SSEP Mission 16 to ISS: Selected Flight Experiments, Communities, Teams, and Abstracts

Contact: Jeff Goldstein, SSEP National Program Director, 301-395-0770, jeffgoldstein@ncesse.org

A total of **1,262 proposals** were submitted from student teams across the 22 communities participating in Mission 16 to ISS. Of those **539 proposals** were forwarded for review by **Step 1 Review Boards** in each of the communities. Each Step 1 Review Board selected up to three finalist proposals, which were submitted to the **National SSEP Step 2 Review Board**. On November 30, 2021 and May 10, 2022 the Step 2 Review Boards met via Zoom, reviewed all **70 finalist proposals**, and selected one proposed experiment to fly for 20 communities, 2 proposed experiments for two communities, for a total of **24 flight experiments, which will fly on SpaceX-26**. It is noteworthy that the 1,262 proposals received reflected a total of **6,497 grade 5-16 students fully engaged in experiment design**.

1. Ukraine

Dental Filling Material Solidification in Microgravity Conditions

Grade 11, Kharkiv gymnasium № 47 in collaboration with Junior Academy of Sciences of Ukraine

Co-Principal Investigators: Harkavets Mykhailo, Volkov Vladyslav

Co-Investigators: Davydova Sofiia, Sadchykova Yelvzaveta

Teacher Facilitator: Savoilov Andrii

Proposal Summary:

The main question addressed by this paper is: how microgravity affects dental restorative material adhesion and structure. Dental problems are widespread on the Earth, but they may become even more dangerous in space. Such problems are known to happen on the ISS. There were cases when astronauts made luting indirect restoration of his tooth to prevent further tooth destruction until he returned to the Earth (Menon A., 2012; Aldredge W., 2016). In any case, dental problems are inevitable, even considering the possibility of astronaut screening by tooth health. The main reason is insufficiently evoking of enamel and dentin restoration process due to the softness of astronaut food. Thus, decalcification occurs, and teeth become brittle. Therefore, dental operations will be needed in space, especially in long- term flights to other planets. The experiment will show any difference between filling materials prepared in space and on the Earth. Henceforth, the research will show microgravity effects on filling`s integrity, homogeneity, strength, and adhesion to the teeth.

2. Ukraine

The Effects of Microgravity on Potassium Hexacyanoferrate(III) Crystals

Grade 8, Communal Institution, Richelieu Scientific in collaboration with Junior Academy of Sciences of Ukraine

Co-Principal Investigators: Hryb Andrii, Skrypnyk Nikita

Teacher Facilitator: Anastasiia Maskechko

Proposal Summary:
This proposal relates to the problem of crystal growth under microgravity conditions. The main goal is to study the effect of microgravity on the crystal's shape and volume during its growth. Another aim is to develop a proper algorithm for crystallization in microgravity and a confined vessel. As an object of the investigation, potassium hexacyanoferrate (III) crystals are chosen for their rich color and distinct shape. Under the typical conditions on the Earth's surface, its monocrystals grow red and rod-shaped. It is hard to expect to see a monocrystal in this experiment. However, a difference in shape and size still will be observed. It is expected to have a much slower growing process and smaller samples in space compared to earth conditions.

3. Coquitlam, British Columbia, Canada
The Changes in Beneficial Metabolites by Lactic Acid Bacteria in Microgravity
Grade 9, Port Moody Secondary School
Co-Principal Investigators: J.E. (Jong-eun) Lee, Yong Lee
Teacher Facilitator: Marina Mehai

