

UNIVERSAL WELLNESS

How Astronauts Stay Healthy in Space

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Contents

Introduction	2
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Living Like an Astronaut: Present-Day Life in Space	6
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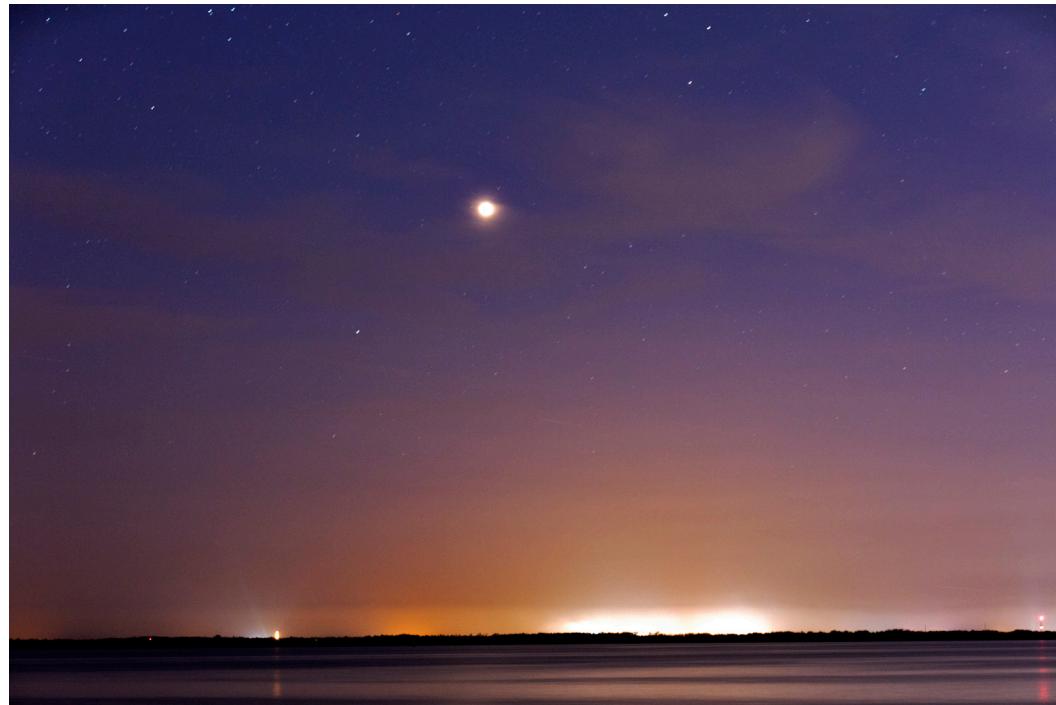
Daily Exercise.....	7
Household Chores.....	8
Sleeping in Zero Gravity.....	9
Personal Hygiene	10
Nutrition	11
Galactic Gardening	13
Water.....	14
Sights Set on Mars.....	15

Before We Leave for Mars: Preparing for Long-Term Missions	18
---	-----------

Preparation.....	19
Safety Concerns	20
Far From Home	21
Changes to Body.....	22
Case Study: Kelly & Koch	24
Radiation.....	25
Growing Food	27
The VEGGIE	28
Looking Forward	29
Mars Simulation.....	30

To Mars and Beyond	31
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Sources	34
----------------------	-----------



View of Mars in the night sky during the 2018 close approach.

Introduction

Imagine you are traveling through Glacier National Park. During the nighttime you lie down on a grassy field and observe the night sky. Around you there are countless stars and you think about how amazing and beautiful everything is here on the earth. As you think this, you think about the unlikelihood of traveling to space... and then remember that now, with modern technology, space travel is becoming increasingly possible. NASA prepares for travel in space by adapting their spacecraft and astronauts, both here on Earth, and in orbit around Earth, doing research and gathering information - all for the purpose of eventually being able to send astronauts by rocket to establish our future homes on the Red planet. This goal of NASA's is a given.

Maybe one day you want to become an engineer, a mathematician, a rocket scientist, or an astronaut and take advantage of the endless possibilities offered at

NASA, which stands for National Aeronautics and Space Administration. By joining NASA, you may have the opportunity to experience visiting outer space or even living there. So have you ever considered how NASA prepares for space travel, or perhaps wondered how NASA is trying to make life on Mars possible? This paper will answer those questions.

The NASA institution is curious about outer space; as Kelli Mars from the Lyndon B. Johnson Space Center stated, "The more we know about the universe, the more we learn about ourselves. Every NASA mission embodies the spirit of discovery" ("Living and Working in Space"). That makes them feel determined to learn more about outer space than we could have ever imagined about what is possible in our future.

