SSEP Mission 17 to ISS: Selected Flight Experiments, Communities, Teams, and Abstracts

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A total of **2,261 proposals** were submitted from student teams across the 37 communities participating in Mission 17 to ISS. Of those **1,208 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, 2022 and January 19, 2023 the Step 2 Review Boards met via Zoom, reviewed all **112 finalist proposals**, and selected one proposed experiment to fly for 35 communities, 2 proposed experiments for two communities, for a total of **39 flight experiments, which will fly on SpaceX-29**. It is noteworthy that the 2,261 proposals received reflected a total of **12,859 grade 5-16 students fully engaged in experiment design**.

1. Edmonton, Alberta, Canada

The Effects of Microgravity on the Statoliths and Statocyst Cells in *Lepidium sativum* (Garden Cress)

Grade 9, Parkview School, Edmonton Public Schools
Co-Principal Investigators: Samuel Cullen, Scott Erskine
Co-Investigators: Marcus Li, Xiaolin Liu
Teacher Facilitator: Morgan McKinnon

Proposal Summary:

This experimentation will test the effects of microgravity on the statolith and statocyst cells in a garden cress plant (Lepidium sativum). By looking at the direction, length, and general health of the shoots and roots of a garden cress plant grown on the ISS, compared to a *Lepidium sativum* grown here on Earth, will gain an excellent idea on how microgravity can affect the statoliths inside plants. This experiment will be useful should humans ever need to sustain life in an environment with little gravity. The information this experiment provides will help grow plants reliably in space, which is necessary should humans ever need a renewable food source in space to survive, whether for convenience or survival sake. Being able to grow plants in space will allow us to prolong the amount of time astronauts can stay up in space, possibly even allowing long time space travel for years at a time, in time. Growing plants in space will also have the added bonus of letting the astronauts have a fresh meal every once in a while. It also helps to examine the importance of statoliths and statocyst cells inside plants, being one of the main six stimuli plants use to determine the direction of growth in its different parts.

2. Ukraine

Effect of Humic Substances on the Growth and Metabolism of Yeasts in Microgravity

Grades 8-10, Municipal extracurricular educational institution “Junior Academy of Sciences for School Students” of the Dnipropetrovsk Regional Council in collaboration with the National Center “Junior Academy of Sciences of Ukraine”

Principal Investigator: Tetiana Rodyhina
Co-Investigators: Daniela Dykun, Roman Rodynskyi, Marko Yurchenko
Teacher Facilitator: Maryna Bilan

Proposal Summary:
Yeasts are cheap, attractive, and readily available residual sources of proteins and valuable bio-active compounds (amino acids, vitamins) directly at space stations. Moreover, we can use genetically modified yeasts to obtain valuable substances there. Yeasts are simple to cultivate and a well-known biological model object. Yeasts can react differently to microgravity conditions: they change morphology and biochemical processes. Microgravity conditions can adversely affect yeast growth, protein content, and other physiological processes. It is essential to find low-cost yeast growth promoters in microgravity. They would provide sufficient yeast yield. In earth conditions, yeast growth may be enhanced by adding humic substances to yeast cultural medium. Humic acids provide the higher biological value of yeast products obtained. In addition, we can use yeasts and humic substances as effective plant growth biostimulator at space stations. We want to discover whether humic acids can be used as yeast growth promoters in microgravity and how these substances affect yeast division, growth, protein content, and fermentation. We hypothesize that humic substances will be effective yeast biostimulants, so it will be possible to improve yeast cultivation at space stations and during long space flights to obtain valuable products.

3. Ukraine
Influence of Microgravity and G-force on Diffusion in Metals
Grade 9, Kryvyi Rih Lyceum No. 129 in collaboration with the National Center Junior Academy of Sciences of Ukraine
Principal Investigator: Victoria Syvolap
Co-Investigators: Yelyzaveta Harasimova, Yelyzaveta Melnychenko
Collaborator: Hanna Martyniak
Teacher Facilitator: Natalia Lykhopavlo

Proposal Summary:
The expansion of humanity within the Solar System is natural and inevitable. The crucial requirement for any extraterrestrial human settlement is to set up a habitat with conditions like on Earth. Constructing space stations involves the application of various materials. In particular, conventional copper and aluminum alloys are used in construction. They provide long-term and consistent performance in metal structures, as conductors, and as components of heating systems. Solid metals are known to diffuse into each other during long-term operation, which changes the properties of products produced from these metals and alloys. In some cases, when the tightness of a structure is required, this phenomenon will be advantageous. Alternatively, if a specific item requires systematic replacement or movement after long-term exploitation, the diffusion process will extend the time required to troubleshoot and repair failed equipment. We hypothesize that metal diffusion processes will occur more intensively in microgravity and during transportation (G-Force conditions). The project aims to evaluate the change in diffusion that occurs in contact with different metal surfaces during transportation to and from earth orbit and microgravity. This research will contribute to the development of microgravity materials science.

4. Phoenix, Arizona
Red Desiree Potato and Sweet Potato
Grade 5, Desert Mirage Elementary School, Pendergast Elementary School District #92
Co-Principal Investigators: Zoe Harrold, Sophia Ketring, Brynn Smith
Teacher Facilitator: Catherine Linhardt

Proposal Summary:
Why are potatoes grown in space? Let us tell you why potatoes and sweet potatoes are serious contenders for space agriculture! Due to their high carbohydrate content and their tuberous nature that gives them low light requirements, potatoes should grow well in space. As well, the eyes of potatoes produce sprouts that can be used to grow more plants, thereby making them a simple, reliable food source. If sweet potatoes grow in space then why shouldn't others, if others do not grow why? Our theory is that all potatoes grow but if not, is it because of vitamins content or sugar level? Potatoes can be a reliable food source for astronauts and it is also high in a lot of nutrients. Potatoes have a good recourse of vitamins that could be helpful for astronauts to eat. The potato is a staple food source for many people around the world. With zero percent fat, potatoes contain many important vitamins. Red Desiree Potatoes are the healthiest potatoes if they can grow in space. The sweet potato has more vitamin B5, fiber, and manganese but red potatoes have more vitamin A RAE and vitamin C. This might be the reason why only sweet potatoes grow in space but we want to find out.

