SSEP

Student Spaceflight Experiments Program

SSEP Mission 12 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 **2,498 proposals** were submitted from student teams across the 31 communities participating in Mission 12 to ISS. Of those**1,101 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 and December 1, 2017, the Step 2 Review Board met at the Smithsonian National Air and Space Museum, reviewed all **98 finalist proposals**, and selected one proposed experiment to fly for 28 communities, and 2 proposed experiments for 3 communities, for a total of **34 flight experiments**. It is noteworthy that the 2,498 proposals received reflected a total of **12,150 grade 5-16 students fully engaged in experiment design**.

1. Sao Paulo, Brazil

Addition of "Green Plastic" to Enhance Cement Properties in Space
Grade 7, Dante Alighieri, EMEF Perimetral, Projeto Âncora, São Paulo. Cotia – Brazil
Co-Principal Investigators: Guilherme Funck, Laura D'amaro, Lorenzo Morrison, Natan Cardoso, Sofia Palma de Ávila Reis, Otto Gerbaka
Teacher Facilitator: Tiago Bodê

Proposal Summary:
We propose to answer the question: Is it possible to include powder from recycled plastic to the mixing process of cement production to make it more suitable to space application? Considering ISS will receive a plastic recycler machine, from the American company Made in Space, next year, our group is looking for new construction materials to make possible advanced manufacture in space. Our main concern here is to understand how the mix of three materials will be performed in space in comparison with the same process on Earth. The development of the material proposed here has the potential to mitigate some risks that cement could offer in the Microgravity. The "green plastic" is a sustainable polymer provided by the Brazilian company Braskem and current in use at the ISS with 3D printers of Made in Space.

2. Nanaimo, British Columbia, Canada

Prevention of Muscle Atrophy in Microgravity: an Evaluation of L-carnitine in Planarian (*Dugesia tigrina*),
Grade 11, Nanaimo District Secondary School, School District 68
Co-Principal Investigators: Parker Davie, Megan Poteryko, Abigail Sitler
Teacher Facilitator: Mary Anne Perkins

Proposal Summary:
Muscle atrophy in astronauts due to microgravity is a critical problem threatening long term space travel. Astronauts can lose up to 20 percent of their muscle mass on space flights with durations of just five to eleven days (Fitts, 2016). In order to counteract the muscle atrophy, the astronauts must exercise for over two hours each day; however, this may not be adequate to

maintain muscle mass (Fitts, 2016). The goal of this experiment is to provide more insight on the supplement, L-carnitine and its effectiveness in treating muscle atrophy in a microgravity environment. L-carnitine has been shown to decrease muscle atrophy (Jang et al., 2016). The experiment is performed in a MixStix. In Volume 1 there are six planarians microinjected with a 0.01 mL saline solution to act as a placebo. In Volume 2 there are six brown planarians, *Dugesia tigrina*, that have been microinjected with a dose of 0.01 ml of 10 percent L-carnitine and India Ink. In Volume 3 there is 2 ml of 10% formalin to preserve the results. The planarians are weighed to determine changes in muscle mass. This preliminary experiment performed on the International Space Station will determine if L-carnitine has the same effectiveness on inhibiting muscle atrophy in microgravity as it does on Earth. If this experiment is successful, it can lead to further research of new ways to treat muscle atrophy in a microgravity environment.

3. Winnipeg, Manitoba, Canada

Growth of Lacinato in Microgravity
Grade 6, Grosvenor School, Winnipeg School Division
Co-Principal Investigators: Charlie Buehler, Keaton Fish
Co-Investigators: Quinn McMullan, Kale Peterson
Collaborator: Merrik Williamson
Teacher Facilitator: Brandy Anderson

Proposal Summary:
Our group would like to see if lacinato kale grows better in microgravity. If it grows better in space then it could help on long-term space missions. The reason we choose lacinato kale is because it is one of the healthiest vegetables on the planet and has many vitamins such as vitamin A, K, E, C, B1, B2, B3, B6, Iron and Magnesium. It has more calcium than a container of milk, more vitamin C than an orange, and more iron than beef. It can be compacted into small spaces and it is very lightweight. If it can grow in an 8.4 ml test tube then astronauts can grow plenty more vegetables and will have food for a very long time. Lacinato kale is one of the fastest growing plants and germinates in 5-8 days. Lacinato kale doesn’t need much water to grow, but has so much nutrients. Lacinato kale has many health factors, including: it gives you a lower chance of getting cancer, it also keeps your skin healthy and lacinato kale is very helpful for your small intestine and your liver. Lacinato kale is great food to eat because it is easy to eat and is easy to clean and kale can be used for many things such as salads, sandwiches, wraps, pita, soup, and just by itself. When the lacinato kale returns to earth we will measure the growth of the stem, root and leaf. We will observe differences in color using a microscope.

Can Yarrow Germinate in Microgravity?
Grade 5-6, Wolseley School, Winnipeg School Division
Co-Principal Investigators: Betty Ngo, Emelia Stephenson, Kiara Dayson, Madeline Stewart, Sariah Dayson
Teacher Facilitator: Suzanne Mole

Proposal Summary:
The question we are focusing on for our experiment is whether Yarrow seeds will germinate in microgravity. We decided to focus on Yarrow seeds because Yarrow is a traditional Manitoba plant that can be used for different types of medicine. We learned through our research that Indigenous people used Yarrow to cure headaches, toothaches, and stomach issues. We think that the Yarrow can help the astronauts on the space station because if they can grow Yarrow in space then they can grow their own medicine. Our Experiment will use two of the

FME 3 Mini Labs- one for on the space station and one for our control experiment here at school. In our experiment, we are going to place ten seeds harvested from our school garden into Rockwool in Volume 2 of the mini lab. On the second day in space, we will have the astronauts unclip the clamp and add 3 ml of distilled water. We asked NASA staff about the temperature of the Space Station and were told that it was 22-25 degrees Celsius. We know that in temperatures such as this it takes Yarrow 14-28 days to germinate. We have planned to have the astronauts release the second clamp and add 3 ml of the fixative 10% Neutral Buffered Formalin to the growing seeds on day 31. This will preserve the seeds at exactly that time so that we can compare these seeds with the seeds from our control experiment to decide whether microgravity affected germination of the seeds.

