# Lifestyle and How It Affects Cellular Aging

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## Introduction

On Menlo Grandfriends Day, my grandma was noticeably absent. She was diagnosed with dementia and Alzheimer's last year and could not attend. It all started six years ago when my grandma hit a mailbox while driving. Once she returned home, my parents got a call that she hit someone's mailbox, but she had no recollection of the incident. After the incident, my dad sent her to the doctor to see what was wrong. My parents didn't know for sure what it was but knew something about her was off. Alzheimer's is a degenerative disease that worsens progressively, and there is no medication to treat it. Now that she has reached stage 5, she has been having outbursts of frustration and has the mentality of a five-year-old. In the beginning of her Alzheimer's condition, she would forget to do basic things such as washing dishes and daily chores. Then, she would start to refuse to wash her own hair but only if she went to the salon. My mom would take her to the salon every week for 6-7 months. Later on, she would forget she got her hair down and have mental breakdowns as if she were a 5-year-old. Now, we cannot take her out because she has lots of episodes and forgets family members. My experience with my grandma sparked my interest in biology and how cells are affected by aging. I am mostly interested in aging because I want to see how Alzheimer's is caused, how people are affected by aging, and why. In this essay, I will ask three main questions. The first question is, what happens in the changes of an aging cell? Secondly, what is epigenetics, and how does your body recognize problems? Finally, how do diet and exercise help your cells?

## Cellular Aging

Over time as people age, cells also age and become senescent. At this stage, they are affected by telomere degradation as well as genomic instability. Telomeres are little caps of DNA that protect the ends of chromosomes. The more we age, the more cells divide and the shorter the telomeres become (Max Planck Institute for Biology of Ageing, 2022). Cells stop dividing once the end of the chromosome becomes short up to a certain point. This can cause inflammation of many cells and result in early aging. Luckily, a rare enzyme called telomerase can prevent the telomeres from becoming shorter by re-attaching more DNA to the telomere. However, most cells in the human body do not contain the enzyme. Although telomerase can prevent accelerated aging by lengthening telomeres, if the human body generates too much telomerase, it can also make humans more susceptible to accelerated aging and diseases such as cancer (Aunan et al., 2016).

The next part of how cells become affected during aging is genomic instability, or when DNA becomes extremely damaged, which is also a mark of cellular senescence. Our DNA is frequently being damaged externally and internally. Some factors that damage the human body are UV radiation from the sun or reactive chemical species and enzymes in the mitochondria. The DNA in our body is estimated to be damaged about one million times daily from these factors. Luckily, most of the damage is fixed immediately because the cells have excellent

reaction and repair mechanisms (Max Planck Institute for Biology of Ageing, 2022). However, sometimes repairing the human body could be better than we think. Sometimes, a small amount of the damaged DNA is unrepaired. As we age, this DNA damage accumulates and continues to develop, which can cause several negative effects. The mutations in our DNA can cause an increased susceptibility to tumor growth and cancer risks (Aunan et al., 2016). Finally, the damage to our DNA can cause the cells to function less and cause cells to become senescent, also causing a loss of organ function.

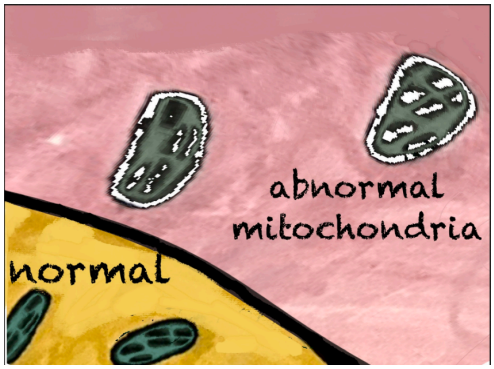


*Figure 1.* Normal and Abnormal Mitochondria (own photo).

As we age, the epigenetics in our body change. But what is epigenetics, and how does it change? Epigenetics is a part of the body's blueprint stored in your DNA. Sometimes our DNA is bookmarked by specific chemical changes, and this results in various proteins wrapping around the DNA and recognizing it for specific functions, which altogether is called the epigenome. Epigenetics is very important because it helps the human body adapt to what we eat, what drugs we use or consume, and changing levels of stress as we age. One of the most important changes is called DNA methylation, which adds a small chemical group onto a portion of DNA. Some people call it an "epigenetic clock" as a metaphor because DNA methylation may measure how well someone is aging (Max Planck Institute for Biology of Ageing, 2022). This so-called "clock" can be used as a marker to see how to treat certain conditions and to help patients build a new lifestyle. For example, if someone is sick, the clock can be a perfect tool to identify what treatment doctors need to offer and what type of lifestyle the patient will need after being diagnosed with a particular sickness. Although the epigenome may be a perfect marker for new treatments, it can also play a role in aging. Although this is possible, it has not yet been proven in the clinic.

Another reason why our body recognizes problems is mitochondrial dysfunction and how the proteins in the mitochondria develop problems. The mitochondria are tiny little compartments, or organelles, inside of all cells and particles that work as a powerhouse to generate energy for your cells. They use oxygen to create energy with a process called mitochondrial respiration. The mitochondria have their own special genome called mtDNA (Max Planck Institute for Biology of Ageing, 2022). With mice, scientists discovered that having damaged mtDNA can cause accelerated aging. This is why mitochondria are a very important component of our bodies: they can let us have healthy and well-aged lives. The mitochondria can also make reactive oxygen species, also known as ROS, while producing energy. ROS can be a negative effect sometimes because excessive levels might hurt important cells in the

human body. Many scientists thought that ROS could cause people to age faster, but recently, scientists have been finding different results. They found that ROS can also be a positive factor by letting cells communicate and fix things. The mitochondria in younger people have the perfect balance between protein damage and stress response pathways, meaning that the stress response pathways have enough time to fix most of the protein damage that is caused (Moehle et al., 2019). But as we age, the protein damage that builds up over time as we age ends up exceeding how much our stress response pathways can handle.

