SSEP

Student Spaceflight Experiments Program

SSEP Mission 14 to ISS: Selected Flight Experiments, Communities, Teams, and Abstracts

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A total of **3,076 proposals** were submitted from student teams across the 32 communities participating in Mission 14 to ISS. Of those **930 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 December 1-2, 2019 the Step 2 Review Board met at the NASA Goddard Spaceflight Center's Visitor Center in Greenbelt, MD, reviewed all **97 finalist proposals**, and selected one proposed experiment to fly for 31 communities, 2 proposed experiments for one community, for a total of **33 flight experiments, 27 of which will fly on SpaceX-21**. It is noteworthy that the 3,076 proposals received reflected a total of **16,600 grade 5-16 students fully engaged in experiment design**.

1. Sao Paulo, Brazil

The Influence of Microgravity on the Breakdown of Lactose and the Development of Bacteria in the Gut Flora

Grade 11, Colégio Regina Coeli
Co-Principal Investigators: Karine Gabriella Ascoli, Larissa de Oliveira Paes, Eduardo Felipe Pagnan Vieira
Co-Investigator: Marina Santin Cavalcante
Teacher Facilitator: Michele Poleze

Proposal Summary:
Lactose intolerance (a body's inability to break down/digest the sugar in milk) is a world-scale issue that has been increasing exponentially over the last few years, affecting about 65% of the adult population, especially in European, African, and Middle Eastern countries according to the Global Lactase Persistence Association. With research being developed regarding the stay of astronauts under microgravity conditions – mainly aboard the International Space Station (ISS) – as well as the possibility of the colonization of Mars, it is essential that astronauts and future colonizers are in healthy conditions. This can only be achieved through a balanced diet and perfect nutrient absorption, so it is extremely important that future settlers and astronauts understand how the gut flora works. This project investigates the development of probiotic bacteria (*Lactobacillus acidophilus* and *Lactobacillus bulgaricus*), which are commonly used in the dairy industry, in microgravity. These bacteria are endogenous and actively participate in processes involving the gut flora, so any type of deficiency or delay in their development might result in difficulties to absorb nutrients. In conclusion, the research will observe the lactose break down under a microgravity environment, so that we can understand the relationship between gravity and the break down of this type of sugar.

2. Edmonton, Alberta, Canada

The Effect of Microgravity on the Early Development of Brine Shrimp Eggs

Grades 7 and 9, Highlands & Rosslyn Junior High
Principal Investigator: Sofia Sejutee
Collaborators: Adrien Hanna, Madison Keown, Bradley Vith
Teacher Facilitators: Sarah Graham, Alena Manera

Proposal Summary:
The experiment will determine the effect of microgravity on the early development of brine shrimp. Brine shrimp are extremely resilient micro-crustaceans that can withstand harsh environments and varying salinity levels. During the early stages of development, the eggs can arrest as dehydrated cysts, and can be easily transported to space. To reactivate growth, saltwater is added. The timeline for growth and development is well suited to experimentation on the ISS. Brine shrimp are highly nutritious and full of protein, which make them a great food source for aquatic life such as fish. The Japanese Experiment Module on the ISS has an aquarium stocked with fish. Although this is mainly for studying the fish, if brine shrimp development is successful they can potentially be a sustainable food source for the fish, which can in turn feed astronauts on long term space missions. This will incorporate more vitamins, calcium, iron, zinc, potassium, and omega-3 fatty acids into the astronaut's diets. Astronauts can also directly eat brine shrimp as it is rich in protein and omega-3 fatty acids. Brine shrimp can also be dried and made into a powder that can be taken as a nutritional supplement. Upon completion of the experiment, results will be analyzed under a microscope.

3. Halifax, Nova Scotia, Canada

The Effects of Microgravity on an Activated Carbon Filtration System

Grade 9, Gorsebrook Junior High
Co-Principal Investigators: Eliana MacDonald, Katherine Scottie Sneddon-Simons, Rihanna Waligura-Newman
Teacher Facilitator: Sonja Goold

Proposal Summary:
This experiment explores the effectiveness of activated carbon filtration systems in microgravity, by using the capillary process to collect the clean, drinkable water as well as the adsorption process of the activated carbon used to purify said water. This system will contribute to the knowledge and data necessary for living sustainably outside of Earth's gravitational field. If proven effective, this will eliminate unnecessary transport of drinkable water to the ISS, and additionally, it will be extremely effective at purifying water when found outside of Earth. The supplies necessary for transport would be very lightweight, and could be used multiple times. Furthermore, we will be able to increase energy efficiency at the ISS by reusing water already on board.