Proposal Summary:
Microorganisms have been found to react differently in microgravity conditions (8, 9). Bacteria composing the human gut microbiome provide many benefits (10) and affect the host both physiologically and psychologically. (11, 12, 13) Bacteria in the gut produce vitamins otherwise not synthesized in the body. These include B vitamins, vitamin C and vitamin K. (19, 20, 21, 22) B vitamins help the brain and energy production (27), and vitamin C is necessary for building and repair of tissues. (28) Most importantly, vitamin K is an important factor in bone mineralization. (24, 29) Furthermore, its metabolites, specifically butyrate, an SCFA have been linked to many health benefits from reduced inflammation to autophagy (14, 15), which will be beneficial for the reduction in frequent rashes or hypersensitivity, and loss of muscular mass commonly experienced in space. (16) Knowing if the production of these beneficial compounds changes can greatly affect the wellbeing of future astronauts in microgravity long-term. The investigation will look at the effect of microgravity in the production of short-chain fatty acids (SCFAs) by *Lactobacillus casei* (HA-108), *Lactobacillus rhamnosus* (HA-111), *Lactobacillus acidophilus* (HA-122), and *Bifidobacterium longum* (HA-135) in the fermentation of prebiotic fibers present in chia (*Salvia hispanica*) seeds.

4. Moreno Valley, California
The Effects of Microgravity On The Germination Of Carrot Seeds
Grades 11 and 12, Valley View High School
Co-Principal Investigators: Andrea Cortez, Georgina Ramirez
Co-Investigators: Alexis Cuevas, Lindsey Luong
Collaborator: Jocelyn Mora
Teacher Facilitator: Salvador Martinez

Proposal Summary:
The goal of the experiment is to compare and contrast the germination of carrot seeds in microgravity and on Earth experiments. One main reason for this study is to determine if carrots are a possible resource to consume. This experiment will determine if carrots can be an accessible resource for consumption in microgravity. The study will showcase how carrots can be a helpful resource to provide protein and other vitamins to help occupants on the ISS to maintain their health. If the experiment is unable to sustain a steady growth on the ISS, the carrots will not be brought to the ISS in the future. Further research will be conducted to find

substances that can provide health benefits to help people on the ISS to survive if strawberries aren't able to grow on the ISS.

5. Perris, California
The Effect of Microgravity on the Germination of Quinoa
Grade 6, March Mavericks Middle School
Principal Investigator: Kiedan Sareth
Co-Investigators: Enrique Rodrigues Ruiz, Jonathan Zamora
Teacher Facilitator: Lisa Petmecky

Proposal Summary:
After doing research, the students at March Middle School named Kiedan Sareth, Jonathan Zamora, and Enrique Rodriguez Ruiz are proposing the launch of an experiment on the germination and growth of quinoa. This test's purpose is to see whether quinoa can germinate in space and how the effect of microgravity could change the quinoa seeds. If the experiment were to succeed, then the growth of quinoa seeds would be an improvement to the health of astronaut researchers and explorers. Quinoa is high in nutrients, fiber and amino acids, of which will enable the human body to continue growing and allow them to be less prone to diseases like diabetes. Quinoa, once grown, can be used as wheat or grain and may also be used in salads, with lush leaves and tender shoots, or stems. Growing quinoa would give astronauts more variety and keep them healthy as well if eaten raw.

6. Redlands, California
The Effect of Microgravity on Weevils (*Sitophilus Oryzae*) Found in Rice
Grades 9 and 10, Redlands High School
Principal Investigator: Bernice Nunez
Co-Investigators: Diego Martinez, Francisco Perez Ortiz
Collaborators: Mathhew Daguerressar, Francesca Krstenansky
Teacher Facilitator: 1st Sgt. SMSgt. Ionne` Barnes-Joshua

Proposal Summary:
The experiment will be able to identify how weevil growth on rice is different from free fall to gravity, the investigation will help identify how in the future, foods can be transported and stored in space. Also, if the weevils are also able to grow in space, we could use these weevils to help pollinate other plants and help with the growth of plants.