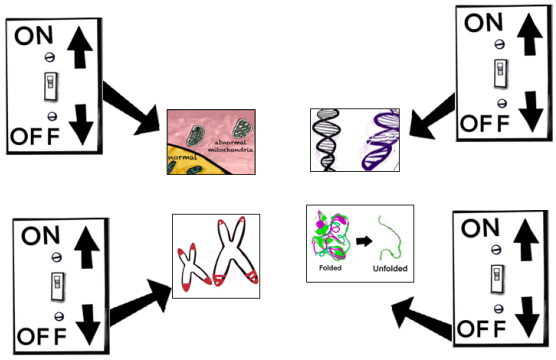


*Figure 2.* On and Off Switch for Cellular Aging (own photo).

**Diet and Exercise**

Diet and exercise can also be crucial factors in health and aging. For example, impaired perception of nutrients, exercising, fasting, and sugar all dramatically affect how we age. How much animals eat has also been shown to affect healthy aging. Reduced food intake, or dietary restriction (DR), extends life and can improve health, affecting not only animals but also a wide variety of organisms. Originally, scientists and people thought that the cause of extended living and health was high caloric intake, but now recent studies have shown a reduction in dietary systems. They realized protein is an extremely important part of the dietary system, which includes lots of nutrients. The cells in our body sense nutrients so that we can grow and sustain metabolism. The cells have pathways to extend life, which represents a type of “network” that responds to certain foods. This can also help doctors and scientists to find and develop new medications. Another factor in healthy aging is fasting. Eating less and having restrictions can help your health by reducing inflammation and having a diminished chance of accelerated aging. It activates a “cleaning” process called autophagy which helps your brain and muscles. It also can raise NAD+, a certain chemical, and strengthen people’s DNA (Moehle et al., 2019). This can put people’s bodies in “survival mode,” meaning that if they are in very rough situations with getting food, they won’t have too much trouble and will still be strong and have energy.

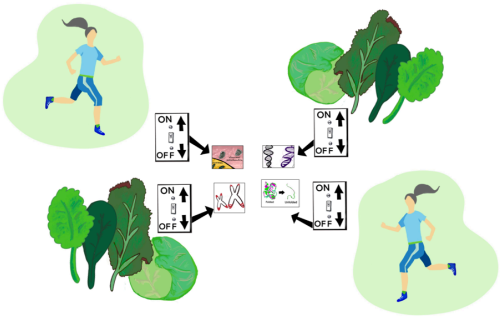

*Figure 3.* Healthy Diet and Exercising (own photo).

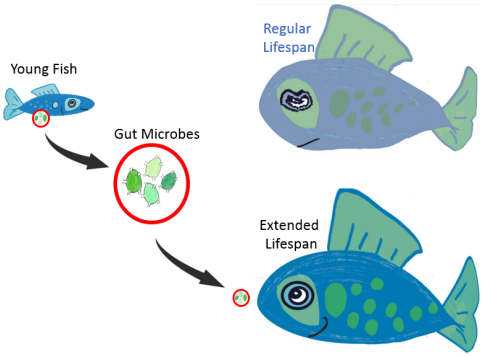


*Figure 4.* Regular Lifespan and Extended Lifespan (own photo).

Another factor in healthy aging is sugar intake. People's dietary styles are not meant to involve so much sugar. Extreme amounts of sugar intake can lead to type 2 diabetes and even cause heart disease. Sugar can also shut down pathways that involve AMPK and sirtuin molecules, which are known as two connected mechanisms of increasing lifespan. Consuming too much sugar can lower your defenses against disease and aging. This means that when people consume sugar, their bodies will slowly lose the power of protection from diseases and accelerated aging (Moehle et al., 2019).

Finally, exercising is the last factor in healthy aging. Many studies show that acute exercising relates to the process of aging so much that their effects on the body are almost identical. This is true in multiple organ systems, including the brain, cardiovascular system, neuroendocrine system, metabolic systems, and musculoskeletal system. Rates of chronic disease are lower, and rates of normal aging increase when we exercise frequently. When we work out, our body experiences a "go" or stressful process, which is similar to the process of aging; however, working out also includes a "rest" process. When people's bodies go through the resting process, they are able to cool down the stress that they are dealing with. If we stop exercising, it gives us time to recover, which helps our body get stronger and more used to dealing with challenges. Because acute exercise and aging are similar, repetitive exercise can help the human body become more prepared as we age. This can help decrease our susceptibility to diseases and accelerated aging in general (Moehle et al., 2019)

## Conclusion

Based on my research I have learned that reduced sugar intake and exercising can help prevent cellular aging. Some factors of cellular aging are cellular senescence, genomic instability, and telomere shortening. Some future questions are whether scientists and researchers will find a way to reduce accelerated aging. Based on my research, I really want to find out how people in the blue zone areas work and how their population lives the longest. For example, how does a balanced diet help with aging and how can having a plant-based diet and less processed foods help aging? Another reason is exercising and based on my research, exercising naturally– such as by taking your dog out for walks, standing more, and spending more time outside– can be more effective than going to the gym. Something I found extremely interesting is how drinking wine, belonging, and hanging out with your loved ones make an impact on aging on a cellular level (Buettner et al., 2016). In the future. I want to see how doctors can prove that this can reduce accelerated aging.

## References

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