4. Winfield, Alabama

What are the Effects of Microgravity on the Germination of *Aloe barbadensis* Seeds?

Grade 6, Winfield Middle School
Co-Principal Investigators: Caroline Leigh Carothers, Avery Scott Lawler, Emma Grace South, Bella Claire Thompson, Anna Claire Tidwell
Teacher Facilitator: Ashley Seals

Proposal Summary:
What are the effects of microgravity on *Aloe barbadensis*? It is common knowledge that *Aloe barbadensis* can have a very positive effect on many different things. Possible space applications include using *Aloe barbadensis* to lower blood sugar, tightening skin, restoring muscles, healing burns and reducing dental plaque. The investigation will determine if *Aloe barbadensis* has the ability to germinate in microgravity, and what effects microgravity will have on the *Aloe barbadensis* that is trying to grow. If *Aloe barbadensis* has the ability to grow in space, then it can be used for a number of medical benefits. The leaves of an *Aloe barbadensis* plant contain slimy tissue that stores water. This gel is easily extracted for use in space, and contains the vitamins, minerals, amino acids and antioxidants in the plant.

5. Buckeye, Arizona

How will Microgravity Affect the Erosion and Durability of Teeth?
Grade 7, Steven R. Jasinski Elementary School
Co-Principal Investigators: Tatiana Caldera, Fabian Espinoza, Angelique Lugo, Jacob Ochoa
Teacher Facilitator: Holli Sierra

Proposal Summary:
The investigation compares the rates of erosion and reduced durability of teeth in microgravity, to those on Earth in the same conditions. Tooth erosion may be an issue in microgravity more so than on Earth. Dental care can rarely be provided in microgravity, leaving room for dental problems. Tooth erosion is the loss of dental enamel, which is a thin layer on the surface of the tooth made up of hard tissue. As the enamel begins to weaken, tooth erosion begins to occur. Certain beverages and acidic foods normally cause dental erosion, because they increase the acidity in your mouth as well as the bacteria that is housed in your mouth that forms acid. This experiment will be using lactic acid (the acid that is formed from bacteria exposure in the mouth) and phosphate buffered saline (acting as the base or buffer) as the elements to gauge microgravity's effect on the erosion, durability, and density of teeth.

6. Corcoran, California

Red Piranha Venus Flytrap Germination in Microgravity
Grade 7, John Muir Middle School
Co-Principal Investigators: Blake Cabral, Aaron Dias
Co-Investigators: Steven Amador Sandoval, Adrian Vazquez
Teacher Facilitator: Keylee Navarro

Proposal Summary:
The investigation tests the ability of a challenging plant to grow, the Red Piranha Venus Flytrap plant, to germinate in microgravity. If Red Piranha Venus Flytrap can germinate in microgravity then other hard to germinate plants would most likely germinate as well. The investigation provides the Red Piranha Venus Flytrap seeds with rich soil and water to test germination. The experiment is stopped, with Formalin before returning to Earth. The results of the microgravity investigation are compared with an identical ground investigation to determine microgravity's effect, providing scientific information for hard to germinate plants in space.

7. Moreno Valley, California

Germination of Alfalfa in Microgravity

Grade 11, Canyon Springs High School
Co-Principal Investigators: Anthony Avina, Jadyn Roscelle Patos
Co-Investigators: Hannah Caswell, Jason Ng
Teacher Facilitators: Sharon Scott, Divina Elbo