4. Winfield City, Alabama

The Effects of Microgravity on the Germination of Kudzu Seeds

Grade 7, Winfield Middle School, Winfield City Schools
Co-Principal Investigators: Seth Birdsong, Cole Kirkpatrick, Will May, Banks Roebuck, Izzy Stewart
Teacher Facilitator: Freda Curd

Proposal Summary:
We know that kudzu is well known for being an invasive species, but we think that the pros outweigh the cons. We want to see if *Pueraria lobata*, kudzu, seeds will germinate and grow in space. We have been unable to find any evidence that kudzu seed germination has been tested in space. So, as possible space kudzu pioneers, we think that if kudzu will grow in space, it would be great for many space expeditions in the future. Kudzu has a variety of health benefits. The leaves, vine tips, flowers, and roots are edible. Also, kudzu is said to taste very similar to spinach. Kudzu is also a super food, which is rich with antioxidants and protein. Kudzu is also used for a lot of medical treatments, such as neck pain, chest pain, diarrhea, muscle pain, measles, fever, headache, gastrointestinal problems, and even alcoholism. It produces oxygen, so if there is a shortage of oxygen, it produces that as well. If kudzu seeds germinate in space, it could be an unlimited food source, compared to growing lettuce or other greens. This is due to the fact that kudzu grows up to one foot per day, when in the right environment. This could be very useful for long space expeditions to Mars and in the future to many other planets.

5. Corcoran, California

Broccoli Study

Grade 6, John Muir Middle School, Corcoran Unified School District
Co-Principal Investigators: Angelica Medina, Montserrat Maldonado
Co-Investigators: Laisha Fernandez Haro, Lupita Nunez
Collaborator: Midanny Madrigal
Teacher Facilitator: Alexandria Dias

Proposal Summary:
The SSEP project proposed will be testing a broccoli plant experiment. The reason for this experiment is to test how the plant grows in space and how long it takes. Also we wish to determine if food can be grown in microgravity, to provide continuing supply of food for astronauts the farther they venture into space. Broccoli is a healthy choice of food because it contains many vitamins like Vitamin A, Vitamin C, Vitamin D, Vitamin B6, Vitamin B-and fiber. This experiment contains supplies like water, soil, fertilizer, broccoli seeds, and isopropyl 91% of alcohol. The exact steps to using this experiment in space are; Step 1: Put in the plug, Step 2: Add 2 ml of soil, Step 3: Add the 3 broccoli seeds, Step 4: Add an additional 2 ml of soil, Step 5: Insert the first clamp, Step 6: Add 2 ml of purified water, Step 7: Insert the last clamp, Step 8:

Add 1 ml of isopropyl alcohol, Step 9: Insert the last plug. While the plant is growing in space, there will be another broccoli plant here on Earth will be growing and will be observed different time it takes to fully grow. If this experiment works out, it can change humanity's thoughts of how we can grow plants in space. Not only helping astronauts but also humans here on Earth with growing crops. Without this experiment going to space, these questions are not put to rest.

6. Moreno Valley, California

Effects of Microgravity on Soybean Germination

Grades 10-12, Valley View High School, Moreno Valley Unified School District
Co-Principal Investigators: Titan Lam, Roman Lara, Semajj Martinez, Douglas McCormack
Teacher Facilitator: Stacy Katzenstein

Proposal Summary:
Soybeans (*Glycine max*) provide a great amount benefits for consumption. It is low in fat, excellent source of fiber, and rich in calcium. Aside from nutritional benefits, soybeans provide health benefits. They boost the metabolic activity in the body, lower cholesterol levels, improve digestive and bone health, and improves blood circulation and heart health. By growing soybeans on the International Space Station (ISS), it will promote the growth of other foods onboard. A soybean plant being grown in the microgravity environment will not only provide a food source, but will be more cost efficient in providing food for astronauts. Instead of sending food from Earth to the ISS, astronauts will be able to grow their own food on the International Space Station. It will also allow the recycling of wastes, aide in the removal of CO2, add the ability to purify water, and produce O2. This experiment overall will provide a better understanding of what role gravity plays on soybean growth. The seed germination process will begin once the seeds have reached the International Space Station. At the same time, we will start our own experiment in our lab on Earth under identical conditions. Just before the microgravity seeds return to Earth, we will stop the sprouts from growing with a fixing agent. When the two sets of germinated seeds are compared back in our lab, we will look at sprout and root length, root morphology, note differences in ramifications, node lengths, and masses of germinated seeds. We will use a microscope to observe changes in the cell structure of the soybean roots; this will provide us with the data needed to know the effects that microgravity has on a microscopic scale. Knowing how microgravity affects each aspect of the germination process will help determination the germination rate of soybeans in microgravity. Scientists and engineers can also use this knowledge to design effective microgravity gardens.

7. Riverside, California

The Brine Shrimp

Grade 6, Mark Twain Elementary School, Riverside Unified School District
Co-Principal Investigators: Maya Romero, Emily Ortega, Nicole Sanchez, Cynthia Martinez
Teacher Facilitator: Scott Ebie

Proposal Summary:
Our experiment will compare the hatching of brine shrimp eggs in a microgravity environment to the hatching of brine shrimp on Earth. Our experiment will consist of astronauts on the International Space Station mixing brine shrimp eggs with water with a pH of 8 (similar to sea water). The brine shrimp will hatch during this time. After two days a solution of paraformaldehyde will be introduced to the brine shrimp. This should stop the experiment and preserve the brine shrimp. Once the experiment is returned we will measure the number of brine shrimp that hatched in 0.1 mL of solution. Several 0.1 mL samples will be taken and the mean will be used. The experiment will be repeated in our classroom with the same parameters.