Suppose a space crew leaves Earth to explore space for long periods of time. Environmental differences and

gravity cause changes in the way their bodies function because it is well known that space has zero gravity, so there is less resistance. Exercise is critical in keeping astronauts' bodies functional. In addition, astronauts have to perform daily tasks in space such as household cleaning, personal hygiene, and sleep. To maintain good mental health, they

are allowed to communicate with family, friends, and co-workers through use of the Softphone via a laptop computer. I believe having that routine in their lives keeps them busy and also strengthens their physical and mental health in order to stay strong as they continue to fly into deep space towards Mars.

AR INSTRUCTIONS

Augmented reality (AR) is the overlay of the digital over the physical, experienced through the camera of your smartphone. The AR features in this book were created using a platform called Zapworks and can be experienced by scanning a zapcode, like the one to the right. **Download the free Zappar app on Google Play or from the App Store** to start scanning. Simply open the app and scan the code—no account needed!

When a zapcode is directly adjacent to an image, the AR content is contained within, or tracks to, that image. You can pan or swivel your phone vertically, horizontally, or in a circular motion over the image to engage with three dimensional content. Hold your phone closer or further away from the image for a zoom effect.

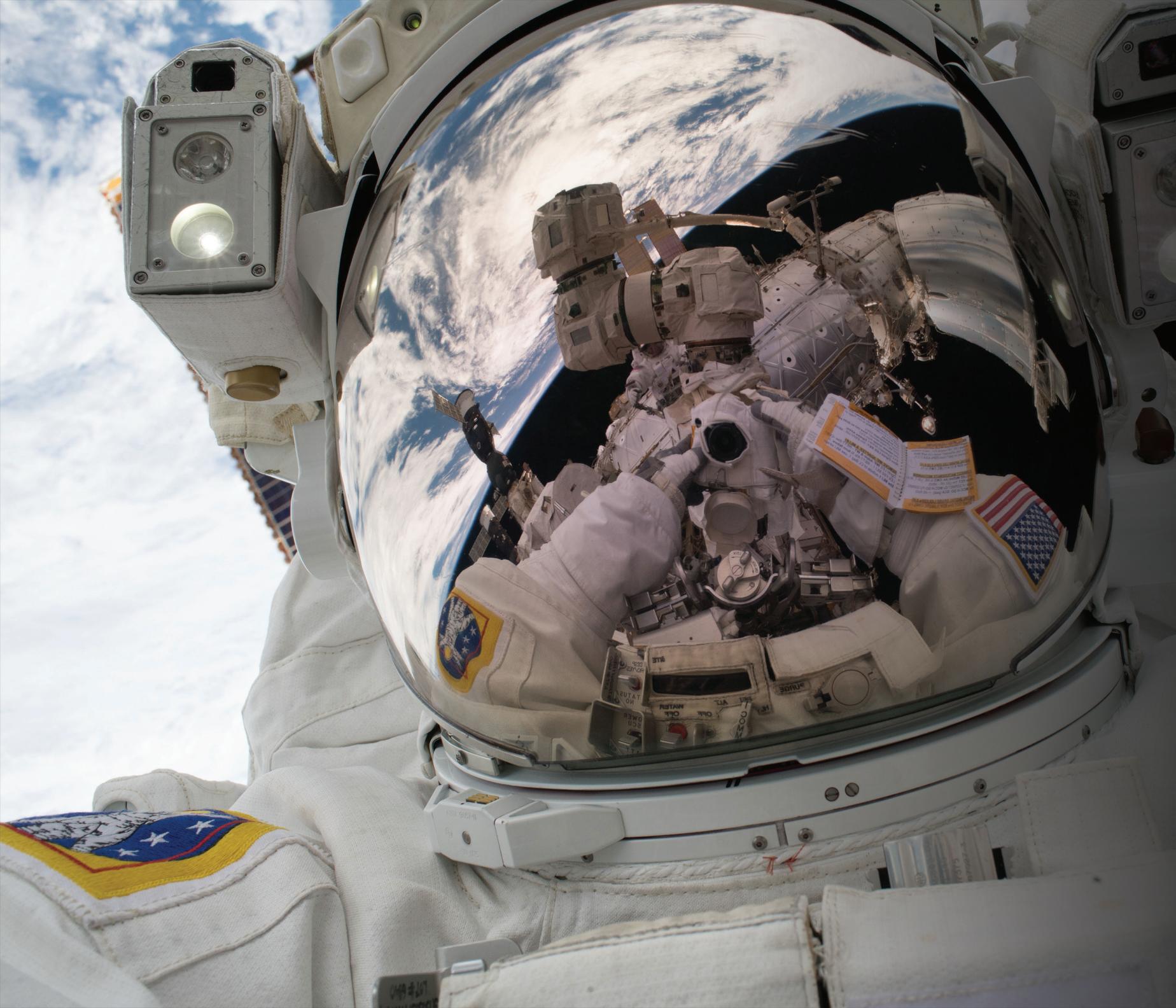
Watch for zapcodes and a short description of each AR experience throughout this book. Happy scanning!

