2020 Genes In Space Competition

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1. Describe your project in tweetable form.

Combating bacterial infections and antibiotic resistant infections on the ISS using antibodies effused from shiitake mushrooms.

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?

The scientific problem being addressed is the need to provide medical treatment for people who live in isolated areas and cannot obtain pharmaceutical drugs to treat medical conditions. This includes the environment on the ISS. Mushrooms effuse compounds called metabolites. Metabolites are the mushroom's natural defense against microbes. Since a property of mushrooms is to effuse metabolites, these metabolites could be used to create a personalized, low-cost treatment for the destruction of bacterial infections. Mushrooms grow quickly and easily in many diverse environments, making them accessible to everyone and are a natural alternative to pharmaceuticals. If the bacterial infection was to mutate, the secondary metabolite produced by the mushroom would also change which is critical when treating drug-resistant strains. Since PCR has already been used to detect the presence of E Coli and over twenty other bacterial infections including pneumonia, it could also be used to detect the presence of bacterial infections for this study. A significant fact is that in today's world, bacterial infections are becoming more resistant to current treatments. This technology could be used not only on Earth but also onboard the ISS where medical facilities are limited.

3. State your hypothesis. What are your objectives?

The objective of this study is to examine the possibility of using the chemical properties of mushrooms to create an antibiotic that combats bacterial infections in people. On Earth, mushrooms are showing promise in effectively destroying bacterial infections through the

production of metabolites. Mushrooms effuse metabolites creating a personalized treatment that may be able to mutate as bacteria mutates. We want to test this theory against *Streptococcus A* which causes strep throat, scarlet fever, rheumatic fever, sepsis, and a flesh-eating disease called necrotizing fasciitis. *Streptococcus A* is known to have mutated into 137 identified strains and is becoming resistant to the current treatments using penicillin, ampicillin, amoxicillin, and cefotaxime. Therefore, if one of the chemical properties of mushrooms is to produce metabolites, then a personalized vaccine could be effused from the mushroom itself because metabolites are compounds that mushrooms produce which fight the microbes responsible for bacterial infections. The environment on the ISS could be used to compare cultured bacteria samples against samples cultured on Earth. The effectiveness of the metabolites against the destruction of harmful bacteria would be analyzed in both locations. This study is relevant both on Earth and on the ISS where medical facilities are limited.

4. Explain how the unique environment aboard the ISS is required to test your hypothesis. What conditions of the space station are essential for your research? (200 words)

The ISS has a unique environment because of the microgravity aboard. Studies have shown that bacterial cells grow faster and are more lethal in space than on ground level. Because of this, higher doses of antibiotics are needed to treat the bacteria. If bacteria grows faster in space, the need for antibiotics becomes critical for the health of the astronauts. A study which began in 2016 by Tradd Cotter has had encouraging results using the metabolites from mushrooms to kill bacteria and combat drug-resistant strains of bacteria. The ISS is needed to test several parts of the theory as it pertains to space travel. First, mushrooms can grow in an environment that has microgravity. Second, if the mushrooms do grow, will they still produce metabolites? Finally, testing the effectiveness of the metabolite on samples of bacteria cultured on the ISS and comparing the findings to the samples cultured and tested on Earth. Mushrooms may be the answer to personalized medical treatments 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.

PCR tests for the presence of bacterial infections. Our experiment uses PCR to test for *Streptococcus A* bacteria: emm1, emmu28, and emm89, the most common and difficult mutations to treat with ampicillin, amoxicillin, and cefotaxime. The gene, *pbp2x* seems the most resistant to treatment as reported in a study by James Musser, MD, PhD, chair of the department of pathology and genomic medicine at Houston Methodist Hospital. Materials and conditions will be replicated on Earth and the ISS. Materials: 60 spore bearing fruiting bodies of shiitake mushrooms brought in bags containing sawdust, the growth nutrient, and divided into three groups corresponding to the strains emm1, emmu28, and emm89. Test tubes designed for microgravity, supplied by *BioServe Space Technologies,* contain three bacteria strains. Since the test tubes have four compartments: nutrient, bacteria, antibiotic, and preservative, the design needs to be modified so the metabolites from the mushroom can be injected into the bacteria. PCR will perform the gene expression analysis both on Earth and the ISS. Growth requirements: temperature between 45 and 70 degrees Fahrenheit, humidity between 75 to 85 percent, indirect /shaded light conditions. We hope the bacteria on Earth and the ISS will respond identically to the mushrooms.

6. How did you hear about Genes in Space?

We heard about Genes in Space from our teacher.

7. Citations (optional)

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