8. Sanger, California

The Effect Microgravity has on the Developmental Stages of Brine Shrimp

Grade 7, Fairmont Elementary School, Sanger Unified School District
Co-Principal Investigators: Austin Griesner, Sean Viau
Collaborators: Jacqueline Ramirez, Elisa Rocha
Teacher Facilitator: Nicole Luckin

Proposal Summary:
In this experiment, we will be investigating how microgravity affects the developmental stages of brine shrimp. This can be useful to the world because aquaponics is a topic being explored in space currently as a means of a possible food source. Learning to produce food sources will allow humans to survive for extended periods of time in space or even another planet like Mars. Aquatic animals would be a good source of food. The developmental stage will be determined using the scheme devised by Weisz, "these stages are numbered 0–19, depending on when the last thoracic (0–13) or abdominal (14–19) segment rudiment first appears. Stage 19 is taken as the final stage and covers all of the remaining life cycle of the sexually mature adult. Total body length will be measured using an ocular micrometer. Body length will be taken as the distance from the front of the median eye to the posterior margin of the telson (Wachter, 1992).

9. San Jose, California

The Effect of Microgravity on Spider Plant Seed Germination

Grade 7, Discovery Charter School
Co-Principal Investigators: Amelia Lipcsei, Kimberly Wei
Co-Investigators: Grace Farrell, Morgan Lord, Natessa Wright
Teacher Facilitator: Susan Leftwich

Proposal Summary:
This experiment will examine the effect of microgravity on the germination of a spider plant seed, and will determine if the spider plant can successfully grow in space. This is important because scientists have found that indoor air pollutants are ranked among the top five environmental risks to public health. In addition, living and working in places rife with air contaminants can cause headaches, dizziness, nausea, and can eventually lead to cancer. These chemicals are even more prominent in space and on the ISS, and spider plants would reduce up to 90% of formaldehyde, carbon monoxide, O-xylene, and P-xylene, which would dramatically purify the air. Our findings would greatly benefit the health of future astronauts; if this test is successful, we could plant spider plants in microgravity, and the air quality in space would get significantly better. To test our idea, we will send eight spider plant seeds into space along with a solution of water and a nutrient, as well as a growth inhibitor, separated by two clamps. On the day of the arrival on the ISS, the astronaut will release Clamp A, combining the spider plant seeds and water/nutrient solution; starting its process of germination. Two days before undocking, the astronaut will release Clamp B, mixing in our growth inhibitor, which would terminate the process. At the same time, an identical test would be done on Earth so that we can compare the results to the test we perform in microgravity.

10. Bridgeport, Connecticut

The Effect of Microgravity on Nanoparticle-Cellular Interaction

Grades 15-16, University of Bridgeport
Co-Principal Investigators: Feissal Djoule, Emily Juliano
Teacher Facilitators: Dr. Issac Macwan

Proposal Summary:
A cell contains numerous proteins on its surface and in the cytoplasm that carry out a variety of functions. Maleimide – functionalized Graphene quantum dots (m-GQDs) have the ability to attach or "tag" both cell surface and intracellular proteins in the gravitational setting. Such quantum dots have photoluminescent properties, which can be utilized for tagging the cysteine residue on the proteins thereby using them towards bio-imaging applications. This experiment proposes whether m-GQDs will have a stable binding onto the cellular surface and intracellular proteins found in Chinese Hamster Ovary (CHO) mammalian cells under the influence of microgravity. If this is found to be successful, it can provide useful information for studying the effects of microgravity on a physiological system based on the way proteins behave compared to a gravitational setting. The basic principle of this procedure can be further utilized to study many other cellular processes under the influence of microgravity by simply tracking these "tagged" cellular proteins under a fluorescence microscope.

11. Stamford, Connecticut

Effects of Crossbreeding *Sordaria fimicola* in Microgravity

Grade 11, Stamford High School, Stamford Public Schools
Co-Principal Investigators: John Bolognino, Matthew Dattiolo, Augustus Doricko, Vedant Gannu, Lalith Goli, Ryan Hoak, Grihith Manchanda, Jordan Ordonez, James Pease, Alejandro Ross, Adarsh Sushanth, Imtiaz Uddin, Patrick Zaleski
Teacher Facilitator: Greg Lewis

Proposal Summary:
Our mission seeks to analyze the effect of microgravity that occurs in the reproduction of the fungus *Sordida Fimicola*. In a reproductive cycle, this fungus undergoes meiosis and mitosis. Meiosis is the sexual process in which cells reproduce, and crossing over is vital to achieve greater genetic variation. Crossing over is a process that occurs in meiosis that involves the switching of genes between two homologous chromosomes. Without this gene shuffling, there will be fewer possible ways in which a gene can be made, decreasing genetic variety. With a wider variety of offspring, the species is more likely to adapt to environmental changes. Our experiment analyzes the effect that gravity has on crossing over. To measure crossing over, our experiment breeds together two colors: a black (wild type) strain and a tan (mutant) strain. When Sordaria Fimicola breeds, it creates ascii with eight ascospores each, and the arrangement of the colored ascospores can indicate whether or not crossing over has occurred. Another aspect that is visible is whether or not a mutation has occurred. There are expected to be eight ascospores, and four of each color, in those created as a result of crossing over. If one of these conditions isn't met, it becomes evident that a mutation has occurred. These two individual factors show scientists how prepared organisms are for the vast emptiness of space, and arm them with the knowledge to tackle these problems should they appear.

