Understanding the Discovery of the Ideal Amino Acid Pattern for Human Nutrition

A remarkable discovery has been made in the field of human nutrition, and its implications are profound.

Although this research is new to North America, in Europe over 12,000 physicians have incorporated its results into their practices.

> The discovery of the ideal amino acid pattern for human nutrition can be considered to be one of the most important nutritional discoveries of our time.

The following overview provides some background information to help facilitate an understanding of the significance of this development.

The beginning…

The scientific discoveries related to proteins and their constituent amino acids began in about 1820, when the essential amino acid leucine was discovered.

In 1935, William C. Rose (1887-1985) completed the identification of the eight essential amino acids with the discovery of threonine.

By 1946, three key concepts had been recognized:

1. There are daily essential amino acid requirements.
2. The nutritional value or *quality* of a dietary protein depends upon its amino acid profile.
3. For protein synthesis to occur, all eight essential amino acids must be available *simultaneously* at the sites of the body's protein synthesis. (If one amino acid is missing, protein synthesis will not take place.)

In 1946, Rose was the first to *estimate* the daily essential amino acid requirement for humans.

Unfortunately, amino acid formulas based upon this estimate had a poor nutritional effectiveness, along with the adverse effect of increased Blood Urea Nitrogen (B.U.N.) which caused researchers and health care practitioners to become disillusioned.

The nutritional failure of amino acid formulations

The nutritional failure of amino acid formulations generated even more discrepancies and confusion among the scientific community about basic questions, such as:

a. How many amino acids are essential for human nutrition?

b. What is the "ideal" combination of amino acids for human nutrition?

c. How can the daily requirement of amino acids be calculated?

d. Should an amino acid mixture provide only the essential amino acids or also the non-essential amino acids? (And in what proportion?)

These questions were finally answered and confirmed years later, after more than two decades of research. Shortcomings of the previous research methodologies were found and remedied. The result:

The discovery of the ideal amino acid pattern for human nutrition.

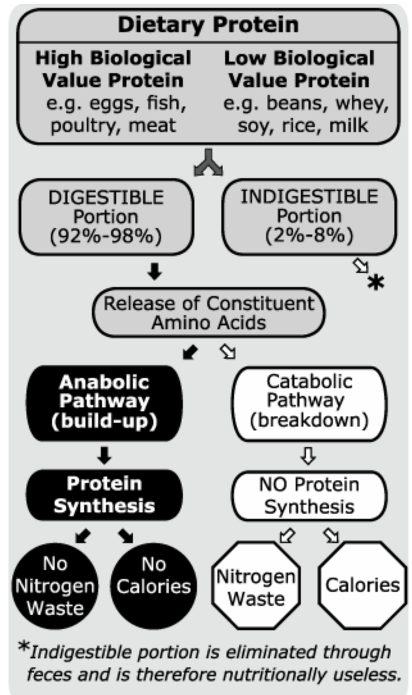
This pattern is comprised of *unique proportions* of essential amino acids.

> As a result, for the first time in medical history it is now possible to provide protein nutritional support that releases virtually *no* nitrogen waste or calories.

Understanding protein nutritional values

From a nutritional point of view, the most important aspect of a protein is its amino acid composition.

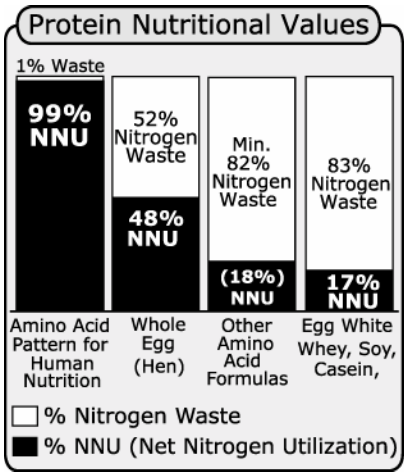
Amino acids from a dietary protein or an amino acid supplement are absorbed in the small intestine. These amino acids can then follow either the anabolic pathway (build-up) or the catabolic pathway (breakdown). To illustrate:



When dietary amino acids follow the *anabolic pathway*, they act as precursors or "building blocks" in the body's protein synthesis. Throughout the *anabolic pathway*, amino acids do not release any nitrogen catabolites (metabolic waste) or calories.