7. Hillsborough County, Florida
The Effects of Microgravity on the Bio-electrolysis of *Anabaena sp. PCC 7120*
Grade 8, Walker Middle Magnet School
Co-Principal Investigators: Brad Beenhakker, Henry Bravo, Rehan Dost, Samuel Fernandez, Rohan Halarnkar, Luke Oldenburg
Teacher Facilitator: Jodie Dukes

Proposal Summary:
The experiment the group is proposing will address the question "How does microgravity affect the bio-electrolysis of *Anabaena sp. PCC 7120*?" For humanity to explore the vast expanse of space it needs an easily obtainable fuel source to perform its exploration. The best fuel source for upper stages of spacecraft (the upper sections of the ship) and for deep-space travel is hydrogen because of its efficiency, energy density, and power. The most efficient way to produce hydrogen is through electrolysis, which splits water molecules into hydrogen and oxygen using an electrical reaction. Of the different forms of electrolysis, the proposed form is

known as bio-electrolysis, which uses living organisms to naturally perform an electrolysis reaction. The reason the group is studying the hydrogen and oxygen production of the cyanobacteria *Anabaena sp. PCC 7120* is to determine if it produces enough hydrogen and oxygen in microgravity to be useful in space travel. *Anabaena sp. PCC 7120* is the species of choice because it produces excessive amounts of hydrogen and oxygen, both of which can be used for space travel. Although investigations have been performed in the ISS regarding photosynthesis, nothing has ever been performed to study the results of bio-electrolysis in microgravity. If bio-electrolysis in microgravity is shown to produce a significant amount of hydrogen and oxygen, then *Anabaena sp. PCC 7120* may be a viable hydrogen fuel source to power humanity's interstellar exploration.

8. Hillsborough County, Florida
Purslane Spaceflight Proposal
Grades 6 and 7, Randall Middle School
Co-Principal Investigators: Ayden Bartlett, Miguel Garcia, Aditya Laveti, Benicio Schuster
Teacher Facilitator: Mary Vaughn

Proposal Summary:
For this proposal, the investigation will explore the effects of microgravity on the Purslane plant (*Portulaca Oleracea*) and if Purslane is capable of properly growing and retaining nutrients in microgravity. The basis for this investigation is the prior knowledge that Purslane contains many nutrients including valuable Omega-3 fatty acids and high amounts of Vitamin E and beta carotene. If the hypothesis proves true, then Purslane will prove as an easy to grow, yet nutrient rich microgreen, even in microgravity. It may also provide a viable crop for long duration missions and stays at the ISS, as a way to have fresh food beyond our home.

9. Ocala, Florida
What is the Effect of Microgravity on the Amount of Ethanol Produced by Yeast Fermentation?
Grade 5, Dr. N. H. Jones Elementary
Co-Principal Investigators: Anakan Keithan Gopalan, Aarya Jaiden Seevaratnam
Teacher Facilitator: Lisa Dorsey

Proposal Summary:
This investigation will determine the amount of ethanol produced by fermentation under microgravity in a period of time. In this experiment, glucose will be fermented using yeast to figure out the amount of ethanol produced under microgravity and will be compared to the amount of ethanol produced on Earth using the exact amount of glucose/yeast/water. Fermentation is a chemical process of converting carbohydrates or sugars into either ethanol or lactic acid without oxygen using microorganisms. The type of organism used in fermentation determines the by-products. With yeast fermentation, ethanol and carbon dioxide are produced. The amount of ethanol produced in weightless condition within a period of time depends on how yeast feeds off glucose for energy. Research shows that *saccharomyces cerevisiae*, yeast, is very virulent in microgravity meaning fermentation could be faster, therefore, ethanol can be produced faster. Fermentation plays an important role in food and alcoholic beverage production, food preservation, the production of biofuel, nutritional supplements, vaccines, and waste management. Fermentation makes food richer in nutrients by breaking down the nutrients and making them easier to digest. Fermented food increases the amounts of good bacteria in the digestive system, which boosts digestion, immunity, and antioxidants. These health benefits can have a positive impact on the health of astronauts. The outcome of this experiment is important since fermentation can be used to recycle waste in space and the by-products can be used for other purposes such as biofuel, disinfectants, and photosynthesis.