5. Glendora, California
Mushroom Leather Proposal
Grades 11-12, Glendora High School, Glendora Unified School District
Co-Principal Investigators: Tyler Lai, Benjamin Tallman
Investigator: Dylan Anderson
Collaborator: Justin Tong
Teacher Facilitator: Jimmy Liao

Proposal Summary:
By testing the growth capabilities of mushrooms on the International Space Station, an interval of gravity may be established where mushrooms can grow. If mushrooms grow sufficiently in zero gravity and with Earth's gravity, planets smaller than Earth will also be suitable for mushroom growth. Due to the many capacity restrictions both sending materials to space and areas that may be dedicated to farming, there are many problems with traditional cloth farming methods. Traditional cow leather would be extremely difficult to sustain in space, because bringing up live animals would take up precious space and materials making this difficult, costly, and impractical. Traditional production of cotton would require both soil, water, and space to be farmed. Bringing mushrooms up into space would be area efficient (grown in tubes) and resource efficient (all parts are usable). Measuring how mushrooms grow in a zero gravity environment will allow humans to determine the viability of creating mushroom leather in space as an option for sustainable cloth.

6. Moreno Valley, California
The Strength of Concrete with Eggshells as Filler in Microgravity
Grade 11, Canyon Springs High School, Moreno Valley Unified School District
Co-Principal Investigators: Jeannavie Bonos, Sidney Figueroa
Investigator: April Snyder
Collaborator: Samantha Piotrowski
Teacher Facilitator: Divina Elbo

Proposal Summary:
The team attempts to answer the question: "How does microgravity affect the strength of the concrete with eggshells as a filler?" The experiment will hopefully help to add more solutions to the challenges of NASA's plans to colonize the moon. In the future when space habitats similar to Earth are discovered, there will be a challenge of reducing wastes like the problem on Earth. Eggshells are potential agricultural waste in space that could potentially be used as a filler for concrete. The eggshell concrete mixture has already been made on Earth and thus the team wants to investigate the strength of the concrete mixture if they are the same or comparable to the one made on Earth. Using eggshells within the experiment would create an efficient and

sustainable filler for concrete. Many materials that are needed to create concrete with eggshell fillers are already found in space, which means the potential results of the experiment could also support the minimization of storage space on the ISS and an avoidance of the total cost of transporting materials to space. If the experiment is successful, it will be a sustainable method that can further NASA's plans of setting-up research facilities and colonizing the moon.

7. Hillsborough County, Florida
The Microgreen of the Future: *Amaranthus tricolor*
Grades 6-8, Randall Middle School, Hillsborough County Public Schools
Co-Principal Investigators: Savannah Kersey, Sanjana Rao
Investigator: Nathan Bohra, Crystal Heidenreich, Ricardo Melendez, Nichita Scobelev
Teacher Facilitator: Mary Vaughn

Proposal Summary:
The essential question to be addressed is if the Red Garnet Amaranth Microgreen (*Amaranthus tricolor*) can sustain its germination rate in microgravity and therefore sustain its nutritional value as compared to Earth? This question is so essential to the astronauts because if the microgreen can germinate properly, growing substantial amounts of *Amaranthus tricolor* in space is necessary for astronauts to get their daily nutrients. It is full of vitamin K which helps with proper bodily clotting. This helps the astronauts who are very prone to liquids clotting in their nose and other areas. It is also full of Calcium, which is such a necessity to astronauts because of possible bone and teeth decay in space. It also contains magnesium, which can help with heart health and circulatory health while in space. That combined with the fact that it can be mass produced in hundreds in one enclosure make it the ideal plant to carry with you on long expeditions far from home while in microgravity. Even though astronauts venture into space for prolonged periods of time their genetic compound still originates from earth, as they are still human, and they still need the same necessities as regular people if not more, due to the effects of microgravity. The Red Garnet Amaranth Microgreen (*Amaranthus tricolor*) can meet those expectations and more on earth, but if it can germinate in space, and retain that same nutritional value, it would be a major achievement for astronauts.

8. Hillsborough County, Florida
The changes of nutritional and germination values of Sesame microgreens in microgravity
Grades 7-8, Randall Middle School, Hillsborough County Public Schools
Co-Principal Investigators: John Lonappan, Aadrita Roy
Teacher Facilitator: Mary Vaughn

Proposal Summary:
This experiment addresses the problem of sufficient nutritional value of food on long duration flights. The plan is to grow the seeds on Earth and in microgravity and measure frequency of growth, as well as the nutritional value of sesame microgreens (*Sesamum indicum*) before and after sending them up into space. The base for this experiment is the knowledge that sesame microgreens have nutrients including Selenium, Calcium, Vitamins A, B1, B3, B5, B6, E, and is rich in antioxidants which are especially important nutrients especially when in space. Success of the experiment will result in a variety of nutritious crops that will serve as a supplement to astronauts' meals. When carrying out the experiment, the team will be using an instrument called the Brix Refractometer which will measure nutrition. It will play a key role in the investigation, since not only is the team investigating the frequency rate for germination, but also checking to see whether the nutritional value will be retained in microgravity. If the experiment proves that sesame microgreens can keep their nutritional value, the Sesame microgreens will be a reliable, easy to grow source of nutrient rich food for long duration flights in space for astronauts everywhere around the world.

9. Ocala, Florida
Does Microgravity Affect Protein Production of *Escherichia coli*?
Grades 5-6, Dr. N.H. Jones Elementary, Marion County Public Schools
Principal Investigator: Collins Sheldon
Teacher Facilitator: Lisa Dorsey

Proposal Summary:
This experiment will test if protein production in microgravity is possible and more efficient than under normal gravitational conditions. If protein production is possible and more efficient can biopharmaceuticals ever be made in microgravity and if so, would the outcome be more efficient? The manufacturing of proteins in microgravity could have positive implications towards the production of medications to treat diseases such as cancer, diabetes, influenza, and even Covid. As bacteria becomes resistant to the medications used to treat illnesses, new biopharmaceuticals will be needed to improve health and save lives. As space colonization becomes a reality, space pioneers will need the ability to create effective medications in microgravity conditions for the health and safety of space travelers. The results from the microgravity mini lab will be analyzed and compared to the ground truth mini lab results.

