

## **Giving NAG New Meaning.**

**NAG** also known as N-Acetyl-Glucosamine, belongs to a class of nutrients called amino sugars, which are formed from glucose and amino acids (glutamine, in the case of NAG) Amino sugars are essential components of all body tissues, being integral parts of cell membranes and their surface structures, as well as of the tissues which hold cells together. Recent research has revealed that this often overlooked bodily component can be of vital importance to our overall health.

Our bodies use approximately 10 different amino sugars. They are burned for energy and used in the manufacture of tissue components. During the course of the body's normal wear-and-tear, tissues are constantly broken down, and then replaced or restructured, creating a continuous demand for amino sugars. Unfortunately, because dietary supplies of amino sugars are usually low, the body must synthesize them from glucose and the appropriate amino acid.

## **The Need for Supplementation.**

The body is able to meet its need for amino sugars under normal circumstances; but as the body ages, these change. Research has revealed that under a variety of less-than-optimal conditions, the body's production of amino sugars - and their assembly into larger molecules - may be impaired. These conditions can include surgery and/or surgical recovery, severe stress, burns and major injuries, as well as ageing. By supplementing your diet with **NAG** there are key advantages that may be obtained: Numerous steps in the conversion of glucose and amino acids to amino sugars are eliminated. Amino sugar production may be enhanced. Tissue-building properties may increase.

## **NAG & the Body's Ground Substance: Fundamental Building Blocks**

Just as amino acids are the basic building blocks of proteins, amino sugars, such as NAG, are the basic building blocks of giant molecules called glycosaminoglycans, or mucopolysaccharides. **Glycosaminoglycans** are large, spongy, water-holding molecules which produce the gel-like matrix that forms the basis of the body's **ground substance**. **Connective tissue** - found in skin, tendons, cartilage, ligaments, and the matrix of bone - is made up of insoluble protein fibers which are distributed throughout this ground substance. The character of connective tissue is dependent to a large extent on the relative proportions of the ground substance and embedded fibrous proteins. For example, cartilage is rich in ground substance, whereas tendon is composed primarily of protein fibers. The viscous, lubricating properties of **mucous secretions** also result from an aqueous solution of glycosaminoglycans, a fact that led to the original naming of the compounds **mucopolysaccharides**. An additional example of specialized ground substance is the **synovial fluid** that serves as a lubricant in joints, tendon sheaths, and bursa (the sac in between joints). Mucopolysaccharides are components of every cell membrane, as well as the organelles (intracellular "micro-organs") and the cytoplasm (the gel-like liquid that fills the space between the outer cell membrane and the nucleus) of every living cell. Without adequate mucopolysaccharides, the vital exchange of nutrients and other biochemicals across the cell membrane could be impaired.

## **Not Only Skin Deep**

Another important function of mucopolysaccharides is to help maintain the elasticity of skin and blood vessels, an important component of both. Mucopolysaccharides have the special ability to bind large amounts of water, and thus help to keep our skin moist, elastic and youthful. So, as we get older and our ability to produce them decreases, our skin ages, losing its firmness and moisture. Taking supplemental NAG may return our mucopolysaccharides back to vital, youthful levels.

## **More Reasons to NAG**

Not only is NAG a source for the production of many other amino sugars, it is stable, pH-neutral, tasteless, and freely water soluble. It is readily absorbed from the intestines, stays in the blood for several hours, and is used exclusively for cell structures, with very little being excreted. Continuing investigation into the roles amino sugars play in our health is proving to be a promising area of nutrition research.

***NAG (N-Acetyl Glucosamine) is a key component of the "glue" that holds our bodies together. Found in all body tissues, cells, cell membranes, inter-connective tissues, bone matrix, cartilage, skin, and mucous membranes, NAG may be one of the most important supplements to add to your nutritional program.***

## **NAG vs. Glucosamine sulfate (GS)**

Glucosamine compounds, also known as amino sugars, are critical components of virtually all connective tissues and lubricating fluids in the body. This includes the protein matrix into which calcium crystallizes to build bones, the mucus lining of organs, tendons and ligaments, blood vessels, cartilage, cell membranes, the gel that holds cells together, the fluid between joints and in the eyes, and the skin.

Amino sugars are constituents of larger compounds known as glycosaminoglycans and glycoproteins, which make up the bulk of many tissues. Due to their vital nature and their presence throughout the body, whenever there is any damage to tissues and related fluids, it is critical to replace the basic raw materials - amino sugars - in order to regain their integrity and function. While the body is able to manufacture amino sugars from dietary amino acids and sugars, sometimes this does not occur at optimal levels. That's where glucosamine supplementation provides a special advantage.

## **NAG: A Superior Form of Supplementation**

When glucosamine is used in the body, it is often as **NAG** and rarely as glucosamine sulfate: of six classes of glycosaminoglycans, three use **NAG** as their main amino sugar versus one based primarily on GS. This makes **NAG** the form of glucosamine with the widest range of applicability of all related compounds. The addition of an acetyl group (called acetylating) to a glucosamine molecule always occurs before the addition of a sulfate (when this latter reaction is

needed at all). In terms of supplementation, pre-acetylated glucosamine (NAG) thus provides a much greater advantage to the body than pre-sulfated glucosamine sulphate

Even under normal conditions, it is easier for the body to sulfate a molecule than it is to acetylate it. Therefore, while it would not necessarily follow that **NAG** could be made from GS, GS could easily be made from **NAG**: This means **NAG** is the glucosamine supplement with the greatest assurance of benefit.