10. Lake Charles, Louisiana
Sunflower Microgravity Growth
Grades 6 and 7, F.K. White Middle School
Principal Investigator: Priscilla Moncada
Co-Investigators: Edith Evey, Cynthia Chulo
Teacher Facilitator: Dana Istre

Proposal Summary:
The investigation will attempt to determine whether or not the germination of sunflower seeds will be affected by exposure to a lack gravity. The Space Investigators will leave the sunflower seeds alone during the experiment on the International Space Station. When the seeds return to Earth, there will be an experiment conducted to determine whether or not the seed's exposure to a non-gravitational environment has affected its ability to germinate on Earth.

11. University System of Maryland, Maryland
Generation of Metallic and Ceramic Nanoparticle Aggregates in Microgravity for Novel Insights into Planetary Formation
Grade 14, University of Maryland, College Park
Co-Principal Investigators: Vincent Lan, Adrian Seemangal
Investigator: Brian Sun
Teacher Facilitator: Michael Kio

Proposal Summary:
Nanomaterials are composed from as little as 10 atoms but have contributed to revolutionary advancements in many fields including energy, medicine, manufacturing, and computing. Not only are nanomaterials the foundation for many of humanity's greatest modern achievements, but they may also serve as principal components to understanding the initial formation mechanisms of planetary bodies. Nanoparticles contain a relatively few numbers of atoms with many atoms residing on the surface, contributing to a great amount of surface energy compared to larger bulk materials. To reduce energy, nanoparticles cluster form aggregates. Current understanding of planet formation relies on the sticking and clustering of cosmic dust particles, aided by a star's gravitational and magnetic field. Once diameters exceed a few centimeters, aggregates transition into planetesimals and self-gravitation becomes the primary growth mechanism. However, before that point in the millimeter-to-centimeter range, planetesimals bounce off one another instead of sticking together, hindering growth. This specific problem has puzzled planetary scientists. Thus, this investigation will seek insights from the formation of metallic and ceramic nanoparticles clusters in microgravity to develop detailed understanding of planet formation. Metallic and ceramic particles represent the compositions of the cosmic dust considered to be the building blocks of the Solar System. Understanding aggregation of nanoparticles will enhance the efficiency of novel technologies including, but not limited to, heat-based cancer treatment, 3D-printed electronics, and the operation of portable MRI devices on the International Space Station (ISS). Insights from this investigation could contribute to the advancement of these technologies.

12. Grand Blanc, Michigan
Microbial Solutions for Food Waste In Space
Grade 8, Perry Innovation Center
Co-Principal Investigators: Genevieve Monterosso, Isaiah Marble, Kenedy Brazell, Patrick Ireland, William Dean
Collaborators: Connor Burton, Zeyland Holden
Teacher Facilitator: Jason Valimont

Proposal Summary:
On Earth, food waste in America alone includes 1.3 billion tons of food every year and often sits in landfills. Finding solutions to efficiently decompose food matter that may be used again for growing new food in microgravity is key to sustainable space exploration. This is important because more people will be visiting space where they will have greater quantities of food waste in the near future. Our research question is: How is the decomposition of blueberries affected by microgravity? This experiment should be conducted in microgravity because the results could greatly benefit space agricultural programs. This investigation will analyze the decomposition of rehydrated blueberries on the ISS and here on Earth. Observations and measurements will be taken based on the weight, size, microbial film, and appearance of the blueberries.

