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Nuffield Research Placement Report

# THE PRESERVATION OF A DNA MOLECULE AND HOW TO MAINTAIN IT OVER TIME.

By Leah Doolan

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# The preservation of a DNA molecule and how to maintain it over time.

## Contents:

## Abstract

This report includes information about DNA and how to preserve it over time. It also mentions space radiation and how to prevent that.

It is a Nuffield research placement report and also has information about the Lunar Mission One project.

## Lunar Mission One – background information


Lunar Mission One is a publicly funded unmanned moon mission and is planning to leave a permanent archive of human life buried on the moon's south pole.

They are planning for the mission to take place in 2024. One of the main goals is to place an archive of human life on the moon but also to drill a hole on the South Pole in the crater Shackleton and see if there are any valuable materials there.

Shackletons crater is around -73°C so keeping the archive cool will not be a problem.

# Introduction

In this research placement, we were given the task of investigating a certain area for the Lunar Mission One Project.

We were asked to choose a subject (mainly Chemistry, Biology, Physics or Maths) and this would determine what part of the Lunar Mission One we would research; I choose Biology. We were told about the different types of biology that would relate to the mission and had to choose a topic. I decided to investigate how the DNA in the time capsules could be preserved.

Our supervisor gave us some good links and websites to use to get started on finding information.

I was already aware of some aspects of my projects, for example I knew quite a bit about DNA from College.

# Methodology

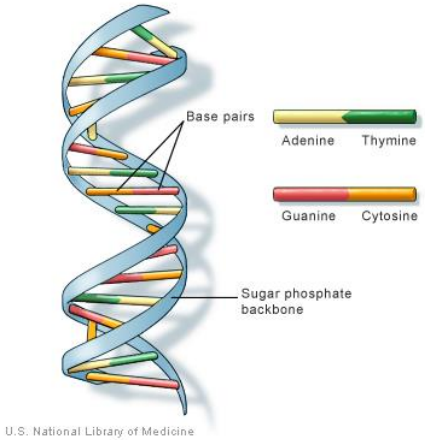
For this project, we were mainly based in the IT suite, as we needed to collect as much research as possible. We used sites such as Research Gate and Google scholar.

As I continued to research my topic I collected any valuable information and grouped it all together so I would have it all in one place. I then sieved through this information when I needed to use it.

# Results and discussion

## What is DNA?

DNA (deoxyribonucleic acid) is a biochemical code in the nucleus of each of your cells. It stores your genetic information and is unique only to you.




It is made up of 4 different nitrogen bases Adenine, Thymine, Guanine and Cytosine more commonly known as A, T, G and C. DNA is formed in a double helix and attached to a sugar-phosphate backbone.

It has been researched that should a DNA molecule remain stable, it could last up to 50,000 years.

One important factor of DNA is that it is able to replicate itself. Each strand in the double helix acts as a pattern for duplication the base sequences.

## Preserving DNA

One way to store DNA would be to use a substance called cryoprotectant to cover the DNA then freeze in liquid nitrogen. Cryoprotectants have low molecular weight, are non-toxic and cheap which all affect DNA on its journey to -196°C.

They are split into two main types: intracellular agents and extracellular. Intracellular agents penetrate the inside of the cell preventing any ice crystals to form, which could rupture the membrane. Extracellular agents do not penetrate the cell and instead try to improve the osmotic imbalance that happens during freezing. However it has been concluded that intracellular agents are the best to use.

When the DNA reaches 196°C it enters something called a glassy state. This causes the molecules to lose the ability to diffuse. This

mean's that there is no movement on the molecular level, which results in no chemical reactions taking place.

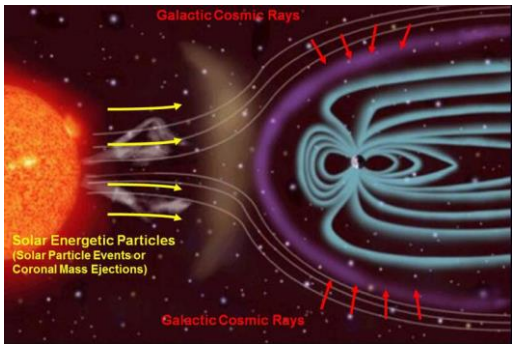
When thinking about preserving DNA, you will have to think about what form it will be in. For example it could be a sample of blood or a hair sample. However if a blood sample were used, red blood cells would not be able to be used, as they do not contain any DNA.