12. Hillsborough County, Florida

The Effect of Microgravity on Wheat Germination

Grade 5, Limona Elementary School, Hillsborough County Schools
Co-Principal Investigators: Josue Bueno, Lyric Judge, Lindsay Wills
Collaborators: Soleil Gates, Ben Rieger, Meghana Thomas, Pranav Verma
Teacher Facilitator: Jane Kemp

Proposal Summary:
Our scientists propose germinating wheat in microgravity and Earth gravity to determine if microgravity affects the growth of wheat. Astronauts in space could quickly germinate wheat – according to our research, two days at the most. Wheat is a very common food that people have

been eating for thousands of years. Since most astronauts have been eating wheat all their lives it might be a comforting food source for celestial travelers. Wheat is very nutritious and can even help prevent type two diabetes and heart attacks. Wheat can also help with weight management, since exercise opportunities for astronauts may be limited this might be important. Astronauts on long space journeys could use wheat to stay healthy and nourished. This is why we propose wheat germination for our experiment. We are going to place five wheat seeds on a piece of felt in the center chamber of a type III FME. On one end of the FME will have a small volume of water that will begin the germination process when the clamp is opened. On the other end of the FME we will have a fixative substance (Formalin) that will stop the germination when that clamp is opened. We can compare the germination rate of our seeds on Earth to the seeds that went to space. Many types of foods are made from wheat. Wheat could add variety to the diet of astronauts. If wheat germinates well in microgravity then it may help support space travelers on their way to Mars.

13. Port St. Lucie, Florida

The Effect of Microgravity on the Growth of Golden Lake *Artemia*

Grade 8*,* Renaissance Charter School at Tradition, St. Lucie County Schools
Co-Principal Investigators: Shivani Chaube, Alexis Mulholland, Ashton Persaud
Co-Investigators: Taylor Dreger, Danielle Hoppas, Ashley Medina, Kelis Stanisclaus
Teacher Facilitator: Kurt Schultze

Proposal Summary:
If we send Sea Monkeys to space, then the hybrid brine shrimp will change the way they live in order to survive in spaces conditions. Our group has collaborated and would like so send the hybrid breed of brine shrimp also known as the Sea Monkeys into space to see if growing them in space will alter how they act and grow. We choose to send Sea Monkeys on a journey to space to see if a hybrid would act different in space. Sending Sea Monkeys into space might cause them to act enervated, and even less responsive to light which sea monkeys are attracted to luminosity since they are naturally drawn to light sources. Sea Monkeys are ephemeral brine shrimp with lifespans of a month or two in a great sustained society.

14. Jackson County, Georgia

Fairy Shrimp in Space

Grade 5, Gum Springs Elementary School, Jackson County Schools
Co-Principal Investigators: Ella Cobb, Anna Holley, Audrey Waters
Teacher Facilitators: Stephanie Purvis, Tammi Gowen

Proposal Summary:
Our research team would like to conduct an experiment to see if *Artemia salina*, fairy shrimp, will hatch in microgravity. Our question to be addressed is whether, *Artemia* will hatch in microgravity to serve as protein for the astronauts. If so, this could provide a working protein source for the astronauts. Protein provides the necessary amino acids for muscle growth and repair. Fifty-two to fifty-six percent of an *Artemia* body is protein. Fully grown *Artemia*are about five centimeters in length. Juveniles are about two centimeters in length. You can eat a small amount to receive a large amount of protein. *Artemia* are great for helping prevent muscle degeneration because of the amount of protein they provide. Astronauts experience muscle loss in microgravity. If *Artemia salina*(fairy shrimp) are able to hatch in space, this could help provide additional protein to astronauts.

15. Honolulu, Hawaii

How Microgravity Affects Reproduction in *Caenorhabditis elegans*
Grade 11, Punahou School, Honolulu School District
Principal Investigators: Allison Li, Daralyn Wen, Veronica Will, Alexa Wong
Teacher Facilitator: Wyeth Collo

Proposal Summary:
This experiment investigates how microgravity affects reproduction of a nematode worm, *Caenorhabditis elegans*. This organism is approximately 1 mm in length, has a lifespan of two weeks, and reproduces in about five days. In microgravity, it has been shown to have reactions similar to humans. The study will compare and contrast how the worms produced in microgravity differ from those produced on Earth, including visual differences in development, as well as differences in rate of reproduction. Fertile *C. elegans* will be deactivated before being sent to the International Space Station. Once in space, they will be activated. They will be given nine days to reproduce, approximately two generations, and then will be deactivated, with Formalin solution, and returned to Earth. Once back to Earth, data will be processed and evaluated. While results of the study cannot be directly tied to human reproduction in microgravity, studying other organisms and how the development of their offspring differs in microgravity than on Earth can help to better understand how microgravity affects human reproduction. As plans for humans to embark on long journeys in space or colonize other planets have become more realistic, understanding reproduction and growth in microgravity is a major concern that needs to be addressed.

16. Indianapolis, Indiana

Growing Carrots on the International Space Station in Microgravity
Grade 8, Saint Simon the Apostle Catholic School, Lawrence Township District
Co-Principal Investigators: Arianna Darling, Amelia Porter, Hannah Nguyen, Marissa Spreitzer
Teacher Facilitator: Cathlene Darragh, Laura Mates

Proposal Summary:
How would grey water affect carrot seeds in microgravity? During our research we learned that astronauts grow a few inches taller while living in microgravity. Will germinating carrots in grey water affect how they grow? If we ever live on another planet, we will need a way to recycle our water because it will be limited. Grey water can be anything from the water you shower with to the water you cook with. Our experiment is designed to see if we can grow carrots seeds using grey water in microgravity. Specifically, we used Dawn dish soap, which is all natural to make grey water. Carrot seeds were chosen for this experiment because they are high in protein, have a high source in antioxidants, and vitamin A. They also protect eye health, decrease the risk of heart disease and stroke, protect against cancer, help maintain oral health, boost skin health and wound healing, and protect against brain health. Growing carrots does not take a lot of work. The germination period for a carrot seed is between 14-21 days. Once they are grown, they can be cooked and can become compost. The green leaves can also, be eaten. If carrots can germinate in microgravity with grey water, we will not have to waste purified water to grow plants.