Proposal Summary:
If NASA attempted to form colonies beyond Earth's boundaries, whether it be on moons, planets, or space stations many challenges would be encountered when trying to sustain life, including lack of food reliability. One extremely versatile and valuable source of food is alfalfa. Alfalfa is an excellent source of calcium, which is beneficial to astronauts because of bone loss resulting from microgravity. Alfalfa also provides a large variety of vitamins and minerals, which can be very limited in an astronaut's diet. This experiment expands upon a previous SSEP experiment by studying not only germination, but also the alfalfa's viability in the nitrogen cycle. Alfalfa, a cost-effective and easily obtained legume, contributes to the nitrogen cycle, which can be used in space agriculture to replenish soil for other crops. It can do this by forming root nodules, which have a symbiotic relationship with rhizobium bacteria. Additionally, as a producer and autotroph, it can be used as part of the food chain to feed both primary and secondary consumers. Alfalfa is a desirable choice for this experiment because it is palatable to humans. It takes as little as two days to germinate, 10 days to form nodules, 40 days to fully mature, and it can be dried and stored indefinitely under proper conditions. In addition, alfalfa can be grown hydroponically. Due to the previously mentioned attributes, the effects of microgravity on alfalfa growth will be investigated to determine if it is able to sustain a place in an interstellar food chain. The team hypothesizes that the experiment in microgravity will have relatively few differences from the ground experiment, including root size, the rate of growth, and nodulation.

8. Redlands, California

Microgravity's Effect on the Germination and Early Growth of the Seeds of *Cymbopogon citratus*

Grades 10-11, Redlands High School
Principal Investigator: Maximilian Florida
Co-Investigators: Evan Kusko, Ayesha Mirza, Anna Nguyen
Teacher Facilitator: Paul N. DeVoe

Proposal Summary:
This experiment assesses the effect of microgravity on the germination and early growth of the seeds of *Cymbopogon citratus* (the scientific name for lemongrass). Specific factors assessed are radicle orientation, germination rate, and root length. Not only will this help to validate and elaborate upon prior conclusions regarding the effect of microgravity on seed germination and early growth, but the results may also be analyzed to discern whether lemongrass overall is a viable plant in microgravity. Discussed extensively in both scientific and popular sources, lemongrass seeds and the mature plant itself are hardy, easy to grow, and tolerant to various adverse conditions, indicating that *Cymbopogon citratus* may be an economically logical plant to cultivate in the outer space environment. Additionally, researchers have demonstrated that its medicinal and practical applications are numerous, assuming important positions in the spheres of pharmacology and aromatherapy. These benefits become more attractive when the difficult conditions astronauts frequently encounter in microgravity are considered, with lemongrass potentially serving as a valuable resource for aiding the immune system, relieving psychological stress, and achieving necessary sanitation.

9. Hillsborough County, Florida

Spinach on the Station

Grades 7-8, Randall Middle School
Co-Principal Investigators: Grace Kalnins, Lucas McMillin
Teacher Facilitator: Mary Vaughn

Proposal Summary:
The investigation will determine the frequency rate of the germination of Giant Noble Spinach in microgravity. The justification for this is so humans can go forward to the Moon and onto Mars with a constant food source that is nutritious and healthy. Spinach is easy to grow, rich in vitamins, trace minerals, protein, and fiber. Research has shown that astronauts need food that is high in nutrients because unlike Earth's environment, space causes stressors on the human body. For example, astronauts' muscles weaken because of microgravity, so to counter this, exercise is required daily to keep muscles in shape. Since astronauts aren't on Earth, they may not be eating fresh, nutritious foods. Fresh spinach has more nutrients than prepackaged spinach that astronauts are currently eating. Researchers predict that fifty percent of the seeds will germinate. The advantages of growing spinach in space would allow for astronauts to maintain longer duration missions and to sustain a healthier presence in space.

10. Pasco County, Florida

How will Microgravity Affect the Efficiency of Amoxicillin on *S. Epidermidis*?

Grade 12, Wendell Krinn Technical High School
Co-Principal Investigators: Amanda Marrero, Shelly Nonnenberg, Emily Null
Teacher Facilitator: Sarah Kumar

Proposal Summary:
Research on *Staphylococcus aureus* in microgravity is imperative for the welfare of astronauts. *S. aureus* is a gram-positive bacterium found in the International Space Station, in human nasal passages and on skin. The effects of *S. aureus* can cause anything from minor skin infections to life-threatening diseases such as boils, pneumonia, meningitis, or sepsis ("Staphylococcal"). In place of *S. aureus*, *Staphylococcus epidermidis* will be used in this experiment because it is a biosafety level 1 organism, which is non-pathogenic and safer for astronauts to use as well as being structurally similar to *S. aureus*. Amoxicillin is a beta-lactam antibiotic that is used against *S. aureus*. This experiment is to determine the effectiveness of Amoxicillin in microgravity. Without this data, astronauts are at risk of with infections that are difficult to treat by other means and may prevent them from recovering properly.