Because acetylating is so often an essential step in the use of glucosamine, the body's ability to perform this process is a critical issue in the usefulness of any glucosamine product. Ironically, many people who rely on glucosamine supplements and are uniquely in need of their benefits are poor acetylators, due to a variety of reasons. Some are born with a rate of acetylating up to ten times slower than normal, some may have acquired such a difficulty through diminished health, and a great many others are regularly exposed to the common external factors that impair acetylating ability. These include alcohol consumption, acetaldehyde poisoning from Candida or alcohol, and the use of aspirin, as well as various other drugs. In any such case, GS may not be the optimal choice for supplementation, as its utilization so often requires the very process the body is inadequately performing. In contrast, supplementation with pre-acetylated **NAG** is an ideal way to productively enhance the body's glucosamine levels, while bypassing any impeding difficulties.

### **The Benefits of Acetylating:**

The issue of impaired acetylating is major reason pre-acetylated amino acids and amino acid derivatives are such a positive advancement in supplementation. Another reason is that acetylated forms of many biological substances are very often the superior forms - in terms of heightened stability, absorption through the intestine, increased solubility in the plasma, and better transport across the Blood-Brain-Barrier. Because the acetylating process is expensive to execute - much more so than simple reactions, e.g. sulfating - these superior forms often command a higher cost. However, the superior results are well worth the expense!

### **Therapeutic Benefits of N-Acetyl Glucosamine**

Preliminary research suggests that N-acetyl glucosamine may offer certain health benefits. Here's look at several key findings from the available studies:

#### **1) Osteoarthritis**

N-acetyl glucosamine may help reduce the inflammation associated with osteoarthritis, suggests a preliminary study published in *Annals of the Rheumatic Diseases* in 2005. In tests on rabbits, scientists determined that N-acetyl glucosamine helped alleviate arthritis-related inflammation and inhibit the breakdown of cartilage.

## **Inflammatory Bowel Disease**

N-acetyl glucosamine shows promise in the treatment of inflammatory bowel disease (a class of conditions that includes Crohn's disease and colitis), according to a pilot study published in *Alimentary Pharmacology and Therapeutics* in 2000. In tests on 10 children with severe Crohn's disease and two children with severe ulcerative colitis, researchers found that daily treatment with N-acetyl glucosamine led to a significant improvement in symptoms and a decrease in inflammation.

## **3) Multiple Sclerosis**

A 2011 study from the *Journal of Biological Chemistry* indicates that N-acetyl glucosamine may help suppress the destructive autoimmune response involved in multiple sclerosis. In tests on mice, researchers demonstrated that N-acetyl glucosamine may help inhibit the growth and function of abnormal cells that -- in multiple sclerosis patients -- prompt the immune system to break down central nervous system tissue involved in insulating nerves.

## **4) Skin-Whitening**

N-acetyl glucosamine may help promote lightening of the skin when used as an ingredient in skincare products, according to a 2007 study published in the *Journal of Cosmetic Dermatology*.

In an eight-week-long clinical trial, the study's authors found that use of N-acetyl glucosamine helped reduce abnormal darkening of the skin. The study also found that N-acetyl glucosamine may be especially effective for skin-whitening when used in combination with niacinamide (a form of vitamin B sometimes used in skincare products).

### **Sources**

- 1) Shikhman AR, Amiel D, D'Lima D, Hwang SB, Hu C, Xu A, Hashimoto S, Kobayashi K, Sasho T, Lotz MK. "Chondroprotective activity of N-acetylglucosamine in rabbits with experimental osteoarthritis." *Ann Rheum Dis*. 2005 Jan; 64(1):89-94.
- 2) Salvatore S, Heuschkel R, Tomlin S, Davies SE, Edwards S, Walker-Smith JA, French I, Murch SH. "A pilot study of N-acetyl glucosamine, a nutritional substrate for glycosaminoglycan synthesis, in paediatric chronic inflammatory bowel disease." *Aliment Pharmacol Ther*. 2000 Dec; 14(12):1567-79.
- 3) Grigorian A, Araujo L, Naidu NN, Place DJ, Choudhury B, Demetriou M. "N-acetylglucosamine inhibits T-helper 1 (Th1)/T-helper 17 (Th17) cell responses and treats experimental autoimmune encephalomyelitis." *J Biol Chem*. 2011 Nov 18; 286(46):40133-41.
- 4) Bissett DL, Robinson LR, Raleigh PS, Miyamoto K, Hakozaiki T, Li J, Kelm GR. "Reduction in the appearance of facial hyperpigmentation by topical N-acetyl glucosamine." *J Cosmet Dermatol*. 2007 Mar; 6(1):20-6.