products significantly reduced dentin hypersensitivity vs placebo and also performed better than fluoride in some comparisons.

- In enamel/dentin remineralisation: multiple in vitro/in situ studies show HAP is *non-inferior* to fluoride in early lesions, and shows promise especially where fluoride use is limited.

- Implication for longevity: By preserving enamel and dentin early, HAP supports long-term structural integrity, reducing risk of decay, tooth loss, and invasive interventions which burden systemic health.[34]

Additional remineralising agents

- Nano-hydroxyapatite (nHAP): Smaller particle size increases surface area, enhances penetration of micro-pores, improves remineralisation potential.
- Self-assembling peptides (e.g., P11-4): These peptides infiltrate early carious lesions and provide a scaffold for new mineral formation, effectively guiding HAP nucleation.
- Bioactive glass particles: (see next section) — modern review emphasises their role in enhancing tooth life.

2.2 Whitening / Aesthetic + Functional Actives

- DL-Malic acid: Found in fruits; acts by oxidising surface stains on enamel, and interacting with enamel calcium ions to modify surface hardness/structure.
    - Provides a multifunctional effect: aesthetics (whitening) + underlying functional effect (surface mineral interaction).
- Important caveat: Whitening should not compromise structural integrity; hence actives are shifting toward those that support mineral health rather than aggressively abrade or oxidise.[35]

2.3 Microbiome / Barrier / Immune Modulators

- Research is increasingly targeting the oral microbiome, mucosal barrier integrity, and subclinical inflammation in gingiva/periodontal tissues.
- Ingredients and technologies involved: probiotic/postbiotic lysates, peptides supporting mucosal adhesion, barrier-enhancing minerals/ions, anti-microbial/anti-biofilm actives.
- This links oral health with systemic inflammation (periodontitis → systemic cytokines) and thereby longevity.[46]

2.4 Delivery & Diagnostic Technologies

- Nanocarriers for minerals/peptides: ensure penetration into micro-lesions, sustained release in oral environment.
- Biomimetic scaffolds: e.g., self-assembling peptides that facilitate mineral deposition.
- Diagnostic technologies: intra-oral imaging, optical coherence tomography of enamel/dentinal lesions, microbiome sequencing — enabling personalized oral care regimens.[36]

3. Formulation Technology & Delivery Systems for Oral Longevity

- Particle size & morphology: Smaller nanoparticles (nano-HAP) penetrate deeper into enamel/dentin micro-pores; higher surface area → better re-mineralisation.
- Ion-substituted HAP: e.g., zinc-carbonate HAP which more closely mimics natural dental apatite (contains minor ions like Zn, CO_3). These substitutions may improve solubility, bioactivity, and adherence.
- Controlled release & adhesion: Products formulated to deposit a durable HAP film on enamel, resisting clearance by saliva/chewing. The meta-analysis on dentin hypersensitivity shows longer term stable layer formation.
- Combination therapies: e.g., HAP + fluoride, HAP + ozone, HAP + plant extracts, to exploit synergistic mechanisms.
- Bioactive glass particles: Another technology reviewed in 2024: These release Ca, P, Si ions to support remineralisation and enamel repair.[39][40][41]

4. Holistic & Longevity Dimensions in Oral Care

- Oral health as systemic health marker: Conditions like gingivitis, periodontitis, enamel/dentin breakdown are associated with systemic inflammation, cardiovascular risk, diabetes, and accelerated ageing. By preserving oral tissues, we support longevity.
- Tissue resilience & repair capacity: The shift is to maintain the *repair capacity* of teeth, gums, mucosa rather than wait for obvious disease. Early intervention, preservation of mineral content, and barrier function are key.
- Integration with lifestyle: Diet (acid intake, sugar consumption), smoking, sleep, stress, immune status all affect oral health. Oral-care innovations integrate with lifestyle medicine – for example, microbiome modulation, stress-linked barrier dysfunction in gums.
- Emotional/psychosocial well-being: A healthy smile, absence of pain or sensitivity, good confidence contribute to mental well-being, which itself influences healthspan through stress-reduction pathways.
- Preventive longevity mindset: Rather than reactive (fillings, extractions), focus shifts to *maintenance*, *early lesion repair*, *minimising interventions*, preserving function for decades.[37][38]

5. Challenges & Future Research Directions

Challenge	Details	Needed Research
Evidence gaps in humans	Many studies are in vitro/in situ; fewer long-term RCTs on remineralisation & systemic outcomes.	Large scale longitudinal clinical trials linking oral-care actives with tooth longevity and systemic health markers.

Delivery in complex oral environment	Saliva flow, pellicle, biofilm, chewing forces can remove or inhibit deposition of actives.	Improved formulations with better adhesion, retention, and sustained release; real-world testing.
Personalisation	Oral health risk varies (diet, genetics, microbiome, anatomy).	Diagnostic tools to stratify individuals and tailor formulations (e.g., more mineral support for heavy acid diet; more microbiome support for high biofilm risk).
Regulatory frameworks	As actives begin to claim systemic/health benefits (microbiome, immune modulation), the boundary between cosmetic vs drug becomes blurred.	Clear regulatory guidance globally for oral care ingredients with health claims; standardised endpoints.
Sustainability & bio-innovation	Biocompatible materials, eco-friendly production, safe nanomaterials.	Research into plant/biotech derived minerals/peptides, safe nano-materials, life-cycle assessment.
Linking to systemic outcomes	While oral health links to systemic disease are known, showing that a given oral-care intervention will reduce e.g., cardiovascular events is extremely challenging.	Integrated clinical studies with oral interventions and systemic biomarker tracking (inflammation, oxidative stress, vascular health).

