2015 Genes in Space Honorable Mention Winning Proposal

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1. **Describe your project in tweetable form.**

   We're sending cell lines into space to see if microgravity has an effect on DNA repair enzymes when fixing cancer mutations in the p53 gene.

2. **Describe the scientific problem that you propose to address. What is the question you are trying to answer? What makes it significant, relevant, or interesting?**

   What is the effect of microgravity on DNA repair? Previous studies reveal that cells grow slower in microgravity environments. Could microgravity impact DNA polymerase and other enzymes' ability to copy the genetic code for cells? The scientific problem we're trying to address is whether or not the chance of mutation can be decreased if DNA and DNA polymerase are exposed to a microgravity and UV radiation environment. Perhaps the effect of slowing the cell cycle will improve the ability of the cell to properly replicate its genome. It would be interesting to see if this unique environment increases the function and fidelity of these powerful enzymes. Deficiency in proofreading and exonuclease activity of DNA polymerases has been linked to many cancer pathologies. Many point mutations in the most common cancers are caused by problems with DNA polymerase. For example, the vast majority of melanomas are caused by UV-induced mutations in tumor suppressor genes. Many people all across the world are concerned about cancer and finding a cure, and so this is a very real-world issue.

3. **State your hypothesis. What are your objectives?**

   Our hypothesis is that DNA replication is improved in space because the microgravity environment may slow down DNA polymerase function, allowing cells to fix mistakes made during replication more easily. This may be the reason why cell proliferation is slower as seen in other studies. It is known that mammals have many DNA polymerase proteins that help during the S phase of interphase that serve different functions such as DNA repair, replication, and have different levels of DNA proofreaders. If DNA replication processes are improved leading to slower cell proliferation, theoretically it could reverse cancer pathologies in organisms. We could test if cancer pathologies are reversed by using mammalian cell models and use PCR to detect if the p53 mutation is decreased in the cells after being exposed to this unique microgravity environment. If microgravity has a positive effect on DNA replication processes leading to improved exonuclease activity, it could also lead to an increase in the functional unmutated version of the p53 gene in cell lines with the cancer pathology. PCR could be used to detect presence of unmutated and mutated versions of the p53 gene in the cells.

4. **Explain how the unique environment aboard the International Space Station is required to test your hypothesis. What conditions of the space station are essential for your research?**

   The unique environment aboard the International Space Station (ISS) is essential to test our hypothesis because of the microgravity in space. Due to the lower gravity, this could cause the DNA polymerase function to slow down when replicating DNA and be a better proofreader. Back on Earth, polymerase

can easily make a mistake and cause a mutation in the genetic code that could ultimately lead to cancer. The reason why we simply cannot just compare UV treated cells on Earth is because we need to see if the microgravity will increase the fidelity of the DNA polymerase, therefore making less mistakes when assigning a complementary nucleotide base and potentially making the mutated cells able to have a functional p53 gene. The only way we can see this difference is through observing two different mammalian cell types that have been subjected to a lower G-Force than that on Earth, and the perfect place to do this is in space.

5. **Outline your experimental plan. How will you use PCR to test your hypothesis? Specify for example the samples you will analyze, controls that you will use, and the possible experimental outcomes.** (200 word limit)

   We plan to expose mammalian cells to 4 different conditions. Group 1:Cells grown in the ISS and exposed to microgravity and UV irradiation. Group 2:Cells grown in the ISS and exposed only to microgravity. Group 3:Cells grown on earth and exposed to UV irradiation. Group 4:Cells grown on earth and not exposed to UV irradiation. DNA Analysis: DNA will be extracted from each group and amplified by PCR using common p53 primers. Once amplified, sequences will be analyzed statistically for mutations. UV damage induces C-T mutations. We'll use sequence homology to identify these specific nucleotide changes and calculate rates of DNA damage for each group. Controls for inducing DNA damage: We expect UV to induce DNA damage. Group 1 should have a higher rate of DNA damage than group 2. Group 3 will also have a higher rate of DNA damage than group 4. We'll calculate the amount of UV irradiation exposure in the ISS (J/m2) and replicate this amount on earth using a UV light bulb. Outcomes: If microgravity aids in DNA repair, we expect group 1 to have a lower rate of DNA damage than group 3. If instead microgravity promotes DNA damage, group 3 will have a lower rate of DNA damage than group 1.

6. **How did you hear about Genes in Space?** (From my teacher, parent, the internet, etc)

   Teacher

7. **Citations** (optional)

   NA (this wasn't a question in 2015)