SSEP Mission 6 to ISS Selected Flight Experiments
Communities, Teams, and Abstracts

SSEP *Yankee Clipper* Experiments Payload
Launching on Orb-3, MARS, Wallops Island, VA

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

1. Kamloops/Thompson, British Columbia, Canada

Creating Crystals in Space

Grade 6-7
McGowan Park Elementary, Kamloops/Thompson #73 School District

Co-Principal Investigators: Jordan Brown, Hunter Galbraith, Kieren O'Neil, and Ryan Watson Co-Investigators: Justin Baker, Kennedy Coates, Daniel Funnell, Kieran Gundel, Dylan Hanson, Grace Heise, Allison Inovas, Jesse Kotani, Kessa Kwiatkowski, Jayden Lajeunesse, Daphne Legault, Blair McLeod, Alysha Muzio, Ellie Parker, Jacob Patton, Daniel Poirier, Jonathan Rinaldi, Kennedy Robidoux, Isaac Sieracki, Jessie Simons, Sylvaine Soth, Tessa Tangas, and Tristan Wyers

Teacher Facilitator: Sharmane Baerg

Proposal Summary; For our project we want to learn how microgravity affects the growth of crystals. Some of the questions we are wondering about are: How is crystal growth different in microgravity than on Earth? Are the crystals the same shape when they form in microgravity as on Earth? Do the crystals grow to the same size (mass) in the same time? (Do they grow at the same speed?) Do the crystals grow to the same size (volume) in the same time? (Do they grow at the same speed?) Is the concentration of the crystals the same? Where will crystals grow in the tube? Is diffusion of the high concentration to the low concentration solution the same in microgravity and on Earth?

We believe this is important because we can learn more about how fluids act and how crystals (precipitates) form in microgravity. The advantage of understanding if a solid has a different structure in microgravity would be that we could create solids with different properties and be able to make unique materials. It may also help us to move forward with a better understanding of how fluid mixing and crystal formation work in space.

2. Oakland, California

Composting in Microgravity

Grade 6
Urban Promise Academy, Oakland Unified School District

Co-Principal Investigators: Kevin Cruz, Cithlali Hernandez, and Jose Morga

Teacher Facilitator: Julia Lehman, Science Teacher

Proposal Summary: Our proposed experiment asks the question; if *Eisenia fetida* (red worms) will compost food waste into soil in microgravity. If they can, it would mean that we could create fertile soil in space that would help plants grow, give out oxygen, and even provide food for astronauts and scientists on the International Space Station [ISS]. We will test this by sending some *Eisenia fetida* to microgravity and seeing if they can compost the food waste into soil. We will do the same experiment on the Earth so we can compare and contrast the ground results and microgravity results. This is important because this could teach us if *Eisenia Fetida* can compost food waste into soil for plant seeds. Growing plants in fertile soil could give out food and oxygen to everyone on the ISS and future space travelers. It is also important because this could help the astronauts and scientists on the ISS decrease the amount of space that food waste takes up.

3. San Marino, California

Effects of Microgravity on Early Musca Domestica Growth

Grade 11
San Marino High School, San Marino Unified School District

Co-Principal Investigators: David Hengky and Nathaniel Rolfe

Teacher Facilitator: Wyeth Collo, Science Department Head Instructor

Proposal Summary: In our experiment we will investigate the development of *Musca domestica* (the common housefly) from pupae to adult in microgravity. The housefly, in addition to being a well-known carrier of disease, is also an ideal candidate for studying development as it is both prevalent, and the right size for the confines of the experiment. One to two weeks is the average extent of a house fly's life cycle but the pupae can remain dormant for upwards of one month, and the adult fly itself can enter a stage of dormancy for close to two days in cold conditions. The experiment will involve the transportation of dormant *Musca domestica* pupae into microgravity where warmer temperatures will induce the flies to exit dormancy, develop, and eventually hatch from the pupae. The flies will then be killed through a mixture of permethrin and formaldehyde to insure preservation and a lack of physical trauma. The carcasses will then be examined on earth for macro- and microscopic changes. By testing the result of microgravity on *Musca domestica* development we can determine any developmental changes that occur in gravity's absence. If developmental changes are seen it would be of further interest to examine potential differences in hormone gradients as gradients could be easily affected by a lack of gravity. The implications of developmental differences are widespread as space travel becomes more ubiquitous and permanent life in space becomes closer to reality.