13. Hoboken, New Jersey
The Effect of Microgravity on Catheter Biofilm Formation by the Bacterium *Pseudomonas fluorescens*
Grade 11, Hoboken High School
Co-Principal Investigators: Feline Dirkx, Kai Hultstrom
Teacher Facilitator: Jean Lebegue

Proposal Summary:
We propose to answer the question: What will be the effect of microgravity on biofilm secretion by the bacterium *Pseudomonas fluorescens*? *Pseudomonas fluorescens* is a common, gram-negative, rod-shaped bacterium. When *Pseudomonas fluorescens* adheres to an object with a moist environment, it grows biofilm. The objective of this research project is to see the effect microgravity has on the formation of *Pseudomonas fluorescens* biofilm. A biofilm is a hydrophilic substance secreted by the bacteria, forming around microcolonies, acting as protection from the immune system and antibiotics, and as a physical layer of protection from other elements. To execute this experiment, we'll use a FME device which is a 3 chamber experimental system, in which volume 3 holding 10% neutral buffered formalin, volume 2 holding tryptic soy broth with a catheter, and volume 1 holding powdered lyophilized culture of *Pseudomonas fluorescens*. All the used equipment will be completely sterilized before the experiment. The minilab will be kept in an ambient temperature as this bacterium is known to grow best within an ambient temperature range. *Pseudomonas fluorescens* will be allowed to grow at this temperature for 2 days as the preliminary optimization experiments determined *Pseudomonas fluorescens* reached its maximum growth after 48 hours. After 2 days, the investigation will end, using the 10% neutral buffered formalin. After the investigation has ended and the minilab system is delivered back to Earth, the catheter will be analyzed for biofilm secretion and growth and absorbance of the mixture will be measured using a spectrophotometer. This data would then be compared to the ground experiment completed on Earth beforehand determining whether the secretion increased.

14. Albany, New York
Microgravity's Effect on the Germination of Basil Seeds Using Hydroponics
Grade 8, William S. Hackett Middle School
Co-Principal Investigators: Aimee Diana Arias, Alina Gasanova, Kaylee Garcia Ramirez, Jasmine Suarez, Sage Volmer
Teacher Facilitator: Craig Ascher

Proposal Summary:
Our group wants to see how basil seeds (*Ocimum basilicum*) when in space (exposed to microgravity) will be affected. The experiment will be using hydroponics to help the seeds germinate. Hydroponics, according to the Hydroponics 101 handbook, is "a method of growing plants in a soil-free, nutrient-rich water solution." The same experiment will be conducted on

Earth to serve as a control group. This will be done using a duplicate of the Type 3 FME Mini-Lab sent to the ISS. The only difference is that the basil seeds on Earth will be exposed to sunlight and gravity. When the experiment ends, the seeds in the mini-lab from the ISS will be compared with the seeds in the mini-lab that were on Earth. The comparison will be done to see any differences in germination. The data will be measured by using a microscope and metric ruler. Therefore, it will be accurate and visually represented by a data table. This experiment was chosen because of its health benefits that could assist and or aid astronauts on the ISS. In addition, more information will be collected on agriculture in space, a major part in the possible creation of colonies on different planets in the future.

15. Buffalo/Niagara, New York

The Effect of Microgravity on the Resistance of *Staphylococcus epidermidis* to Oxacillin

Grade 10, Wellsville Secondary School
Co-Principal Investigators: Serena Boussa, Elijah Brophy
Co-Investigators: Aidan Jadwin, Ben Jordan
Teacher Facilitator: Ross Munson

Proposal Summary:

This experiment strives to test the effect of microgravity on the susceptibility of *Staphylococcus epidermidis* to oxacillin. Multiple studies carried out through NASA and other organizations have observed that increased resistance to antibiotics as a common trait expressed by bacteria that have been exposed to space travel. The cause of this change remains unclear. In an attempt to gain further information on this topic, studies have been carried out by many; however, these tests yield inconsistent data. Through this program our experiment will provide direct and invaluable information to address increased bacteria resistance by exposure to microgravity. After analyzing our results, we will be able to verify if susceptibility is altered. By comparing this to other tests we can determine how resistance varies based on bacteria species. The outcome will add to the current understanding. Based on our team's research it is hypothesized that *Staphylococcal epidermidis* will become more resistant to the oxacillin, an antibiotic to which it was previously susceptible. The results of this experiment are extremely valuable when considering the future of space travel. The safety and ability to perform by astronauts is heavily affected by this topic. Gaining a solid understanding of this will allow us to embark on missions with longer duration, maintain astronaut health, and achieve goals such as commercial spaceflight. It will also allow us to make further advancement in our understanding of modern medicine, a variety of bacteria types, and the microgravity environment.