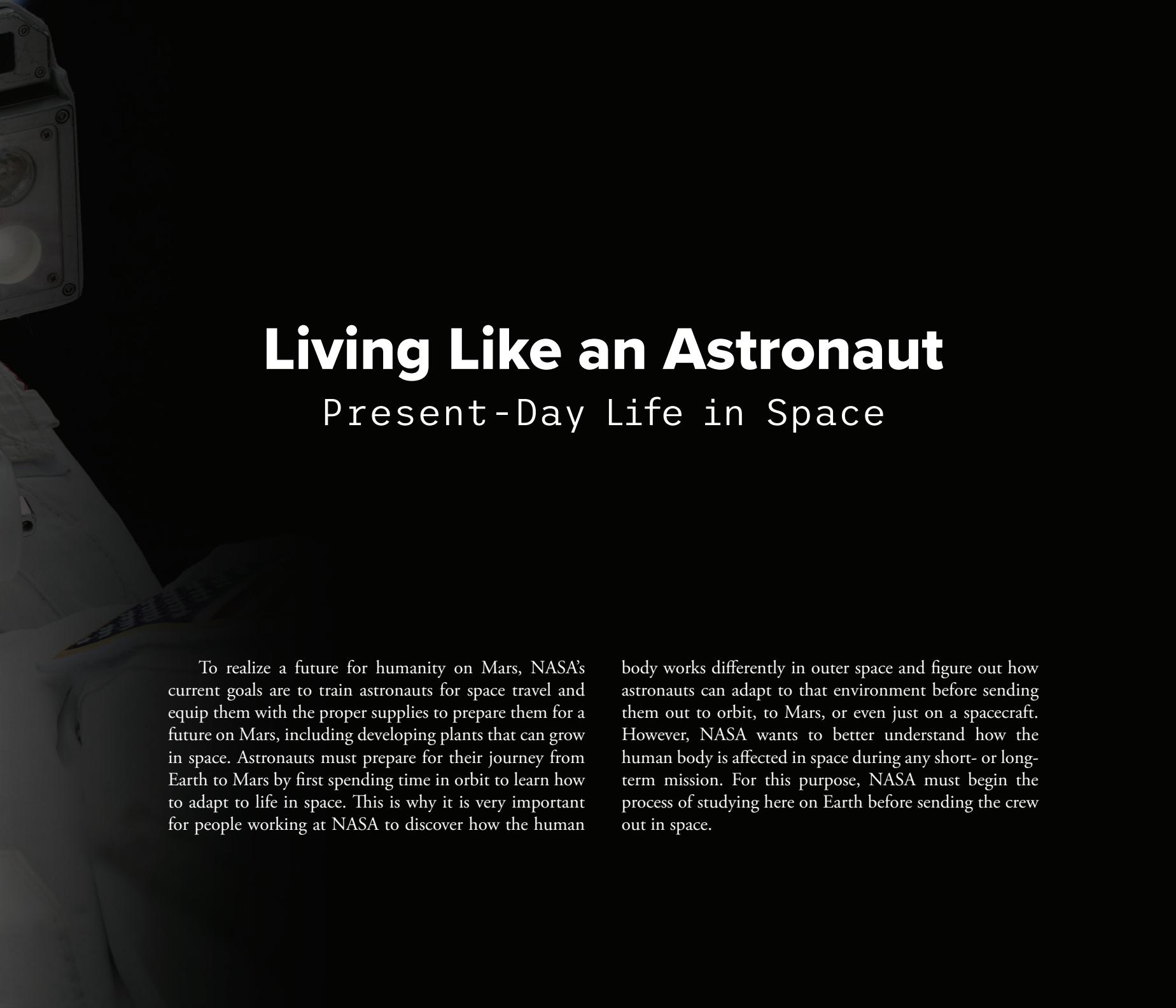
This is a zapcode! 



STAR GAZING:
Experience the night
sky in 3D through the
lens of a telescope.