17. University System of Maryland, Maryland

The Effect of Microgravity on Bacteriophage Replication and Infectivity
Grade 15, University of Maryland, College Park, University System of Maryland
Co-Principal Investigators: Rushi Challa, Natalie Ivanina
Teacher Facilitator: Dr. Daniel Serrano

Proposal Summary:

The 21st century is the time for introduction of bacteriophage therapy for disinfection of food and water, in addition to the replacement of antibiotics. Bacteriophages are effective and environmentally friendly viruses that destroy bacteria, yet remain harmless to humans. Studies on the ISS have uncovered that extreme environmental conditions of space, including low gravitational pull and radiation from galactic cosmic rays, induce greater mutation rates and bacterial changes such as increased biomass, metabolic activity, and antibiotic resistance (observed as a thicker-developed peptidoglycan cell wall) compared to bacteria on Earth. In addressing these growing features and resistance, our project focuses on the effect of microgravity on the infectivity rate of a T4 bacteriophage, opening the question of whether or not phage effectiveness will heighten or appear compromised in microgravity. We propose sending freeze-dried samples of T4 bacteriophages and their target bacteria, *E. coli*, into orbit. Upon arrival both will be activated, bacteria will begin to replicate, and the phages will start their infection cycles. After a two-day time period, we will fix the samples and bring them back to Earth for analysis through transcriptome profiling and observing gene expression changes induced by the microgravity environment. Observing these factors could reveal greater expression of genes coding for certain infection enzymes of the phages, such as integrase (thus, a greater infectivity rate). In the event that we observe a heightened efficacy of phage activity complementary to the respective bacterial growth, this may suggest that bacteriophages could provide a powerful alternative to traditional antibacterial agents.

18. Kalamazoo & Detroit – Michigan Archdiocese, Michigan

Planarian Worm Head Regrowth
Grade 7, St. Fabian Catholic School, Archdiocese of Detroit
Co-Principal Investigators: Eve Hajjar, Katie Kowalyk, James Tringale
Teacher Facilitator: Christina Sobolak

Proposal Summary:
The experiment being proposed is Planaria tail regrowth. This experiment will contain ten planarian worms, 2.5 mL of pure caffeine, and 2.5 mL of ethanol. The team is cutting the Planaria worms' tails off before it gets to space with a knife. Then the team will pour the chemical, ethanol, on the worms to stop it from growing a tail until it gets in space. If the experiment gets chosen, the tube containing the experiment (left to right) will be and an empty space to have more room to shake, 2.5 of ethanol and the worms, and then 2.5 mL of caffeine. This experiment is to see if the Planaria worm will grow a similar way as it does here on Earth. It normally grows right where the cut was first made. According to Helen Pearson, on Earth, it takes about two weeks for the worm's tail to grow back. What some people don't know if Planaria worm's mouths are located in the middle of their bodies so the worms will have food to survive until the worms arrive in space. Ethanol is a substance that slows down cell regrowth. Ethanol is found in gas. The caffeine the group is using the type caffeine that is found in soda. It will cancel out the ethanol that will slow down the worm's tail repopulation. The caffeine will speed up the growth after it has been delayed by the ethanol, therefore canceling each other out.

Rust in Microgravity
Grade 6, St. Monica Catholic School, Archdiocese of Kalamazoo
Co-Principal Investigators: Noah Aiello, Sean Pierucci
Co-Investigators: Dannica McCue, Katie Wolf
Teacher Facilitator: Katherine Hammer

Proposal Summary:
We are proposing to send a 1-gram piece of iron into microgravity to see if it will rust. In the

three-volume tube, on one end will be 1-gram of iron, in the middle will be the Fiji water, and at the end will be 0.1 grams of cotton. On day one, the clip between the water and iron will be removed, and the experiment will begin. Should the iron rust here on Earth in gravity, but not in microgravity, that will tell us a great deal about how microgravity may affect rust. This is an important experiment because rust in space could pose a serious threat to people and living things in future colonies or spacecraft. If there is a rusty, decaying part inside the spacecraft, there could be a rupture and a loss of pressure. That is very bad for anything or anyone onboard. By doing this experiment, we may gain insight on how and if rust forms in microgravity. On return from ISS, the last clip will open revealing the cotton. This will soak up the water, and stop or slow the experiment so the gravity on return to Earth doesn't affect the experiment. Before and after, we will weigh the iron to see any change. The Archimedean Principle will also be used to measure rust growth.

19. East Orange, New Jersey

Effect of Microgravity on Root Growth of *Brassica Rapa*

Grade 7, East Orange STEM Academy, East Orange School District

Teacher Facilitator: Rania Hassan

Proposal Summary:

The purpose of this experiment is to investigate the effect of microgravity on gravitropism of *Brassica Rapa* seed germination. We chose *Brassica Rapa* due to its extremely adaptive characteristics and its quick life cycle (one month on Earth). Plant growth is directly related to responses to stimuli, known as tropism. The two types of tropism that affect plant growth are phototropism (response to light) and gravitropism (response to gravity). On Earth, plant roots grow towards the center of the Earth due to gravitropism. The plant hormone indoleacetic acid (auxin), is responsible for the growth and elongation of plant stems in addition to inhibiting the growth or root cells. (Vogt, Mareno, Countryman, 2017, p.11). We have hypothesized that the microgravity environment will decrease seed germination due to the absence of the external stimulus of gravity.

