

# Collagen Supplementation: Which Type? Which Source? What does it do?

---

How NEM<sup>®</sup> and unhydrolyzed eggshell membrane can help ensure the body has the collagen it needs for optimal performance and maintenance.



NOTICE: While the information contained herein ("Information") is presented in good faith and believed to be correct as of May 2023 here of, ESM Technologies, LLC ("ESM") does not guarantee satisfactory results from reliance upon such Information, disclaims all liability for any loss or damage arising out of any use of this Information or the products to which said Information refers and MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE WITH RESPECT TO THE INFORMATION OR PRODUCTS, except as set forth in ESM's standard conditions of sale. Nothing contained herein is to be construed as a recommendation to use any product or process in conflict with any patent, and ESM makes no representation or warranty, express or implied, that the use thereof will not infringe any patent.

STRATUM NUTRITION® is a registered trademark of ESM Technologies, LLC. ©2023 ESM Technologies, LLC. All rights reserved. May 23

**\*These statements have not been evaluated by the U.S. Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease. The material is intended for informational and educational purposes only and does not supersede the requirement for submitting claims to the FDA.**

# Contents

## Section #1

4

### **All the Hype - Yet Still a Little Confusion**

Collagen is one of the top nutraceutical ingredients, and though it is a prominent ingredient in multiple product categories, there is still some confusion regarding collagen types and how it functions to support both general connective tissue health and specific areas, such as sports recovery, maintenance of skin health, and joint comfort and function.

## Section #2

6

### **Collagen Digestion and Absorption**

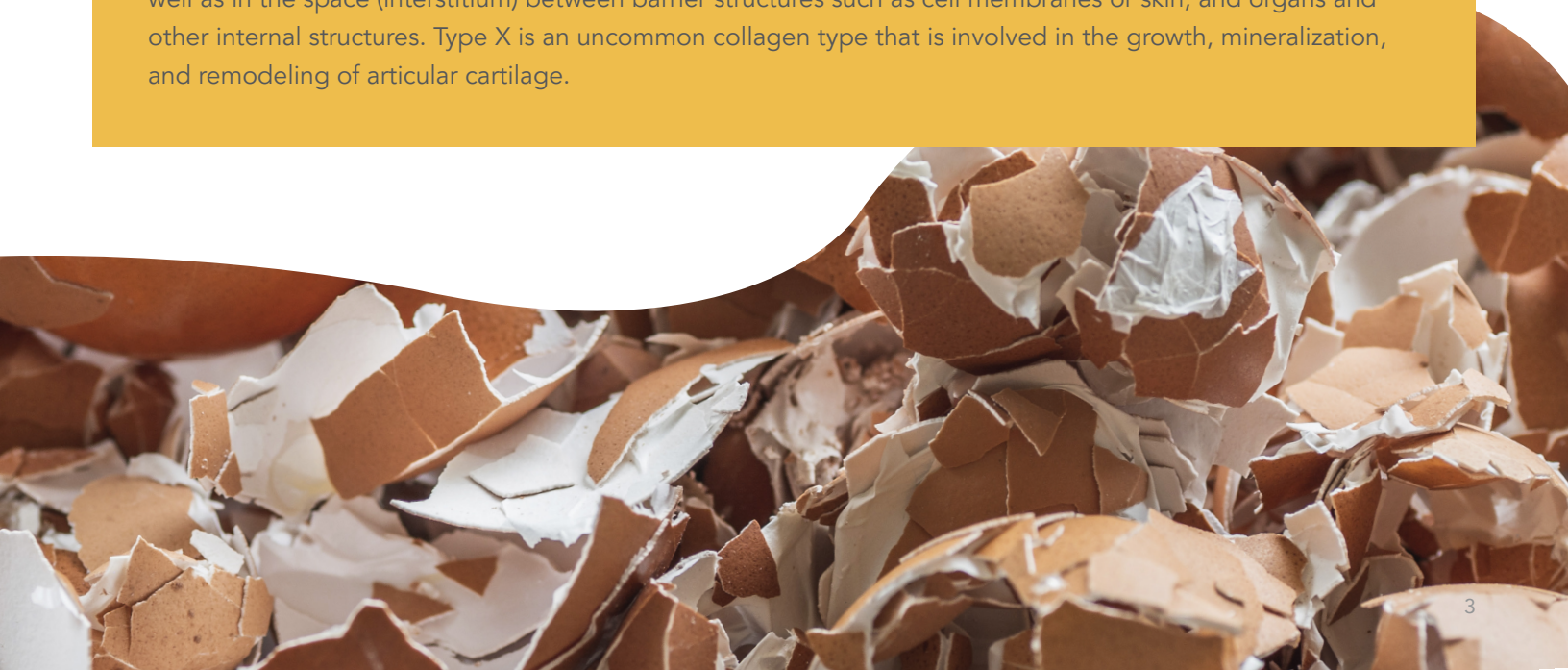
Most foods and other ingested substances must be metabolized or broken down through the process of digestion before they can be absorbed and used by the body. Collagen is a large protein and when ingested, cannot be readily absorbed through the intestinal wall.

