

# Nucleotides – the forgotten basis of micronutrient therapy

The established concept of micronutrient therapy starts with the idea that the human body is not a machine, but a self-regulating biological system with a desire for balance. This type of therapy assumes that micronutrients form the lowest level and thus the basis for all further metabolic processes and physiological control loops – and are a prerequisite for successful regulation.

This is not wrong, but it is only half the truth. Why? The basic assumption is that the body can compensate for and remedy imbalances, deficiencies and damage on its own and initiate growth. This means that if such a system is provided with everything it needs and disruptive factors are kept to a minimum, it will independently achieve and maintain a healthy, functional state.

This leads to what is needed according to this theory: In addition to macronutrients (proteins, carbohydrates, fats), micronutrients are also required, as only they enable various metabolic processes to take place as cofactors.

However, one thing is often forgotten: in order to benefit fully from micronutrients and use them to maximum effect, their use must be optimally coordinated – which brings us to the most fundamental organisational level of biological systems, the information level.

This is expressed in genetic information, DNA, and the genes encoded in it. They are the basis for the formation of all proteins and enzymes in our body. The ability to activate, regulate and pass on DNA in a precise and targeted manner is the cornerstone of our health, indeed of our very existence.

However, this is precisely what is not taken into account in most micronutrient therapies. Every process in the organism, every material component – be it cells, tissues or organs – is based on information. Only this information and its proper regulation enable homeostasis (maintenance of a dynamic balance) at all other levels of life. This makes the functioning of DNA the most fundamental level of biological health.

And this is precisely where the problem lies with many conventional micronutrient therapies: most micronutrient therapies do not take into account the structural integrity and activity of DNA.

## Nucleotides and their functions

Let's start with a quick refresher on biology: Nucleotides are the building blocks of genetic information, both DNA and its working copy, RNA. If we look at DNA and RNA at a structural level, we see that the main components are nucleotides. When a gene is activated, it forms mRNA, the blueprint that can then be converted by the cell into a specific product (and thus a protein). The translation of mRNA into a molecule takes place in the ribosomes, which are also essentially made up of nucleotides. So whether it's storing information, retrieving it or converting it into specific cellular processes, nothing works without nucleotides.

Nucleotides are also part of various signalling pathways, enabling cells to respond to hormones such as insulin. Due to their structure and the phosphate groups they contain, nucleotide-containing molecules are often particularly energy-rich and are therefore

suitable as energy stores – classically in the form of ATP (adenosine triphosphate), the body's universal energy carrier.

## Nucleotide turnover and synthesis

Apart from their relevance, the enormous quantitative demand for nucleotides is also often ignored. Every day, the human body replaces 50 to 70 billion cells – that is about 1 million cells per second. Before each cell division, the DNA is duplicated, requiring over 6 billion nucleotides per cell division.

But what about the supply of nucleotides? Well, they are not essential, as the body can produce them as needed. Specifically, the synthesis of nucleotides requires:

- Large amounts of essential micronutrients, especially methyltetrahydrofolate and methylcobalamin, i.e. bioactive vitamin B9 and vitamin B12
- Macronutrients in the form of amino acids as suppliers of amino groups and C1 groups (especially glutamine, glycine, aspartate)
- Energy: 8-12 ATP per molecule
- Electrons in the form of NADH and NADPH

This is an impressive list of ‘expensive’ ingredients. It is explosive and suggests that a deficiency in nucleotides may not be as rare as initially thought. The supply of vitamin B<sub>9</sub> and vitamin B<sub>12</sub> alone is suboptimal in our population. The prevalence of vitamin B<sub>12</sub> deficiency, for example, is around 5-7 percent and increases with age. Up to 30 percent of people over the age of 60 have a subclinical deficiency [1,2]. Energy and electrons can also become scarce in certain situations, for example in the presence of a chronic disease.

