



FUTURE U.

From Sleep to Shining Pee

Overview

Keep the crew safe and healthy as a human systems engineer!

How do astronauts sleep without floating away? How do they exercise? Where does their pee go?!

It is the job of a Human systems engineer to make sure the astronauts can eat, sleep, exercise, and even pee safely in space. As a family, try out this important work.

In this activity you will learn about the job of a human systems engineer before trying your hand at purifying water (no pee needed) and making your own astronaut ice cream!

Background

Space is a tricky place to live: weightlessness, lack of oxygen, extreme temperatures, and tight living quarters. It takes a team of people to help prepare astronauts for a trip to space! *Human systems engineers* support the health and safety of the crew and strive to give them what they need so their spacecraft can feel like home. They ensure that all of the systems the astronauts need are operating perfectly. For instance, astronauts have a daily routine just like you. They need to shower, brush their teeth, and comb their hair. In tight quarters like on the CST-100 Starliner, astronauts don't have much room, so it is an important skill for *human systems engineers* to think creatively and be extremely well organized. They spend time with the astronauts and help to set up and organize all their needs before the trip begins and to ensure some of their favorite foods are included on their journey.

Another system to think about is the astronaut's body. Every organ in the body is affected by the weightlessness of space. Staying healthy in space needs to be more intentional than on land. Without the resistance gravity puts on our bodies on Earth, bones begin to deteriorate and muscles atrophy in space. *Human systems engineers* fit exercise bikes, treadmills, and weightlifting machines in spacecrafts so astronauts can exercise daily while in orbit.

The foods the astronauts eat need to be higher in protein to keep their muscle mass up. They also need extra calcium for their bone health. A *human systems engineer* works with a dietician to make sure the food is nutritious, and they also need to think about how to keep the food fresh, keep food bags from flying away (Velcro!), and how to create the least amount of waste and trash. Finally, once the food is eaten, what's the best way for an astronaut to, well, evacuate?

That's right; everyone poops. *Human systems engineers* have created toilets with a little suction so that astronaut poop doesn't float around and make a mess. Another system takes the astronaut pee and purifies it into drinking water for them!

Human systems engineers have to think of all the tiny and mighty details to keep the astronauts in tiptop shape!

Spacey Spotlight

Dr. Kavya Manyapu moved to the United States from India when she was sixteen years old. She is the first ever PhD graduate in space studies from the University of North Dakota. During her work there she developed a new technology for space suits! Her patented space suit smart fabric repels lunar dust (a big problem on other space missions) when an electric current is applied. Dr. Manyapu spent her ten years on the Boeing team working on the CST-100 Starliner, a spacecraft that takes astronauts to the International Space Station. Now as a NASA space scientist, she thinks about safety and training needs of astronauts performing extra-vehicular activities, also known as spacewalks!



Dr. Camille Alleyne, born in Trinidad and Tobago, is a mechanical engineer with a Doctorate in Education. She worked for the Department of the Navy and the Missile Defense Agency as an aerospace engineer before she began her work at NASA. Dr. Alleyne worked on the Mars Mission and contributed work to the design, development, and testing of the space shuttle Orion. She then founded Brightest Stars Foundation, “dedicated to educating, empowering and inspiring young women around the world to be future leaders, through the study of science, math and technology.” Dr. Alleyne is currently the Deputy Manager for Commercial LEO Development Program at NASA Johnson Space Center.



Are you ready to work like a human systems engineer? Grab a grown up and let's get started!

Materials

For Astronaut Ice Cream

- 4 large egg whites, at room temperature
- ¼ teaspoon cream of tartar
- 1 cup sugar
- 1 tablespoon vanilla extract or 1 teaspoon peppermint
- Gel food coloring (optional)

For Water Filtering Activity

- 1 Large plastic soda bottle
- 2 Cotton balls
- 1 Cup of sand
- 1 Cup of rock/gravel
- 1 Cup of activated charcoal (at pet stores or online)
- 1 Pair of scissors
- 1 Plastic cup
- 1 Liter of muddy water (make your own by mixing dirt or mud into water)

Activities

Imagine you are a human systems engineer and a crew is preparing the CST-100 Starliner for takeoff to the International Space Station. They are requesting ice cream for their flight and you have to make it! A freeze dryer is an expensive machine that freezes astronaut food at very low temperatures and then uses a powerful vacuum to remove all of the moisture. Chances are you do not have a freezer dryer in your home, but you can still recreate the taste and texture of freeze-dried ice cream by baking meringue scoops in your oven!