11. Anne Arundel County, Maryland

How does Microgravity Impact the Germination of Thyme

Grade 7, Central Middle School
Co-Principal Investigators: Abigail Ippolito, Ella Lovelace
Co-Investigators: Mary-Cate Parks, Natalie Wolf
Teacher Facilitator: Margaret Sieber

Proposal Summary:
How does microgravity impact the germination of thyme? Microgravity can change the growth of roots due to the lack of gravity pulling the roots down towards the Earth. Growing thyme in microgravity is important to test because of the number of uses thyme has, including alleviating an upset stomach, and killing fungi and bacteria naturally. A thyme plant generally takes 6-12

days to germinate. For the project, it might take a little longer since the conditions in the mini-lab are not optimal. In this project, the ISS crew initiates germination on station to determine how microgravity affects the germination of thyme seeds, and how it changes the ideal plant structure.

12. Westford, Massachusetts

How does *Brassica napus* (rapeseed) Germinate in Microgravity?
Grade 6, Stony Brook School
Co-Principal Investigators: Erin Cassidy, Makayla Cassie, Anvita Damera, Grace Hinkle, Hradini Shinde
Teacher Facilitators: Jennifer Masterson, Sandra Femino

Proposal Summary:
How will *Brassica napus* (Common name: rapeseed) will germinate in microgravity? The rapeseed plant can be used for many different edible and non-edible purposes. Rapeseed oil can be used for biodegradable soft plastics, biodiesel, soap, lamp fuel and hydraulic fluids. The rapeseed plant's biodegradable projects and biodiesel can help astronauts in microgravity because it will make less air and water pollution in a possible colonization in space.

13. Harper Woods, Michigan

The Effect of Microgravity on Tomato Seed Germination
Grades 9-10, Chandler Park Academy High School
Co-Principal Investigators: Aaron Jackson, Martinez Jordon, Kendal Snow, Katyra Waller
Teacher Facilitator: Christopher Trepanowski

Proposal Summary:
The purpose of this investigation is to find out if microgravity affects the germination of tomato seeds. The study will consist of cherry tomato seeds and water to promote germination. The microgravity and ground control seeds will be inspected to see the ones that germinated and the ones that didn't germinate. The main goal is to determine if a plant will germinate more or less when on the space station in a microgravity environment. This experiment will help astronauts if they want to try to grow their own fruits and vegetables while in space.

14. Galloway, New Jersey – Stockton University

The Effects of Nitrogen Fixation in Microgravity
Grade Undergraduate, Stockton University
Principal Investigator: Sophia Bradach
Teacher Facilitator: Peter Straub

Proposal Summary:
Humans have long dreamed of long-term space travel; it has been present in our media since the 1800's. For this human dream to come into fruition the perfection of self-sustainable agriculture in altered gravity conditions must be attained. This experiment will investigate an essential part of sustainable agriculture under the pressures of microgravity, nitrogen fixation. In microgravity and on the ground, legumes are germinated in a confined environment allowing the fixation of nitrogen to occur then a fixative is introduced to freeze the experiment for analysis. Thereafter, nitrogen related compounds will be tested and quantified in both the plant tissue and synthetic soil used (vermiculite). The results of this experiment will be able to investigate the effects microgravity has on this important natural process under the strains of microgravity. This delicate symbiosis could effectively open the door to space colonization and long-term flights.

The practical applications of this experiment open the door to foreign soil development and sustainable subsistence agriculture in space.

15. Springfield, New Jersey

Pond Microorganism Growth in Microgravity
Grade 7, Florence M. Gaudineer Middle School
Co-Principal Investigators: Jacob Cunningham, Samuel Levy, Simon Perez, Michael Urbach
Teacher Facilitator: Alison Gillen

Proposal Summary:
What is microgravity's affect on biodiversity of pond microrganisms? Microorganisms were studied on Earth in a mock pond inside a test tube that was relatively the same diameter as the FME tube, using the right conditions for the organisms to thrive. Within several days, small bacteria started to develop. Then, protozoa began feeding on the bacteria. After about one-week, photosynthetic algae started to appear. As a result of this research, it is known that the organisms thrive on Earth, but it is unclear if they can thrive in microgravity conditions. Will the lack of waves and water currents cause the microorganisms to have excess energy to carry out their life activities, which may include reproducing? Will the progression of feeding levels be maintained in microgravity? Will the succession of microorganisms remain the same in microgravity as on Earth? After giving a rehydrated pond mixture 12 days to develop in microgravity a fixative will freeze all growth preserving the organisms for analysis upon return to Earth.