## Nucleotide deficiency in chronic diseases

Chronic diseases are associated with a permanent additional burden on the organism. Various cycles that are actually self-regulating are disrupted, resulting in the following situation:

- Increased cell wear and tear due to increased regeneration requirements; cell regeneration is correspondingly increased
- ATP deficiency in the context of mitochondrial stress (keyword: mitochondriopathy) leads to functional impairment of the affected cells
- Oxidative and nitrosative stress: Chronically ill patients are usually burdened with free radicals, which themselves promote degeneration and negatively influence various biological processes
- Cellular wear and tear, energy deficiency and radicals initiate inflammatory processes, which in turn promote degeneration and radical formation; a vicious circle that is now referred to as ‘inflammaging’ [3]

This situation is exacerbated by the extremely common disturbances of the intestinal environment and an unbalanced diet. Less nucleotides are obtained from food, so an increased nucleotide requirement is then met by a reduced supply. However, if expenditure exceeds income in the long term, massive problems are inevitable.

Tissues with a high degree of proliferation, i.e. a permanently high demand for cell division, are particularly prone to deficits and ultimately degeneration.

The usual suspects are easy to name: intestinal mucosa, immune cells and white matter of the nervous system – none of which are entirely unimportant tissues. But it doesn't stop there. The hypofunction of these tissues will gradually exacerbate the problems:

- Malassimilation (inadequate utilisation of food) leads to an increase in micronutrient deficiencies; vitamin B12 deficiency in particular occurs in old age, mainly due to malassimilation in the small intestine and poorer stomach function.
- Weakened immunity promotes chronic infections
- The monitoring and elimination of malignant cells is impaired, increasing the risk of cancer in the medium term
- Regeneration deficits in the nervous system increase the risk of neurodegenerative changes with advancing age (keyword: dementia)

The perfect vicious circle develops in the mitochondria: their biogenesis declines, and with it the production of the energy-rich nucleotide ATP, our most important source of energy. Due to a lack of energy, we produce fewer nucleotides, the deficiency of which then reduces energy production. Without intervention, this extremely unfavourable situation can hardly be resolved.

## Innovative therapy with nucleotides

We are beginning to understand why the administration of micronutrients alone, even if they are the very best, most biologically valuable and most bioactive representatives of their kind, cannot lead to lasting success. If we want to build a pyramid from the bottom up in micronutrient therapy, we should not neglect the base of the pyramid – the nucleotides. If this is sufficiently appreciated, there are some astonishingly positive consequences:

- The regenerative capacity and cognitive performance of the CNS increase [4,5]
- DNA damage decreases [6]
- Oxidative stress decreases, while antioxidation and energy production increase [7,8]
- The performance of the immune system improves, especially under stress [9,10]
- T cells, which in turn play a crucial role in defending against viruses, benefit particularly from this [11]
- The number of mitochondria increases, as does their performance [12,13]

There are therefore a number of good and important reasons to use nucleotides extensively, especially for chronic problems and at the beginning of therapy – and very few reasons not to. In view of their proven positive effects, their use in the field of prevention is also likely to be of enormous benefit to many people.

The use of nucleotides in everyday life is taking on new significance, particularly in view of our changing eating habits. These nutrients, which are not actually essential, are mainly found in foods that were favoured by our ancestors but are less common in today's diet. The diet that was intuitively followed at that time, known as the paleo diet or Stone Age diet,

was naturally rich in nucleotides due to the consumption of offal and broth. By utilising the entire animal, people at that time consumed precisely those components that are rich in nucleotides. This complete utilisation of the animal is a thing of the past, as the consumption of offal, bone broths and the like has declined sharply. Instead, low-meat and high-carbohydrate diets are now in vogue. Nucleotides are therefore in short supply in our food.

By way of comparison, beef small intestine contains about six times the amount of nucleotides found in the same amount of spinach. However, pure meat, such as beef steak or chicken breast, contains hardly any nucleotides – even less than spinach or other vegetables [14,15]. This is another reason why the additional intake of nucleotides is gaining new relevance and why nucleotide supplements can be useful both in prevention and therapy.

## Literatur

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