10. Osprey, Florida
The ability of microalga ,*Chlorella vulgaris,* to remove nitrogen and phosphorous from wastewater in microgravity
Grade 7, Pine View School for the Gifted, Sarasota County Schools
Co-Principal Investigators: Yatharth Kakkad, Felix Ratner, Rugan Suresh, Rishik Yellu
Teacher Facilitator: Marie Rosander

Proposal Summary:
This experiment investigates the ability of microalga *Chlorella vulgaris* to remove nitrogen and phosphorous from wastewater in microgravity. Microalgae are complex photosynthetic organisms that have evolved for over three billion years and are emerging as a green solution for water treatment and nutrient recycling on Earth. If microalgae can remove contaminants from synthetic wastewater in microgravity, then they could play a key role in self-sustained life support systems which are essential for long term space missions. The contaminants in the synthetic wastewater that the microalgae are removing would provide nutrients for the microalgae to grow, creating an optimal cycle. The strain *Chlorella vulgaris* has been chosen because it can grow heterotrophically using organic carbon and wastewater. In both the ground control and ISS experiments, the *Chlorella vulgaris* culture will be added to a mixture of wastewater and glucose solution. Two days before undocking for return to Earth, both experiments will be terminated using a fixative. The difference in the levels of nitrogen and phosphorous between the ground and ISS experiments will be analyzed to determine how microgravity impacted the experiment. Using microalgae as a solution will not only provide the benefit of cleaner water in space but will also generate oxygen and high value bioproducts in the process.

11. Viera, Florida
***E-coli* and endotoxin detection in microgravity via LAL-Horseshoe crab blood testing**
Grade 7, Pinecrest Space Coast Academy, Brevard County Public Schools
Principal Investigator: Liam Hauser
Co-Investigators: Connor Santore, Eric Distasi, Evan Ireland, Luke Costa
Teacher Facilitator: Consuelo Praetorius

Proposal Summary:
Think for a moment; how could horseshoe crab blood (*Limulus polyphemus*) save the lives of

people in space? That is exactly what this experiment will investigate. The team's experiment will test the bacterial 'finding' capabilities of the horseshoe crab blood, by using LAL (*Limulus Amebocyte Lysate*). LAL is a main component of the horseshoe crab immune system that fights bacterial infections in the crab. Our experiment will mix (LAL) and *E.-coli* in the FME tube in microgravity. The dried LAL and *E-coli* will both be placed into separate sealed sections of an FME experiment tube, with a clamp in between the two substances. Why is this group doing this you might ask? Their hypothesis is that microgravity will not affect the ability of LAL to react with *E. coli* in microgravity, and the bacterial killing activity of LAL will decrease the number of live *E. coli* in the FME. This can lead to advances in medicine on the Earth, as well as provide for improved health for Astronauts and colonizers in space. The LAL from -horseshoe crab blood, can be used to detect bacteria and act as possible early detection of diseases during space travel. It can also be utilized to detect bacteria and bacterial endotoxins on surgical equipment, prescription storage containers, and even human tissue samples. All of these reasons make this LAL-Horseshoe Crab Blood experiment an ideal candidate to be conducted in microgravity aboard the International Space Station for the SSEP program.

12. Jonesboro, Georgia
Germination of *Mentha spicata* in microgravity
Grade 7, Mundy's Mill Middle School, Clayton County Public Schools
Principal Investigator: Caleb Kenneth Walker
Co-Investigators: Anthony Justin Micheal Chin, Kevin Fernando Martinez-Bello
Teacher Facilitator: Heather Peterson

Proposal Summary:
This project is to see how spearmint, *Mentha spicata*, germinate in microgravity. Knowing if spearmint could germinate in microgravity would be useful for astronauts. Spearmint can be useful on the ISS because it can be used to treat digestive conditions, reduce swelling, boost antioxidant levels, and it contains other beneficial compounds to help lower blood sugar and balance hormones. When it is onboard the ISS, volume 1 will contain 3 mL of distilled water and volume 2 will contain 20 spearmint seeds. On the first interaction day, A=0, the seeds and water will be mixed and shaken for 10 seconds. The seeds will be left to germinate for the remaining time. Once the project returns to Earth, we will compare how the spearmint developed in microgravity conditions to how the spearmint developed on Earth. We will measure the stem and roots of the spearmint plants to determine germination.

13. 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:
Lactobacillus acidophilus is a probiotic bacterium that can be found in the human mouth and intestines. This bacterium is classified as beneficial due to its effectiveness at preventing issues with digestion and diarrhea that result from antibiotic treatments. Several bacterial strains of *Lactobacillus acidophilus* have been shown to be able to assimilate and uptake cholesterol in a laboratory setting. The uptake and assimilation of cholesterol by *L. acidophilus* may be useful as a therapeutic approach for lowering cholesterol levels in humans. High levels of cholesterol are a contributing factor to cardiovascular disease which is the leading cause of death in the Western world. There are several cholesterol lowering drugs prescribed for patients that are at high risk for cardiovascular disease. The most widely prescribed cholesterol lowering drugs include statins and PCSK9 inhibitors. While these drugs have demonstrated efficacy towards lowering cholesterol levels in patients, they often have undesirable side effects. The potential

adverse effects of statins include musculoskeletal symptoms, increased risk for diabetes, and strokes, while PCSK9 inhibitors side effects include muscle aches, infections, and fevers. Therefore, alternative cholesterol lowering treatments with fewer side effects are warranted. It has been demonstrated that several strains of *Lactobacillus acidophilus* are able to lower cholesterol levels in vitro. In addition, experiments done in simulated microgravity have provided insight into the mechanism for how *Lactobacillus acidophilus* expresses the genes involved in the metabolism of cholesterol. In this investigation, in vitro cholesterol lowering activity by *Lactobacillus acidophilus* in a microgravity environment will be studied.