A black and white photograph of an astronaut floating in the void of space. The astronaut's white spacesuit is visible on the left, featuring a circular hatch and a window. The background is a deep, dark void.

Living Like an Astronaut

Present-Day Life in Space

To realize a future for humanity on Mars, NASA's current goals are to train astronauts for space travel and equip them with the proper supplies to prepare them for a future on Mars, including developing plants that can grow in space. Astronauts must prepare for their journey from Earth to Mars by first spending time in orbit to learn how to adapt to life in space. This is why it is very important for people working at NASA to discover how the human

body works differently in outer space and figure out how astronauts can adapt to that environment before sending them out to orbit, to Mars, or even just on a spacecraft. However, NASA wants to better understand how the human body is affected in space during any short- or long-term mission. For this purpose, NASA must begin the process of studying here on Earth before sending the crew out in space.



DAILY EXERCISE

With this in mind, the way astronauts live in space is not the same as living on Earth. Astronauts' bodies weigh much less in zero gravity compared with the weight of their bodies on Earth. They do not use their legs near as much when they float in space, which causes loss of bone and

muscle mass. In order to prevent this loss, astronauts are required to exercise two hours per day on the treadmill or on a stationary bicycle. Otherwise they would not be able to walk or stand up well when they return home to Earth.



HOUSEHOLD CHORES

Just as they must maintain their health and live in the space station, astronauts are responsible for household cleaning. This is a crucial part of their mission, similar to how on Earth we need to do household chores to maintain cleanliness. The tasks are not complex: they simply wipe the windows, walls, and floors. In order to keep a dust-free environment, they also vacuum, and if dust escapes and floats they catch it with a hose. After wiping and vacuuming, the astronauts use soap with wet wipes to wash their utensils and food trays since the station does not have sinks or dishwashers. Furthermore, they have to take out the garbage. For this purpose, a space shuttle contains four garbage bins: three are for dry trash, and the other one is for wet. When all of the bins are full they are then closed tightly, except for the wet trash bags, which connect to a special hose that helps direct the bad smell away from the astronauts (Canright, "Living in Space"). This is important because doing these tasks well helps them stay healthy and breath better. If not, it can be dangerous for them.



WE ARE GO FOR LAUNCH:
Experience the flight deck
and launch of three of
NASA's shuttles in 3D.



SLEEPING IN ZERO GRAVITY

After the astronauts' work and assignments of the mission day end, they want to have a good night's sleep to prepare for the next day ahead. Just like you plug in your phone or computer to charge, our bodies need to re-fuel through nightly sleep. Astronauts typically have eight hours of scheduled sleep time. Sleeping in space is similar to what we do on Earth; for example, astronauts can have dreams and snore just like we do. The difference is that astronauts can sleep anywhere in the space station as long as they attach themselves and their sleeping bags to a wall or something else inside the crew cabin. This prevents them from floating around and bumping into something (Canright, "Sleeping in Space"; Mars, "Living and Working in Space").

At the same time that the space station is quietly orbiting Earth, astronauts can suffer from sleep deprivation. This can be due to noise from other stations

or crew members, or it may be because the astronauts experience 16 sunrises per day while in orbit. To simply find a way to block out noise and light, each of them uses a sleep mask and ear plugs. Conversely, author Kristine Rainey suggests seven ways for NASA to address sleep deprivation in their astronauts including scheduling sleep and wake times, providing sleep education and training, setting up an environment conducive to sleep, controlling light, providing access to non-prescription sleep and alertness substances, providing sleep cognitive behavioral therapy, and introducing pharmacologic interventions ("Seven Ways Astronauts Improve Sleep May Help You Snooze Better on Earth"). This plan is meant to provide astronauts, as well as people on Earth, with improved sleeping methods. By lessening their disrupted sleeping patterns, NASA can keep the astronauts healthy while on their mission in space.

PERSONAL HYGIENE

After waking up in the morning the first thing you want to do is take care of your body. You go to shower and brush your teeth regularly like you would daily with personal hygiene. Astronauts do the same thing but in different ways. They don't have running water in the space station so many of the crewmembers' options when brushing their teeth is to either swallow by taking a drink of water, or spitting into a washcloth when they are done brushing. Some use floss but most of them don't. For those taking a bath, they use the same type of soap patients in the hospital use when they can't get in the shower (sponge bath). They must be careful not to make bubbles when they wash themselves or the particles will flow off into the air. After their washing is done, they will use a towel to dry themselves.