16. Garden City, New York

How does Microgravity Affect the Germination of a Tomato Seed?

Grade 7, Garden City Middle School
Co-Principal Investigators: Bridget Coviello, Isabelle DeNoto, Samantha Racich, Elsie Ross
Teacher Facilitator: Christine Lebenns

Proposal Summary:

The experiment will allow to observe the differences between germinating seeds in microgravity as opposed to on Earth. Specifically, the germination rate of 3 cherry tomato seeds in space will be performed and studied to compare to germination on Earth. Cherry tomato, or scientifically known as *Solanum lycopersicum var. cerasiforme* seeds were chosen to investigate if agriculture could arise in space for long distance space exploration. If nutritious foods like tomatoes and other vegetables are able to grow in microgravity, then astronauts will be able to have a bigger variety of food sources. Tomatoes supply a large amount of antioxidants, which can help reduce the risk of heart disease and cancer in future space exploration. The healthy characteristics of cherry tomatoes are perfect for eating, making them helpful for a balanced

diet. The cherry tomato seeds were also one of the tiniest compared to other seeds to use, so they were perfect for fitting inside the FME mini lab tube. This experiment is important because agricultural growth might come into play for future space flights, and would allow people in space to grow foods.

17. Norwood, New York

The Effects of Microgravity on *Chlamydomonas reinhardtii* Algae when Exposed to Optimal Nutrient Levels

Grades 8 and 10, Harrisville Central School
Co-Principal Investigators: Elaine LaVancha, Ethan LaVancha, Hailey Meagher
Teacher Facilitator: Nicole Taylor

Proposal Summary:
This experiment aims to analyze the effect of nutrients on algae growth in microgravity. Nitrogen and phosphorus are the two main nutrients being analyzed, as these are the chemicals that most affect algae growth. We will use a Fluids Mixing Enclosure (FME) mini-lab with three different sections, this will allow the algae growth to be activated and stalled in space. The algae being used is *Chlamydomonas reinhardtii*, a common pond algae. The study will examine the algae's growth in biomass after flight to determine if the nutrient concentration was more or less effective in microgravity. The same experiment will be conducted on Earth under the same condition to see if it differs from the one that was in space. Algae is very important because it produces oxygen, can be used as fuel, a fertilizer, and can even be used as a food source. It cannot be understated the effect that algae have on ecosystems, as it provides about half the oxygen produced by photosynthesis in our atmosphere. This makes algae a very valuable resource for future missions in space exploration, and an invaluable resource here on Earth; which is why we chose to focus on algae in our experiment. It is our hope that the results of this experiment will help further our understanding of algae production here on Earth and in microgravity.

18. Pickerington, Ohio

Algae: The Fuel Source of Space

Grade 12, Pickerington High School Central
Co-Principal Investigators: Trevor Blankenship, Isaac Hoshor
Teacher Facilitator: Brian Hoff

Proposal Summary:
The experimenters will study the growth of *Chlorella vulgaris* and its capacity to produce oil for biofuel in microgravity, then compare it to the same experiment on Earth. As space travel becomes more prevalent in modern times, there will be a point where resources are limited on manned space expeditions. Missions will take much longer and require resources independent of Earth, the farther mankind attempts to travel through space. One necessary resource for expansion of humans into space is a source of fuel. Current fuel sources cause a greenhouse effect, which is one of the reasons we are looking for other bodies to inhabit in space. The algae *Chlorella vulgaris* can be used as fuel by growing it in space. Growing *Chlorella vulgaris* in space can fuel civilization on other planets.

