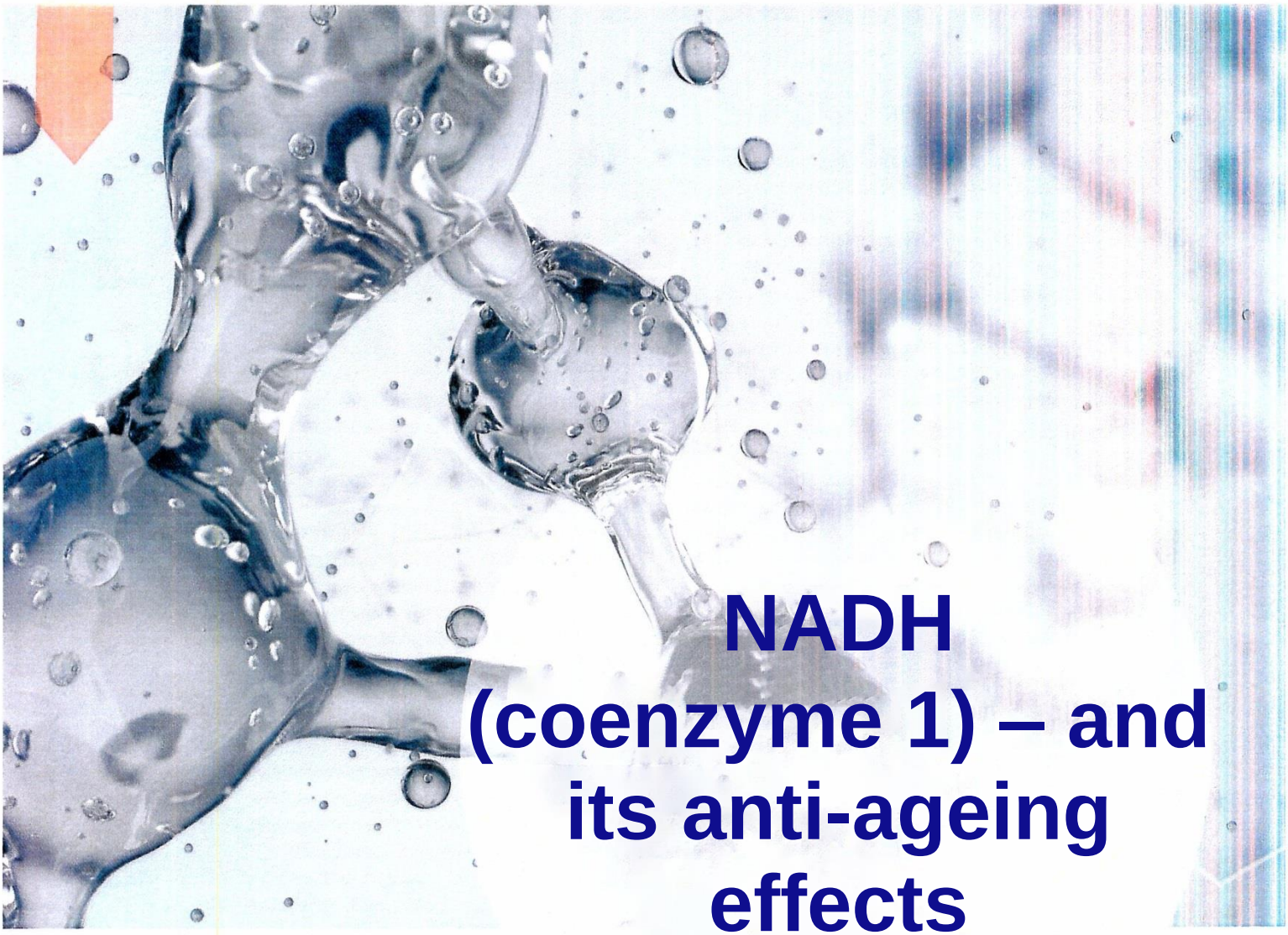


NADH (coenzyme 1) – and its anti-ageing effects

NADH, the acronym for nicotinamide adenine dinucleotide hydride, is the biological form of hydrogen. It reacts with the oxygen present in every cell and produces energy in the form of ATP (adenosine triphosphate). The more ATP a cell has available, the better it functions and the longer it lives. It is the most important coenzyme in our body. The term “anti-ageing” has been somewhat overused for years, because many researchers are looking for substances and methods that could delay the ageing process. What happens when our organism gets older? Four main phenomena are responsible for ageing.

1. **Decrease in ATP – energy production in the cells**
2. **Damage to DNA**
3. **Oxidation of lipid membranes**
4. **Shortening of the telomeres**

1. Decrease in ATP – energy production in the cells

The central question is: can one increase the concentration of ATP in a cell? The answer is: yes, with NADH. This was proven in a study of isolated heart cells (Pelzmann et al. 2003); however, the study showed that **only NADH**, but not its oxidised form NAD+, could pass the cell membrane. This means that only NADH, but not NAD+, can increase the ATP energy in the cell. The precursor of NAD+, nicotinamide, and nicotinamide riboside also cannot, because they cannot penetrate the lipid membrane of the cell due to their charge. This means that neither NAD+ nor nicotinamide or nicotinamide riboside can lead to an increase in ATP.

Recently some researchers, especially in the USA, have been claiming that NAD+, or its precursor, nicotinamide riboside, is a more potent anti-ageing preparation than NADH. However, these colleagues, such as e.g. Dr. David Sinclair, have failed to provide scientific proof of this.