This "Hygiene in Orbit" report presented facts I had never thought were an issue in space. It talks about the author Andrea Kowalczyk who was a dental hygienist who worked with Dr. Hatcher, a dentist for NASA's astronaut corps. Kowalczyk was intrigued about astronauts' oral care routine while in space for over 6 months or longer on their missions. During her interview she asked him questions like whether astronauts can choose their own dentists. Astronauts can choose their own dentists, however there are only two dentists in the Clear Lake area in Houston so all astronauts must go to check in with one of the two annually to maintain their flight status. I believe that oral care is very critical, and can affect the astronaut's health

if they do not take care of their teeth. Personal hygiene practice is essential for their health as well.





NUTRITION

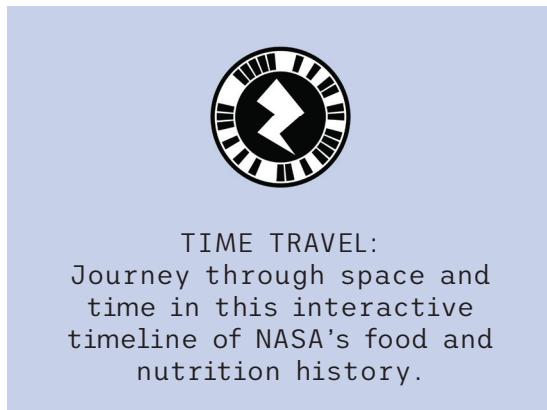
Another thing that's important for good oral hygiene, is that astronauts eat well. If they don't have the right nutrition it can affect their bodies. Astronauts need to eat balanced meals daily containing fruits, vegetables, proteins, and grains to sustain themselves in space. I find it interesting that long ago, during NASA's early Apollo and Gemini missions to the moon, there was no refrigerator or oven in the space shuttle, and the astronauts certainly couldn't go to the grocery store to buy food. Astronauts needed to figure out how to preserve and ration food and bring it with them on their journey in space. In the article "Food in Space," a Smithsonian writer talks about how John Glenn was the first American astronaut to eat food in space in 1962 when he boarded the Friendship 7. Glenn and other crew members prepared meals by

rehydrating food that had been in a vacuum package, packed in a tube, or freeze-dried. They would rehydrate meals by injecting water from the Gemini program, which provided cold water. The other Apollo program had both hot and cold water. They then would open the package with scissors for consumption. Several examples of old Apollo space food included pineapple fruitcake, peaches, beef with vegetables, chocolate pudding, brownies, and beef hash. Although the food did not require refrigeration, the food was not pleasant to taste due to a lack of variety. However, many years after the Apollo missions ended, the food quality improved on later missions. There are various ways in which NASA preserves food for astronauts to use. Until the present the history of space food had changed over time, after the space station was constructed 62 years

ago. A new Skylab mission came equipped with a full galley, including a refrigerator and additional storage for astronauts to cook their own chosen meals.

In recent years NASA's Space Shuttle has changed to the International Space Station (ISS), a large spacecraft orbiting close to Earth. For astronauts to obtain food from NASA, NASA will regularly ship food packages to the space station to cover astronauts' nutrient needs, otherwise it causes problems with their health if unable to receive adequate nutrition. NASA needs to come up with new ideas to solve this problem. Possibly by growing plants out in space instead of shipping freeze-dried foods to astronauts or to the space station

The International Space Station food system has some of the same types of food they used during the Space Shuttle including thermostabilized, rehydratable, natural form, and irradiated, with packaging methods and materials. However, the ISS crew members maintaining their health is important to influence their bodies function in space right now. The food system they have is half from the U.S. and half from Russia, but are planning to partner with other countries including Japan and Canada later. NASA ensures astronauts get enough balance of essential nutrients, like calories, vitamins, and minerals, the same as for people living on Earth. Sometimes they should take less amounts of sodium and iron because if they take too much into their bodies it can cause other health problems. Especially vitamin D. It is healthy for the bones for people living on Earth, but for space travelers on the ISS, taking Vitamin D supplements are recommended to make sure they are provided with enough nutrients as they eat. Different food systems help prevent health problems in the future for long-duration (Mars, "Space Food").



GALACTIC GARDENING

NASA has other teams who are doing research with plants to see if they can grow in space. The Space Station Processing Facility at Kennedy Space Center in Florida is a place where researchers experiment with differences between the Vegetable Production System called Veggie for short and Advanced Plant Habitat (APH). Veggie for instance, is a method where we feed a plant to grow in a garden. Teams of researchers have successfully planted several varieties of plants including three types of lettuce, Chinese cabbage, Mizuna Mustard, Red Russian Kale, and one flower called Zinnia. As a result they want to produce more vegetables and fruits in the future. APH is similar to Veggie but it is self-sufficient, without needing much care during the day from the crews. Although they found some pathogens like fungus, started to grow on the plants that killed other plants, scientists try to use the BRIC-LED experiment to see how the plants react with different defense systems.