20. Galloway, New Jersey – Stockton University

The Effects of Microgravity on PGMA Based Self-Assembly and Impacts on Drug Delivery Systems

Grades 13-14**,** Stockton University

Co-Principal Investigators: Daniel Schneider, Christina Tallone

Teacher Facilitator: Dr. Pamela Cohn

Proposal Summary:

With the emergence of controlled release pharmaceuticals and their benefits in our society, the proposed experiment will contribute valuable information to this new field of study. Hydrogel drug delivery systems are incredibly valuable and used in several important aspects of medicine: from anti-cancer drugs to insulin. However while assembling, hydrophobic drugs, like many psychoactive medications, form polydispersed micelles and are not useful in drug systems. Polydispersed micelles are unpredictable and deliver medicines at varying rates. There is currently no known method for assembling monodispersed micelles around hydrophobic molecules. The proposed experiment will test to see if microgravity conditions will result in monodispersed micelles, which could be used for drug delivery. The experiment includes the self-assembly of PEGMA around indigo dye, a hydrophobic molecule, in place of a drug. An PEG dithiol crosslinker will add stability to the micelles formed. With the addition of microgravity, we are intending to find monodispersed micelle formation. If microgravity leads to monodispersed micelles, the more favorable formation, pharmaceutical companies can use this information in preparation of these important drugs, that otherwise cannot be delivered using these systems. Outside of pharmaceuticals, this experiment could also have future implications for drug delivery applications with humans participating in space travel, progressing the research of hydrogels, and the increasing the level understanding of self-assembly as a whole.

21. Springfield, New Jersey
Will Tardigrade Eggs Hatch and Develop in Microgravity?
Grade 7, Florence M. Gaudineer Middle School, Springfield Public Schools
Principal Investigator: Cecilia Perez
Co-Investigators: Paige Lieberman, Emma Pallitta, Kripa Patel
Collaborator: Maria Paula Mazo
Teacher Facilitator: Alison Gillen

Proposal Summary:
Tardigrades are microscopic animals that can survive almost anything. They were even proven to survive in microgravity, but tardigrade eggs haven't hatched/developed in microgravity. So our question is: Are tardigrade eggs able to hatch and develop in microgravity? Based on our research, tardigrades can survive in any temperature, and they can survive up to thirty days without food or water. No one knows about their eggs in microgravity, so the results of this experiment will justify that information about tardigrades. One of the reasons that we have a lot of knowledge about tardigrades is because we found an expert on tardigrades. Her name is Emma Perry, and she professes at Unity College in Maine. She has given us a lot of information about tardigrades, including a packet with facts about them, and a video about how to find them. We tried to find a few tardigrades, but our science class does not have a dissecting microscope with light coming from the side. Otherwise, we cannot see them. So she has agreed to give us twenty tardigrade eggs, ten for here and ten for the space station. Tardigrade eggs are able to survive for months without water, and they will not start to develop until they get in water, which will be on the space station. The expert has been extremely helpful for our experiment and us. On the space station, the tardigrades will have water, to start their growth, moss for food and a fixative to end the experiment.

22. Belen, New Mexico
Death and Decomposition of Tomato Leaves in Microgravity
Grades 9-12, Belen High School, Belen Consolidated Schools
Co-Principal Investigators: Isaiah Baca, Julia Castillo
Co-Investigators: Evelyn Dozal, Savannah Lajeunesse
Collaborators: Tamika Fleming, Iris Thomas
Teacher Facilitator: Chelsey Servantes, Stephen Boliver

Proposal Summary:
What's more thrilling than the miracle of life? Leaves! Well, dying, decaying leaves. We're sure everyone's just as excited. Our experiment involves the use of tomato plants, which directly relates to current astronaut research into sustainably growing food in space. Our group plans on investigating how the process of plant decomposition reacts to microgravity conditions present aboard the International Space Station (ISS). In turn, our research group will run the same experiment on Earth in order to compare the results gathered on the ISS. In collecting this data, conclusions will be made regarding differing/similar decaying plant matter response.

23. WNY STEM – Buffalo/Niagara, New York
The Effect of Ascorbic Acid on the Rate of Regeneration in Microgravity

Grade 12, Wellsville Secondary School, Wellsville Central School District
Co-Principal Investigators: Brandon Bailey, Tyler Watson
Co-Investigators: David Graham, Shannon Nye
Collaborators: Nichelle Dannheim, Trinity Roulo
Teacher Facilitator: Ross Munson

Proposal Summary:
Vitamin C, or ascorbic acid, is a water-soluble vitamin that is essential to functions in the body. Vitamin C aids in the synthesis of collagens, important proteins found in connective tissues. Collagens are vital to wound healing and create the fibers of the subepidermal membrane-muscle sheath system in planarians, which suggests that ascorbic acid will promote regeneration in planarians. Our experiment aims to find evidence on the effects of ascorbic acid on the rate of planarian regeneration. Consisting of three Type 3 FME Mini-Labs, our experiment utilizes two earth-bound Mini-Labs and one that will experience the effects of microgravity. The three volumes allotted with the Type 3 Mini-Lab will contain an ascorbic acid solution, planarians and food suspended in water, and a fixative. One of the Mini-Labs on Earth will not have the ascorbic acid and will act as an overall control group in the experiment. Upon the return of the Mini-Lab to us, we will analyze the physical characteristics of the planarians from all three Mini-Labs to determine the validity of our hypothesis. We will use measurements of physical characteristics and an additive point system where points are awarded based on physical features that were regenerated to compare our results

24. Sumter, South Carolina

The Effects of Microgravity on Seed Germination in Sodium Polyacrylate
Grade 6, Alice Drive Middle School, Sumter School District
Co-Principal Investigators: Ashlin Farmer, Alyse King
Co-Investigators: Alana Garrick, Mary Brooke Mooneyham
Teacher Facilitator: Cynthia Parker

Proposal Summary:
We propose that sodium polyacrylate will absorb water in microgravity and serve as a growth medium, which will allow embedded radish seeds to have access to water so they can germinate. Student researchers discovered sodium polyacrylate will absorb water and increase in its size to form a polymeric gel on Earth. This allows for it to become a good medium for seed germination. We plan to embed radish seeds into sodium polyacrylate in the Type 3 FME Mini Lab and then expose the mixture to water in space. If microgravity does not have any effect on the ability to absorb water then we predict the radish seeds will germinate. If our hypothesis is true then it would be extremely useful information. It would allow us to know that sodium polyacrylate in its lightweight form will mix with water in microgravity to form a polymeric gel that will serve as a growth medium for seedlings. This will be useful information as far as seed germination and growing plants in space in the future and could potentially lead to further studies such as determining if sodium polyacrylate is a good substance for other purposes such as protecting fragile samples being brought back from space.