On the other hand, when dietary amino acids follow the *catabolic pathway*, they do not act as "building blocks". Throughout the *catabolic pathway*, amino acids release calories and unwanted nitrogen catabolites.

The *percentage* of the total amino acids in a dietary protein or an amino acid formula that **are used** as "building blocks" represents the protein nutritional value and is known as **Net Nitrogen Utilization** (NNU).



Net Nitrogen Utilization (NNU)

- Represents the nutritional value of a dietary protein or an amino acid formula.
- Is the percentage of amino acids that act as precursors or "building blocks" in the body's protein synthesis.

What determines which pathway amino acids follow?

Only essential amino acids available in the correct proportion follow the anabolic pathway.

This proportion is very specific. Even the slightest change in the proportion of the amino acids in a dietary protein or amino acid formula can affect its nutritional value. (The homogeneity of the amino acids in an amino acid formula can also affect its NNU.)

To better understand why a minimal change in an amino acid pattern can be significant, consider that a tree, bird, or human being are all composed of amino acids. However, each is different in accordance with its own amino acid pattern.

Each species in the animal kingdom has its own specific *nutritional* amino acid pattern.

If the amino acids are not in the correct proportion, or if there is an excess amount, then the amino acids are catabolized. (There is no storage mechanism for amino acids as there is for lipids or carbohydrates.)

A nutritional formula based upon the ideal amino acid pattern for human nutrition, if properly manufactured, has a 99% NNU.

> This means that it would be safer and 400% to 500% more nutritionally effective than other amino acid formulas or protein isolates from whey, casein, or soy.

An amino acid formula that has been proven to have a 99% NNU can be safely used in the dietary management of:

- pregnant and lactating women;
- infants, children, adolescents;
- adults, athletes and the elderly;

regardless of health status.

The "nutritional dilemma" solved

To date, many health disorders have been misinterpreted as "natural" consequences of the aging process.

As people age, inadequate nutrition in quantity or quality becomes more common and can compromise protein synthesis.

> In reality, it is not the aging process itself but the inadequate nutrition associated with it that can cause many health challenges.

During the aging process, the lean-body mass (the living-cell mass that makes up muscles, organs, skeleton, antibodies, enzymes, etc.) usually decreases (up to 25% in the average 70-year-old individual). During the same period, fat-body mass usually increases (up to 100%).

The loss of lean-tissue begins around the age of 25 and usually becomes noticeable by the age of 45. This process can occur even in the absence of weight loss or illness. (Muscle is the major source of protein for functions such as antibody production, wound healing and white blood cell production during illness. If the body's protein reserves are already depleted, there is less protein to mobilize during illness.)[1]

The degree of the loss of lean-tissue can vary among individuals. The effects of this loss can range from a mild loss of tissue firmness, skin elasticity and stamina to a significant loss of tissue integrity and function.

Until now, achieving adequate nutrition during the aging process has been a nutritional dilemma.

During the aging process, kidney function also decreases. As a result, average 70-year-old individuals may retain only 30% of their juvenile kidney function. Under these circumstances, even an adequate daily protein intake could be contraindicated as it could provoke an increase of nitrogen catabolites such as ammonia or Blood Urea Nitrogen (B.U.N.).

However, it is now possible to provide protein nutritional support that releases virtually no nitrogen waste.

> As a result, individuals at any age can safely meet their daily protein requirements without stressing kidney and liver functions.

Maintaining normal protein turnover rates

After water, protein is the next most abundant substance in the body. Proteins make up the major structural and functional component of all cells and have incredibly diverse functions.

For example, proteins make up enzymes and polypeptide hormones that regulate metabolism. In bone, the protein collagen forms the framework on which the calcium phosphate crystals are deposited.[2]

Proteins in the body are not static. Since they are synthesized and degraded continually, an adequate supply of amino acids is necessary to maintain normal protein turnover rates.

The rate of turnover of proteins varies widely. For example, some proteins such as digestive enzymes and plasma proteins are rapidly degraded, having half-lives measured in hours or days. However, structural proteins, such as collagen, can have half-lives measured in months.

The rate of turnover of proteins tends to follow their function in the body, i.e., proteins whose concentrations must be regulated (e.g., enzymes) or those that act as signals (e.g., peptide hormones) have relatively high rates of synthesis and degradation as a means of regulating concentrations. On the other hand, structural proteins such as collagen and myofibrillar proteins or secreted plasma proteins have relatively long lifetimes.

