SSEP Mission 18 to ISS: Selected Flight Experiments,
Communities, Teams, and Abstracts

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A total of **1,859 proposals** were submitted from student teams across the 36 communities participating in Mission 18 to ISS. Of those **797 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 29-30, 2023, the Step 2 Review Board met at the Goddard Space Flight Center Visitor Center, reviewed all **110 finalist proposals**, and selected one proposed experiment to fly for 35 communities, 2 proposed experiments for two communities, for a total of **38 flight experiments, which will fly on SpaceX-31**. It is noteworthy that the 1,859 proposals received reflected a total of **14,253 grade 5-16 students fully engaged in experiment design**.

1. Edmonton, Alberta, Canada
The Effect of Microgravity on Reproduction of *Dugesia japonica*
Grade 8, Michael Strembitsky School, Edmonton Public Schools
Co-Principal Investigators: Owen Banfield, Hudson Mohr, Riley Ng, Brett Pascuzzo
Teacher Facilitator: Julie Arsenault

Proposal Summary:
This investigation tests how microgravity will affect the reproduction of *Dugesia tigrina*. *D. tigrina* has the ability to regenerate any body part using neoblast cells. This makes *D. tigrina* an ideal model system for studying stem cell reproduction in space. Neoblasts are stem cells which can regenerate any cell type. Stem cells have been found inside of growing human fetuses and bone marrow. These cells have been used to cure certain medical conditions such as cancer and diabetes.

2. Guelph, Ontario, Canada
Will Soil Bacteria Biodegrade Compostable Plastic in Microgravity?
Grade 6, Alma Public School, Upper Grand District School Board
Co-Principal Investigators: Lily Craven, Will Kelly, Myelle Mulder, Cohen Pearl
Teacher Facilitator: Keri Hons

Proposal Summary:
Will soil bacteria biodegrade compostable plastic in microgravity? On Earth, people use compostable bags because they can be placed into a compost bin and the bacteria will biodegrade the bag. If soil bacteria can break down compostable plastic in microgravity it will allow for the collection of food waste in space, which can then be degraded to provide soil nutrients for growing plants. Ground control experiments will be conducted for comparison with the microgravity flight experiment.

3. Kingston, Ontario, Canada

The Impact of Lectins on *Escherichia coli* Biofilm Formation in Microgravity

Grades 15-16, Queen’s University
Co-Principal Investigators: Grant Hurley, Maisha Maliha, Gurleen Multani, Cole Munro, Tessa Murchison, Ryan Stewart
Teacher Facilitators: Dr. Diane Tomalty, Dr. Olivia Giovannetti

Proposal Summary:
Despite extensive research efforts to develop new antibiotics, the United Nations projects that drug-resistant bacteria will cause 10 million deaths annually by 2050. This public health crisis could force millions of people into extreme poverty in the next decade. Those with compromised immune systems, including astronauts, are at the greatest risk of developing bacterial infections, which are becoming increasingly challenging to treat. *Escherichia coli* (*E. coli*) lives inside the human gut and has been identified on spacecraft surfaces and in the air. Since astronauts cannot return to Earth for medical care during long-duration space flights, developing new ways to treat these infections is imperative to combat antibiotic resistance. Without the physical stresses of gravity, *E. coli* can share genes, proteins, and other molecules that protect them from immune cells and antibiotics more effectively. Bacteria like *E. coli* also secrete sticky substances that allow them to attach and grow together, forming a biofilm. Lectins are protective proteins made by plants that attach to the sugar chains on the outside of bacteria and can prevent them from forming biofilms. This proposed project would be the first to investigate whether lectins decrease the growth of *E. coli* in a microgravity environment. The results could lead to a practical opportunity in combining lectins with antibiotics, allowing scientists to enhance their effectiveness for astronauts and immunocompromised patients on Earth. Using lectins to improve current antibiotic treatments is a more feasible and cost-effective solution than spending billions on designing new antimicrobials that will eventually become obsolete.

4. Ukraine

Production of Biomedical Purpose Hydrogels in Microgravity

Grades 10-11, Skolivsky Secondary School I-III degrees No. 2 named after Stefaniia Vitruk, Junior Academy of Sciences of Ukraine
Co-Principal Investigators: Viktoriia Batko, Sofiia Rudenko
Co-Investigators: Viktoriia Kavchak, Tetiana Malanchuk, Maksym Shvets
Teacher Facilitator: Larysa Romanyshyn

Proposal Summary:
The study aims to evaluate the effect of microgravity on the structure and physical and mechanical properties of hydrogels based on copolymers of 2-hydroxymethacrylate (HEMA) with polyvinylpyrrolidone (PVP). This hydrogel must be placed in an aqueous solution of medical drugs with certain properties (for example, hemostatic, antimicrobial, analgesic) and then applied to the wound. This research will contribute to the development of microgravity materials science. If the synthesis is successful, then based on these substances, with the addition of other components, polymers with other properties can be synthesised by the needs of the ISS. So, it should be possible to reduce the weight of luggage that must be delivered to the ISS. Therefore, hydrogels will be needed in space, especially during long flights to other planets.

