Peptides and Hair Growth: Scientific Mechanisms, Clinical Evidence, and Practical Applications in Modern Trichology

Dr. Samuel Sarmiento • December 15, 2025

Key Takeaways

- **Peptides Support Scalp and Follicle Health.** These small amino acid chains act as signaling molecules that penetrate the scalp and influence follicle function. They help regulate the hair growth cycle, anchoring, and structural integrity.

- **Peptides Are Not a Cure for Hair Loss.** While they improve scalp conditions and reduce shedding, peptides are best seen as supportive tools—not replacements for pharmaceutical treatments or solutions for genetic hair loss.

- **Three Peptides Show Promise in Research.**

- **Clinical Studies Show Encouraging Results.** Small trials report improvements in hair density, thickness, and reduced shedding. However, large-scale, independent studies are still needed to confirm long-term efficacy.

- **Formulation Quality Is Critical.** Peptide stability, concentration, and delivery systems (e.g., encapsulation, carrier agents) determine whether products can deliver results. Wash-off shampoos can still be effective with consistent use.

Introduction

Peptides have emerged as one of the most talked-about ingredients in cosmetic science and trichology. Once limited to anti-aging creams and wound-healing research, they are now being incorporated into a wide range of skin and hair formulations.

For hair health, peptides are being added to:

- Shampoos
- Conditioners
- Serums
- Scalp treatments

All with the goal of supporting follicle strength, anchoring, and growth.

Their small molecular size makes them particularly interesting: unlike larger proteins, certain peptides can penetrate the scalp barrier and deliver targeted signals to cells within the follicular environment.

But with this excitement comes an important question: *Do peptides truly support hair growth, or are they simply the latest cosmetic trend?*

What are Peptides and Why are They Relevant?

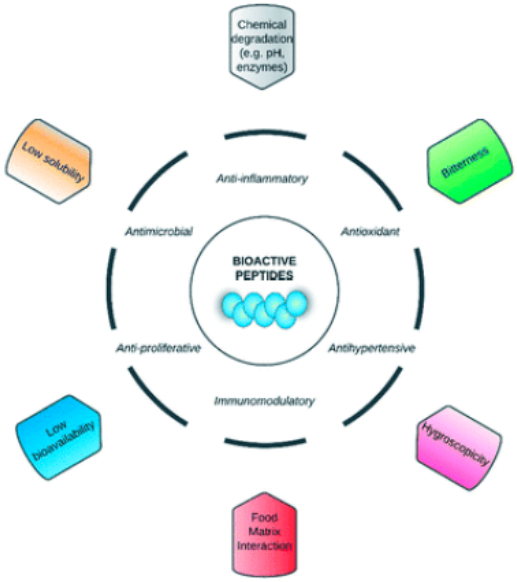

Figure 1. Bioactive Peptides cycle[19]

Peptides are short chains of amino acids, which are the same building blocks that make up proteins. Unlike long proteins, however, peptides are much smaller in size, typically consisting of only 2–50 amino acids.

This compact structure allows them to act as messengers within the body, sending signals that regulate cell behavior, repair processes, and tissue growth[1].

In skin and hair biology, peptides play multiple roles. They are involved in cell-to-cell communication, telling cells when to divide, when to produce structural proteins like collagen and elastin, and when to initiate repair after damage[2].

This is why peptides have long been studied in wound healing: they can accelerate regeneration by stimulating fibroblasts, keratinocytes, and other supportive cells[3].

The same signaling pathways are relevant for hair follicles, which undergo constant cycles of growth, regression, and renewal.

It is helpful to distinguish peptides from related terms:

- **Amino acids** are the smallest units, single molecules that link together to form larger structures[4].
- **Peptides** are short chains of amino acids with specific signaling roles.
- **Proteins** are much longer chains that fold into complex structures, making up the body's tissues, enzymes, and hormones[4].

This difference in size matters when it comes to topical application. Peptides are small enough to travel across the upper layers and reach target cells[5].

Key Peptides in Hair Growth Research

Copper Tripeptide-1 (GHK-Cu)

Copper tripeptide-1, often referred to as GHK-Cu, is one of the best-studied cosmetic peptides.