4. Washington, DC – DC Space Grant University Community

The Effects of Microgravity on the Development of Chrysanthemum morifolium Seeds

Sophomores and Juniors
The George Washington University and Georgetown University

Co-Principal Investigators: Thomas Burchfield, Maryellen Campbell, Jun Xi Ni, and Shayda Shahbazi

Teacher Facilitator: Sarah Miller, Professor of the Practice at Georgetown University

Proposal Summary: The air we breathe plays an integral role in human health. Indoor air pollution can cause detrimental health effects such as sick-building syndrome and cancer. These health problems become problematic when considering the enclosed nature of space vehicles. Research has found that *Chrysanthemum morifolium* plants are able to remove harmful toxins from the air. The goal of this experiment is to expand upon this research and determine if these plants could be used to purify the air on [crewed] space vehicles. In order to ensure that *Chrysanthemum morifolium* plants can be used for extended periods of time, it would be beneficial for the plants to successfully reproduce to guarantee their air purifying effects during long-term space exploration. Therefore, this experiment will determine the ability of *Chrysanthemum morifolium* seeds to germinate in a microgravity environment. Seeds, potting mix, and distilled water will be used to initiate the germination process in space. After returning to Earth, the seeds will be planted alongside a control group and the growth rates of the two groups will be compared. Finally, seeds will be cultivated from each group and it will be determined if seeds from a plant in the experimental group can germinate and grow into a healthy plant. The results of this proposed experiment may provide a means for NASA to adequately purify space vehicles, even for long-term space flights. This strategy could improve spaceflight passenger health by reducing the prevalence of pollutant-associated health problems.

5. Plaquemine, Louisiana

The Effect of Microgravity on Phototropism and Geotropism on the Germination of Soybean Seeds

Grade 4
Iberville Math, Science & Arts Academy-West, Iberville School District

Co-Principal Investigators: E. Irwin, L. Morgan, and N. Warner

Teacher Facilitator: Mallory Olivier, Science Teacher

Proposal Summary: Plants are important to life on Earth and will be important to life in space, too. Plants can be used for food, to help replenish the oxygen supply, and can potentially help recycle air and water for future space explorers. We have conducted research about the need to find a quick and effective method of growing plants in space. The problem with growing plants in space is that it is not like growing plants here on Earth. There are challenges such as a lack of gravity and naturally occurring light. There is also a limited amount of space available for crops. We want to see how plants begin growing in space. We chose to study the germination of soybeans. We will send soybeans in space and will replicate the same experiment on Earth to see if a microgravity environment effects the germination of soybeans. We want to see how different the soybean seeds germinate in space versus on Earth. Tropism is the growth movement a living organism has toward an external stimulus, like gravity. There are three different types of tropism we learned about. There is phototropism, which is the movement of plants toward light; geotropism is the movement caused by gravity; and hydrotropism is movement toward water usually found in the plant's roots. In this experiment, we aim to answer the question, "What will the effect of a microgravity environment be on phototropism and geotropism during the germination of soybeans?"

6. Kalamazoo, Michigan

Microgravity's Effects on Dry Lake Fairy Shrimp

Grade 8
St. Monica Catholic School, Diocese of Kalamazoo

Co-Principal Investigators: Delaney Hewitt, Natalie Moyer, and Mackenzie Ortlieb

Co-Investigator: Grace Brennan

Teacher Facilitator: Mrs. Page

Proposal Summary: We are proposing to send Dry Lake Fairy shrimp to the ISS. We are hoping to discover if microgravity affects the muscle of these shrimp. We hypothesize that if we hatch Dry Lake Fairy Shrimp eggs in microgravity, then the hatched shrimp would be smaller, underdeveloped, and unable to swim because of lack of muscle. We chose Dry Lake Fairy Shrimp because they are small in size and we believe that we could relate our findings to the muscle loss astronauts endure in microgravity. By doing our experiment, we can broaden our understanding of muscle loss in microgravity and possibly find a way to prevent it.