5. Mesa, Arizona

The Growth and Mutation of Staphylococcus epidermidis Biofilm in Microgravity

Grades 4-5, 9 and 12, Red Mountain High School, Zaharis Elementary School, Red Mountain Ranch Elementary School, Mesa Public School District
Co-Principal Investigators: Ella McTaggart, Emma Randall
Co-Investigators: Jack Anderson, Kristen Colborn, Christian Kim, Elizabeth Miller, Bryson Parker, Lilly Roberts, Kambel Schulze

Collaborators: Joel Ortega, Sophie Mills, Gianna Martellaro, Sumer McVey, Payton Hiltner, Farmanullah Khaliq, Emma Paquet, Lyrik Thomas
Teacher Facilitators: Jennifer Klein, Dr. Nancy Darling, Kyle Williams

Proposal Summary:
The protection of astronauts against the diseases they may encounter in space is of the utmost importance. *Staphylococcus epidermidis* is a common symbiont bacterium that can become infectious upon entering a human host. The infection can lead to many unfortunate complications, especially among astronauts in microgravity. The bacteria produce biofilm upon entering the body (through an overgrowth on the skin or medical devices). This biofilm acts as a defense against the human immune system. This investigation will compare the evolution of *Staphylococcus epidermidis* in microgravity to that on Earth by analyzing the growth of its biofilm. Evaluating the growth of *Staphylococcus*'s biofilm in microgravity and how it differs on Earth may lead to new discoveries and provide a better understanding of how astronauts can be protected. With health risks set aside, astronauts can put their time and energy into critical research that will enhance the world and better our future.

6. Tolleson, Arizona
Effects of microgravity on *Arabidopsis thaliana* seed germination
Grade 8, Dos Rios Elementary School, Union Elementary School District No. 62
Principal Investigator: Clementine Mukeshimana
Co-Investigators: Merlyn Montoya Lopez, Maryjane Hernandez, Mariano Sunn
Teacher Facilitator: Dr. Saima Afroze

Proposal Summary:
The investigation will observe and quantify the germination rate of *Arabidopsis thaliana* seeds under microgravity conditions, root development in microgravity, and most importantly germination rate. *Arabidopsis* seeds were chosen because research has shown that they can be used in treatments that will be helpful for future human colonization in space. Additionally, they are inexpensive to grow and have a rapid life cycle (about 4-6 weeks from germination to mature seed) making them easy to cultivate in restricted space.

7. Glendora, California
Cyanobacteria (*Trichormus variabilis*) Growth in Extreme Conditions of Microgravity
Grade 10, Glendora High School, Glendora Unified School District
Principal Investigator: Saphira Prakash
Co-Investigators: Janell Jimenez, David Scott
Collaborator: Jaden Vibberts
Teacher Facilitator: Chris Alertas

Proposal Summary:
Cyanobacteria are evolutionarily crucial organisms that facilitated an explosion of life-forms on Earth, due to evolving metabolic pathways, including photosynthesis, nitrogen fixation, and oxygen production. There is significant interest in determining whether cyanobacteria can be transported to the moon and Mars to be useful for terraforming these celestial bodies into Earth-like conditions. This investigation will compare the growth rates of a freshwater cyanobacteria strain, *Trichormus variabilis* (formerly *Anabaena variabilis*), on Earth to conditions on the International Space Station: microgravity, and higher radiation, while in extended darkness. This study will help determine if it is a good candidate for future space missions. Cyanobacteria are highly efficacious photosynthesizers. Hence, they recycle waste gasses while producing breathable oxygen from minimal light. Many strains reproduce quickly and need minimal space and resources (such as an inorganic carbon source and a few photons) to survive. *Trichormus variabilis* was chosen for this experiment for several reasons: 1. It has important characteristics that would make it potentially useful for future long-term space travel including potential biofuel,

cell resilience, biomedical, agricultural, and phytoremediation of toxic environments. 2. To our knowledge, it has never been studied in space. 3. Like other cyanobacteria, it recycles carbon dioxide, fixes nitrogen, and produces breathable oxygen. This study will help determine if this strain of cyanobacteria may be beneficial for use in future colonization purposes. If it can thrive and endure prolonged periods of low light, radiation, and microgravity, it would represent a significant stride forward in our quest to terraform extraterrestrial locations.

8. Lamont, California
Effects of Microgravity on *Spinacia oleracea*
Grade 8, Mountain View Middle School, Lamont School District
Co-Principal Investigators: Permission to post names not granted
Teacher Facilitator: Aaron Kelly

Proposal Summary:
This experiment investigates the germination of *Spinacia oleracea* (spinach) in microgravity. Spinach was selected for its nutritional value, which could benefit astronauts during space missions. The flight team will compare the germination of organic *Spinacia oleracea* seeds in both space and on Earth. Necessary materials include organic *Spinacia oleracea* seeds, Rockwool (as a growth medium), tap water, and a fixative to halt growth in space. The objective is to discern any differences in germination and nutritional content under microgravity conditions.

9. Moreno Valley, California
The Effects of Microgravity on Arugula
Grades 7-8, Landmark Middle School, Moreno Valley Unified School District
Co-Principal Investigators: Daina Brambila, Zion Greenland, London Lawson, Benjamin Seay-McGee, Sarah Smith
Teacher Facilitator: Deborah L Collins

Proposal Summary:
Can arugula seeds sprout in the conditions of microgravity at the International Space Station (ISS) and what are microgravity's effects on the process? Arugula seeds will be germinated on the ISS and on Earth and will compare and analyze the two samples. If arugula seeds germinate in microgravity as well as on Earth, astronauts could bring bring arugula seeds to space on their missions because arugula is known to help prevent bone loss and strengthen bones. This would be very helpful to astronauts so their bones would not be as frail as they normally would be upon return to Earth.