19. Bandera, Texas

Will the Germination Rate of Quinoa Seeds be Affected by a Microgravity Environment?

Grade 8, Bandera Middle School
Co-Principal Investigators: Kylie Minton, Landree Ryan, Cassandra Steffler, Ariana Young
Teacher Facilitator: Kathleen Foster

Proposal Summary:
This investigation will aid recent advances in astronaut nutrition by exploring whether quinoa seeds will germinate in a microgravity environment. Quinoa seeds are a nourishing gluten-free alternative to many typically eaten grains. The nutritional value of quinoa surpasses almost all grains. A single cup of quinoa contains far less carbohydrates and calories than a cup of rice, and does not spike your blood sugar as much as most typical grains would. Quinoa is also gluten free, which makes it a viable option for individuals who suffer from gluten intolerance. (Dhanorkar) Additionally, if quinoa is available as a healthy food substitute to typical dietary options, then astronauts will not only feel better because all of these nutritional needs are being fulfilled, they will be less likely to make mistakes during their daily routine because of the mental effects linked to malnutrition (Lewin).

20. Burleson, Texas
The Effect of Microgravity on Agar Consumption of Penicillium Mold
Grade 6, Nick Kerr Middle School
Co-Principal Investigators: Noah Boulter, Madalynn Cannon, Elizabeth Castaneda, Cameryn Pierce, Lane Schott, Taylor Symes
Teacher Facilitator: Jonathan Hawley-Bernardez

Proposal Summary:
Penicillium mold has been grown in microgravity before, therefore scientists know that penicillium can be grown on the International Space Station. What the experiment is intending on finding out is if mold grown in microgravity needs more nutrients or less. This could lead to the question: do astronauts need more nutrients or less than what the average person would need? The project will take potato dextrose agar and a penicillium mold stock culture with a small amount of water and let it grow; in the International Space Station, the astronauts will unclamp the clip and shake the FME gently, mixing in formaldehyde that was stored in a separate volume of the FME. Once this is completed it will be stored in a cooling unit until the return of the project. When the FME arrives, students will measure the differences between the two and compare the amount of agar that remains in the two tubes. If there is a noticeable difference between the amounts of agar remaining in each FME, this would indicate that the molds required different amounts of nutrition to grow. This could indicate that microgravity plays an important role in the nutritional value of food.

21. Ector County,Texas
Effects of Microgravity on formation of *Serratia marcescens* Biofilm
Grade 12, Permian High School
Principal Investigator: Swetha Kesavan
Teacher Facilitator: Gregorio Barajas

Proposal Summary:
The goal of SSEP project is to determine the effects of microgravity on biofilm formation. Biofilms are a community of one or more types of microorganisms that can grow on different surfaces. The bacterium that is being investigated to create a biofilm is *Serratia marcescens*. *Serratia marcescens* is a bacterium that occurs naturally in soil and water and produces red color pigment at room temperature, different from other types of bacteria. *Serratia marcescens* can cause healthcare associated infections and antimicrobial resistance. This bacterium is also abundant in damp environments. However, the bacteria sample of *Serratia marcescens* that the investigation will be using is non- pathogenic and BSL-1 Safety Level so that there is no opportunity of infection. The growth medium used is nutrient broth that enables proliferation of the bacterium, *Serratia marcescens*. Once the growth the initiated, it is left to grow for a week. After that time, the fixative glutaraldehyde is added to stop the growth of the

biofilm. It is important to identity a specific bacterium to send to the International Space Station to see if it poses a potential threat for life in space and how harmful can the bacteria become. Sending *Serratia marcescens* provides the ability for astronauts in space and researchers on Earth to visually detect the differences in the development of bacterium in space and Earth. The purpose of this project is to study the effects of microgravity on the mass, thickness, and morphology of *Serratia marcescens*.