This is the purpose of Veggie and APH plants method research to help NASA better understand how to grow and develop plants in space. According to author Anna Heiney by Kennedy Exploration Research and Technology reveals, “NASA is looking at ways to provide astronauts with nutrients in a long-lasting, easily absorbed form-freshly grown fresh fruits and vegetables. The challenge is how to do that in a closed environment without sunlight or Earth’s gravity” (“Growing Plants in Space”). Therefore the research teams also provide NASA with information on how to keep plants healthy and nurture them well in space. The ISS also decided to build gardens in chambers all over the space station because of the nutrients benefits

to astronauts’ health, when they have more variety of growing plants to eat and help them endure long-duration missions.





WATER

In order to develop a variety of nutritious food that can grow in space, it is important to remember that humans cannot live without water. Water is necessary for almost everything: we need to drink it to help our bodies function better, we use it to feed the plants we grow, and so much more. So that is the reason NASA desires to learn more about the fourth planet in our solar system: Mars, also referred to as the Red Planet. NASA hopes that they

can find evidence on Mars that humans can live there like they do on Earth. So first they sent the following four unmanned rovers there: Sojourner, Spirit, Opportunity, and Curiosity. When the evidence from the rovers was acquired via long-distance signals to NASA scientists, they were awestruck that some of it showed that Mars has similarities to Earth.

SIGHTS SET ON MARS

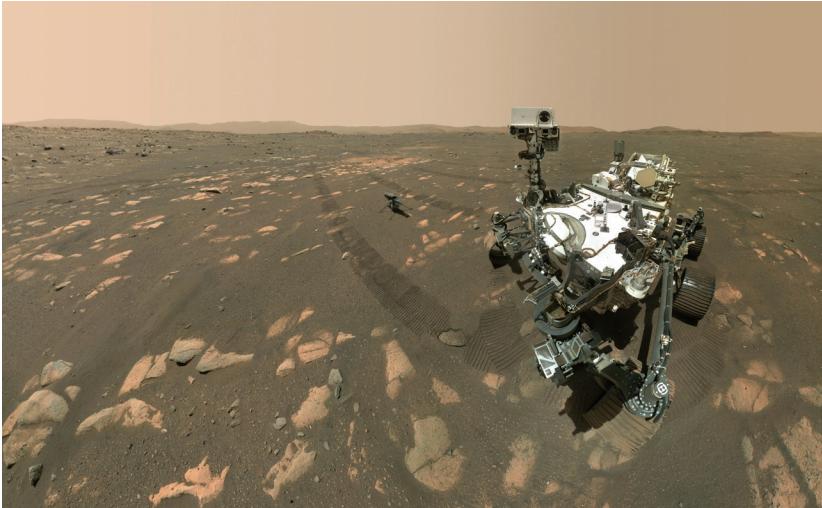
Four months after the Curiosity rover landed on Mars, NASA announced that they were building a new Mars 2020 rover named Perseverance, designed in the same California lab as the previous ones. Perseverance looks similar to Curiosity, but includes technological improvements and costs an additional million dollars. NASA also added a small helicopter drone named Ingenuity. Both Perseverance and Ingenuity landed at Jezero Crater, Mars, on February 18, 2021 (Bell, pp. 25-26, 28). Perseverance's main mission goal is to seek for signs of ancient life. Author Jim Bell clarifies what this means:

"Ancient means not focusing on any potential living organisms on the surface of Mars today (which are highly unlikely to exist, given the harsh radiation, low surface pressure, and frigid temperature). Instead, Perseverance will seek evidence of organisms that may have lived billions of years ago, during a time early in Mars' history when the surface environment was a lot more like Earth's" (26).

Along with searching for signs of life on Mars, Perseverance performs tasks like collecting samples of rock and soil in tubes and sending them back to Earth for scientists to analyze and study in greater detail. This way they can determine whether Mars may have water in their lakes or if the soil would support plants on Mars's surface.

These are steps that must happen before the first humans are sent to Mars in 2030, which is NASA's goal.