This compound is made of combines a naturally occurring tripeptide (glycyl-l-histidyl-l-lysine) with copper ions, which are essential cofactors for many enzymatic processes in the body.

GHK-Cu stimulates angiogenesis, the development of new blood vessels, which can improve microcirculation around hair follicles[6].

It also has anti-inflammatory properties, reducing oxidative stress by:

- Quenching up free radicals
- Limiting the inflammatory signals

In dermatology, GHK-Cu is well known for its role in wound healing and skin regeneration, where it promotes collagen production and tissue repair[6].

Biotinoyl Tripeptide-1

Biotinoyl Tripeptide-1 (Glycyl-L-Histidyl-L-Lysine) is a peptide linked to biotin; a vitamin associated with hair health[7].

This peptide is designed to strengthen the anchoring of hair follicles within the scalp by stimulating extracellular matrix production and improving the structural connection between the follicle and surrounding dermal tissue[18].

Acetyl Tetrapeptide-3

Acetyl Tetrapeptide-3 (Ac-Lys-Gly-His-Lys-NH2) functions by stimulating the production of extracellular matrix proteins, including[8]:

- Collagen III
- Laminin
- Collagen VII

These proteins form the supportive framework that secures the hair follicle within the scalp and helps maintain proper attachment during the active growth phase. By enhancing the synthesis of these structural components, Acetyl Tetrapeptide-

3 reinforces the dermal–epidermal junction surrounding the follicle. This strengthened anchoring reduces mechanical stress on the hair shaft, lowers the risk of premature shedding, and supports a more stable follicular environment. Over time, consistent use may contribute to improved hair retention, stronger follicle attachment, and reduced hair breakage without affecting hormonal pathways.

The Evidence

Several small clinical studies have evaluated topical peptide formulations in humans:

Copper Tripeptide-1 (GHK-Cu)

In a randomized double blind clinical trial, 60 patients with Alopecia Areata (AA) were treated with a cosmetic product containing GHK-Cu.

Over 3 months, a statistically significant improvement in hair density and thickness was observed, with some participants showing visible regrowth in areas of diffuse loss[9].

Biotinoyl Tripeptide-1

In an open-label study, 56 patients with androgenetic alopecia (AGA) or telogen effluvium (TE) applied a lotion to the scalp one daily overnight that contained Biotinoyl tripeptide.

Over 6 months, there were statistically significant improvements in hair density, thickness, and more time spent in the growth phase[10].

Acetyl Tetrapeptide-3

In a triple-blind controlled trial, 32 patients with AGA received 1mL topical applications of either an herbal extract containing Acetyl tetrapeptide-3 or 3% minoxidil twice daily.

Over 24 weeks, the herbal extract had comparable effects to 3% minoxidil, including in metrics of hair density, and terminal and vellus hair growth. Notably, there were no reported side effects, unlike minoxidil users[11].

Gaps in Evidence

Despite encouraging findings, the body of research on peptides for hair growth is still relatively limited.

Most clinical studies are small, industry-sponsored, and often combine multiple active ingredients, making it difficult to draw firm conclusions about long-term efficacy and the specific compound in question.

Independent, large-scale, peer-reviewed trials are needed to bolster the evidence.