10. Colorado Springs, Colorado
Calcium Sulfate Crystal Growth in Microgravity
Grades 13-16, University of Colorado Colorado Springs and Pikes Peak State College
Principal Investigator: Luke Davis
Co-Investigators: Noah Grebe, Blake MacDonald
Teacher Facilitator: McKenna Lovejoy

Proposal Summary:
The investigation will test microgravity's effects on the formation of inorganic crystalline structural growth, and use, within a controlled setting. Calcium sulfate crystals are commonly used in a wide range of projects from building materials to food additives and fertilizers. Larger and more pure instances of this substance created in microgravity will prove useful in future space exploration missions as a high-quality fertilizer that can be produced on orbit. The experiment will mix a volume of aqueous sodium sulfate with aqueous calcium chloride, which will react to form a precipitation of calcium sulfate dihydride and crystalize over an extended period on orbit. This process will give way to the crystallization of calcium sulfate, occurring both

on Earth and in microgravity. The purpose of this investigation is to analyze and compare the size, structure, and purity of the resulting crystalline formations with varying prescience's of boundary forces and other gravitationally based influences. The research being proposed within microgravity conditions with inorganic crystal structures will analyze the possibility of altered lattice structure formation, which will give insight into the involvement of how forces play a role in crystallization. If a larger, more pure calcium sulfate crystal can be shown to grow in microgravity, this substance can be used more effectively in many applications in space mission and be produced on orbit as required, leading to a significant impact on future space missions.

11. Loveland, Colorado
***Capsicum annuum* Seed Germination in Microgravity**
Grade 7, High Plains School, Thompson School District R2-J
Co-Principal Investigators: Lee Soyland, Maelle Webb
Co-Investigators: Aiden Gondalez, Conor Greene
Collaborator: Zachary Collins
Teacher Facilitator: Aaron Estevez

Proposal Summary:
Investigating germination in microgravity is the first step to advancing long-term space missions. *Capsicum annuum* will be germinated in microgravity and in Earth's gravity and the results will be compared. By investigating *C. annuum* seeds into these conditions, then planting and growing them on Earth, the experiment could answer questions about the effectiveness of growth in microgravity and the efficiency of farming on land. If germination proves successful, researchers will be able to incorporate these realizations to future expeditions. With plentiful resources, increasingly complex trips would be able to take place, and the rocket will need less fuel for the lesser weight of food.

12. Hillsborough County, Florida
Handy, Dandy Dandelions – Germination of Dandelion in Microgravity
Grade 7, Randall Middle School, Hillsborough County Public Schools
Co-Principal Investigators: Bridget Bohan, Jade Thorn
Teacher Facilitator: Mary Vaughn

Proposal Summary:
This investigation explores the effects of microgravity on the hydroponically grown common dandelion, *Taraxacum officinale*, to obtain information on whether it can properly grow and change in microgravity. The team will be looking at changes in its physical properties and cell composition in hopes of observing growth rates in microgravity. The team also plans to use microscopy to analyze cell changes and if microgravity negatively affects the dandelion. The basis for this investigation includes the prior knowledge that the common dandelion contains numerous health benefits (Section 4 benefits listed) The hypothesis is that microgravity may increase the frequency rate of the germination of common dandelion, *Taraxacum officinale*, and will support the growth of this herbaceous plant. If microgravity supports the growth, then the common dandelion will be a sustainable food source to grow in microgravity. The growth of the *Taraxacum officinale* will also provide evidence supporting if it could be a practical crop for long duration missions and future stays at the ISS.

13. Hillsborough County, Florida
Fenugreek and its Nutritional Value in Microgravity
Grade 7-9, Randall Middle School, Hillsborough County Public Schools
Co-Principal Investigators: Sanjana Rao, Aadrita Roy
Co-Investigators: Nathan Bohra, Crystal Heidenreich, Lonappan John
Teacher Facilitator: Mary Vaughn

Proposal Summary:
Does microgravity slow the growth of Fenugreek affecting it's nutritional value? Fenugreek can help astronauts is it provides a rich source of calcium which is known to increase bone mass. Therefore, making it vital to astronauts as they can lose up to 20% of bone mass in microgravity. Fenugreek not only has calcium, but also many other nutrients. To address the question posed, the nutritional values of Fenugreek in microgravity and on Earth must be compared. A Brix Refractometer is used to measure the nutritional value of Fenugreek grown on Earth and on the ISS.

14. Pittsfield, Massachusetts
The Effects of Microgravity on Mitosis in Onion Root Tip Cells
Grade 14, Berkshire Community College
Co-Principal Investigators: Anastasiya Bolotova, William Garrity, Erica Langnickel
Teacher Facilitator: Dylan Carman

Proposal Summary:
Does microgravity affect mitosis in onion root tip cells? The hypothesis is that the onion root tip cells that will enter mitosis in microgravity will have more physical and chromosomal abnormalities than the cells that will enter mitosis in Earth's gravity. During metaphase, alignment of chromosomes on the metaphase plate is important for ensuring that both daughter cells have the same number of chromosomes and are completely identical. Prior experiments have shown that microgravity affects the cytoskeleton of the cell, which is crucial for chromosomal alignment on the metaphase plate, and chromosomal segregation in anaphase. As each stage is dependent on the stage before it, if metaphase is disrupted by microgravity, then anaphase and telophase would also be disrupted. For this experiment, onion seeds will germinate in microgravity on the International Space Station and in Earth's gravity on the ground lab. The onion root tips' lengths will be measured, and cells will be stained and observed using light microscopy to compare the cells growing in microgravity to the cells growing in Earth's gravity for any visual abnormalities. As human cells perform mitosis similarly to plant cells, this proposed experiment will be able to provide insight into the possible effects of long-term exposure to microgravity and other low gravity environments on humans and on the growth of plants in microgravity.