We want to know what will happen to the shrimp if they are hatched and develop in microgravity. We believe that when the eggs are submerged in water up in space, when and if they start to grow, they will develop with much less muscle mass and possibly growth defects or develop in an irregular shape or size.

We would like to see if the development of the Dry Lake Fairy Shrimp's muscle loss compares in any way to the muscle loss of the astronauts. We have seen other studies where some animals lose a larger percent of muscle mass compared to astronauts. We are wondering if it has the same effects on shrimp.

7. Madison Heights, Michigan

Coliform Bacteria

Grade 7
Wilkinson Middle School, Madison District Public Schools

Principal Investigator: Farah Sabah

Co-Investigators: Israa Alfadhli and Regina Alsabagh

Collaborator: Maryam Kafra

Teacher Facilitator: Angel Abdulahad, Enrichment Teacher

Proposal Summary: This experiment will test the effects of microgravity on the interaction of Iodine tablets with Coliform infected water. We plan on doing the following experiment: Mixing Iodine tablets with coliform infected water while gravity is "shut off" on the International Space Station (ISS).

Our proposal will examine whether the effects of Iodine tablets are similar to the results conducted here on Earth. We will conduct a similar experiment with the only variance being gravity. Both bacterial samples will be examined and tested using a water purification test kit provided at the local hardware store [before launch]. The test will be conducted [again] once the water sample arrives back from the International Space Station. The reason for this experiment is twofold, one being, water is recycled on the ISS using a water filtration system because the weight of the water prevents the Space program from sending water to the ISS for daily use for their astronauts. Secondly, an unknown water source might be discovered while exploring planets and lands both on Earth and in space where water will need to be treated.

8. Kansas City, Missouri

Biocides and Bacteria

Grade 7
St. Peter's School, Kansas City – St. Joseph Diocese

Co-Principal Investigators: Nicole Ficklin, Holden O'Keefe, and Eamon Shaw

Teacher Facilitator: Robert J. Jacobsen, Seventh and Eighth Grade Science Teacher

Proposal Summary: The co-investigators would like to determine the effects of the antibacterial cleaning agent liquid iodine against *Escherichia coli* bacteria in the microgravity of the International Space Station as compared to the effects of liquid iodine on *E. coli* in the gravity on Earth.

Microbes, specifically bacteria, are present on the ISS; if there were to be an outbreak of a harmful strain of bacteria on the ISS, it would be imperative to eliminate the aforementioned strain as completely as possible. For this reason, the co-investigators would like to determine the difference in the amount of *E. coli* bacteria eliminated by liquid iodine in microgravity versus gravity.

9. Berkeley Heights, New Jersey

Baby Bloodsuckers in Outer Space

Grade 7
Columbia Middle School, Berkeley Heights School District

Co-Principal Investigators: Julia Ellis, Kasia Kapustka, Gia LaSalle, Bianca Urbina, and Lilyana Walsh

Teacher Facilitator: Pamela Wilczynski, 7th Grade Science Teacher

Proposal Summary: Our experiment will be to test the development of *Aedes albopictus* mosquito eggs in microgravity as compared to normal gravity. When launched, the eggs will be dry so when a clamp is released, water will activate the fertilization of the eggs. We believe the eggs will hatch and mature into larvae even in microgravity. On Earth, the larvae float to the surface of water to breathe and mature into pupae. We will have the astronauts preserve the mosquitoes shortly after they should have matured into pupae. However, without gravity we believe the larvae will lack a mechanism to rise to the surface and therefore will fail to mature. On Earth we will perform the same experiment. After both experiments are completed, we will observe the differences between both specimens.