6. Summary Table: Top Oral-Care Actives & Technologies (2025)

Category	Ingredient / Technology	Mechanism of Action	Evidence Level	Longevity Relevance
Biomimetic mineral	Hydroxyapatite (HAP) / nano-HAP	Mineral deposition, tubule occlusion, biofilm antagonism	Moderate to Strong (systematic reviews/meta-analysis)	Maintains enamel/dentin integrity long-term
Ion-substituted mineral	Zinc-carbonate HAP	Enhanced mineral mimicry, solubility, tubule occlusion	Moderate	Improves durability of mineral repair
Self-assembling peptide scaffold	P11-4 (oligopeptide)	Penetrates early lesions, scaffold for mineral regeneration	Emerging/Moderate	Enables early repair, reduces intervention
Bioactive glass particles	Ca/P/Si releasing glass	Ion release for remineralisation, buffering, antibacterial	Emerging	Adds new longevity-oriented repair path

Whitening functional	DL-Malic acid	Surface oxidation + mineral interaction for stain reduction	Low to Moderate	Aesthetic + underlying mineral effect, supports confidence & well-being
Microbiome / barrier modulator	Probiotics/postbiotics, barrier minerals	Bio-film modulation, mucosal immunity, barrier support	Emerging/Low	Supports systemic inflammation reduction via oral health
Delivery & Nano-carrier systems	Nanoparticles, sustained release vehicles	Better deposition, retention of actives in oral environment	Emerging	Improves efficacy of longevity-oriented formulations

7. Key Takeaways

- Oral-care science is shifting from maintenance/hygiene to regeneration, resilience and longevity of dental and periodontal tissues.
- Biomimetic minerals (especially HAP) are central, with clinically meaningful evidence supporting their role in remineralisation and hypersensitivity reduction.
- Emerging technologies (nano-HAP, self-assembling peptides, bioactive glass, microbiome modulators) broaden the scope of what oral care can achieve — not just whitening/fresh breath but structural health, microbial homeostasis, barrier integrity.
- The holistic health connection is strong: oral health ↔ systemic inflammation ↔ longevity. Preventing tooth/periodontal tissue loss is part of preserving systemic vitality.
- Effective formulations will increasingly need to integrate material science, microbiology, nanotechnology, and systems biology.
- While the prospects are promising, more long-term human clinical data, personalisation, and sustainability frameworks are required.[43][44]

Conclusions and Future Perspectives

In this review, we have examined recent advances in cosmetic science across skincare, haircare, oral care, and the emerging field of neurocosmetics, emphasizing their potential to influence not only external appearance but also physiological resilience and emotional well-being. In summary, recent advancements in cosmetic science signal a pivotal shift from a narrow emphasis on external esthetics to a more holistic approach that embraces both internal and external well-being. This

integrative perspective aligns with the World Health Organization's definition of health, as a state of complete mental, physical, and social Cosmetics 2025, 12, 202 19 of 24 well-being. By incorporating cutting-edge technologies and bioactive natural ingredients into modern skincare, haircare, and oral care formulations, the field recognizes the profound interdependence of mental and physical health in the aging process. Innovations like aromatherapy and neurocosmetic actives further illuminate the profound link between sensory perception, emotional balance, and physiological health. The continued exploration of advanced delivery systems and multifunctional ingredients ensures that cosmetic products go beyond enhancing appearance, actively contributing to systemic health, stress resilience, and longevity. At the same time, the current body of evidence is marked by important limitations. Some ingredients, such as ectoine, the combination of Aloe vera extract with trimethylglycine, and hydroxyapatite in oral care, are supported by relatively robust clinical data, including randomized controlled trials, showing improvements in skin hydration, elasticity, barrier repair, and enamel remineralization. In contrast, other promising actives—including acetyl tetrapeptide-5, biotin, andrographolide, as well as wasabi (6-MSITC), vanillyl butyl ether, and DL–malic acid—are primarily supported by in vitro findings, animal studies, or small-scale human trials, limiting their translational value. This discrepancy underscores the need for larger, longitudinal, and well-controlled clinical investigations. In parallel, also the field of neurocosmetics exemplifies both promise and current limitations. To date, most neurocosmetic formulations are in preclinical or early clinical stages. Most studies rely heavily on subjective measures such as self-reported mood, relaxation, or quality of life's endpoints that are vulnerable to placebo effects and influenced by individual variability in neurocutaneous signaling, skin type, microbiome composition, and psychological baseline. Within this area, EEG-based studies require particular caution. Although they provide insight into neural responses to olfactory and sensory stimuli, they remain constrained by small sample sizes, heterogeneous methodologies, and lack of standardization in fragrance concentration and recording protocols. This heterogeneity compromises reproducibility and interpretability. Larger, well-designed, longitudinal studies incorporating multimodal assessments are needed to confirm efficacy and safety and to define the role of neurocosmetics within evidence-based dermatologic and esthetic practice. Despite these challenges, ongoing research indicates that cosmetic science is gradually evolving beyond esthetics, potentially supporting psychological well-being, and healthy aging. Advances in clinical research, standardization of methodologies, and integration of objective measures are likely to accelerate the transition from preliminary findings to consolidated evidence. In this perspective, cosmetics and neurocosmetics represent not only an area of technological innovation but also a promising field of preventive health, capable of redefining personal care and driving a transformative shift that integrates beauty, well-being, and longevity. As research continues to bridge these realms, the industry is moving toward a more seamless integration of external and internal well-being, where each element reinforces and sustains the other. Funding: No external funding was received for this publication. Institutional Review Board Statement: Not applicable. Data Availability Statement: Data are contained within the article. Conflicts of Interest: The authors serve as Key Opinion Leaders for SkyLab AG; however, they were not compensated for their authorship or specific contributions to this publication.

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