15. Oak Park, Michigan
How Watermelon Germinates in Space Versus on Earth
Grade 5, Pepper Elementary School, Oak Park School District
Co-Principal Investigators: Raydein Balkcom, Aaliyah Bates, Ricardo Jackson, Kamdyn Lauderdale
Teacher Facilitator: Jill Burdick

Proposal Summary:
The investigation will show how watermelon seeds germinate on earth and in space. Watermelon was chosen for this experiment because it has many health benefits. It helps people stay hydrated. Watermelon could reduce cancer risk. It may improve heart health, and it can help with weight management. Watermelon contains essential nutrients. Watermelon is a unique plant to grow because of how it grows on a vine.

16. Edina, Minnesota
Does Gravity Affect the Germination Growth of Raspberry Seeds
Grade 5, Creek Valley Elementary School, Edina Public Schools
Co-Principal Investigators: Nithini Weerakkodi Arachchilage, Kaydence Chen, Fallon Smith, Marit Western
Teacher Facilitator: Cody Ellis

Proposal Summary:
The investigation tests the effect gravity has on raspberry germination. Raspberries have many benefits and positive effects on the human body like vitamins A, B6, C, E, and K. They also contain potassium, iron, and antioxidants, and help manage diabetes, improve heart health, and ease arthritis pain. Raspberries are easier to grow than other plants because they are fairly resistant to diseases and pests. If raspberries are able to germinate in microgravity, the astronauts on the ISS can benefit from its many nutrients.

17. Albany, New York
The Effects of a Microgravity Environment on the Growth of Mold on Strawberries
Grade 8, William S. Hackett Middle School, Albany City School District
Co-Principal Investigators: Permission to post names pending
Teacher Facilitator: Craig Ascher

Proposal Summary:
Mold causes many problems on Earth, including food spoilage and mold-borne diseases. NASA plans to send humans to live on the ISS, the Moon, and possibly Mars. Problems on Earth are magnified in space because of the complexity and the expense of space travel. Mold has been found in the HEPA filters on the ISS, suggesting potential mold-related problems. The goal of this experiment is to test the effects of a microgravity environment on the growth of mold. In identical experiments on Earth and the ISS Penicillium notatum will be grown on freeze-dried strawberries, a preserved food that will resist mold prior to the experiment. Penicillium notatum will be introduced to freeze-dried strawberries. After a period in which mold may grow, formalin will be introduced to kill and preserve the mold spores. The types and quantities of mold spores present in both experiments will be compared using PCR tests and fluorescent stain tests. It is expected that less mold will grow in a microgravity environment because mold has evolved to grow in the conditions on Earth. Microgravity may also disrupt the formation and spread of sporophores. It is anticipated that the same varieties of mold spores will grow in both the control and the experimental lab because the FME Mini-Labs will not be exposed to any outside contaminants. This basic science research will have applications for future space habitation, food preservation, the prevention of mold-borne diseases, and other problems associated with mold growth.

18. Garden City, New York
The Effects of Microgravity on the Mass of *Salvia hispanica L.* (Chia Seeds) Abundant with Omega-3
Grade 7, Garden City Middle School, Garden City School District
Co-Principal Investigators: Anjali Motwani, Tanya Oza
Teacher Facilitator: Dr. Zaferiou

Proposal Summary:
The experiment will investigate if microgravity affects the growth of *Salvia hispanica L.* Chia seeds are rich in minerals, omega-3 fat, antioxidants, and fiber and easy to prepare. Studies suggest that they have various health benefits, ranging from weight loss to a reduced risk of heart disease. The biggest benefit to astronauts would be to their skin, which is significantly affected by microgravity. The main purpose of this project is to understand if Chia seeds will be just as easy to grow in microgravity as they are on Earth.

19. Long Beach, New York
The Effect of Microgravity on the Germination of Watercress Seeds
Grade 6, Long Beach Middle School, Long Beach Public Schools
Principal Investigator: Katrina Casey
Investigator: Jasmine Davidson-Smith

Collaborators: Claire Cristallo, Kaylee Cooper
Teacher Facilitators: Natasha Nurse, Elizabeth Chimienti, Dina Callahan

Proposal Summary:
Fruit is essential on Earth, what about in space? With the lack of gravity, is it possible to have sustainable food? These two questions have led to the focus of this experiment: to test pieces of an apple in microgravity and see if it grows molds. Mold is a natural occurrence that is able to spread rapidly on Earth. However, the conditions in which mold can grow in space are different due to microgravity. Mold in microgravity conditions seems to have a different affect compared to mold here on Earth. The focus of the project is to study the effect of microgravity on fruit decomposition. The purpose of the project is to examine mold in microgravity. The study is important because there is mold in the International Space Station. By studying the growth and rate of spread in bacteria, it is possible to prevent the spread of mold in microgravity conditions. We are testing mold to see if fruits decompose faster or slower than they would on Earth.