Peptides in Formulations: Why Shampoo Matters

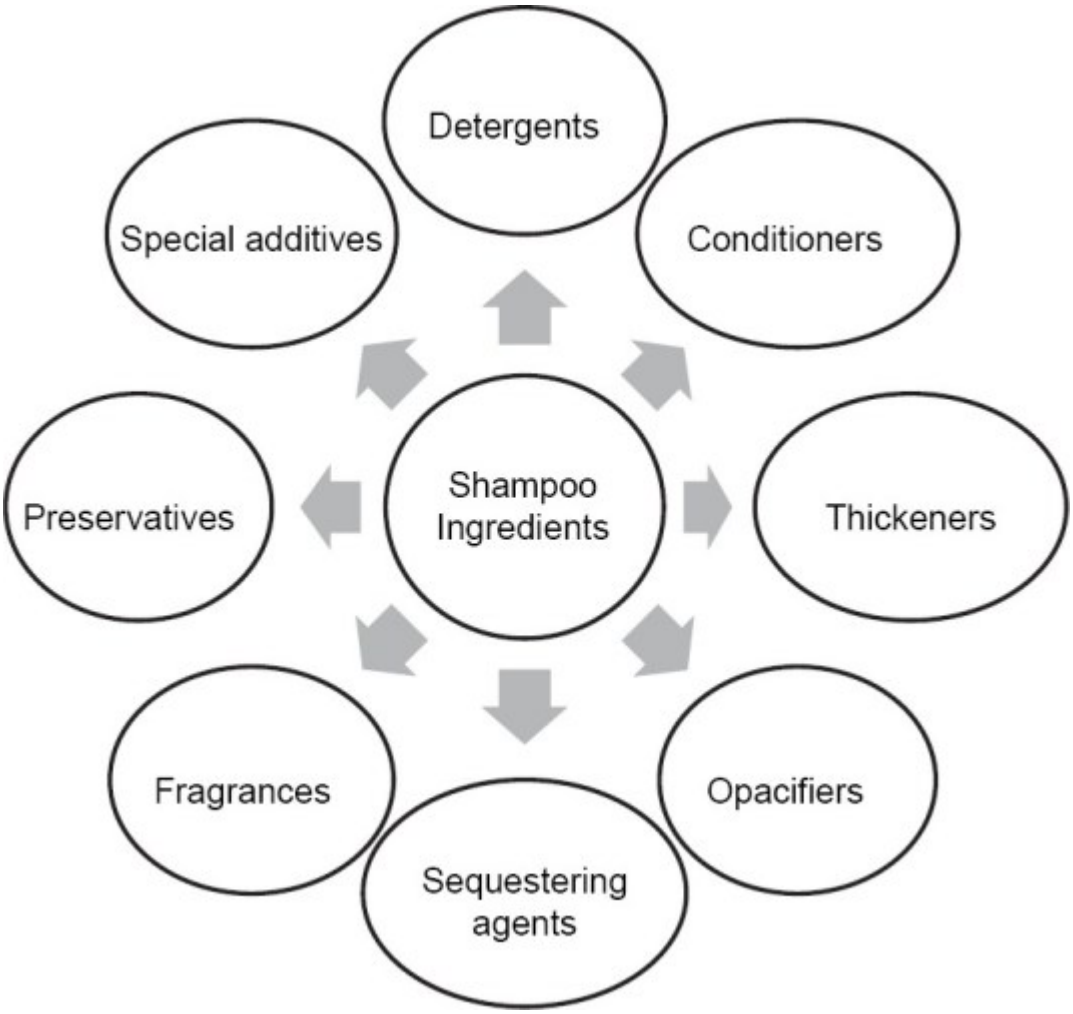

Figure 2. Basic ingredients present in shampoo[20]

When evaluating the effectiveness of peptides for hair growth, the formulation and delivery system are just as important as the peptide itself.

Unlike oral supplements or injections, topical hair products face the challenge of penetrating the scalp barrier and maintaining peptide stability in a cosmetic environment.

Wash-off vs. Leave-in Products

Shampoos are typically wash-off products, raising the question of whether peptides have enough time to exert their effects. However, repeated exposure through consistent use can compensate for shorter contact times.

Each wash delivers bioactive peptides directly to the scalp, allowing cumulative benefits over weeks of regular application.

Leave-in serums and conditioners may provide longer exposure, but shampoos play a critical role in creating a healthy scalp foundation and delivering actives at high frequency[12].

Formulation Science Matters

Peptides are delicate molecules that can degrade if not stabilized correctly.

Successful peptide shampoos rely on formulation strategies such as:

- Carrier systems[13]
- Protective encapsulation[14]

that preserve peptide activity until it reaches the scalp.

This is why not all peptide-based hair products on the market produce consistent results; stability and delivery technology are key.

Synergistic Benefits

Peptides also work best when paired with other supportive compounds. Ingredients like[15]:

- Biotin

- Panthenol
- Botanical extracts

can enhance follicle health and scalp resilience, amplifying the effects of peptides.

When Peptides Don’t Work

While peptides hold significant promise for supporting hair health, it is important to set realistic expectations. Not every peptide-based product will produce visible improvements, and several factors determine whether they deliver results.