Now you may wonder how we will get to Mars. That question leads to our next top question. First we need to build a rocket that will fly into outer space toward Mars. In the same way, NASA already had flown to the moon many years ago after President John F. Kennedy had announced their goal to land a man on the Moon. The Moon landing will be similar to NASA's Mars Exploration Program design with rockets and technology that will be state of the art and look more advanced from old Apollo Command Modules. According to the author Joshua Flader, he explains briefly on how they are planning to use the new spacecraft. The Orion Spacecraft is a low-mass spacecraft module that NASA has already been working on since before it was announced in 2011. There are some improvements such as a glass cockpit, an automatic-docking feature, advanced waste management facilities, a nitrogen/oxygen mixed atmosphere, and advanced computers. They made all of these changes for more safe travel and are designed to carry four astronauts into outer space for up to 21 days ("Moving to Mars"). All of this, as a result shows what NASA is doing in the process of sending humans to Mars in the near future.



THE EAGLE HAS LANDED:
See what it's like on
the surface in this
panoramic view of Mars.



RED ROVER, RED ROVER:
Experience the
Perseverance Rover in
3D.



Before We Leave for Mars

Preparing for Long-Term Missions

Have you ever thought about what it would be like to live in space? Or, even what it would take to get to another planet? What would be required to live in space? How long do you think you would be living in space? There is so much prep work that goes into getting into space and planning around having to live there for months and maybe even years at a time. There are so many practice exercises that the astronauts have to go through to be physically prepared, but they also have to prepare mentally. Exercise is just as important to the crew's health as their nutrition is.

There are more threats that space will give to the crew than just their physical health. There are worries about their mental health due to the isolation and knowing that help is very far away. Is it worth it for scientists to eventually get people to Mars to live out the rest of their lives and for future generations? There's so much that needs to be planned with the food like storage options, waste, and so many other dangers they have to already have plans in place in case the crew needs to take action quickly.

PREPARATION

Astronauts have a lot that is required of them before they go to live in space. There is so much training that happens because they have to figure out the best exercises for the crew to do because they won't have gravity to work the muscles, so they create a lot of machines that simulate zero gravity to see how their bodies react. But in order to have the energy to be able to do the exercises they have to be able to have good food and nutrition. Each crew member is measured by each of their individual nutritional needs. The NASA in flight macronutrient diets have remained at fifty-five percent carbohydrates, thirty percent fat, and fifteen percent protein and have very little deviations or substitutions (Baba, et al.). Then after they have been measured to make sure it's correct for each person they trial run the diet to make sure it is enough nutrition so, they have the strength to do the activities for the exercise and also all the other physical exertions that come with living in space and having to do manual labor on the space craft as well. Because the macronutrients are based off of what astronauts needed with very little required physical activities and less than 30 days in space, adjustments may be needed for going into space for possibly over 2 years for the mission to Mars.



SAFETY CONCERNS

They have summarized the hazards and stressors that happen to the body from being in space for long periods of time with the acronym RIDGE. Which stands for Radiation, Isolation and confinement, Distance from earth, Gravity fields, and hostile/closed Environments. Like if they wanted to just be done early and come home at any point and things like that. But when first going to the Moon and the eventually to Mars they will have to monitor the crew mental health as previously stated. It's also hard to know that help is far away or, if something happens with family that you can be there. Because right now the space station is 240 miles above earth and the moon is 1,000 times further than that and Mars being 140 million miles away and these large distances it can cause communication lag of at least twenty minutes. But also if we can get to the point where the crew can get to Mars but

also still be able to eventually come back to earth they will experience no gravity on the space craft but even once they get back to some gravity on Mars, it's still only one third of Earth's gravity. They have to re-get used to it coming back to Earth so they will be more exhausted because they will feel much heavier than they have in the times of being in space and possibly the surface of Mars. They will have to continue to do tests about whether the immune system changes cause white blood cells to attack healthy cells and not just the bad bacteria. (Abadie)

Jennifer Fogarty said, the spacecraft these astronauts launch aboard "will have to provide them everything they need for basic survival, but even more than that, because we expect them to be capable of doing a job — a job that has cognitive demands, a job that has physical demands."



Radiation
Isolation & confinement
Distance from Earth
Gravity fields
Environments (hostile/closed)

FAR FROM HOME

Currently to get to Mars it takes a minimum of six months and just as long or even longer to get back. NASA currently wants to achieve a crewed mission by the end of 2030. They aren't going to start by going straight to mars they are going to attempt to get to the moon first. (Wall) The space craft will be going 24,600 mph and will travel about 300 million miles. As the spacecraft travels, they will need to continue to course adjust to make sure that they land at Jezero Crater. To ensure their safety on the mission and continued success they will have engineers on earth that have to have a check list of precautions. The length of the journey also depends on when the planets are in the best alignment and its only about once every 26 months (Timeline).