14. Lake Charles, Louisiana
Growth of Spirulina in Microgravity
Grade 8, F.K. White Middle School, Calcasieu Parish School Board
Principal Investigator: Sam Dondapati
Teacher Facilitator: Sandra Hayes

Proposal Summary:
The experiment will see the effect on “Growth of Spirulina in microgravity.’ The hypothesis for this experiment is the growth will be higher compared to the growth on earth due to lack of stress from the environment. Astronauts can consume Spirulina for their daily needs of vitamins and proteins in the space station. Spirulina is a blue-green algae from the genus Arthrospira (“arthro” roughly meaning “joint,” and “spira” meaning “spiral”). Spirulina is a reliable source of several nutrients, including fat-soluble vitamins (A, E, and K), fatty acids (DHA, EPA), beta carotene, and minerals. It is also a source of protein. it also helps in increasing antioxidant capacity, lowers the blood pressure, controls the blood sugar, lowers the bad cholesterol, and increases the good cholesterol, reduces the metabolic syndrome, helps to improve mental health, and reduces obesity (Verywell Health, 2022). Spirulina can cause allergy for those who are allergic to algae.

15. University System of Maryland, Maryland
The Effect of Microgravity on Telomerase Activity and Efficiency in *Saccharomyces cerevisiae*
Grade 16, University of Maryland, College Park
Co-Principal Investigators: Arthi Ramkumar, Jessica McClelland, Korina Vlahos, Sara Dawood, Shan Dawood
Teacher Facilitator: Daniel Enrique Serrano

Proposal Summary:
Space exploration is expanding to more prolonged journeys and destinations beyond the moon.cTherefore, understanding how microgravity conditions impact the biochemical process that contributes to aging and chronic conditions like cancer is imperative, specifically pertaining to the functionality of telomerase. The purpose of this study is to determine how telomerase activity and efficiency is impacted by the exposure of microgravity. This investigation will use the yeast model *Saccharomyces cerevisiae* to quantify the function of telomerase by measuring the telomerecextensions and mRNA telomerase expression levels in *Saccharomyces cerevisiae* before and after the experimental groups return to earth. We will additionally host a control group experiment on Earth. The results of this investigation can contribute to improving the fitness of astronauts. Understanding how microgravity impacts telomerase function is integral to understanding how humans age in space, as well as to obtaining insight as to how disorders related to cell division like cancer are impacted and treated.

16. Westland, Michigan
Mushroom Germination in Microgravity
Grade 5, Walker-Winter Elementary School, Wayne-Westland Community School District
Co-Principal Investigators: Bailey Needham, Michaela DeVries
Co-Investigators: Bassam Qaqish, Brayden Albright, Devid Zace, Kinnidy Jones
Teacher Facilitator: Michael Hall

Proposal Summary:
If mushrooms can germinate in a microgravity environment, then future space explorers could benefit greatly. We will be germinating Lion's Mane mushrooms because they have many benefits, not just for a person's health, but for the environment as well. Some health benefits include lowering risks of cancer caused by space radiation, boosting the human immune system, and protection from mental disease. Mushrooms also can help terraform planets and be made into biofuels. We want to see if Lion's Mane spores will germinate in a microgravity environment. To do this, we will assemble a mini-lab and have an astronaut follow our experimental procedure aboard the ISS while we conduct the same experiment in the classroom on the ground. The mini-lab will be returned to us so we can determine if mushroom spores germinated in a microgravity environment.

17. Edina, Minnesota
Bean Root Growth in Microgravity
Grades 10 and 12, Edina High School, Edina Public Schools
Co-Principal Investigators: Joshua Cram, Grayson Irons, Colin Shaw
Teacher Facilitators: Jodi Ramirez and Shannon Seaver

Proposal Summary:
In this experiment, 2 mung beans will be germinated on the ISS and their root growth will be compared to identical plants grown on Earth to see the effects of zero gravity and a lack of light. Because the main factors of plant root growth are gravitropism (gravity) and phototropism (light), it would be interesting to see how plants grow without either of those factors. The hypothesis for this experiment is that other factors, such as hydrotropism (water) and thigmotropism (growth around obstacles), will have more of an effect than usual, as well as the orientation of the beans. This experiment will help people learn more about how plants grow in a zero-gravity environment.

18. Las Vegas, Nevada
***Wolffia* in Microgravity**
Grade 8, Pinecrest Academy of Nevada, St. Rose Campus
Principal Investigator: Ezrah Maie Cortez
Co-Investigators: Baylee Jones, Elyse Garrett, Sofia Camacho
Teacher Facilitator: Mariah Schwenn

Proposal Summary:
Seeing as astronauts need a substantial food source in microgravity, the focus question for this experiment is "Will Wolffia (duckweed) grow in microgravity? If so, what is the duplication rate?" Duckweeds are small floating plants that thrive in nutrient rich water. This is the fastest growing plant in the world and can be grown in large quantities. Wolffia plants can be used as a beneficial human food because of the high nutritional value. Not only is it used for food, it can help purify wastewater and potentially be used for medicinal purposes including as an antibacterial agent, and for improved immune function, and digestion in humans. In this experiment, duckweed (Wolffia) will be used. The mini-lab required for this experiment is Type 3. The dependent variable for this experiment is the length of time for Wolffia to grow. Wolffia will be mixed with a water and plant food mixture in order to determine the growth and multiplication rate of the plant. The space experiment and ground experiment will be performed

at different times. The ground experiment will be done after the launch. Once the space lab experiment is returned to Earth, it will be analyzed and compared to the ground experiment to determine how microgravity affected the Wolffia plant, in terms of duplication and growth.

19. Camden, New Jersey
Mold Growth in Microgravity: A evaluation on the spread of fungi in microgravity conditions
Grade 5, Camden's Promise Charter School
Co-Principal Investigators: Sahara Miller, Sianny Lee, Inari Toledo
Teacher Facilitators: Christopher Hernandez and Marquise Grant

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. Springfield, New Jersey
The Effect of Microgravity on Gray Mold
Grade 7, Florence M. Gaudineer Middle School, Springfield Public Schools
Co-Principal Investigators: Sharlyn Dubey, Avital Kandel, Aria-Rose Molinelli, Taylor Tripet, Isabella Zabinski
Teacher Facilitator: Alison Gillen

Proposal Summary:
Strawberries are a nice flavorful fruit, but when mold grows on these strawberries, they're ruined. The mold that grows on strawberries is *Botrytis cinema* (Gray or White mold). At the time they are picked, strawberries usually mold in about 14 days (2 weeks). The mold consumes about 65% of the strawberries. Once this mold has sprouted on one strawberry it can easily spread from one strawberry to another. We are using dehydrated strawberries to control when they will mold. When the strawberries are getting transported to the I.S.S, they won't be hydrated yet. The astronaut's will unclamp the tube and let the water soak into the strawberries. Once this happens, the water will rehydrate the strawberries instantly. Down on earth, the strawberries took 13-14 days to mold. In space, we believe it will take a shorter period of time for the strawberries to mold.