## Space radiation

Something that could affect the DNA samples is the radiation that it may come in to contact with on its way to and on the moon.  Space radiation is made of mainly ionizing radiation, which exists in the form of high-energy charged particles.

Space radiation is made up of three kinds of radiation:

- Trapped Radiation
- Galactic cosmic radiation
- Solar energetic particles




Trapped radiation occurs when charged particles become trapped in the Earth's magnetic field and spiral around inside the field.

Galactic cosmic radiation is thought to come from supernovas. This type of radiation is emitted as immense clouds of high-energy charged particles.

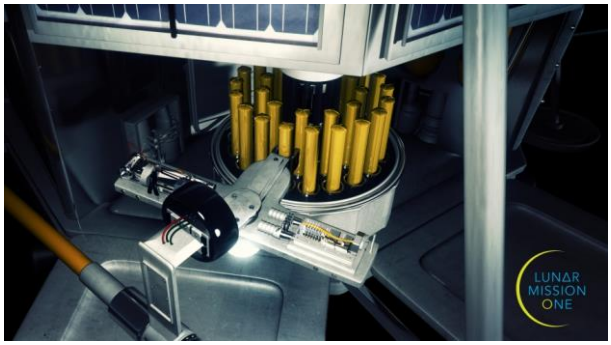
Solar energetic particles are released by the sun in solar particle events. This can result in sudden, intense storms on Earth.

If this radiation were to contact the DNA molecule directly it would break the DNA strands into clusters and is not easily repaired by cells. Also because space radiation can disrupt an atom, it can produce more particles when it makes contact - which is called a secondary effect.

There is also another type of radiation: ultraviolet radiation. This is less energetic and the particles pass on energy to the atoms and molecules with which they interact but they do not strip off electrons.

## Preventing Radiation

One way to prevent radiation is to use lead as the storage material. Lead can reduce types of radiation because of its high density and high atomic number. The high atomic number means that when the radiation hits, the atoms of the lead will absorb the energy instead of the DNA.

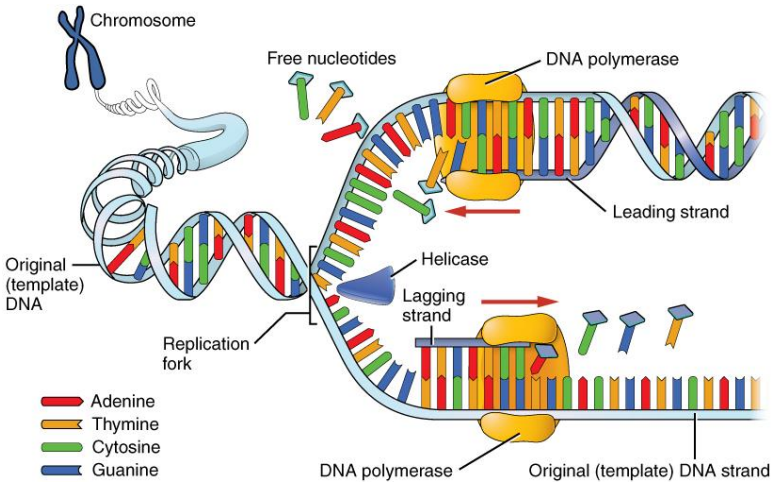



Example picture of the time capsules.

## Maintaining the DNA molecule

A way to maintain a DNA molecule is by DNA replication. Doing this enables the DNA to produce two identical daughter cells.

An enzyme, DNA helicase, causes the two DNA strands to separate by breaking the hydrogen bonds  that join the bases together. Any free nucleotides bind to their complementary bases. They are then joined together by DNA polymerase, which makes phosphodiester bonds. The remaining unpaired bases continue to attach to their nucleotides. Finally, all the nucleotides are joined to form complete polynucleotide chains.



## Evaluation

To conclude, this research shows one way in which you could preserve a DNA molecule for space travel. However I think that there are definitely points that could be expanded on and there are probably other complications to be considered too.

One complication is what DNA sample to choose. It makes storage and collection difficult as well. For example how would they collect it and how would they choose to take it from.

# References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