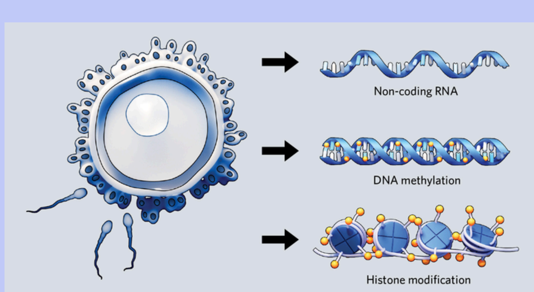
PREVENTION OF TELOMERE SHORTENING THROUGH EPIGENETICS

Introduction

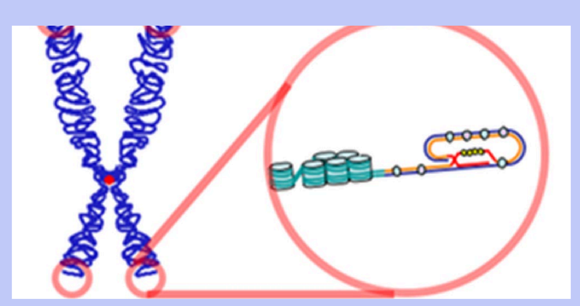
Telomeres, the protective nucleoprotein caps at the end of chromosomes, are vital for chromosomal stability through preventing degradation at the chromosomal level. As cells divide telomeres progressively shorten. Upon becoming too short, the cell can no longer divide triggering senescence and aging, the biological term for aging and cell death respectively. Thus, **developing an understanding of how telomere length can be regulated and identifying whether there are possible interventions to help counteract telomere shortening have become an important area of research within the medical field of aging**.

One such promising intervention comes from the role of epigenetic processes. Epigenetics, defined as the field of changing gene expression without changing DNA itself, has become a more widely studied discipline within the science community. With epigenetics comes its application, known as epigenetic processes. These, including but not limited to DNA methylation and histone modifications, are ways to influence gene expression without changing the DNA behind it. Typically epigenetic processes are used to stop or reverse things within the body, whether it be the expression of an X chromosome, the spreading of malignant tumors, or repetitive element transcription. Thus, **the potential epigenetics has to reverse and stop natural concepts within the bodies has gained considerable interest within medicine as it could potentially reverse aging.**

Upon a review of past literature, **it can be determined that there is a gap in current research that this study will address, which is whether or not epigenetic processes can be used to prevent the shortening of telomeres.** Past researchers found the significant impact genetic reversal and other epigenetic processes have on cancer therapy, as illustrated through the literature review by the study of (Baylin & Jones, 2011), these studies did not examine if epigenetic processes can be applied in other medical fields, specifically aging. Other researchers such as (Sharma et al., 2010) have also studied the field of epigenetics, especially how to apply it to cancer and tumors; however, they also do not address any implications epigenetics could have on aging. Thus, **there exists a research question on can epigenetic processes be applied to prevention of telomere shortening.**