Formulation Quality

The science behind peptides is compelling, but their effectiveness depends heavily on how they are delivered.

If a shampoo or topical treatment contains peptides at too low a concentration, or if the molecules are unstable within the formulation, they may degrade before reaching the scalp.

Similarly, without proper carrier systems or stabilizing agents, peptides may fail to penetrate the follicular environment where they are needed16.

Type of Hair Loss

Peptides are not a cure for genetic conditions such as androgenetic alopecia.

They may improve scalp health, follicle anchoring, and shedding in early or stress-related thinning, but they cannot completely reverse hair loss driven by strong hormonal or genetic factors.

In those cases, peptides are best seen as supportive tools rather than standalone treatments.

Consistency of Use

Like most hair and scalp treatments, peptides require regular, long-term application to deliver benefits.

Intermittent use or unrealistic timelines often lead to disappointment. Consistent exposure, even in wash-off formulations such as shampoos, is key to maintaining follicle support.

Safety and Tolerability

One of the strongest advantages of peptides in hair care is their favorable safety profile. Unlike pharmaceutical treatments that can carry systemic side effects, peptides are naturally occurring molecules designed to mimic biological signaling.

Low Risk of Irritation

Most cosmetic peptides, including copper tripeptide-1, Biotinoyl Tripeptide-1, and Acetyl Tetrapeptide-3, are associated with minimal irritation potential[17].

For most users, they integrate smoothly into scalp care routines without redness, dryness, or sensitivity. This makes them an appealing choice for individuals with sensitive skin who may not tolerate harsher actives.

Dose and Stability

The safety of peptides also comes from their low-dose efficacy. Because they act as signaling molecules, only small concentrations are required to trigger

biological responses. This reduces the likelihood of overexposure and systemic absorption.

In addition, cosmetic-grade formulations undergo stability testing to ensure that peptides remain effective without breaking down into potentially irritating byproducts.

Comparison with Pharmaceuticals

While medications such as minoxidil or finasteride remain mainstays for treating certain types of hair loss, they can cause side effects ranging from scalp irritation to systemic hormonal changes.

By contrast, peptides are non-hormonal and typically localized in their action, making them a safe adjunct for long-term use.

Conclusion

Peptides represent one of the most exciting frontiers in cosmetic trichology, offering a biologically plausible way to support scalp health, follicle strength, and hair density.

Among the most promising are:

1. Copper tripeptide-1 (GHK-Cu), to enhance circulation and reduce oxidative stress
2. Biotinoyl Tripeptide-1, to strengthen follicle attachment and reduce shedding
3. Acetyl Tetrapeptide-3, to support collagen and laminin production

Together, these peptides target complementary pathways, creating a multidimensional strategy for healthier hair.

Peptides are not a cure-all. They work best as part of a comprehensive regimen, complementing nutrition, stress management, and medical treatments when needed.

Their greatest advantage may be their excellent safety and tolerability, offering a gentle yet effective option for individuals seeking daily-use solutions to support hair vitality.

References

1. ^Wang L, Wang N, Zhang W, et al. Therapeutic peptides: current applications and future directions. Signal Transduct Target Ther. 2022;7:48. doi:10.1038/s41392-022-00904-4
2. ^Seong SH, Lee YI, Lee J, et al. Oral consumption of Bonito fish-derived elastin peptide (VGPG Elastin®) improves biophysical properties in aging skin: A randomized, double-blinded, placebo-controlled study. Skin Res Technol. 2024;30(3):e13634. doi:10.1111/srt.13634
3. ^Pintea A, Manea A, Pintea C, et al. Peptides: Emerging Candidates for the Prevention and Treatment of Skin Senescence: A Review. Biomolecules. 2025;15(1):88. doi:10.3390/biom15010088
4. ^Allowances NRC (US) S on the TE of the RD. Protein and Amino Acids. In: Recommended Dietary Allowances: 10th Edition. National Academies Press (US); 1989. Accessed September 4, 2025. https://www.ncbi.nlm.nih.gov/books/NBK234922/
5. ^Zhao X, Zhang X, Liu D. Collagen peptides and the related synthetic peptides: A review on improving skin health. Journal of Functional Foods. 2021;86:104680. doi:10.1016/j.jff.2021.104680