16. Shoreham, New York

Can Mung Beans Germinate in Microgravity?
Grade 5, Wading River School
Principal Investigator: Louis Cerniglia
Collaborators: Jeffrey Ramirez, Christopher Votruba, Alex Zimmerman
Teacher Facilitator: Tara Constant

Proposal Summary:
Will a Mung Bean plant take longer to germinate in microgravity than here on Earth? Mung Beans are very easy to grow and are a healthy food to eat. Mung beans have many benefits for health, including nutrients and high antioxidant levels, which may reduce chronic diseases, and aid in digestive health. Eating Mung beans may also help to maintain hydration, which is very important for astronaut health and wellbeing on the space station. Mung beans also germinate quickly, in just 4-6 days. The quick growth rate, together with the many health benefits, suggest that Mung beans would make a good food source for astronauts. The hypothesis is that Mung Beans will germinate faster on Earth than in microgravity.

17. Bethany, Oklahoma

The Effects of Microgravity on Culicidae Eggs
Grades 10-11, Bethany High School
Co-Principal Investigators: Ben Brody, Jenna Cobb, Dalyn Gomez, Jackson Heffron, Hudson Howard, Lazarus Larson, Rachel Privette, Andrew Ratterman, Alejandro Reyes, Reese Rhodes, Margarita Rojas-Lopez, Zane Wright
Teacher Facilitator: Amie Sellers

Proposal Summary:
The experiment is aimed at giving data, insight, and knowledge on the effects of microgravity on observable and physical abnormalities in mosquitos. The team will be looking exclusively at observable differences and similarities. The team may be able to observe developmental markers, glean how mosquitoes grow in length, and deduce differences between mosquitoes born on Earth and ones exposed to microgravity.

18. Enid, Oklahoma

Pinto Bean Germination Experiment
Grade 6, Longfellow Middle School
Co-Principal Investigators: Georado Pacheco Arriaga, Trace Beddoes, Cheyanne Stufflebeam
Co-Investigators: Michelle Hernandez, Pablo Mora, Kalie Moreno, Tuan Taevin Nguyen, Melany Ramirez
Collaborators: Daniel Benor, Logan Bruner, Dareon Cole, Tyler Daniell, Miguel Ochoa Diaz De La Vega, Anijah Grim, Myah Helms, Emilio Isaias, Saint Langinmej, Phoenix Lawson, Eduardo Mendoza, Sheila Mosqueda, Chance Nafus, Jude Newman, Alex Nieto Vargas, Bweua Peter, Marlene Ramirez, Ally Richey, Kourtney Wright
Teacher Facilitator: Jessica Patnode

Proposal Summary:
What effect does microgravity have on the germination of pinto bean seeds? Pinto bean seeds have all the required energy to germinate, when water is introduced. An experiment conducted on the ground and in microgravity will provide information about any differences in directional growth of sprouts, as well as the rate of germination. The results of the investigation can be used to determine if seeds can be grown in space and potentially used as a food source.

19. Pittsburgh, Pennsylvania – University of Pittsburgh

Effects of Microgravity on the Oxidation of 3-D Printed Aluminum with Unique Topography
Grade 15, University of Pittsburgh, Swanson School of Engineering
Co-Principal Investigators: Marissa DeFallo, Nikolas Vostal
Teacher Facilitator: Dr. Sachin Velankar

Proposal Summary:
Aluminum alloys are used throughout the aerospace field, including aboard the International Space Station, due to its light weight and high strength properties. Aluminum corrodes when it is oxidized and forms a white powder-like substance on the surface of the material. In the presence of chlorides, such as salt, corrosion can tunnel through the aluminum and form pits which have a lower modulus and leave parts weakened. These corroded areas can lead to structural failures if they are not studied and prevented. One solution to prevent failure is by engineering surface textures to intentionally corrode sacrificial sections of a part. With recent advances in metallic 3-D printing it is easier than ever to create intricate aluminum parts with extreme precision. The importance of conducting this experiment in microgravity is because the force of gravity on earth trumps the surface tension of water at size scales exceeding a few millimeters. This will allow parts with large surface gradients to hold the salt water solution away from the main body, showing the effectiveness of different surfaces. This experiment will give insight into how aluminum corrodes in microgravity and provide useful data for creating corrosion-resistant aerospace parts in the future.