Epigenetics



Telomeres

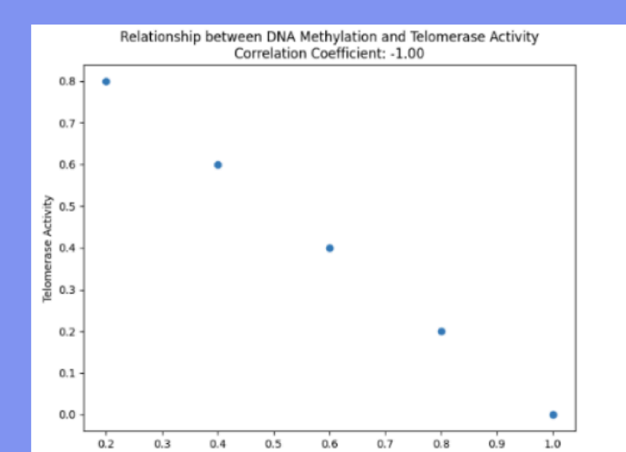
Methodology

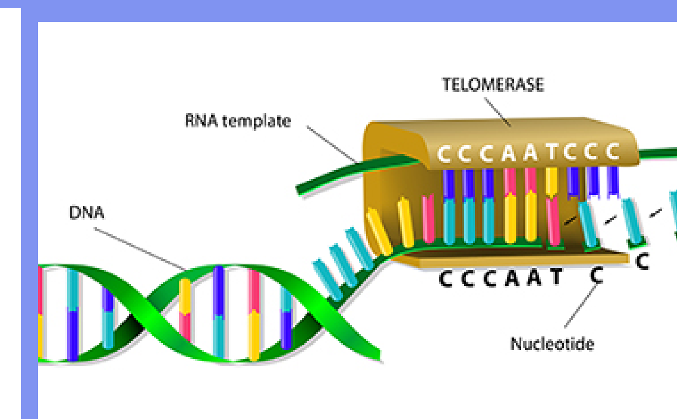
Through a meta-analysis, it will allow for the overlap of sources to help create a fundamentally new understanding, meaning that it will derive from past peer-reviewed research. A meta-analysis itself is like a big picture analysis where researchers combine the results of multiple studies on a similar topic. This helps them see if there's a general trend and how strong the evidence is. In order to conduct the actual meta-analysis the researcher took five steps: 1). **located sources, 2). Developed an Inclusion and Exclusion criteria, 3). evaluation of search terms, 4). extraction of data, and 5). coding of data** (**see below**).

Themes	Coding Criteria			
	Oncological (Cancer) Based Research	Metabolic Disease Based Research	Neurological Disease Based Research	Aging Based Research

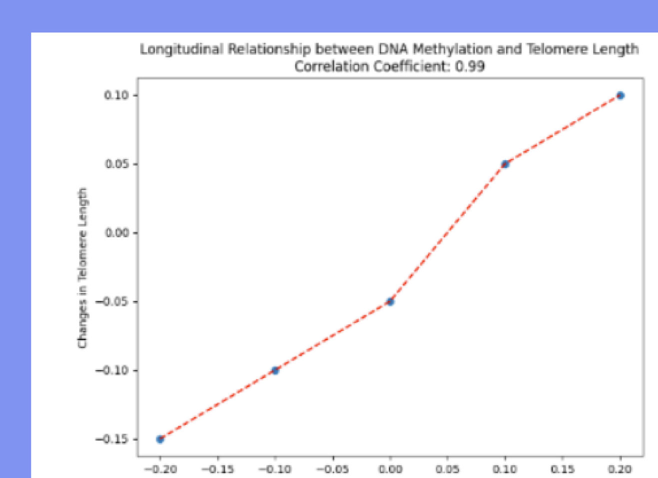
Findings

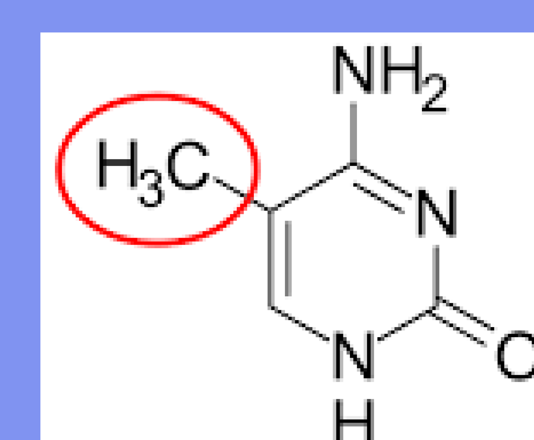
A key finding from the research conducted is the **strong inverse correlation between DNA methylation in the TERT promoter region and telomerase activity** as illustrated by figure 1.