20. North Tonawanda, New York
The Crystallization of the Spores of *Bacillus thuringiensis* in a Microgravity Environment
Grades 11-12, North Tonawanda High School, North Tonawanda City School District
Principal Investigator: Cailee Cinquino
Collaborators: Emma Clancy, Tavery Cater, Natalie Scheifla, Madeline DeVantier
Teacher Facilitator: Melissa Elliott

Proposal Summary:
The bacterium *Bacillus thuringiensis*, or *Bt,* produces crystalline proteins with toxins in aqueous environments. When inside the guts of insects, it damages and kills these insects, while making spores at an exponential rate, which grows the colonies of this renowned bacteria. This species is commonly used in pesticides, as this bacterium, in all strains, is only harmful to specific insects, proposing no risk to humans and animals alike. We are seeking to compare the bacterium of *Bacillus Thuringiensis* ability to manufacture its unique crystalline toxins and spores in Microgravity, compared to its abilities to produce its toxin under Earth's gravity. In our experiment, we plan to culture *Bacillus Thuringiensis* when in Microgravity to call into question if this bacterium can continue to function similarly as it would on Earth. We believe this experiment will facilitate the gain of data and knowledge for the future, to put forth the idea of growing crops and the beginnings of agriculture under microgravity in space, as the bacteria that follows the crops into space is just as important as the agriculture themselves. In addition, through gene manipulation of agricultural crops, our crops now also make the same crystals that *Bt* makes. We seek to understand if the crystals will be made in the same amount in microgravity as on Earth.

21. Red Hook, New York
The Effect of Microgravity on the Hatching Rate of *Rotifers*
Grade 11, Red Hook High School, Red Hook Central School District
Co-Principal Investigators: Giacomo Buitoni, Ava Hubner, Lotta Pflaum, Emmy Nelson-Madore
Teacher Facilitator: Deborah Beam

Proposal Summary:
The goal of the experiment is to determine how *Rotifers* will reproduce and develop in microgravity. The investigators will compare how the zooplankton grow under the effects of microgravity with how they develop under Earth's gravity. The investigators hypothesize that *Rotifers* will reproduce and develop more rapidly under microgravity than they will on Earth. On both Earth and the ISS, equal samples of *Rotifer* eggs will be freeze dried prior to the start of the experiment. They will be rehydrated in freshwater. A fixative will be combined with the rehydrated *Rotifers* after a few days. Then, the hatching of the plankton on the ISS will be

compared with that of the plankton on Earth. The goal of this experiment is to determine the effect, if any, of microgravity on the hatching rate of *Rotifers*. The results of the experiments could be used in waste management of fresh water, as these organisms can be used to prevent clouds of waste in water.

22. Grand Forks, North Dakota
The effects of 6-Benzylaminopurine enriched soil on the growth of *Phaseolus vulgaris* (Black Beans) in Microgravity
Grades 14-15, University of North Dakota
Co-Principal Investigators: Peter Gauthier, Christopher Erickson, Colin Hoff
Teacher Facilitator: Keith Crisman

Proposal Summary:
This investigation will determine the effects that microgravity has on the ability of 6-Benzylaminopurine to affect *Phaseolus vulgaris* sprouting. The goal is to determine whether growth in microgravity is not only possible, but also sustainable for future endeavors in space exploration. The ability to sprout and grow plants quickly in a microgravity environment is paramount to ensure the ability of the crew to remain healthy and fed throughout long journeys.

23. Athens, Ohio
Effect of Spaceflight-Adapted Bacteria on Plant Growth and Resilience in Microgravity
Grades 14-16, Ohio University
Co-Principal Investigators: Michael Lane, Nathan Smith, Victoria Swiler
Teacher Facilitator: Nicholas Whitticar

Proposal Summary:
Manned space travel and colonization of the Moon, Mars, and beyond requires growing plants for food, nutrients, and gas exchange. One method of promoting plant growth in stressful environments, such as microgravity, is by inoculating them with beneficial bacteria. Novel strains of *Sphingomonas sanguinis* have been identified on the International Space Station (ISS) that contain plant growth-promoting genes, but their effects on plants have not been tested. Therefore, the proposed experiment will determine if *S. sanguinis* promotes resilience to microgravity in the model plant *Arabidopsis thaliana*. *Arabidopsis* will be grown with and without *S. sanguinis* in microgravity and on Earth, creating four experimental conditions. In preliminary experiments, *S. sanguinis* from the ISS demonstrated benefits to plant growth within the mini-laboratory device. To determine if *S. sanguinis* is beneficial to plant growth under the unique stresses of microgravity, a spaceflight experiment is necessary. *Arabidopsis* and *S. sanguinis* will be grown on the ISS and Earth and fixed with RNAlater to halt growth and preserve the RNA. RNA expression for plant and bacterial genes related to bacterial detection, growth, and virulence factors will be quantified with qPCR to reveal the details of the plant-bacteria interaction. Root and shoot length, germination, and bacterial growth will also be measured. All data will undergo statistical analysis to test the hypothesis that *S. sanguinis* will benefit *Arabidopsis* resilience in spaceflight by reducing microgravity-induced stress. With this knowledge, we become one step closer to growing crops that thrive in microgravity and allowing humanity to explore new frontiers.

24. Kent, Ohio
The Effects of Microgravity on Pisum sativum Roots
Grades 13 and 15, Kent State University
Co-Principal Investigators: Jonathan King, Mackenzie Guy
Teacher Facilitator: Syed Arbab Mohd Shihab

Proposal Summary:
The investigation will explore the hydroponic-based microgreen growth of *Pisum Sativum* (green

pea) roots and how this growth is affected by a microgravity environment. This experiment will focus on how successful the *Pisum Sativum* is in thriving in a microgravity environment and if root growth can be controlled by providing a supplementary medium for the microgreens to take root into. While microgreen growth in microgravity has been researched previously, root growth manipulation has less published research. If the investigation is successful, it will reinforce the reliability of hydroponic microgreen growth in microgravity environments and will establish a way to support the root systems of plants grown hydroponically in microgravity and consequently improve the efficiency of microgreen growth. The proposed experiment is crucial to the advancement of space exploration, because while living conditions become increasingly adverse as humanity ventures further from Earth, the need for easy-to-replicate systems that support life grows immensely. These innovations are greatly beneficial, as they would provide a renewable source of nutrients for astronauts in space, reducing the need for transport of resources from the Earth's surface. By reducing the need for the transport of resources, less pollution will occur from launch pollutants like fumes, and astronauts will be able to survive for longer outside of Earth's atmosphere. Additionally, it will act as a baseline for more complex experiments related to hydroponic root management, allowing for advanced research to build from the concepts demonstrated in the proposed experiment.

