

Hong Kong Student Science Project Competition 2023

Template of Extended Abstract (Investigation)

(Word Limit: 1,600 words, Pages: 3 pages only)

Team Number: SBBC039

Project Title: The effect of NMN on planarians

Project Type: Investigation

*To our best knowledge, there are / are no * similar works in the field;*

I. Background

- Provide background information of project and/or state the problem to tackle
- Provide highlights of the **literature review** with the support of pertinent and reliable references
- Provide an overview of work and mention the **research gap that the project is trying to fill**

NAD⁺ is a coenzyme found in all living cells and plays an important role in regulating metabolism in organisms. During chronological aging, the NAD⁺ level in the body would decline, which leads to the development of metabolic dysfunction and age-related diseases. Therefore, increasing the NAD⁺ level in the body has appeared as a method of targeting metabolic dysfunction diseases, and studies have shown that it can be accomplished by oral administration of NMN, one of the NAD⁺ precursors. This experiment aims to test the effect of NMN on the regeneration of planarians by putting planarians into NMN solutions with different concentrations and observing the rate of binary fission of planarians. The results demonstrate the rate of binary fission of planarians is at the highest when the concentration of NMN in the solution is $5.61 \times 10^{-3} \text{M}$. This experiment can serve as evidence that NMN may be beneficial in reversing the aging process in humans through the regulation of energy metabolism.

II. Objectives

- State the **aim(s)** of project

NMN products in the market claim that they can against aging by synthesizing NAD⁺ levels hence enhancing energy metabolism. Our aim of the experiment is to find out the effect of the concentration of NMN on planarians' reproduction rate by measuring their rate of binary fission. We evaluated the effects of different concentrations of NMN solutions on the planarians by observing the process of planarians plotting their tails.

III. Hypothesis

- Propose an explanation for a phenomenon and stating how the **hypothesis** can be tested by experiments

We predict that the higher the concentration of NMN solution, the higher the rate of binary fission of planarians. Since NMN is a precursor of NAD⁺, which is a coenzyme in respiration, NMN can enhance NAD⁺ levels through biosynthesis pathways to reverse the aging process by regulating respiration

IV. Methodology

- List out the materials used
- Describe the **experimental protocol** including the set-up of **control experiment** (if any), **repeated experiment** (if any), and its scientific theory
- Indicate with the support of reasons, the **analysis** used in the investigation

25 cm³ pipette, 100 cm³ volumetric flask, Filter funnel, glass rod, dropper, Petri dishes, fish eye lens, and grid paper.

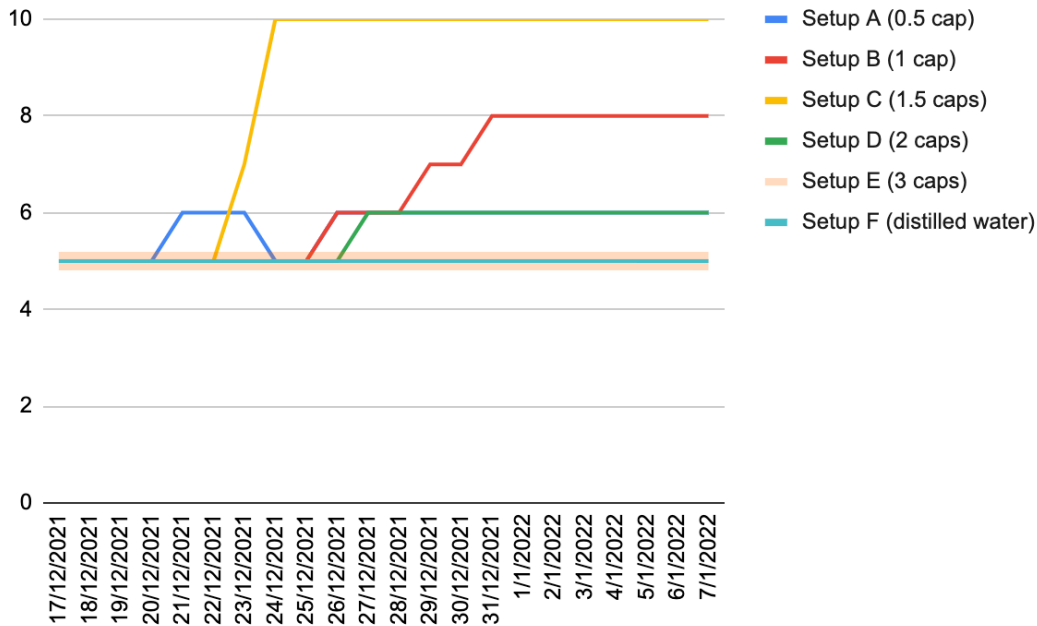
Firstly, we diluted the solution into different concentrations after dissolving a different number of capsules into distilled water. Secondly, we have to pick planarians of similar sizes and put them into 6 set-ups for the experiment. Then, one of our members brought all 6 set-ups home during the observation period. We have to take pictures of each planarian in the set-ups by the fisheye lens on grid paper, to record the size of it while also marking down the number of planarians present in the petri dish each day.