The Effect of Silver Nanoparticles on the Immune Response of *Daphnia Magna* in Microgravity
Undergraduate and Graduate, University of Pittsburgh, School of Pharmacy and Swanson School of Engineering
Co-Principal Investigators: Samantha Bailey, Jordan Butko, Amanda Carbone, Prerna Dodeja
Teacher Facilitator: Sravan Kumar Patel

Proposal Summary:
Since the beginning of the space program in the 1960's, the effect of space on earthly phenomena has intrigued scientists. Particularly, the effect of microgravity on the immune system is of prime importance in terms of astronaut health. The highly controlled environment aboard the International Space Station would necessitate the use of antibacterial products, many of which often contain silver nanoparticles. Exposure of these nanoparticles has been associated with significant toxicity in the liver as well as brain. Prior experiments investigating the model organism *Daphnia magna* in space indicates its ability to adapt to living in microgravity. Moreover, the organism can produce a quantifiable immune response. Building upon these principles, this proposal aims to investigate the specific effects of silver nanoparticles on the immune response of *Daphnia magna*.

20. Sumter, South Carolina

The Effects of Microgravity on *Artemia Franciscana*'s Growth Rate
Grade 6, Alice Drive Middle School
Co-Principal Investigators: Anna Alan, Addie Griffin
Co-Investigators: Katelyn Makowske, Mary Carter Smith
Teacher Facilitator: Dr. Marina Mosneaguta

Proposal Summary:
This experiment proposes that microgravity will affect *Artemia franciscana's* growth rate. This investigation will explore the growth rate and the differences of *Artemia franciscana* when it is grown in microgravity in comparison with a sample grown in regular gravity. *Artemia* cysts are grown in microgravity and the growth and characteristics are compared with those of a ground experiment to see if microgravity had any effect on the *Artemia*. This experiment can be used to form further studies about the effects of microgravity on human muscles or the growth of organisms in microgravity and how it affects living organisms.

21. Knox County, Tennessee

Effects of Microgravity on the Efficiency of Lactic Acid Fermentation in the Production of Kimchi
Grades 11-12, Farragut High School
Co-Principal Investigators: Rachel Constantin, Blake Cragen, Taylor Sussmane
Teacher Facilitator: Neely R. Tonos

Proposal Summary:
Fermented foods have impacted Asian food culture since ancient times. Fermentation serves as a preservation method for perishable foods and a source of probiotics that are vital to a healthy digestive system. As plans for long-term interstellar travel and extraterrestrial settlements become more prevalent and achievable, it is imperative that the scientific community conduct research on microgravity's effect on essential biological processes that contribute to the health of participants of these plans, like lactic acid fermentation, the process used to make kimchi (fermented cabbage). Lactic acid is produced when bacteria (notably *L. mesenteroides*) resorts

to anaerobic respiration as the principle method of survival; this usually means submerging the cabbage in water to deprive the cells of oxygen. To determine microgravity's effects on the fermentation process, a sample of cabbage will be sent to the International Space Station where it will be submerged in water and left to ferment. Upon its return to Earth, a simple titration (acid-base neutralization method) will be conducted to provide an estimate of the amount of lactic acid that was produced. After being compared with data obtained from a "ground-truth" experiment, the nature of fermentation in different gravity environments can be reasonably concluded.