25. Pickerington, Ohio
Effects of Microgravity on Liquid I.V. Hydration Multiplier
Grade 12, Pickerington High School North, Pickerington Local School District
Co-Principal Investigators: Macy Erickson, Dorian Hamilton
Teacher Facilitator: Daniel McCullough

Proposal Summary:
This experiment will investigate how cell hydration levels in microgravity will compare to cell hydration levels on Earth. Liquid I.V. is a type of hydration substance that uses cellular transport technology (CTT) to hydrate faster than just water alone due to multiple modes of transportation that enhance water absorption into the body. Their products use Smart Hydration Technology to hydrate better than water alone through multiple modes of transport. This technology is done through the use of CTT, made up of five different substances: sodium, potassium, glucose, water, and micronutrients. With this information, the research team will test how efficiently the Liquid I.V. product hydrates living cells in this case Elodea plant cells in microgravity. Liquid I.V. often emphasizes a specific ratio of electrolytes and glucose to create an osmotic force that enhances water absorption at the cellular level, potentially promoting faster and more effective hydration. These substances will allow water to enter the body faster, making cells more hydrated to recover from strenuous activity or exercise. If the results of this experiment show that the solution can function in microgravity the same as it would on Earth, this hydration substance would support astronauts to keep them hydrated due to the limited amounts of water they have in space.

26. Pittsburgh, Pennsylvania - CCAC
Effect of Microgravity on the Enzymatic Degradation of Polyurethane by *Penicillium chrysogenum*
Grades 13-14, Community College of Allegheny County
Co-Principal Investigators: Maya Burns, Faith Dunn
Collaborator: Connor McDonagh
Teacher Facilitators: Patricia Donehue, Anne Duffy

Proposal Summary:
Every year, around 360 million tons of the common industrial and consumer use of the plastic, polyurethane (PUR), is produced; 80% will be reduced to pollution. Landfills hold a tremendous amount of plastic waste and pollute both land and water; some plastics are even incinerated and contribute to air pollution. The scientific community has seen an increased interest in

attending to plastic pollution through several avenues, including the reduction of already existing plastic pollution that, without intervention, is likely to remain indefinitely. Several organisms have been found to be capable of reducing the plastic polyurethane into smaller, recyclable chemical compounds. This experiment will test how microgravity affects the fungus *Penicillium chrysogenum*'s biodegradative enzymes ability to degrade a sample of polyester-polyurethane. This information can be used to facilitate the transition to circular production/waste economies, both on Earth and in space exploration endeavors.

27. Columbia, South Carolina
Gravitational Effects on Calcium Oxalate (CaOx) Regulation in Edible Greens
Grades 13-14, Midlands Technical College
Co-Principal Investigators: Craig Elliot, Robert Ferguson, Emmi Rosario, Will Turner
Teacher Facilitator: Jordi Fernandez

Proposal Summary:
This investigation concerns the production of Calcium Oxalate (CaOx) in edible greens. The ability to cultivate greens in space is an important idea that could lead to self-sufficiency in terms of providing some extra food while in space. Plants, including edible greens, produce CaOx primarily for calcium regulation. However, these crystals have been known to aid in the production of kidney stones, which is something that astronauts struggle within greater numbers than the average person on Earth. The experiment hopes to find whether microgravity will affect the edible greens' ability to produce CaOx. Specifically, whether the micro gravity will cause the plants to produce more and larger calcium oxalate crystals. As well as further research that has been assessed of CaOx in vitro during a micro gravity environment.

28. Arlington, Texas
Germination of *Pisum sativum* in microgravity
Grades 10-11, James Martin High School, Arlington Independent School District
Co-Principal Investigators: Camilo Henao, Grant Hester
Co-Investigators: Ethan Chen, Kaleb Kim, Sofia Ochoa
Teacher Facilitator: Krassimira Hansard

Proposal Summary:
This experiment will measure how microgravity affects the germination of *Pisum sativum*, or more commonly known as pea shoots. Pea shoots are very nutrient-dense with strong antioxidants that protect cells from damage. By measuring the germination and formation of the pea shoots, this experiment would analyze how viable pea shoots are in space as a fresh food source. One of the many health benefits pea shoots have are carotenoids. Carotenoids are crucial to human nutritional health as they contain β-carotene and α-carotene, dietary precursors of vitamin A, and are essential for the eyes and immune system. Pea shoots are also a good source of dietary fiber, contain copious amounts of vitamins C, E, and A, and consist of antioxidants that help decrease the risk of various chronic diseases such as cancer and cardiovascular diseases. Pea shoots may aid in the health of astronauts in space as they experience space anemia or decreased production of red blood cells. Due to the rapid growth of pea shoots, we theorize that we will be able to observe nearly the entire growth of a pea shoot, from a dry pea to a nearly fully grown pea shoot ready to harvest.