21. Albany, New York
The effects of microgravity on *Oryza sativa* (rice)
Grade 8, Hackett Middle School, Albany City School District
Co-Principal Investigators: Everett Mercier, Sadeer Othman, David Stefano Rosales, Yomar Santiago, John Thang
Teacher Facilitator: Craig Ascher

Proposal Summary:
The investigators hope to find out how *Oryza sativa* will grow and mature in microgravity. The investigators also hope to find how fast *Oryza sativa* takes to germinate, and how differently the roots and stems of the *Oryza sativa* plant will grow in space compared to if it was grown on Earth. Here are three things the investigators learned while they researched their topic. Finally,

the investigator learned that under microgravity conditions guttation (a type of pressure release for plants) is enhanced and *Oryza sativa* grows and germinates faster. The investigator hypothesizes that *Oryza sativa* will become slightly more nutritious and will grow better in microgravity. To conduct this experiment, the investigators would place *Oryza sativa* seeds into a nutrient-rich liquid or flooded soil so that the *Oryza sativa* would grow with the soil. The investigators can do this because *Oryza sativa* is grown in an extremely moist environment. On Earth, the investigators would plant *Oryza sativa* in the normal traditional way with flooded soil. It would be beneficial to learn how microgravity impacts the subject of our experiment because the investigators' results could vary depending on whether microgravity affects the subject positively or negatively and if it will be different compared to the research done on Earth and in the past. It would also be beneficial because we would be able to obtain more accurate results.

22. Brooklyn, New York - BSEA
The effects of microgravity on the germination of radish seeds
Grade 6, Brooklyn Science & Engineering Academy, District 18
Co-Principal Investigators: Tristan Cole, Rundell Swan
Teacher Facilitator: Minica McGarrell

Proposal Summary:
This team would like to find out the effects of microgravity on the germination of *raphanus sativus* (radish seeds). In the presence of gravity on Earth, the force of gravity pulls roots downward which allows the nutrients and water to be easily transported to the stem and leaves of the plant. The team would like to investigate how the roots would grow during germination if gravity was changed. Radishes were selected for this experiment because this plant germinated very quickly compared to other seeds. According to resources from the Brooklyn Botanic Garden (BBG) "farmers and gardeners commonly plant radishes. They're easy to raise because they grow fast and are usually ready to harvest within eight weeks of planting." If radishes are able to produce healthy plants in the presence of microgravity, it can be a good source of water and hydration for astronauts, considering that "radishes contain mostly water". In this experiment radish seeds will be sent to space where water would initiate the germination process. The experiment will then be stopped before returning to Earth. When the experiment is returned to Earth the seeds that germinated will be compared to the control group grown on Earth. This experiment will provide data on the effects of germination on *Raphanus Sativus* (radish seeds) and the overall growth of the plant and its ability to germinate a healthy radish plant.

23. Buffalo/Niagara, New York
The Effect of Microgravity on the Germination of Chamomile Seeds
Grade 5, Wellsville Elementary School, Wellsville Central School District
Co-Principal Investigators: Zia Muska, Maggie Viglietta
Co-Investigators: Adeline Brubaker, Samuel Green
Teacher Facilitators: Stephanie Viglietta and Dan Allen

Proposal Summary:
In this experiment, we are trying to send German chamomile seeds up to space to see if they germinate and to test the effect of microgravity on the germination rates. The reason for our experiment is that astronauts could experience stress in space. Chamomile has many benefits like, improving heart health, supporting bone health, relieving menstrual pain and calming anxiety. Also, matured chamomile is called chamomile calming tea and is known to help with sleep. We are using three different variables in our attempt to germinate chamomile including: in the dark, indirect and direct sunlight. We are trying to do the experiment with three different variables because we are not sure of the exact conditions the scientists have to grow it in space. It will also allow us to make further advancement in our understanding of modern technology, gardening and the microgravity environment.

24. Garden City, New York
Effects of Microgravity on Dill Seed Germination
Grade 7, Garden City Middle School, Garden City School District
Co-Principal Investigators: Tejas Bera, Fallon Grant, Ryan Schmidt, Sarah Ullrich
Teacher Facilitator: Amanda DeRiso

Proposal Summary:
The proposed experiment will be investigating if dill seeds (*Anethum graveolens*) will germinate in microgravity conditions. On Earth, plants feed our populations and sustain humanity, allowing humans to thrive. However, astronauts do not just need food, they need to be healthy during the long-term space travel. Astronauts need strong immune systems, which in space, can be severely weakened, according to some studies. Dill is packed with essential vitamins and minerals and is shown to strengthen immunity. Even though the dill is not high in calories, it has been used by people for various medicinal purposes since ancient times. To thrive during long space travel and exploration of other planets, humans need a constant source of healthy nutrients. If we can learn to germinate dill seeds and grow dill in space, it can be one of these sources. The investigation of the effects of microgravity on dill seed germination is an important step toward developing space agriculture of the future.

25. Long Beach, New York
How Does Microgravity Affect the Germination of Oyster Mushroom Spawns (*Pleurotus Ostreatus*)?
Grade 6, Long Beach Middle School, Long Beach Public Schools
Principal Investigator: Giuliana Urrego
Investigator: Gregory Seifert
Collaborators: Frank Depace, Nathaniel Kaplan, Jackson Spitz
Teacher Facilitator: Mrs. Dean

Proposal Summary:
The question being tested is how microgravity will affect the growth of oyster mushroom spawns. The group is exploring this question because mushrooms don't need sunlight to grow and in space there is none. This makes it the perfect environment to grow oyster mushrooms in. Mushrooms have a lot of vitamins such as Vitamin B and Vitamin D which comes from the sun. There is no Vitamin D in space so that's why it's best to bring oyster mushrooms up there to eat because everyone needs Vitamin D. In addition there are even more vitamins in oyster mushrooms. Including, niacin (providing 21% of the recommended daily intake), riboflavin (18%), and pantothenic acid (11%). The humans eating the oyster mushrooms can also get small amounts of folate, Vitamin B and a Vitamin of the B complex, thiamin.