Set-up	Number of capsule(s) to be dissolved in 100 mL of distilled water	Molarity of the solution of NMN
A	0.5 capsule	$1.87 \times 10^{-3} \text{ M}$
B	1 capsule	$3.74 \times 10^{-3} \text{ M}$
C	1.5 capsules	$5.61 \times 10^{-3} \text{ M}$
D	2 capsules	$7.48 \times 10^{-3} \text{ M}$
E	3 capsules	$11.22 \times 10^{-3} \text{ M}$
F	Distilled water	0


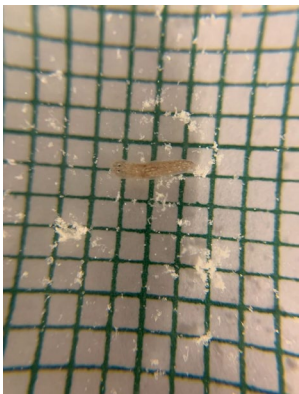
V. Results

- Present the **data** with figures, tables or photos
- **Data analysis** (if any, with emphasis on data reliability and the reproducibility based on statistics)
- Interpret the results and its implication
- Discuss **limitation** and compare with existing related works (if any)
- Discuss the importance or impact of the research and how it is applicable to real problems

Comparison graph of number of planarians in each set-up



Set-up C (1.5 caps)

	17/12/2021	7/1/2022
Photo	 <p><i>Set-up C planarian on the first day, before binary fission</i></p>	 <p><i>Set-up C planarian at the last day, after binary fission</i></p>
Appearance	Longer	Shorter

Number of planarians	5	10
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As the graph shows, our hypothesis is partially correct.

In set-up A to D, the final amount of planarians found after the observation period increased. Yet in set-up E (3 capsules) and F (distilled water), the number of planarians found after the observation period remained unchanged. From set-up A to set-up C (0.5-1.5 capsules), there is an increasing number of planarians found at the end of the observation period, implying that the binary fission rate is increasing gradually with an increase in NMN concentration. Whereas in NMN concentration beyond 1.5, fewer planarians can be found after the observation period when compared to set-up C. The binary fission rate of planarians is the highest in set-up C ($5.61 \times 10^{-3} \text{ M}$).

It is believed that our findings in the effect of NMN on planarians can partly help verify the effect of NMN on human cellular energy metabolism.

Firstly, the reason why we chose planarians as our investigation target is there are certain extent of similarities between humans and planarians. Some sources showed the majority of glucose catabolized in planarians is fated for aerobic glycolysis [1] and when the energy demand of planarians increases, the rate of glycolysis is higher [2]. So, it is believed that the energy consumed in binary fission might come from aerobic glycolysis of planarians. Moreover, NAD^+ acts as a hydrogen acceptor in glycolysis, therefore the availability of NAD^+ is a limiting factor for the steps of glycolysis [3]. Hence, if there is an increase of NMN, there will be an increase of NAD^+ level, a faster rate of glycolysis, and more energy will be generated for binary fission. Thus, the higher binary fission rate shown by the planarians put in NMN solutions in our experimental result has implied that NMN can facilitate binary fission by providing more energy through glycolysis. Similarly, the first step of respiration in humans is also glycolysis, and it is used by all cells in the human body for energy generation [4]. Therefore, it can be concluded that the effects of NMN in planarians, an enhancement of energy generated by glycolysis, might be the same on humans.

Secondly, depletion of the NAD^+ level is associated with downregulation of energy production in mitochondria, increasing oxidative stress, DNA damage, cognitive impairments and inflammatory diseases. NMN, as the precursor of NAD^+ , has been seen to likely reverse these age-related complications and slow down the rate of aging by enhancing the NAD^+ level in the body [5].

The first area of improvement is that we can take photos of the planarians more frequently per day (i.e. twice or three times per day), to have more accurate data on the time needed for planarians to undergo binary fission as we only took pictures of planarians once per day in this experiment. Second, we can repeat the experiment using smaller concentration intervals between 3.74×10^{-3} M and 7.48×10^{-3} M (1 cap to 2 cap) to estimate more accurately on the concentration for planarians to have the highest rate of binary fission.

VI. If your team will compete the Sustainable Development Award, please indicate the specific sustainable development goal the project is related to, and provide justification for competing for this award. (Word limit: 300 words)

The project is related to goal 3, ensuring healthy lives and promoting well-being for all. Currently, COVID-19 has affected over 500 million lives worldwide according to the United Nations. At the same time, the disease has left post symptoms for patients, for example, fatigue or brain fog. We discovered the supplement, NMN, has been promoted in mainstream media to boost energy production and increase the rate of cellular repairment, it might be a helpful supplement to help patients recover from their post symptoms. However, advertisements rarely mention the recommended dose of NMN per day, where overdose could be an issue. Hence, with the goal of ensuring healthy lives, we investigated the problem of the optimum dose of NMN that can bring the highest metabolic effect on planarians, where the result may possibly be linked to humans as we share genetic similarities to a certain extent.

VII. If your team will compete the Social Innovation Award, please list the target group or social issue the project focuses on, and provide justification for competing for this award. (Word limit: 300 words)

The project is targeted at people who are in their late 30s. The supplement, NMN, is targeting their products to people who have decreasing NAD⁺ levels. According to a medical organization, people in middle age have half the NAD⁺ level compared to their 20s, where higher NAD⁺ levels are shown to promote better health. NMN has been advertised as the “booster” of the NAD⁺ level. However, there were barely any instructions on the recommended dose of NMN to be intaken. Therefore, the report presents a reliable result of the optimum amount of NMN intake per day in order to bring out the highest metabolic rate in planarians, where it may possibly be linked to humans as we share genetic similarities to a certain extent.

VIII. Conclusion

- Make a **data-driven** conclusion of the project and the way forward of the research
- Justify if the proposed project meets the objective(s)

The experiment concluded that NMN solution can affect the rate of binary fission of planarians. Increasing the concentration of NMN solution can increase the rate of binary fission for concentration not higher than 5.61×10^{-3} M. When the concentration is increased beyond 5.61×10^{-3} M, the rate of binary fission of planarians will not further increase.