10. Long Branch, New Jersey

Hydroponics vs. Microgravity

Grade 5
Gregory School, Long Branch School District

Co-Principal Investigators: Zachary FitzGerald, Ronnie Gibson, Jonathan Rocha, and Michael Zapcic

Teacher Facilitator: Laura Lazzati, 5th Grade Teacher

Proposal Summary: Our proposal is to determine whether or not hydroponics will be different in space than on Earth in terms of [plant] size, color, and taste. We are doing this proposal because we are trying to see if hydroponics is more efficient in space than on Earth. We are trying to solve the problem of world hunger. Hydroponics might help solve the issue of world hunger if we can determine if food can be grown faster in space. Since hydroponics is more efficient on Earth, it might be even more efficient in space so that the world hunger problem might be solved by space hydroponics, which will feed the poor and hungry people of the world. In terms of size, a hydroponic [garden] might be bigger or smaller or it might just stay the same. In terms of taste, [plants] might taste better or might taste worse [compared to those grown using] Earth hydroponics.

Today, hydroponics on Earth is more efficient than plants grown in soil. Our one concern is that space hydroponics could have a negative effect by altering the growth structure of the plant. If this is the case, we may be unable to use any hydroponic growth in space if we don't know the effects of the altered growth structure. We chose to do our proposal on hydroponics because we think this is a unique idea and we are interested to explore the results.

11. Ocean City, New Jersey

Attachment of Escherichia coli K-12 Strain to Lettuce

Grade 11
Ocean City High School, Ocean City School District

Co-Principal Investigators: Lauren Bowersock, Mercy Griffith, Kristina Redmond, Daniel Loggi, Kaitland Wriggins, and Alison Miles

Teacher Facilitator: Catherine Georges, Honors Biology Teacher

Proposal Summary: Conditions in space have a profound impact on the human body and all living organisms are affected by microgravity. For our experiment, we chose to examine the impact microgravity has on *Escherichia coli K-12*'s attachment rates. Previous studies have shown that microgravity increases bacterial reproduction rates, however our group chose to look at the effect microgravity has on bacteria's attachment rates. We hypothesize that microgravity will inhibit *E. coli*'s ability to attach to a host. Reduced rates of *E. coli* attachment can be beneficial to astronauts if they are exposed to a pathogenic strain; however, these reductions can also be severely detrimental to the human body. Inhibited attachment of the commensal strains of *E. coli* that reside in the colon, which assist in digestion, food absorption and vitamin K processing, can also be detrimental for human health. *E. coli K-12* is a refined lab strain of *E. coli* that has been found to attach to lettuce. In space, we will expose *E. coli K-12* to lettuce for a number of days. Before the end of the experiment, we will expose both the *E. coli K-12* and the lettuce to a fixative, formalin, which will kill the bacterial cells, freezing them in their positions attained in space in order for accurate analysis on Earth. Studying *E. coli K-12*'s rate of attachment is crucial for the advancement of science in space exploration.

12. Flushing, New York

Can Zero Gravity Affect the Germination of Chia Plants?

Grade 7
World Journalism Preparatory School, New York City School District 25

Co-Principal Investigators: Ethan Reres, Gabriella Marin, Jamila Tejada, Michael Fourniotis, and Raul Castrejon

Teacher Facilitators: Christian VanDeurs, 7th Grade Science Teacher, and Dr. Mark Baribault, Chemistry/STEM Teacher

Proposal Summary: We want to know if reduced gravity will have an effect on chia seed germination. We're doing this experiment by comparing the number and size of germinated seeds in normal gravity, compared to microgravity. This experiment will have an impact on humanity because it will show if reduced gravity has an effect on seed growth.