26. Lynbrook, New York
How do microgravity and space conditions affect the growth of the wine cap mushroom, *Stropharia rugosoannulata*, mycelium?
Grade 9, Lynbrook High School, Lynbrook Union Free School District
Co-Principal Investigators: Aidan Michaels, Jack Murray
Collaborator: Ethan Palacio
Teacher Facilitator: Stoycho Velkovsky

Proposal Summary:
The experiment is designed to assess how wine cap mushroom (*Stropharia rugosoannulata*) mycelium grows under the effect of microgravity. This is important because if the mushroom grows well in microgravity, it could be planted in the garden of the International Space Station as a potential food source for the astronauts. The wine cap mushroom is nutritious and is a

source of several vital vitamins and minerals, including Vitamin D, which is very important for astronauts since they are not exposed to sunlight. The wine cap mushroom also helps rejuvenate the soil around it, which would make the garden on the ISS more effective at producing fresh food. The wine cap mushroom does not need much water, sunlight, or care, which is why it is considered one of the easiest mushrooms to grow and why it would have a high likelihood of success at growing in the ISS garden. It is of the utmost importance that the astronauts remain healthy and have a source of fresh food, especially during long-term missions. The combination of being easy to grow, a good source of nutrition, and a benefit to the soil it is planted in, make the wine cap mushroom potentially one of the most important food sources grown in the ISS garden. The goal of the experiment is to determine whether wine cap mushroom mycelium could grow effectively in space as both a food source for the astronauts on the ISS and as an asset for other plants being grown.

27. Norwood, New York
The Effects of Microgravity on the Reproduction Cycle of *Drosophila melanogaster* (Common Fruit Fly)
Grades 10 and 12, Harrisville Central School, Harrisville Central School District
Co-Principal Investigators: Nadia Atkinson, Maia Bernhard
Teacher Facilitator: Nicole Taylor

Proposal Summary:
Fruit flies, specifically *Drosophila melanogaster*, are one of the most commonly used animals in genetic research. Because of this, it is vital that we learn as much as we can about how the fruit fly's environment affects it. According to previous studies, microgravity affects many things, so it stands to reason that it might affect the life cycle of the *Drosophila melanogaster* – it's important to find this out. The researchers proposing this experiment would like to send male and female fruit fly specimens to measure how the life cycle is affected and the mortality rates of pupae and adults. To do this, the amount of larvae, pupae, and adults will be counted upon return to Earth, and compared with the control experiment. Once the experiment is activated (clamp A unclamped), the males and females will be able to interact, providing the opportunity for them to begin mating. The hypothesis of this experiment is that the fruit flies will breed slightly less, and mortality will be higher than in the control experiment conducted on Earth. These results could lead to the generation of more efficient ways to source fruit flies for genetic experiments in space, as well as further conclusions about how microgravity affects the life cycle of other animals that have similar DNA.

28. Red Hook, New York
Examining *Artemia salina* Hatching in the Presence of Microgravity
Grade 12, Red Hook High School, Red Hook Central School District
Co-Principal Investigators: Jessica Amato, Zola Campisi, Avis Roszko, Raphael Senterfit-Sanjuan, Tucker Sheahan
Teacher Facilitator: Deborah Beam

Proposal Summary:
The proposed investigation will examine the presence of microgravity and its impact on the hatching of brine shrimp. By utilizing a small, quickly-hatching organism, the results of the experiment can serve to commence a bigger movement to research sustaining earth-based life in environments featuring microgravity. The goal of the experiment is to convey the potential changes in standard life processes that may result from differences in pressure on the internal and external structures of organisms, providing insight to more complex cellular interactions in microgravity in the future. This exploration is also ideal for displaying the differences between microgravity and standard environments because of the lack of modification of said environments. The eggs do not have to be in a refrigerated or heated environment in order to hatch, controlling the results further. This experiment will allow for examination of complex

organism interactions in differing environments, allowing insight to astronaut physicality and future sources of energy and food in space.

29. Pickerington, Ohio
Bamboo Growth in Microgravity
Grade 6, Harmon Middle School, Pickerington Local School District
Co-Principal Investigators: Naila Abdi, Abigayel Ghebireegzabher
Teacher Facilitators: Erica Lovely and Anna Meyer

Proposal Summary:
The purpose of this experiment is to explore the effects of microgravity on the growth of bamboo seeds. Comparing the system in a microgravity environment and on Earth will allow us to know if bamboo can grow in microgravity.This research is important because bamboo can provide many nutrition and medical benefits for astronauts. The experiment this group is proposing will address the question “How does the rate of bamboo growth change in microgravity?” If we can grow bamboo in microgravity the astronauts on the International Space Station will be able to develop more nutrition and medicine. This experiment seeks to evaluate the germination rate of bamboo and the quality of the bamboo nutrients.

30. Gervais, Oregon
Patulin Growth in Space
Grades 11-12, Gervais High School
Co-Principal Investigators: Diana Garcia, Lauren Ferschweiler, Miguel Orozco, Sinai Reyes
Teacher Facilitator: Kristen Shirley

Proposal Summary:
The research question being tested is how well Patulin will grow in space as opposed to on Earth. Patulin is the result of several molds, and this experiment focuses on the fungus *Penicillium Expansum*, and how apple products decompose or produce patulin. *P. Expansum* is a blue mold which causes soft spots and gradually disintegrates certain fruit. The amount of Patulin produced has a direct correlation to the amount an apple product has decomposed. This could potentially help astronauts in space when they need to decide what foods to bring or what foods need to be preserved better. Patulin growth is an indirect, but still related way of measuring decomposition in apple products. This experiment was chosen due to a collective interest in bacteria and decomposition of cells. The expectation for the experiment is to get a measurable amount of Patulin from two different samples, and compare which has more. One of the samples will have been molding on Earth while the other in space. They will decompose for the same amount of time, and start with the same amount of bacteria and apple sauce. To make sure the test that is sent to space has no time to grow on Earth, the astronauts will mix ethanol with the sauce before it is to return to Earth, to preserve it. The results will be measured by using a Patulin ELISA test.