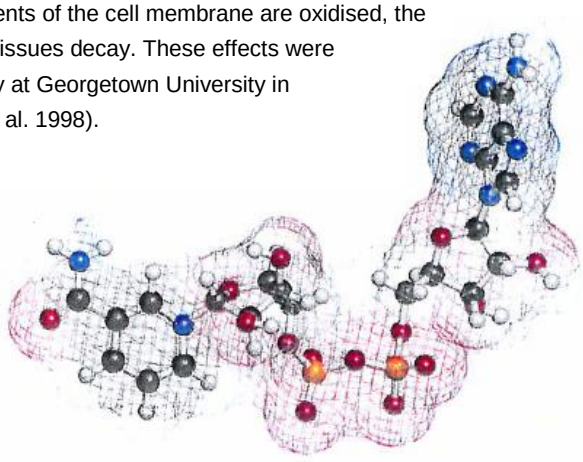
He claims that one must increase the level of **NAD+** in a cell to increase the ATP energy in that cell. As one can read in biochemistry textbooks, ATP production requires **NADH** and not NAD+. Dr. Sinclair also asserts that the NADH that is produced in the citric acid cycle should be viewed as a by-product. This statement is also false, because **only NADH** is capable of producing ATP as part of the oxidative phosphorylation process, and **not NAD+**. Dr. Sinclair ignores the important fact that NAD+ as well as nicotinamide riboside, which is currently being marketed under the product name NIAGEN with an extensive advertising campaign, is not taken up by the cell. Consequently, NAD+ and its precursors cannot have any anti-ageing effect. NADH increases ATP production not only in cell cultures, but also in people. In athletes, taking 30 mg of NADH per day resulted in an increase of up to 12% of ATP in muscle cells after just one month, as evidenced by muscle biopsies (Misner B, 1999). With more ATP in cells, tissues and organs, these function better and stay vital longer.

2. NADH can repair damaged DNA and cells

DNA is constantly being damaged by toxic substances, poisons in the environment, UV rays, free radicals and medications, especially chemotherapeutic agents. This changed DNA is the cause of errors in cells, tissues and organs. However, our body has enzymes that can repair damaged DNA. NADH is a cofactor of this DNA repair system, and the more NADH a cell has available, the better its DNA functions. Repair enzymes. A scientific study demonstrated that DNA damaged by the chemotherapeutic agent doxorubicin could be repaired with NADH (Zhang et al. 1998). This group of researchers could also prove that liver cells that were lethally damaged by X-rays could largely be revitalised with NADH (Fa-Quan 2003). In other words, NADH protects from radiation damage and would therefore be an effective means to prevent radiation damage.

3. Oxidation of lipid membranes

NADH is a strongly acting biological antioxidant. It is therefore vital to provide the organism with enough antioxidants to ward off the attacks of the free radicals. Dr. Richard A. Passwater, US biochemist and expert in antioxidants, writes in his prologue to my book, “NADH – The Energising Coenzyme”: “*There is not a single substance in the human organism that one could describe as the most important molecule or the most significant antioxidant, but NADH comes as close as any one substance can to this description*.” NADH is the most important coenzyme in all living cells. “It drives reduction and oxidation in the cells’ metabolic processes and is the most important antioxidant” NADH reduces lipid peroxidation.
When the lipid components of the cell membrane are oxidised, the cells and therefore the tissues decay. These effects were demonstrated in a study at Georgetown University in Washington (Busheri et al. 1998).



4. Shortening of the telomeres

Every cell contains a set of chromosomes in which a majority of the inherited information is stored in the form of DNA. This information must be protected to maintain the cell's proper functioning. The endings of the chromosomes, the telomeres, play an important role in this process. They protect the chromosomal DNA. Due to the semi-conservative DNA replication, the telomeres are shortened with every cell division. When the telomeres become so short that they can no longer protect the chromosomes, the unprotected chromosome endings send out signals that ensure that the cell no longer divides. This state is referred to as "senescence". As we advance in age, there are more and more senescent cells, resulting in a loss of tissue and organ functions. (Hennning 2010). The length of the telomeres can be used to estimate the biological age of a person. There are just a few laboratories that can measure the length of the telomeres. One of these laboratories recently found that several people aged 50-60 who had taken NADH for years had the same telomere length as 30-year-olds. This is evidence of the anti-ageing effect of NADH. In the meantime it has been scientifically proven that people with longer telomeres not only live longer but also stay healthy for longer.

The activation of sirtuin enzymes is another mechanism to extend the lifetime of cells. Sirtuins are conserved histone/protein deacetylases that act to extend life and defend against stress. The activity of the sirtuins is regulated by the ratio of oxidised to reduced NAD (NAD+/NADH). Because the availability of NAD+ depends on the cellular metabolism and the energy status, the activity of the sirtuins is regulated by the ratio of oxidised to reduced NAD (NAD+/NADH). The NAD+/NADH ratio is relatively high in resting cells that get their energy mainly from the oxidative metabolism. Quickly dividing cells on the other hand switch to anaerobic energy generation, and the NAD+/NADH quotient drops [5]. The tight relation between sirtuin function and cellular metabolism plays a central role in the regulation of lifespan. Sirtuins are responsible for example for the life-extending effect of calorie restriction.

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A reduced calorie intake results in an increase in general fitness and an extension of the lifespan in all animals investigated so far, including mammals.

Due to its many effects explained above, NADH has a scientifically proven anti-ageing effect. A healthy lifestyle and a reasonable, predominantly vegetarian diet also have a life-extending, and so an anti-ageing, effect.

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