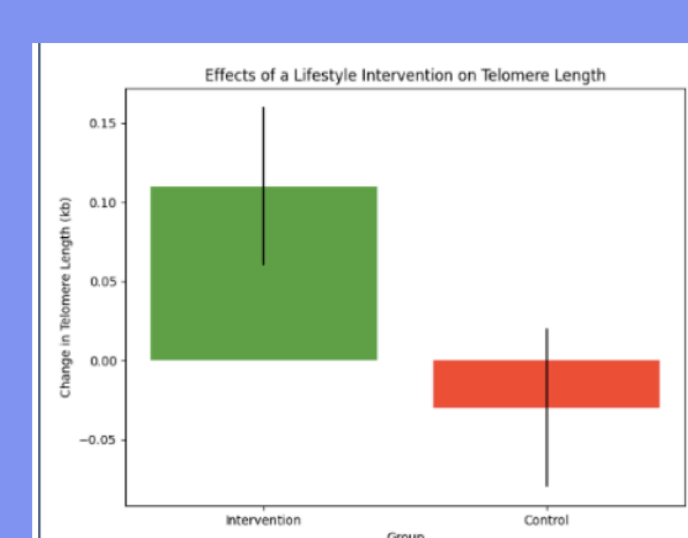
What this suggests is that **epigenetic repression of the TERT gene, which codes for telomerase, can lead to reduced telomerase levels and thus shorter telomeres.** Although seemingly negative, this illustrates that **telomeres can be influenced by epigenetics processes**. In a more positive manner, longitudinal data gathered from the meta-analysis illustrates **the link between epigenetic changes over time and telomere dynamics**, as it showed that histone modifications predicted changes in telomere length in middle-aged adults as represented by figure 2.

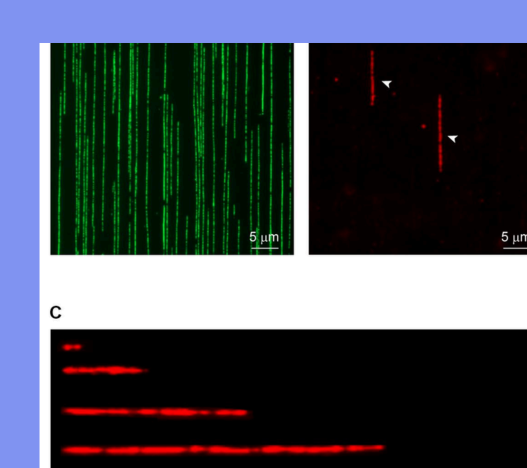




DNA Methylation

The meta-analysis also uncovered that non invasive epigenetic processes may also be able to influence telomere length. For instance, **lifestyle interventions and dietary supplements have been found to influence telomere length.** Lifestyle interventions tended to actually impact the telomere length greatly as the control group in various studies tended to have no change, whereas the groups in which they were tested tended to have a larger change in telomere length as illustrated in figure 3.





Telomere Length Assesment

Conclusion

Through the findings, it can be observed that telomere shortening is affected by all types of epigenetic modifications, whether they be direct or not, meaning that the prior hypothesis is supported by the data gained by the meta-analysis. **Furthermore, epigenetic processes appear to play a significant role in the regulation of telomerase activity and telomere length, suggesting potential for targeted epigenetic interventions to reverse or slow age-related telomere shortening,** the research agrees with (Kane & Sinclair, 2019) that **epigenetics have a place in aging based therapy, and takes it a step further with actually reversing aging rather than only just slowing it down.** This means that in order to boost efficiency of the epigenetic process onto telomere shortening, **it could potentially be helpful to target specific cell populations as some tend to be affected much more than others.**

Future Outlook

Firstly, there is an urgent need for **large-scale studies that employ standardized protocols** for measuring both epigenetic markers, such as DNA methylation and histone modifications, as well as telomere length over long extended periods of time.

Additionally, future research should investigate the efficiency of targeted epigenetic interventions. For instance, these studies should be conducted **based upon how efficient DNA methylation modulators or histone deacetylase inhibitors are** within targeting telomere shortening.

Furthermore, **other medicinal fields may be able to utilize epigenetics as well**, as the boundary of it only being used in cancer can now be broken. Lastly, although not fully grounded, as it can be used to stop telomere shortening, which is essentially aging, **if it can stop aging entirely it opens up a new avenue on how to reach immortality.**