31. Erie, Pennsylvania
The Effect of Microgravity on Crystal Growth
Grades 7-8, Iroquois Junior-Senior High School, Iroquois School District
Co-Principal Investigators: Joshua Allison, Elliot Kemp, Luke Noyes, Alex Pierce, Nicholas Pribyshchuck
Teacher Facilitators: Jacob Bartlett and Shannon Glennon

Proposal Summary:
This proposal asks the question of how microgravity affects the growth of silicate materials. This experiment will be using a quartz crystal in a quartz solution. The group will also recreate the same experiment at the same time to supply a control group for the team, then they will measure the crystals to see if the crystals grow better in microgravity. The group will see if the

crystal in microgravity has less strain defects; quartz grown with less imperfections could lead to better technology, such as crystal oscillators. The group believes that the crystal will have less defects, since it is believed that strain is the main problem coming from gravity. The crystals will be measured by noting the way the crystals diffract x-ray wavelengths. The team hopes that the insights can be used to better humanity in the end.

32. Pittsburgh, Pennsylvania – CCAC
The effect(s) of microgravity on the dormant state of cancer cells
Grade 13, Community College of Allegheny County
Co-Principal Investigators: Jason Gomes, Daniel Roth
Teacher Facilitator: Francis Cartieri

Proposal Summary:
Despite our increasing success in the early detection and removal of primary cancers, most cancer mortality occurs after periods of remission, during which cancer cells may “hide” from immune and therapeutic detection by entering a period of dormancy. The microenvironmental causes of this period of dormancy, which can last for days, months, or years, are unknown. Also unknown are the physical and chemical signals that trigger re-activation of cancer cell division, eventually leading to tumor formation, metastasis, and death. The few studies that do exist indicate that abnormal levels of certain factors (such as inflammatory, growth, and cell adherence signals) are associated with cancer cell dormancy and proliferation. Disturbingly, several of these factors are co-associated with exposure to microgravity. If exposure to microgravity effects cycles of cancer cell proliferation and/or dormancy, this may impose challenging limitations for future space travel and its long-term consequences. Most directly, microgravity exposure could accelerate cancer formation in spacefarers whose bodies harbor dormant cancer cells. Our team proposes to analyze the effects of a microgravity environment on cultured cancer cell lines from the model organism *Xenopus laevis* (African clawed frog). Specifically, relative levels of gene expression for dormancy-associated proteins will be compared between microgravity-exposed cancer cells, and cancer cells not exposed to microgravity. Additionally, cell morphology, proliferation, and intercellular behavior will be assessed in all groups. This study will directly aid in our understanding of microgravity’s impact on cancer dormancy and activation, while improving our limited understanding of the phenomenon of cancer dormancy more broadly.

33. Bandera, Texas
The Effects of Microgravity on Basil Germination
Grade 7, Bandera Middle School, Bandera ISD
Co-Principal Investigators: Emma Rynarzewski, Sophia Whidden, Elizabeth Garcia-Medina
Teacher Facilitator: Kathleen Foster

Proposal Summary:
This investigation will aid in advances in astronaut nutrition and health by exploring whether or not basil seeds will germinate in microgravity. Basil contains many vitamins and minerals, and it also contains antioxidants such as lutein, zeaxanthin, beta-carotene, and beta-cryptoxanthin. Having or adding basil to your diet can help reduce high blood sugar levels. Sweet basil contains a compound called eugenol, which can block calcium channels, which in turn may help lower blood pressure. Essential oils in basil can help lower cholesterol and triglyceride levels as well. Basil also contains magnesium, which can help improve blood flow by allowing your muscles and blood vessels to relax. These oils, including eugenol, linalool, and citronellol, can also help fight inflammation in the body. This in turn can help lower the risk of inflammatory conditions such as arthritis, heart disease, and bowel issues. Basil has antibacterial properties as well. Oils in the herb may help fight bacteria in people with respiratory, urinary, abdominal, and skin infections. Basil also has many other nutrients in it. These nutrients include calcium, vitamin A, vitamin K, manganese, iron, zinc, and potassium.

34. Burleson, Texas
Can a Cotton Ball Instead of Soil Germinate a Lavender Seed in Microgravity?
Grade 6, Kerr Middle School, Burleson ISD
Co-Principal Investigators: Abigail Bain, Jack Crow, Lyla Meek, Addison White
Teacher Facilitator: Terry Briggs

Proposal Summary:
Lavender seeds produced with pretty purple leaves and a refreshing scent. This experiment was chosen to explore the effect of how a lavender seed can grow without using soil. This observation will be using a Type 3 FME tube. The criteria for this lavender plant to germinate is the use of a cotton ball and sprouting of the single lavender seed. A cotton ball was chosen because the soil is denser and higher mass. Mass equals more financial resources used during space exploration. This project also includes water and formalin. Formalin is used to stop the plant's growth in microgravity. This will allow researchers to compare and contrast the growth rates of different test samples. The design of the experiment is planned for the plant to not fully grow, just to sprout. To investigate the plant, it must go through each stage of a lavender seed's life to fully understand its growth. This project can be beneficial in the future because quality plant growth during space exploration will provide a viable food source in the future. Additionally, in the world of privatized space travel, cost will be sufficiently higher based on fuel expenses. Payload size must be considered. The cotton ball option of plant growth is vital to reducing those cost. According to clinicaltrials.gov, lavender is proven to help reduce blood pressure and anxiety with its refreshing scent. High blood pressure and anxiety are known medical issues among the crew members on the ISS. So, in the end "Don't tell me the sky's the limit when there are footprints on the moon."- Paul Brandt

35. Ector County, Texas
***Pestalotiopsis microspora* in Microgravity**
Grades 10-11, Permian Basin STEM Academy, Ector County ISD
Co-Principal Investigators: Evan Hernandez, Bryan Nash
Investigator: Georgi Shoumaroff
Collaborators: Evan Boyer, Kagan Holder
Teacher Facilitator: Karey Grametbaur