22. Burleson, Texas

The Effects of Microgravity on Lentil Growth

Grade 7, STEAM Middle School
Co-Principal Investigators: Macie Davis, Olivia Earley, Alex Mercer, Ava Monroe, Itzel Perez-Orozco
Teacher Facilitators: Alyssa Sanchez, Mrs. Lentz, Stacy Hughes

Proposal Summary:
What is the effect of microgravity on the growth of lentils? Lentils were chosen to determine if they are a solution to help bone density issues and bone degeneration while onboard the ISS. When astronauts enter space bones degenerate, which means they slowly go away and lose muscle tone. Lentils can help bones and muscles develop and strengthen because they contain calcium, magnesium, potassium, and protein. This investigation hopes to determine – Will lentils germinate the same in microgravity as they do in gravity? Are microgravity conditions an adequate environment for farming and developing crops? Are lentils an appropriate crop to cultivate while onboard the ISS?

23. Lumberton, Texas

Mixing of PVA Fibers with Concrete in Microgravity

Grade 11, Lumberton High School
Principal Investigator: Austin Howard
Investigator: Lucas Mason
Teacher Facilitator: Susan Letourneau

Proposal Summary:
The experiment consists of *Quikrete* fast-setting concrete, RMS702 PVA fibers and water. PVA fibers are extremely light, have a high tensile strength and are used to reinforce concrete. The viability of concrete as a structural material in microgravity depends upon both the ability to transport as many materials as possible through the conservation of space by using lighter materials and also upon the ability of said materials to resist breakage. PVA fibers, as opposed to other materials to reinforce the concrete, are being used because they contain the appropriate ratio between weight and tensile strength, are commonly used to reinforce concrete and bond with the concrete at the molecular level. The investigation is expected to determine to what extent PVA-reinforced concrete is able to be used in microgravity.

24. Bellevue, Washington

Effects of Microgravity on *Penicillium Chrysogenum's* Ability to Inhibit Cell Wall Synthesis in *Staphylococcus Epidermidis*

Grade 8, Open Window School
Co-Principal Investigators: Armaan Thomas, Atiwit Miles Chanbai, Cadence Ching
Teacher Facilitator: Elliot Skopin

Proposal Summary:
What are the effects of microgravity on *Penicillium chrysogenum*'s ability to inhibit cell wall synthesis in *Staphylococcus epidermidis*? The question asks how the microgravity environment on the ISS will change *P. chrysogenum*'s ability to prevent cell wall synthesis in *S. epidermidis*. Studies have shown that bacteria virulence will decrease in microgravity, so studying *P. chrysogenum*'s growth in space will accompany that knowledge to create a better understanding of antibiotic effectivity in microgravity. Insight regarding how *P. chrysogenum* develops in space as well as how its ability to interfere with bacterial cell wall bonding is impacted by microgravity could help future space explorers create simpler and more sustainable ways to develop antibiotics in space when needed. Additionally, the proposed experiment can provide more information and general knowledge for other types of antibiotic molds.

25. Hayward, Wisconsin

Fish Egg Development in Microgravity

Grade 7, Lac Courte Oreilles Ojibwe Middle School
Co-Principal Investigators: Evan Heath, Kane LaRonge, Thomas White
Teacher Facilitator: Tammy Moncel

Proposal Summary:
The investigation compares the hatching and development of fish in microgravity to their hatching and development in gravity. If fish can develop in space, it would expand the food supply available for space travel. Astronauts could eat fish, helping them to maintain health and prevent muscle loss. Fish have many valuable nutrients including protein. Fish could be a food source, or could be used in aquaponics. In addition to determining if fish eggs will hatch and develop in microgravity, the ground investigation will be used to assist the trout egg vendor in researching longer-term packaging techniques for shipment.

26. iForward-Grantsburg, Wisconsin

Do Killifish Eggs Develop and Hatch in Microgravity?

Grades 6-8, iForward Public Online Charter School
Principal Investigator: Kirsten Nichols
Co-Investigators: Rachelle Nichols, Josiah Kreuser Peterson, Brandon Orth, Isaac Stanaway
Teacher Facilitator: Andrea Konrath

Proposal Summary:
The investigation studies the development and hatch rate and development of killifish eggs – specifically *Fundulopanchax sjoestedti* – in microgravity, providing information on a potential source of protein for future space study. The experimenters hypothesize that the development and hatch rate of the killifish eggs will be different in microgravity than here on Earth, with 80% or 8 out of 10 eggs hatching and beginning development in microgravity and the control lab eggs showing greater success. The rate of hatching of these eggs is interesting because they are extremely hardy and have the potential to survive long flights in space, thus serving as a possible protein source.

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