6. ^Dou Y, Lee A, Zhu L, Morton J, Ladiges W. The potential of GHK as an anti-aging peptide. Aging Pathobiol Ther. 2020;2(1):58-61. doi:10.31491/apt.2020.03.014
7. ^Yelich A, Jenkins H, Holt S, Miller R. Biotin for Hair Loss: Teasing Out the Evidence. J Clin Aesthet Dermatol. 2024;17(8):56-61.
8. ^Ding W, ed. Chapter Eight – Antihair loss peptides. In: Active Peptides for Skin Care. Academic Press; 2025:117-122. doi:10.1016/B978-0-443-30287-9.00008-0
9. ^Rinaldi F, Marzani B, Pinto D, Sorbellini E. Randomized controlled trial on a PRP-like cosmetic, biomimetic peptides based, for the treatment of alopecia areata. Journal of Dermatological Treatment. 2019;30(6):588-593. doi:10.1080/09546634.2018.1544405
10. ^Garre A, Piquero J, Trullas C, Martinez G. Efficacy and Safety of a New Topical Hair Loss-Lotion Containing Oleanolic Acid, Apigenin, Biotinyl Tripeptide-1, Diaminopyrimidine Oxide, Adenosine, Biotin and Ginkgo biloba in Patients with Androgenetic Alopecia and Telogen effluvium: A Six-month Open-Label Prospective Clinical Study. J Cosmo Trichol. 2018;04(01). doi:10.4172/2471-9323.1000132
11. ^Lueangarun S, Panchaprateep R. An Herbal Extract Combination (Biochanin A, Acetyl tetrapeptide-3, and Ginseng Extracts) versus 3% Minoxidil Solution for the Treatment of Androgenetic Alopecia: A 24-week, Prospective, Randomized, Triple-blind, Controlled Trial. J Clin Aesthet Dermatol. 2020;13(10):32-37.
12. ^Schweiger D, Rippke F, Drescher P, et al. Highly Efficient Rinse-Off/Leave-On Scalp Care Treatments to Reduce Moderate to Severe Dandruff. Journal of Cosmetics, Dermatological Sciences and Applications. 2013;3(1):46-55. doi:10.4236/jcdsa.2013.31A008
13. ^Liu T, Liu Y, Zhao X, et al. Thermodynamically stable ionic liquid microemulsions pioneer pathways for topical delivery and peptide

application. Bioact Mater. 2023;32:502-513. doi:10.1016/j.bioactmat.2023.10.002

14. ^Aguilar-Toalá JE, Quintanar-Guerrero D, Liceaga AM, Zambrano-Zaragoza ML. Encapsulation of bioactive peptides: a strategy to improve the stability, protect the nutraceutical bioactivity and support their food applications. RSC Adv. 12(11):6449-6458. doi:10.1039/d1ra08590e
15. ^D'Souza P, Rathi SK. Shampoo and Conditioners: What a Dermatologist Should Know? Indian J Dermatol. 2015;60(3):248-254. doi:10.4103/0019-5154.156355
16. ^Atrooz OM, Reihani N, Mozafari MR, Salawi A, Taghavi E. Enhancing hair regeneration: Recent progress in tailoring nanostructured lipid carriers through surface modification strategies. ADMET DMPK. 2024;12(3):431-462. doi:10.5599/admet.2376
17. ^Wu CJ, Yang CY, So PB, et al. Safety Profile and Efficacy of Biosea® Revive Serum for Hair Growth Through In Vitro Assessment and Clinical Evaluation. Cosmetics. 2025;12(4):139. doi:10.3390/cosmetics12040139
18. ^Pickart L, Margolina A. Regenerative and Protective Actions of the GHK-Cu Peptide in the Light of the New Gene Data. Int J Mol Sci. 2018;19(7):1987. doi:10.3390/ijms19071987
19. ^A. Iwaniak, M. Hrynkiewicz, J. Bucholska, P. Minkiewicz and M. Darewicz, J. Food Biochem., 2019, 43, e12500
20. ^Fox C. An introduction to the formulation of shampoos. Cosmet Toilet 1988;103: 25-58.
21. ^https://www.peptidesciences.com/peptide-research/peptides-for-hair-growth