## Section #3

8

### **Advantages of NEM® and Unhydrolyzed Eggshell Membrane**

NEM® and unhydrolyzed eggshell membrane contain types I, V, and X collagen. Type I collagen is a major component of skin, tendons, ligaments, and bone. Type V is found within the dermal/epidermal junction as well as in the space (interstitium) between barrier structures such as cell membranes or skin, and organs and other internal structures. Type X is an uncommon collagen type that is involved in the growth, mineralization, and remodeling of articular cartilage.



# All the Hype - Yet Still a Little Confusion

Collagen is one of the top nutraceutical ingredients, and though it is a prominent ingredient in multiple product categories, there is still some confusion regarding collagen types and how it functions to support both general connective tissue health and specific areas, such as sports recovery, maintenance of skin health, and joint comfort and function.



## What is Collagen?

Collagen is the most abundant protein found in mammals and is the key component in connective tissues, including tendons, ligaments, cartilage and skin. It is a fibrous protein and functions to help tissues withstand stretching and movement. There are 28 identified types of collagen in the human body.

Collagen is a large protein and is unique in its content of the amino acids glycine, proline and hydroxyproline, and to a lesser extent, hydroxylysine. All collagens contain similar three-stranded helical segments. The collagen types are distinguished by the segments that lie between the helical segments and by the folding that gives them their three-dimensional structure. Some associate into fibrils, others form sheets and still other types cross-link with other collagen types.<sup>1</sup>

*In the USA, 58% of consumers surveyed associate collagen with helping to aid their mobility health.<sup>14</sup>*

*- FMCG Gurus*



## Collagen Types

Types I-V collagen are the most common and Types I, II and III make up between 80 to 90% of all the collagen in the human body. The other collagen types are found throughout the body at specific locations.



## Supplemental Collagen Sources

Most supplemental collagen is derived from animal sources including chicken sternal tissue and skin, beef and pork hides, fish byproducts such as the bones and skin, and eggshell membrane. **There are no true plant based sources.** Products marketed as vegan collagen are usually made from genetically modified yeast and bacteria, and/or contain nutrients that help boost the body's production of collagen, such as vitamin C.



## Section #2

# Collagen Digestion and Absorption

Most foods and other ingested substances must be metabolized or broken down through the process of digestion before they can be absorbed and used by the body. Collagen is a large protein and when ingested, cannot be readily absorbed through the intestinal wall. It must therefore be broken down into smaller peptides and amino acids prior to absorption. Once absorbed, the amino acids and peptides are reassembled by the body into whatever proteins are needed by the body at the time. Synthesis back into collagen is more likely because of the abundance of glycine, proline and hydroxyproline necessary for collagen production and the body's continual need for this important protein. But the type of collagen synthesized is dependent upon the body's needs at the time.

The body needs a constant supply of collagen to remain healthy and functioning properly, so supporting healthy collagen production throughout life is crucial. Since collagen production begins to decline at around the age of 25, this isn't an area that can be neglected until middle age or later. It should be a concern for all adults.

Consuming a food or supplement containing collagen provides the critical amino acid and peptide building blocks for its synthesis systemically. However, that process is dependent upon other nutrients as well. For the body to efficiently produce collagen, it also needs micronutrients such as vitamin C, calcium, zinc, copper, and glycosaminoglycans (GAGs). Vitamin C (ascorbic acid) is integral for collagen



synthesis in the body. It is a cofactor in two critical enzymatic reactions involved in the synthesis of functional collagen from its precursor, procollagen.<sup>2</sup> Vitamin C also stimulates Type I collagen mRNA production by fibroblasts in the skin.<sup>3</sup> Without vitamin C, the production and stability of collagen is not guaranteed, making it a necessary nutrient for maintenance of skin and bone health.<sup>4,5</sup> Copper and zinc are important because of their roles as cofactors in biochemical reactions that enable healthy collagen synthesis and functioning in the body.<sup>6,7</sup> Ideally these three micronutrients can be obtained through the diet, but individuals consuming poor diets or those with health conditions that deplete the body's micronutrient stores, could benefit from supplemental vitamin C, zinc and copper.