13. Colleton County, South Carolina

Milk in Microgravity

Grade 6
Colleton County Middle School, Colleton County School District

Principal Investigator: Bailey Crosby

Co-Investigators: Amber Avant, Morgan Dandridge, Megan Dewitt, and Casey Powell

Teacher Facilitator: Ann Henson, 6th Grade Science Teacher

Proposal Summary: Our group is trying to figure out what type of milk will spoil the most in 6 weeks time spent in microgravity. The three types of milk we are using are whole, skim, and 1% milk. After doing research for two hours in the library, we found out that whole milk spoils the fastest on earth and skim milk takes the longest to spoil. The reason for this is because of the amount of coliforms in different types of milk. Since bacteria can grow and reproduce asexually, they can reproduce into larger groups faster. Not to mention that bacteria, which is the product of milk spoiling, can grow in any temperature. A benefit is, if you want to drink milk because it has vitamins and nutrients, you need to see which one will stay fresh the longest. Another benefit of this project is, if one day they find out

that humans could possibly live in space, we would need something to drink other than water. We are expecting to find that the results of our experiment will fit our hypothesis which is that whole milk will spoil more in space and on Earth than skim and 1% milk. We will observe the amount of curdles in each section of both FMEs to determine which spoiled the most.

14. North Charleston, South Carolina

How Does Spaceflight Affect the Formation of Tin Whiskers on Lead-free Solder?

Grades 9 and 11
Palmetto Scholars Academy, South Carolina Public Charter School District

Co-Principal Investigators: Joseph Garvey and Rachel Lindbergh

Collaborator: Gabriel Voigt

Teacher Facilitator: Kellye Voigt, Science/Research Teacher

Proposal Summary: Tin whiskers – the crystalline structures that originate from metals covered in or plated with tin – have become a serious problem for electronics manufacturers and scientists. These tin whiskers can short-circuit devices by creating a new electrical current. In fact, tin whiskers have even been known to destroy planes and satellites, resulting in not only considerable risk of human life but in the loss of hundreds of millions of dollars. Tin whiskers have caused the destruction of the Galaxy IV, Galaxy IIIR, and Solidaridad 1 satellites, and more.

Our group is interested in testing the entire experience of spaceflight on the development of tin whiskers, including the launch and re-entry. We believe that the g-force experienced in the journey to and from the ISS and microgravity experienced on the ISS will promote the growth of tin whiskers on the tin-plated testbed and the printed circuit board. We will also utilize a procedure created by Dr. Lyudmyla Panashchenko, a NASA scientist in the Electronic Growth and Packaging program, to maximize the possibility of tin whisker growth on the testbed.

To test our hypothesis, our team would send a lead-free solder testbed to the International Space Station to compare the development of tin whiskers with the control testbed that would remain on Earth. We will analyze the mass of the sample, length, structure, and density of the whiskers. The results of our experiment would increase our current understanding of the effects of spaceflight and microgravity on the stability of electronic devices sent to space.

15. Knox County, Tennessee

Waste in Space: Exploring the Effect of Microgravity on the Rate of Decomposition of Corn Starch by Rid-X

Grades 5-11
L&N STEM Academy, Knox County School District

Co-Principal Investigators: Lydia Barbour and Ethan Fawver

Co-Investigators: Forrest Hamilton, Hunter Hawkins, Sarah Sellers, and Thomas Tison

Collaborators: Nick Corbett, Henry Gertsen, and Jonathan Tison

Teacher Facilitator: David Hawkins and Nick Wilsey

Proposal Summary: The purpose of our experiment is to determine the effect of microgravity on the rate of decomposition of corn starch by Rid-X, a commercial septic treatment product. Rid-X contains enzymes and bacteria, which work together to decompose organic waste and produce carbon dioxide. Some of the carbon dioxide will remain dissolved in the fluid to form carbonic acid. We will measure the rate of decomposition by titrating the fluid in our experimental and control tubes with sodium hydroxide, which will tell us the amount of carbonic acid produced by the bacteria. We will terminate the experiment with ethanol. We chose corn starch as our food source and ethanol as our terminating agent because they are pH-neutral, allowing us to measure the small amount of acid produced by the bacteria. We predict that the rate of decomposition will be slower in microgravity because Rid-X is designed to work in a septic system, which is stratified into layers on Earth by gravity. In microgravity, we expect that the bacteria and enzymes in the Rid-X and the corn starch will float around in clumps. The enzymes in Rid-X therefore should be more likely to find the corn starch and begin breaking it down for the bacteria to metabolize on Earth than in microgravity, because on Earth they both should sink to the bottom and mix in the layer of sludge.