1. Position the racks in the upper and lower thirds of the oven and preheat the oven to 200°F.
2. Line a large baking sheet with parchment paper.
3. Using an electric mixer, beat the egg whites in a large bowl at medium-low speed until just frothy, about 45 seconds.
4. Add the cream of tartar. Increase the speed to medium-high and beat the egg whites until they are white and thick (the consistency of shaving cream), about 2 minutes.
5. Slowly sprinkle in the sugar and flavoring extract, beating until mixed in. Then beat the whites until they form stiff peaks. (Turn the beater upside down: if the peaks do not droop, they are ready.)
6. Drop individual meringues onto the parchment-lined baking sheet using a cookie scoop or spoon. To keep meringue from sticking, dip the scoop in room temperature water and shake off excess. Scoop a healthy heaping of meringue mixture (roughly 1 tablespoon over the top), and invert it onto the baking sheet. The meringue should balloon out over the side, resembling an old-fashioned scoop of ice cream. Smooth any peaks using a spoon dipped in water.
7. Bake for 2 hours, let cool, and serve.

Your job is not completed! While the astronaut food is cooking, you need to test the filtration system in the Starliner's bathroom to make sure it can filter the astronaut urine into clean, drinking water. (**This is just a visual example. The water will not be filtered enough to safely drink, but you could water your houseplants with it!**)

1. Keeping the cap on, cut off the bottom of the plastic bottle with scissors.
2. Stuff the cotton balls into the neck of the bottle.
3. Crush the activated charcoal and pour it into the bottle.
4. Add the sand to the bottle.
5. Add the gravel.
6. Loosen the cap and set your water filtration system on top of the plastic cup
7. Slowly pour muddy water into the top.
8. Observe what happens as the muddy water is filtered.

Extension

- Listen as Jennifer Hammond talks more about being a human systems engineer from 19:20-23:42:
<https://www.boeingfutureu.com/virtual-field-trips/space>
- Tour the ISS modules Harmony, Tranquility, Unity with a NASA astronaut and see how she sleeps, eats, and even poops!
https://www.nasa.gov/mission_pages/station/main/suni_iss_tour.html
- Listen to Kavya Manyapu talk about her work on the Starliner training and preparing astronauts at 14:55-19:05:
<https://www.boeingfutureu.com/virtual-field-trips/space>
- Want more information on the daily routine of an astronaut? Read and watch more here:
https://www.nasa.gov/audience/foreducators/stem-on-station/ditl_morning_routine

Check out these library books!

- Caprara, Giovanni. (2000). Living in Space. Buffalo, New York: Firefly Books, Inc.
- Pogue, William R. (1991). How Do You Go To The Bathroom in Space? New York, NY: Tom Doherty Associates, Inc.
- Schorer, Lonnie Jones. (2006). Kids to Space: A Space Traveler's Guide. Burlington, Ontario, Canada: Apogee Kids' Book.
- Woodmansee, Laura S. (2002). Women Astronauts. Ontario, Canada: Apogee Books.

References

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- <https://astronautfoods.com/blogs/news/how-do-we-make-astronaut-foods>
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- <https://www.brighteststarsfoundation.org/>
- <https://www.camillewalleyne.com/biography>
- https://en.m.wikipedia.org/wiki/Kavya_Manyapu
- <https://www.generationgenius.com/activities/water-quality-and-distribution-activity-for-kids/>
- <https://jenis.com/blog/recipe-astronaut-ice-cream/>
- https://www.nasa.gov/centers/hq/library/find/bibliographies/childrens_space_resources/