29. Burleson, Texas
Growth of Raspberry Seeds in Microgravity
Grade 6, Steam Middle School, Burleson Independent School District
Co-Principal Investigators: Cade Sando, Mac McGinnis
Teacher Facilitator: Alesha Youngs

Proposal Summary:
Can raspberry seeds germinate in damp paper towels in microgravity? If raspberry seeds successfully germinate it could lead to more research on seed germination in microgravity. Raspberries originated from Northern Asia and North America and have a rather sweet or sour taste. They are also said to help prevent some cancers and heart diseases, which could be rather helpful. Trial experiments on Earth have been conducted and were successful. Now the investigation will be conducted in microgravity and the results of both compared.

30. Houston, Texas
Comparison of *Arabidopsis thaliana* germination and cell wall growth in microgravity versus standard conditions
Grades 10-13, San Jacinto College – South Campus
Co-Principal Investigators: Maheen Bukhari, Marcus Pitre, Amna Qureshi
Teacher Facilitator: Carrie Owens

Proposal Summary:
The experiment uses the plant species Arabidopsis thaliana to measure the difference of growth in the cell wall in microgravity compared to cell wall growth on Earth. It will provide crucial intel to determine if cell wall growth is better in space or more beneficial on Earth. The cell wall is an important aspect of any plant because it plays the “skeletal” role of a plant that supports plant growth and acts as the first line of defense when a plant encounters several types of pathogens that could prevent the healthy growth of the plant. The hope is to determine if the variable of microgravity will affect this growth in any way, and how this may help us in the future for food growth in space.

31. Plano, Texas
Growth and Life Cycle of Crickets (*Acheta domesticus*) in Microgravity for Astronaut Consumption
Grade 12, Plano ISD Academy High School, Plano Independent School District
Co-Principal Investigators: Abhinav Ajish, Jacob Castro, Nawal Siddiqui
Teacher Facilitator: Mary Imran

Proposal Summary:
Does microgravity affect the life cycle and development of crickets and their protein makeup for consumption? Due to the high protein makeup of crickets, they are a potential source of nutrition for astronauts. During long-duration space travel, a sustainable food source is necessary, and the experiment seeks to determine if crickets can be used for such purposes. Crickets are made up of 55-73% protein, which is more than chicken, beef, pork, or salmon. They are significantly smaller and more nutritious than alternative protein sources, so they are much more space and cost-efficient. Their high content of essential amino acids will aid in muscle maintenance and overall health, which is especially crucial in the microgravity environment where muscle and bone loss can occur in humans. Crickets can be grown in space to create a sustainable food source for astronauts. By comparing crickets grown on Earth with those produced in space, the researchers will determine what effects a microgravity environment has on the muscle development, size, weight, and life cycle of crickets. The lack of gravity could result in a prolonged life cycle for the crickets due to removing the stressor or muscle atrophy, negatively impacting the nutrition. Analyzing the two samples will aid in answering the research question.

32. San Antonio, Texas
Effects of Microgravity on Chia Seed Growth
Grades 11-12, Theodore Roosevelt High School, North East Independent School District
Co-Principal Investigators: Permission to post names pending
Teacher Facilitator: Christopher Wilson

Proposal Summary:
The extent of the effects of microgravity on specimens from earth are still to be discovered, and as such, this investigation will evaluate the effects of microgravity on the growth of chia seeds. Plants capable of producing stems typically utilize turgor pressure to grow upwards from the ground in response to the presence of gravity. The observations to be gathered from this experiment will be extremely useful for the future of astrobotany, as astronauts will need a sustainable source of nutrition on longer journeys. The expectation is for the chia seeds to grow at a rate of similar value as observed on Earth.

33. Texarkana, Texas
Will Normal Strength Concrete (NSC) keep its structure in microgravity?
Grade 5, Martha and Josh Morris Mathematics and Engineering Elementary, Texarkana Independent School District
Co-Principal Investigators: Lily “Lizzy” Izabella Elaine LaGrone, Lynnley Rae Galloway
Investigator: Isaac Lynn Steele
Collaborator: Cooper Allen Wood
Teacher Facilitator: Marie Goodwin

Proposal Summary:
Normal Strength Concrete (NSC) is the most commonly used type of concrete in the world. The strength of this type of concrete would typically vary from 3,000 to 6,000 psi. If astronauts started a community in microgravity they would need houses, roads, sidewalks, work buildings, and more. Will concrete have the same chemical reaction in microgravity that it does on earth? If microgravity had a weakening effect on the concrete, settlers would not be able to use it make a foundation on Mars or the moon. If the concrete strength is the same or stronger they could build a foundation on Mars or the moon.

34. Waxahachie, Texas
Tardigrade Growth in Space
Grade 6, Eddie Finley Junior High School, Waxahachie Independent School District
Co-Principal Investigators: Peyton Dues, Caris Gray, Olivia Jones
Teacher Facilitator: Ashley Dawson

Proposal Summary:
Are tardigrade eggs able to hatch and develop with gravity turned off for a period of time? Previous research on tardigrades confirmed they are able to survive in any temperature, and they can survive up to thirty days without food or water. This investigation will determine if they hatch and develop in microgravity under the experimental conditions.

35. Waxahachie, Texas
How do microgravity and space conditions affect the growth of Cucumber, *Cucumbis sativus*?
Grade 6, Robbie E. Howard Junior High School, Waxahachie Independent School District
Co-Principal Investigators: Caiden Holmquist, Coralee Holloway, Levi Blaise Lewis, Cadee Smith
Teacher Facilitator: Michelle Dominy

Proposal Summary:
This experiment will measure the effects of microgravity on the early development of *Cucumbis sativus* (cucumber). Cucumber may grow faster in space because there is no gravity there. Gravity pulls things down so the cucumber will not be held back. This investigation will compare how a cucumber seed grows on Earth and in space. cucumber seeds will be used because cucumber seeds are very beneficial to health. We have heard that some ways they are beneficial are to help fight cancer, help with skin care, help with your immune system, help with

blood pressure, and contain many vitamins! (Milovanovic, et al.) The FME tube will be separated into three different parts. The first part will contain seeds. Next to that will be water. And the last tube will hold a fixative. The fixative that will be used is formalin. It will help stop the growth but won't destroy it.