Proposal Summary:
The goal of this investigation is to determine whether or not the fungus *Pestalotiopsis microspora* can survive and reproduce in the unique conditions of an environment in microgravity. Plastic can take anywhere from 250 years to well over 1000 years to decompose, but even after this decomposition, the microplastics left behind are still hazardous to the environment. *Pestalotiopsis microspora* is a fungus capable of breaking down plastic and converting it into easily biodegradable compounds, similar to compost. If the *Pestalotiopsis microspora* is able to grow in a microgravity environment— such as space and is still able to break down plastics, then its recycling capabilities could be a viable alternative to simply shooting waste back at the Earth (the current standard for waste disposal from the ISS). This method would help solve the issue of how to properly reduce or eliminate the waste that astronauts produce in space. In addition, the *Pestalotiopsis microspora* would create a usable byproduct that astronauts could use to grow useful plants in, as the *Pestalotiopsis microspora* turns the plastic into organic material that is highly conducive to plant growth. Though many mushrooms, molds, and fungi were considered, these two very desirable qualities of *Pestalotiopsis microspora* make it a prime candidate to study in microgravity.

36. McKinney, Texas

Does microgravity affect the formation of symbiotic relationships between soy and Rhizobium?

Grades 13-16, Collin College, Collin County Community College District
Co-Principal Investigators: Henry Elmendorf, Stefano Sacripanti
Teacher Facilitator: Tamara Basham

Proposal Summary:
The topic of discussion in this proposal is to determine whether microgravity inhibits the formation of symbiotic relationships between soybeans and rhizobium. In the future when astronauts are on missions that take them further out into the solar system, they cannot rely on Earth for food and supplies and will need to find ways to gain a sustainable food source. Soybeans were chosen as the crop in this experiment due to their nutritional value and vitamin content. In addition, they could be used in the creation of bioplastics and other industrial materials, which could be used in manufacturing replacement parts if the need arises while on mission. In a DuPont experiment conducted in 2002, soybeans were proven to be able to sprout in microgravity. However, soybeans lack the capability to undergo nitrogen fixation on their own and require Rhizobium to achieve this in a process called inoculation. That process improves the yield of soybeans by 66 percent. This experiment will test to see if the formation of the symbiotic relationship is possible between soy and Rhizobium in microgravity. Inoculation will be determined by measuring if nitrogen fixating nodules are present after germination, compared with soybeans that will be inoculated on Earth. It is expected that no significant differences will be observed.

37. Texarkana, Texas

Do Tardigrades Develop Properly in Microgravity?

Grade 7, Texas Middle School, Texarkana ISD
Principal Investigator: Nirav Neupane
Co-Investigators: Kevontae Espada, Max Gaylor
Teacher Facilitator: Sarah Gustafson

Proposal Summary:
This experiment will measure the effects of microgravity on the early development of terrestrial tardigrades. Tardigrades are a phylum of aquatic microorganisms that are found in terrestrial, aquatic, and marine ecosystems and are famous for their ability to survive extreme and harsh environments. Some species have survived temperatures from -234°C to 100°C, others have endured up to 30 years of frozen starvation, and still, others can tolerate the pressures of the deep ocean. Terrestrial forms use a process known as “cryptobiosis, ” a dehydrated state where they can combat extreme cold, vacuum, heat, and radiation in short, the conditions of space. Tardigrades’ early development consists of two stages, the egg and the juvenile stage. Once an egg is completely formed, it hatches within an average of 5-16 days. After about a week of development, it reaches the juvenile stage and continues to grow. This investigation will compare the hatching rates and average sizes of a population of tardigrades in microgravity on the International Space Station (ISS) with a similar set on the ground. If the statistics between these two experimental populations are alike, we will conclude there is no effect of gravity on the development. Our results will lead to further study on how tardigrades are able to perform such intense adaptation, and scientists could eventually learn how their tactics could be beneficial for future long-term and distant manned space missions.

38. Renton, Washington

Microgreen Growth in Microgravity Environment

Grade 8, Risdon Middle School, Renton School District
Principal Investigator: Adrienne Pesito
Co-Investigators: Roland Collette, Mika Vital

Collaborator: Haley Milne
Teacher Facilitator: Amanda Solis

Proposal Summary:
Microgreens are young seedlings of edible vegetables and herbs. Microgreens are smaller, can be grown more compactly, and come in around 60 variations. They have high nutritional value, packed with potassium, iron, zinc, magnesium, and copper. Microgravity environments affect an astronaut's bone density and muscle mass (see page 3). Microgreens are filled with dietary fiber and calcium– two things that heavily support muscle growth and bone density. The following experiment will investigate how microgreen growth and structural development differ in a micro gravitational environment. This study may assist in building a more sufficient and natural diet for those in space and prolonged space travel.

39. iForward-Grantsburg, Wisconsin
Does microgravity affect the germination of *pleurotus ostreatus* spores?
Grade 9, iForward Public Online Charter School, Grantsburg School District
Co-Principal Investigators: KK Turley, Tyler Babinski, Tyler Nerison, Kirsten Nichols, Rachelle Nichols
Teacher Facilitator: Mark G. Dilley

Proposal Summary:
Does microgravity affect the germination of *Pleurotus ostreatus* spores? In this experiment, our team will try to answer that question. If this experiment is successful, oyster mushrooms will be able to be grown in microgravity. This experiment is important because oyster mushrooms can provide many needed benefits to future colonies that may live in space. These mushrooms have good nutritional value and provide fiber, protein, and vitamin D. They also have the potential to help deal with waste. The fact that oyster mushrooms can not only consume decaying matter but also things like plastic is very useful. In the FME, Our team will be using approximately 3 ml plug from a Back to the Roots Mini Mushroom or similar mushroom growing kit, 2ml of sterile water, and 2ml of formalin to preserve the results. On return to Earth, an analysis of the substrate and any mycelial growth will be done and compared to the ground experiment. In conclusion, this experiment will provide valuable information if oyster mushroom mycelia can be grown in microgravity.