25. Knox County, Tennessee

The Effect of Microgravity on Tooth Decay
Grades 7-8, Carter Middle School, Knox County Schools
Co-Principal Investigators: Samara Barnes, Nate Harrell, Elijah Morton, Braxton Purkey, Blake Smith
Teacher Facilitator: Katrina Whipple

Proposal Summary:
Tooth decay is an issue that all people face. Most people receive dental services about every six months and additionally as needed. The estimated time spent in space is approximately six months. Dental services are limited in space, therefore; it would be valuable to examine the effects of tooth decay in microgravity. While in the micro-gravity environment, astronauts lose calcium in their bones. Though sometimes confused with bones, teeth are composed of a calcified tissue called dentin. Because teeth play a major role in the digestive system, it is important to keep one's teeth from decaying. Tooth decay is caused by sugary foods and acids. Plaque is a coating on teeth that is made up of food, bacteria, saliva, and food debris. Usually it comes off when one brushes, but if it doesn't come off, it can and will cause various problems (Tooth Development, Loss, Replacement, and Decay). Plaque builds on teeth for up to twenty minutes after eating. Over time, the plaque emits acid, which destroys the enamel and causes tooth decay. The acids in saliva will also start to decalcify teeth, which makes it easier for teeth to decay. When the tooth returns from space, we will look for changes on the tooth as well as in the amount of calcium and in the pH level in the saliva.

26. Brazosport, Texas

Would Lemnoideae Seeds Germinate in Microgravity?
Grade 6, Grady B. Rasco Middle School, Brazosport Independent School District
Principal Investigator: Blaine Bailes
Co-Investigators: Laybe Kotzur, Dominick Trostle
Collaborators: James Link, Rene Sanabria
Teacher Facilitator: Jamie Morton

Proposal Summary:
Why would a fruit producing, oxygen making, and water purifying plant be amazing to send to microgravity? That is something we were wondering and that is why we decided to do this experiment. Lemnoideae provides vital resources. Some of which are water, oxygen, and food. These things can help lead to farther space flights in the future. NASA would not have to bring a lot oxygen tanks if this project works. Plants provide us with oxygen and food. Another reason is that lemnoideae doesn't have roots. This is because it typically grows in water. Lemnoideae can easily float on water. We feel that this plant could change the world for many reasons. Some reasons are that lemnoideae makes an edible fruit called an utricle. The astronauts can eat this for emergencies. In the future when we perform long-duration human spaceflight, it may be possible for the astronauts to eat some fruit called a utricle. Lemnoideae is also a water based plant so it has to grow in the water.

27. Burleson, Texas

The Effects of Microgravity on Penicillium Mold Growth
Grade 6, The REALM at Kerry Middle School, Burleson Independent School District
Principal Investigator: Gabe McCarthy
Co-Investigators: Ryder Huskins, Eric Sanders
Collaborators: Ethan Moore, Ian Ray
Teacher Facilitator: Laura Smith

Proposal Summary:
Our team will answer the question how Penicillium mold grows in a microgravity environment versus Earth's gravity. This question answers or sparks several other questions such as is it a viable solution for some antibiotics in space or how do antibiotics like penicillin work in the body in space. Will it grow more or will it be the same or maybe grow less? The purpose of our experiment is to provide a viable solution to some bacterial infections in space. Bacteria in

space tends to act more violently so maybe good bacteria or mold will act more furiously to kill those bacteria. Our hypothesis is that it will grow better. This is based off of the fact that in an earlier SSEP experiment the polymers absorbed more water. Which might be the same for organisms like mold so it would make it easier to absorb water. Plus with lower gravity organisms tend to grow larger at least that is many scientist hypotheses. So since there is practically no major gravity or forces in space may be the mold will grow larger than usual. Our group believes this based on the fact that we have researched.

28. Ector County, Texas
The Efficacy of *Ideonella Sakaiensis* in a Microgravity Environment
Grades 9-11, Falcon Early College High School, Ector County Independent School District
Principal Investigator: Deidre Morales
Collaborators: Devin Arriaga, Fabian Carrasco, Francis Dapanas, Mason Driggers, Faith Eleby, Damien Galindo, Kobe Hernandez, Wendy Hernandez, Leodegario Lopez, Juandedios Mendoza, Yazlin Romero, Gracielle Velasco
Teacher Facilitator: Elizabeth Gray

Proposal Summary:
Plastic, specifically Poly(ethylene terephthalate) is commonly used for its convenience here on Earth. In fact, it is used so widely that it is becoming a major burden on our environment. PET can be found in many products that are non-biodegradable which means it can spend a significant amount of years in our environment. A recently discovered bacterium, *Ideonella Sakaiensis* has been proven capable of essentially of metabolizing PET. We are seeking to compare the efficacy of the bacterium *Ideonella Sakaiensis* in a microgravity environment to that on Earth. In our experiment, we plan on putting a culture of *Ideonella Sakaiensis* and Poly(ethylene terephthalate) in the same vial and waiting to see if the bacteria can decompose the material in the same way it would on Earth. We believe this will help us gain a greater understanding of how to dispose of plastics such as PET while in space as well as on Earth.