16. Somerville, Tennessee

Reishi Mushroom VS. Chronic Myeloid Leukemia

Grades 9-10
Fayette Academy, Independent School District

Principal Investigator: Mark Montague

Co-Investigators: Averi Davis, Harley Wade, and Tucker Whittington

Teacher Facilitator: Donna Burrus, Biology Lab Instructor

Proposal Summary: Our team's research question is, "What effect will microgravity have on the Reishi mushroom's [*Ganoderma lucidum*] ability to weaken, damage, or destroy chronic myeloid leukemia cells?" Our project will send the Reishi mushroom and the K562 leukemia cells into a "free fall" environment. We will have three FME labs. One on board the ISS and the second one on the Earth with the same controls running simultaneously. The third one will run on Earth and will include K562 leukemia cells to see how rapidly they grow compared to the other FME tubes. This is important because we want to understand leukemia and how we can fight it with Reishi mushroom and how microgravity can affect it. Reishi mushroom has been used for over four thousand years in China and has shown promising effects. Cancer that starts inside bone marrow is chronic myelogenous leukemia [CML]. In the center of bones, there is soft tissue that helps form all blood cells. CML causes an untamed growth of immature cells that make myeloid cells, which are a certain type of white blood cells. We believe the Reishi mushroom will induce cell-cycle arrest and apoptosis in various human and cancer cells, which has been shown in past research done at UCLA (Muller I. Claudia, et al.).

17. Rockwall County, Texas

How Microgravity Effects Yeast Cell Division and How it Relates to Human Cancer Cells

Grade 8
Williams Middle School, Rockwall Independent School District

Co-Principal Investigators: Ryan Figert and Harrison Smith

Co-Investigators: Will Brown, Brooks Helmer and Chase Howerton

Collaborator: James Matthews

Teacher Facilitator: Mike Stone, Career and Technology Teacher

Proposal Summary: This experiment is about how the division rate of yeast is affected by microgravity. Due to the recommendation of Derek Smith, a researcher at University of Texas Southwestern Medical Center, we plan to use yeast cells as a tool for modeling the cell division processes that occur in more complex cells like human cancer. We will use three volumes in the FME. The first compartment contains a yeast microorganism. The second compartment contains a yeast growth medium, YPD broth, which is usually used to grow the cells in a lab on Earth. The third compartment contains a fixative, glutaraldehyde, to stop the growth of the culture and preserve the results of the experiment for comparison to the ground experiment, which will be conducted in the exact same way, except for the gravity. From the results of this experiment, we can learn the possible effect of microgravity on cell division. If it slows or stops the division rate, the results will reveal methods that can be applied to studies on cancer cells. While in communication with Kartik Rajagopalan of University of Texas Southwestern, said, “Scientists and physicians are always looking for ways to cure cancer in human patients. If we find that microgravity causes a growth defect in cancer, it is possible that [time in microgravity] could be used as a therapeutic option for cancer patients.”

18. San Antonio, Texas

Crystal Formation

Grades 5-6
Howsman Elementary and William P. Hobby Middle Schools, Northside Independent School District

Co-Principal Investigators: Anthony Holmes, Jacob Rubio, Kalista Ybarra, and Madelyn Hickman

Teacher Facilitators: Ronica Korn, Michael Dawson, and Serena Connally

Proposal Summary: We will be doing our experiment on the growth of crystals in outer space. Our experiment will be based on the question “How will microgravity effect the growth of Sodium Bicarbonate crystals?” We believe that without gravity causing the solution to settle to the bottom of the tube, more crystals will form. On Earth the gravity causes the heavier parts of the solution to settle to the bottom. This could result in smaller and fewer crystals. The materials we will be using are: pipe cleaners, sodium bicarbonate solution and our FME. The question we will be trying to answer is: Will sodium bicarbonate crystals forming in a microgravity setting grow at a faster, stronger rate than those formed in a setting with gravity acting upon it?? Our hypothesis is that the crystals will grow at a faster rate and will be larger.