Calcium and GAGs also play significant roles in collagen synthesis and functioning, particularly around the bones and joints. Calcium plays a vital role in regulating the functioning of osteoblasts. Osteoblasts are the cells that form new bone (osteoid) from Type III collagen and other proteins, and then control calcium and mineral deposition in the bone.<sup>8</sup> In addition, calcium

is needed for maintaining the highly ordered fibrillar collagenous tissues of the musculoskeletal system.<sup>9</sup> This function is critical because both the mechanical and structural properties of collagen fibrils are dependent upon calcium ions and the malfunctioning of calcium can lead to several collagen disorders.<sup>10</sup> Since the presence of calcium is so critical to the maintenance of healthy bones and connective tissue, it has been studied as a possible therapeutic in conjunction with collagen for age-related joint pain and changes in skin impedance.<sup>11</sup>

Glycosaminoglycans are essential for collagen structure and integrity in the body. They function to connect collagen fibrils/fibers and provide intermolecular force in the collagen-GAG matrix, thus contributing to the integrity and mechanical properties of the extracellular matrix (ECM) and related tissue.<sup>12</sup> Aging can result in a depletion of GAGs in the ECM, and their mis-regulation has been linked to several diseases.<sup>13</sup>




## Section #3

# The Advantages of NEM<sup>®</sup> and Unhydrolyzed Eggshell Membrane

NEM<sup>®</sup> and unhydrolyzed eggshell membrane contain types I, V, and X collagen. Type I collagen is a major component of skin, tendons, ligaments, and bone. Type V is found within the dermal/epidermal junction as well as in the space (interstitium) between barrier structures such as cell membranes or skin, and organs and other internal structures. Type X is an uncommon collagen type that is involved in the growth, mineralization, and remodeling of articular cartilage. This makes both NEM and unhydrolyzed eggshell membrane ideal ingredients in cosmetic and sports formulations where collagen plays a crucial role in efficacy.

The collagen peptides and other proteins, peptides, and free amino acids inherent in NEM and unhydrolyzed eggshell membrane that are absorbed into circulation provide many of the crucial building blocks for collagen production in the body. Both NEM and unhydrolyzed eggshell membrane are high in the specific amino acids, glycine and proline, as well as hydroxyproline, and peptides containing these amino acids, needed for efficient production of endogenous collagen. These peptides and amino acids, in conjunction with GAGs, such as chondroitin sulfate,

**UNHYDROLYZED  
EGGSHELL  
MEMBRANE**



hyaluronic acid and keratan sulfate, also naturally present in NEM and unhydrolyzed eggshell membrane, might further influence healthy functioning of collagen in connective tissue, such as the extracellular matrix and cartilage around joint tissue and in the skin. Both NEM and unhydrolyzed eggshell membrane also contain a small amount of calcium, potentially contributing to the beneficial effects in supporting and maintaining both the synthesis and maintenance of collagen throughout the body.

The combination of amino acids and peptides needed for collagen production, along with the GAGs and calcium needed for healthy collagen structure and functioning, make NEM and unhydrolyzed eggshell membrane the ideal ingredients for ensuring optimal collagen availability throughout life.



**NEM**<sup>®</sup>



**In North America, collagen ingredient claims have a combined 89% medium to high influence on consumer purchasing behavior when buying food, drink, and supplements.<sup>15</sup>**

*- FMCG Gurus*



## References:

<sup>1</sup> **Molecular Cell Biology. 4th edition.** Section 22.3

<sup>2</sup> Pinnell, S.R. (1985). Regulation of collagen biosynthesis by ascorbic acid: a review. *Yale Journal of Biology and Medicine*, 58(6), 553-559.

<sup>3</sup> Duarte, T.L., Cooke, M.S., and Jones, G.D. (2009). Gene expression profiling reveals new protective roles for vitamin C in human skin cells. *Free Radical Biology & Medicine*, 46(1), 78-87.

<sup>4</sup> Pullar, J.M., Carr, A.C., and Vissers, M.C.M. (2017). The roles of vitamin C in skin health *Nutrients*, 9(8), 866.

<sup>5</sup> Chin, K-Y. and Ima-Nirwana, S. (2018). Vitamin C and bone health: evidence from cell, animal, and human studies. *Current Drug Targets*, 19(5), 439-450.

<sup>6</sup> Kagan, H.M. and Li, W. (2003). Lysyl oxidase: properties, specificity, and biological roles inside and outside of the cell. *Journal of Cellular Biochemistry*, 88(4), 660-672.