29. Fort Bend, Texas
Growing *Solanum Tuberosum* in Microgravity
Grade 5, Settlers Way Elementary, Fort Bend Independent School District
Co-Principal Investigators: Zainab Basit, Isabelle Chang
Teacher Facilitator: Sherry DeMont

Proposal Summary:
Our query is will *Solanum tuberosum* (potato) seeds germinate in microgravity. If our project succeeds, we would like to make it so the process will be sustainable and edible. Our hypothesis is that the *Solanum tuberosum* seeds will germinate in microgravity because NASA has tried different plants like Zinnia and lettuce and they were successful. We think that potato seeds will be best to test because it's high in plenty of different vitamins, and would be good for the astronaut's nutrition and health. Potatoes are a great source of vitamin B6, potassium, copper, vitamin C, manganese, phosphorus, niacin, dietary fiber, and pantothenic acid. Potatoes also contain a variety of phytonutrients that have antioxidant activity which helps to fight off cell damage in the body. We are using a Type 3 FME that contains peat mix and *Solanum tuberosum* seeds in volume 1, water in volume 2, and 70% isopropyl alcohol in volume 3. Overall, we will be testing if *Solanum tuberosum*seeds can germinate in microgravity and if germinating works, we would like to test if the process could be sustainable. Sustainability is when a process is able to keep continuing and not run out of resources. Sustainability is very important in space, because resources are rather limited.

The Effect of Microgravity on the Germination of *Apium graveolens*
Grade 7, Quail Valley Middle School, Fort Bend Independent School District
Principal Investigator: Leena Joshi
Co-Investigators: Athulya Nair, Christina Phong, Michelle Zhou
Teacher Facilitator: Jeanette Morales

Proposal Summary:
The question is, "How Does Microgravity Effect *Apium graveolens'* (celery) Germination?" In microgravity, the ability of most astronauts' to produce saliva is at a slower rate compared to the astronaut's' ability to produce saliva on earth. Saliva is used to prevent biofilm from piling up on teeth. By taking in celery, not only will the astronauts' salivary glands start producing more saliva, but celery will also get rid of their bad breath, which is caused from having a dry mouth. Another benefit of celery is that it contains a high percentage of water, which prevents dehydration, and this fact relates back to how celery can stimulate the astronauts' salivary glands to produce more saliva. The type of FME used for the experiment will be FME type 3. The researchers will first ask the astronauts to unclamp clamp A to add the water to the soil and seeds. Then, after two weeks under the influence of microgravity, the fixative (formalin) will be added to the seeds to stop the growth of the plant. This is to get accurate results for the analysis that will take place once the experiment has returned to Earth. The experiment will be measured based on the difference in growth of *Apium graveolens* in microgravity, compared to the growth of *Apium graveolens* in earth's gravity. The growth will be measured in centimeters.

30. Pharr, Texas
What is the Effect that Microgravity has on the Development of Synthetic Brine Shrimp?
Grade 11, Thomas Jefferson Early College High School T-STEM, Pharr-San Juan-Alamo ISD
Co-Principal Investigators: Rodolfo Cantu, Jacob Fuentes, Joel Quinones
Teacher Facilitator: Andrew Martinez

Proposal Summary:
How will microgravity affect the development of hybrid brine shrimp? Our experiment will hatch multiple hybrid brine shrimp on board the International Space Station as well as on Earth. We will use the Type 3 FME for our experiment. Our plan is to fill Volume 1 with 4 mL of distilled water with the Water Purified Packet (salt, soda, water conditioner). This will also create a saline (salt) environment that will allow the brine shrimp to develop. Next, we will add .2 mL of Instant Life Eggs (5 sea monkey eggs) and .005 ml of Growth Food (yeast and spirluna) to Volume 2. Volume 3 will contain 2 mL of formalin. Upon arrival of the ISS, astronauts will release Clamp A at A=0, which will allow the purified water to get eggs, yeast, borax, soda, salt, and spirulina to the brine shrimp. At U-2 we will release the formalin in Clamp B to kill the synthetic brine shrimp. When the ISS-bound experiment is returned to Earth, we will compare the data that the astronauts collected with the data we collected on Earth. Data will include their reproduction, asexually and sexually; their size; how they adapt to microgravity; and overall development of their appendages. We hypothesize that the development of the hybrid brine shrimp will be abnormal and that their size will be small. Learning about brine shrimp development can help scientists better understand how aquatic life develops in an environment with microgravity.

31. iForward – Grantsburg, Wisconsin
Grain Size and Distribution Analysis of Gallium in Microgravity
Grades 6-8, iForward Public Online Charter School, Grantsburg School District
Co-Principal Investigators: Anita Finch, Grace Mullikin, Andrew Nichols, Dominic Parker
Teacher Facilitator: Ronald J. Cerveny, Constance Quade

Proposal Summary:

Our experiment seeks to determine if there will be a change in the grain size and distribution of processed gallium metal in a microgravity environment. The specific processing to which we are referring involves changing the state of gallium, wherein it is melted, then allowed to refreeze in microgravity. The prospect of gallium's applications in space technologies either alone or as an alloy can only be determined by learning about gallium's most fundamental properties. We will compare the grain size and distribution of grains of the Earth-based sample to the SSEP sample by using optical microscopy and the "Chart Comparison" method. Electron microscopy will reveal evidence of potentially other materials present in the samples. Based on analysis of the results of processing the SSEP sample, we will be able to draw some conclusions as to how the grain structure has been altered and the implications for unique mechanical properties. Unique mechanical properties open the door to uses for gallium not currently considered. The possibilities are endless whether for vehicle design, permanent structures, containment vessels, electronics, or other applications yet to be invented.