There must be an overall balance between synthesis and breakdown of proteins. In healthy adults who are neither gaining nor losing weight, balance means that the amount of nitrogen consumed as protein in the diet will match the amount of nitrogen lost in urine, feces, and other routes. [3]

An inadequate supply of amino acids can alter normal protein turnover rates and affect organ and cellular function.

Inadequate protein synthesis

Proteins are synthesized in all cells of the body from amino acids. Chains of amino acids fold in different ways to create the structure or shape of the different types of proteins that make up the body.

The shape of a protein determines its biological activity or function. On the basis of their three-dimensional structure, proteins can be classified as fibrous proteins (long, linear, pleated sheets) or globular proteins (roughly spherical shaped).

Since proteins are involved in all physiological processes and form the foundation of health, it is important to consider their role when addressing the underlying causes of health challenges.

Inadequate protein synthesis can affect any of the types of proteins or the structures they form, for example:

FIBROUS PROTEINS:

a. Structural
- Collagen:
  - Type I – skin, bone, tendon, blood vessels, cornea,
  - Type II – cartilage, intervertebral disk, vitreous body
  - Type III – blood vessels, fetal skin
  - Type IV – basement membrane
- Elastin: trachea, lungs, large blood vessels, elastic ligaments and joints
- Keratin: skin, hair, nails

b. Movement
- Actin/Myosin - muscle cells
- Microtubules - cilia (respiratory tract, fallopian tubes)

GLOBULAR PROTEINS:

a. Enzymes: digestive enzymes (amylase, protease, peptidase), antioxidant enzymes (peroxidase; e.g. glutathione peroxidase used in detoxification)

b. Transport molecules: hemoglobin, K^+ Channel

c. Hormones: insulin, growth hormone, calcitonin, glucagon, luteinizing hormone, thyrotropin-releasing hormone, antidiuritic hormone, oxytocin, ACTH, gastrin, angiotensin I & II

d. Neurotransmitters: endorphins, enkephalins

e. Immune cells: antibodies, complement proteins

f. pH buffer proteins: albumin, hemoglobin

The protein buffer system

For proteins to function properly, stable pH and temperature are required. The delicate shapes of proteins can be affected (or denatured) by excessive fever or excessive pH (to acidic or basic).

Amino acids can accept or donate hydrogen ions, making them excellent buffers. Since proteins are made up of amino acids, proteins themselves can act as buffers.

Amino acids have a central carbon group with four groups attached:

a. a carboxyl group (COOH)
b. an amino group (NH2)
c. a hydrogen atom
d. an R group

The carboxyl group and amino groups are what enable proteins to act as buffers. (Proteins are found in very high concentration in intracellular solutions and in blood.)

Of the three important buffering systems in the body:

1. bicarbonate-buffer system,
2. phosphate-buffer system and
3. protein-buffer system,

the protein buffering system is considered the most powerful.

Maintaining normal protein synthesis

A loss of body protein means a loss of function.

It is important to help individuals understand the relationship between inadequate protein synthesis and a diminishing quality of life.

Inadequate protein synthesis can affect:

- heart and bone cell turnover rates
- immune function/antibodies
- red blood cell production
- enzyme/hormone production
- skin elasticity/muscle tone
- neurotransmitters/mood
- sense of well-being/stamina
- mobility/joint integrity
- pH and fluid balance, etc.

In clinical practice, it is extremely common to see individuals who, for a variety of reasons, are not meeting the daily amino acid requirements necessary to optimize protein synthesis.

Inadequate protein synthesis can magnify the effect of any health complaint.

The value of maintaining normal protein synthesis cannot be overstated for anyone at any age.

References:

1. Roubenoff B, Castaneda C. Sarcopenia—Understanding the Dynamics of Aging Muscle JAMA.2001; 286: 1230.

2. Champe P.C., Harvey R.A., "Lippincott's Illustrated Reviews: Biochemistry".— 2nd ed. page 1 J.B. Lippincott Company, Philadelphia 1994.

3. Matthews Dwight E., in "Modern Nutrition In Health and Disease" Shils, M.E., Olson, J.A. [et al.].— 9th ed.(Eds), page 21-2, Lippincott Williams & Wilkins, Philadelphia 1999.

Additional information and references are available upon request.