36. Sandy, Utah

Nematodes to the Rescue! - Space Worms as an Integral Component of Space Agriculture

Grade 10, Hillcrest High School, Canyons School District
Co-Principal Investigators: Jasmine He, Rosemary Lu, Bella Nguyen
Collaborators: Samhita Chavakula, Vidushi Shelat
Teacher Facilitator: Clief Luis Castleton

Proposal Summary:
Entomopathogenic nematodes (EPNs) are insect parasites that are used widely in agricultural pest control. These nematodes kill their insect hosts with the aid of symbiotic bacteria that they carry in their guts. EPNs are eco-friendly biocontrol agents safe for humans and are great substitutes for chemical insecticides. To dive further into the effects of EPNs, this investigation will explore the efficiency of the EPNs in microgravity. Understanding the host parasite relationship in microgravity allows investigators to gain better insight into plant protection in space, as space agriculture is becoming increasingly important for bioregenerative life support systems during long-term human space flights. Previous research indicated that EPNs are able to find hosts and reproduce in space. Thus, EPNs may be a practical solution for controlling insect pests when crops are grown in space. However, more research is needed to conclude the capabilities of EPNs under microgravity. Building upon previous work confirming that EPNs are able to reproduce and survive in microgravity, the investigators propose the question: How will microgravity affect the effectiveness of EPN reproduction and virulence, as well as relative reproduction and virulence among species? This helps determine the effectiveness of the EPNs and its potential applications for biocontrol in space. To assess insect mortality, nematode establishment and reproduction, investigators will use two species of EPNs from the *Steinernema* genus, specifically *S. carpocapsae* and *S. glaseri.* Investigators will mimic an EPN's environment in microgravity by using sterile play sand and mealworms as the model insect host for this experiment

37. Chesapeake, Virginia

The Growth of Beets in Microgravity

Grade 5, Crestwood Intermediate School, Chesapeake Public Schools
Co-Principal Investigators: Permission to post names pending
Teacher Facilitators: Daniel Weaver, Cristina Drewry

Proposal Summary:
The investigation will determine the effects of microgravity on beetroots. Beets have such good benefits such as physical health, mental health, and medicinal benefits for those who eat them. They also grow quickly, so they can be harvested quickly. It could be a great asset in space if it can be grown in microgravity.

38. iForward-Grantsburg, Wisconsin

Will Microgravity have an Effect on the Growth and Development of Brine Shrimp?

Grade 9, iForward Public Online Charter School, Grantsburg School District
Principal Investigator: Camron Masalewicz
Teacher Facilitator: Sara Gregorich, MS

Proposal Summary:
Research shows that brine shrimp are able to cope with an ever-changing environment. The

investigation will study the growth and development of brine shrimp under the effects of microgravity. Investigators hypothesize that the brine shrimp will grow bigger due to the effects of microgravity. Past experiments with brine shrimp in microgravity had varying outcomes.

SSEP Mission 17 to ISS: Selected Flight Experiment, Community, Team, and Abstract

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

38. Grayslake, Illinois

The Effects of Microgravity on Cholesterol Lowering Activity by *Lactobacillus acidophilus*

Grade 14, College of Lake County
Principal Investigator: Samuel Banuelos Barrios
Teacher Facilitator: Beth Wilson

Proposal Summary:
The specific aim of this study is to evaluate the uptake of cholesterol by *Lactobacillus acidophilus* grown in a reduced gravity environment in comparison to bacteria grown in full gravity. The uptake and assimilation of cholesterol by *L. acidophilus* may be useful as a therapeutic approach for lowering cholesterol levels in humans. *Lactobacillus acidophilus* is a probiotic bacterium that can be found in the human mouth and intestines. Several bacterial strains of *L. acidophilus* have been shown to be able to assimilate and uptake cholesterol in a laboratory setting. High levels of cholesterol are a contributing factor to cardiovascular disease which is the leading cause of death in the Western world. The most widely prescribed cholesterol lowering drugs include statins and PCSK9 inhibitors. Statins have many side effects including muscular skeletal pain and weakness. Alternative therapeutic approaches are warranted especially in a microgravity environment where muscular skeletal atrophy is a concern. Preliminary data conducted suggest that *L. acidophilus* incubated in the presence of cholesterol is able to assimilate cholesterol anaerobically in full gravity. Samples containing *L. acidophilus* in the presence of cholesterol will be incubated in parallel under the influence of full gravity and reduced gravity. A higher level of cholesterol lowering ability by *L. acidophilus* is expected in the sample grown in microgravity

The Student Spaceflight Experiments Program (SSEP) is a program of the National Center for Earth and Space Science Education (NCESSE) in the U.S. and the Arthur C. Clarke Institute for Space Education internationally. It is enabled through a strategic partnership with Nanoracks, LLC, which is working with NASA under a Space Act Agreement as part of the utilization of the International Space Station as a National Laboratory. SSEP is the first pre- college STEM education program that is both a U.S. national initiative and implemented as an on-orbit commercial space venture.

The Center for the Advancement of Science in Space (CASIS) is a U.S. National Partner on the Student Spaceflight Experiments Program.