<sup>7</sup> Seo, H-J., Cho, Y-E., Kim, T., Shin, H-I., and Kwun, I-S. (2010). Zinc may increase bone formation through stimulating cell proliferation, alkaline phosphatase activity and collagen synthesis in osteoblastic MC3T3-E1 cells. *Nutrition Research and Practice*, 4(5), 356-361.

<sup>8</sup> Gabusi, E., Manferdini, C., Grassi, F., Piacentini, A., Cattini, L., Filardo, G., Lambertini, E., Piva, R., Zini, N., Facchini, A., and Lisignoli, G. (2012). Extracellular calcium chronically induced human osteoblasts effects: specific modulation of osteocalcin and collagen type XV. *Journal of Cellular Physiology*, 227(8), 3151-3161.

<sup>9</sup> Gilchrist, C.L., Leddy, H.A., Kaye, L., Case, N.D., Rothenberg, K.E., Little, D., Liedtke, W., Hoffman, B.D., and Guilak, F. (2019). TRPV4-mediated calcium signaling in mesenchymal stem cells regulates aligned collagen matrix formation and vinculin tension. *Proceedings of the National Academy of Science USA*, 116(6), 1992-1997.

<sup>10</sup> Pang, X., Lin, L., and Tang, B. (2017). Unraveling the role of calcium ions in the mechanical properties of individual collagen fibrils. *Scientific Reports*, 7, 46042.

<sup>11</sup> Fujita, T., Ohue, M., Fujii, Y., Miyauchi, A., and Takagi, Y. (2002). The effect of active absorbable algal calcium (AAA Ca) with collagen and other matrix components on back and joint pain and skin impedance. *Journal of Bone and Mineral Metabolism*, 20(5), 298-302.

<sup>12</sup> Yuying Bi, Prabir P., and Faezipour, M. (2014). Structure of collagen=glycosaminoglycan matrix and the influence to its integrity and stability. *Annual International Conference of the IEEE Engineering in Medicine and Biology Society*. 2014, 3949-3952.

<sup>13</sup> Roth, J, Hoop, C.L., Williams, J.K., Hayes, R., and Baum, J. (2023). Probing the effect of glycosaminoglycan depletion on integrin interactions with collagen I fibrils in the native extracellular matrix environment. *Protein Science*, 32(1), e4508.

<sup>14</sup> <https://fmcggurus.com/reports/FMCG-Gurus-Mobility-Trends-in-2022-Report>. Section MOB28551

<sup>15</sup> <https://fmcggurus.com/reports/FMCG-Gurus-Custom-Survey-Global-and-Regional-Digestive-Health-Q3-2022-Report>. Section DH21506

<sup>16</sup> <https://fmcggurus.com/report-store/FMCG-Gurus-Healthy-Ageing-Skin-Health-Global-Report-2022>, pg 16.

Collagen is the ingredient consumers stated they most associated with skin care, therefore when looking to address their health, this is an ingredient they may look out for.<sup>16</sup>

- FMCG Gurus

## A midwest small town man began what is now Stratum Nutrition, selling eggs out of the back of a family station wagon purchased after his tour in the Korean war.

Due to the founder's vision, tenacity and innovative mindset, 40 years later he had built the midwest's largest vertically-integrated chicken operation.

Realizing the massive amounts of eggshells being trucked out as fertilizer or waste, he recognized an opportunity and immediately began working on a solution.

Upon discovering the historically documented health benefits of eggshell calcium and membrane, he built the patented technology and all-natural process we use today. This process separates the calcium and membrane from eggshells while also decreasing eggshell waste in landfills and improving the lives of millions around the world.



A company from humble midwestern roots, built on innovation and sustainability.



NEM & ESC help divert 2 million lbs of eggshell waste from landfills each year.



We uphold a low carbon footprint and the only byproduct of the NEM & ESC manufacturing process is steam.



We supply unique, sustainable, eco-conscious ingredients with an emphasis on science and claims that create marketability.



Our roots remain steadfast and continue to guide our values. We pride ourselves on being proactive and understand our growth relies on relationships we build.

# We don't expect you to take our word for it.



"Our #1 focus is results which makes NEM a perfect fit as the key ingredient in our Joint Health Advanced formula.



- Dan Chapman, Owner

"NEM has surpassed our expectations and has allowed our product to quickly become one of our best sellers by helping a wide array of customers.

- Patrick Toledano, President





# Launching Ingredients for Success.



VitaSpense®



Curcumin 95



Quality. Integrity. Innovation. Experience.



[stratumnutrition.com](http://stratumnutrition.com)

[info@stratumnutrition.com](mailto:info@stratumnutrition.com)

(800) 970-4479