22. Texarkana, Texas
The Effects of Space Travel and Microgravity on Hybrid Brine Shrimp Eggs
Grade 6, Texas Middle School
Principal Investigator: Rivers Glass
Co-Investigators: Tiffany Bowen, Jayden Rios
Teacher Facilitator: Marcy Kelly

Proposal Summary:
Sea Monkeys have been a popular, and a somewhat unconventional, pet since the 1960's. Commonly used as fish food and eventually sold in a commercialized kit, marketed as a novelty pet, Sea Monkeys are an unusual species. Sea Monkeys are a hybrid brine shrimp called *Artemia NYOS* and were invented in 1957 by Harold von Braunhut. Sea Monkeys are unique in that the eggs of the Sea Monkey come in a type of freeze dried state called "cryptobiosis". In this state they are able to withstand harsh conditions such as the postal service and a variety of weather conditions. Once the Sea Monkey eggs are poured into purified water they come to life. The proposed investigation will be to determine whether Sea Monkey eggs can withstand the conditions of space travel as well as microgravity on the ISS. Understanding the durability and sustainability of this species of brine shrimp will benefit future missions in possibly offering a food source for longer missions. The success of this investigation will lead to experimenting with different varieties of invertebrates such as other species of shrimp, muscles, and clams.

23. Bellingham, Washington
Germination of the *Oplopanax Horridus* (Devil's Club) in a Microgravitational Environment
Grade 10, Lummi Nation School
Co-Principal Investigators: Tony K. Cline, Kaylee R. Morris, Keyonee C. Morris, Serena-Jo N. Pantalia, Dominic A. Solomon, Maddison P. Wilson
Teacher Facilitator: Riley H. Thuleen

Proposal Summary:
The experiment will consist of the seeds of an *Oplopanax Horridus* (Devil's Club) being introduced to distilled water in microgravity in order to observe if the seed will germinate and sprout. This will indicate if the *Oplopanax Horridus* has a possibility to grow to its full extent in a microgravitational environment in later experiments. Devil's Club could be used in the future is a medicinal healing, antibacterial agent for the treatment of minor injuries of space station astronauts and crew members as well as serving positive spiritual and cultural purposes for others. Once grown, it could be utilized as a renewable source of medicine.

24. iForward-Grantsburg, Wisconsin
Growing and Glowing Mushrooms in Microgravity
Grade 6, iForward Public Online Charter School
Co-Principal Investigators: Kai Carter-Fisher, Kassandra Hall, Penya Richards, Rayne Saliger,

Raishaun Sheridan
Teacher Facilitator: Andrea Konrath

Proposal Summary:
We hope to grow *Panellus stipticus* in microgravity. We would like to see if this species of bioluminescent mushrooms can thrive and glow as luminescent as they do on Earth. These mushrooms could be beneficial to astronauts, as they have been utilized for medical purposes, and if these fungi grow successfully, they could be used for future colonies on planets. According to the website, Science Daily, scientist Fydor Kondrashov states, “If we think of sci-fi scenarios in which glowing plants replace street lights — this is it. This is the breakthrough that can lead to this” (Scientists Discovered et. al., 2018). Just as these mushrooms provide light on Earth, a bigger impact could be made in space. We will use a type 3 FME tube with the first section filled with 2.8 ml of water. The second section will have ¼ tsp *Panellus stipticus* spawn and ¼ tsp compost. The third section will hold 2.8 ml of formaldehyde. Within the first week the astronauts will unclamp Clamp A and gently shake for 3 seconds, Then on U-5, the astronauts will need to unclamp Clamp B and shake for 5 seconds, preserving the fungi’s growth until it can be observed and compared on Earth. Our hypothesis is bioluminescent mushrooms can survive, grow, and glow in space. If they do, they could be a natural light source for future settlements on planets like Mars.