Tommaso Ghidini said, "We are not born to live in space- for us, space is still a hostile environment," it's beyond the reach of traditional medical care because of how far the crew will be traveling to get to Mars due to it being months away. Ghidini also said, "Once you have started the mission, you cannot abort it – you can't come back if you have a medical issue. You have to be able to heal the astronaut."

Because of the concerns of bones not only breaking due to fragility there is an even greater concern for the bones to shatter. So, they will need ways of completing surgery if the need arises. So, they have started talking about 3D bioprinting their human skin, bones, and organs can be printed on the spacecraft then placed during surgery but

that has its own risks. So, they thought about having it done remotely but there are lags due to the distance and during an emergency it wouldn't allow for enough time to save the patient. That would mean that somebody onboard would have to have a surgical and medical background (Best).

The crew is at risk of sudden cardiac arrest, smoke inhalation, toxic exposure, seizure, and penetrating eye injuries. So, they need people that can-do surgery for those possible injuries. And they have done many trials as 2D workshops so they can have practice and determine who's best qualified. But with the planned mission to Mars there are many countermeasures that will need to be taken to be able to predict and act on the issues that happen (Robertson, et al.).



CHANGES TO BODY

Another issue that has to be planned for which has been tested is just how much the body changes while in space. The most common changes in space is the muscle mass decreases. Because the muscles mass is decreasing when they get back to gravity, they might not be able to hold themselves up or lift heavy things. Another body part that changes is your bone density it starts getting thinner and lighter and it can cause the same issues with the muscles mass. Decreasing the bones density means they will be more brittle so they can break or fracture a lot more easily. But also, with bones density decreasing the vitamins and calcium which can cause higher sodium levels, it gets into the blood and urine which can cause increased risk of kidney stones. Which are very painful and when big enough can cause more serious problems like unable to use the restroom. The bone density decreases because it is the main reservoir for calcium and if you aren't getting enough of vitamins D, K, and C it has to be taken from somewhere, so it gets taken from the bone and because vitamin D is mainly absorbed to ultraviolet light. Because engineers protect the space craft from the sun ray and provide extra vitamin D in the diets but sometimes that just isn't enough (Enrico 4-7). The average bone loss for being in space is about one to one and a half percent of change. And just coming back to Earth and doing rehabilitation doesn't necessarily mean that you will ever be able to get the full amounts of bone density loss back (Abadie).

They have found other medical problems that have

arisen in long term and even short-term space travel and flight. The crew tend to have issues with the fluid balance in the body due to weightlessness and how the fluids flow through the body. With the fluid shifts it also causes gastrointestinal issues because the gasses can't rise how they normally would be able to when on Earth. Scientists have also been looking at adding pro and anti-biotics to the space diet because of the gas issues and the bacteria naturally found in the colon. Another large concern is the health of the heart, so with concern for that they have increased the omega 3 fatty acid intake for the crews. There's also the iron metabolism they have to think about because space flight anemia is seen very commonly with all astronauts which causes the blood circulation through the body to slow down. Crews need more iron cause its not getting everywhere as quickly due to gravity not being apparent (Enrico 7-12). Also, because the heart rate slowing down it can compromise the immune system over time. So, they have done trials with omega 3 fatty acids so see if they can help stop that to prevent sickness as well (Baba, et al.).

The crews also have oxidative stress which is caused from the extra radiation even with all of the protective barriers along the space craft, there's still some that gets in and gets into the body of the crew members. Scientists have even seen the effects lasting several weeks after coming back down to Earth. And because of this they increased the antioxidant amounts that the crew eats. They also have to plan for the crew's immunity that changes because they

are not being exposed to germs and sicknesses as often and also the extra radiation that they are receiving they have to be more concerned about cancer. But taking probiotics can help with these immunity deficiencies as well. The last bodily function that is a major concern with the crew members are the changes that happens to their eyesight. They have an increased risk of getting cataracts (Enrico 7-12). Which is a form of blindness and sensitivity to light that happens in the pupil. And its why when you see the astronauts come off of the space craft why they have dark sunglasses. Like when rescuers save people that have been trapped in caves because they have only seen artificial light being stuck in a cave. For the crew not as many UV rays from sunlight if any at all can get in because of all the protections on the very limited windows that they may have on the space craft.



HOUSTON, WE HAVE A PROBLEM:
Learn more about the
challenges astronauts face in
this interactive infographic.



CASE STUDY: KELLY & KOCH

NASA has had people that they have studied in space for long periods of time the longest was 11 months by both Scott Kelly and Christina Koch. They studied them because they wanted to get a better idea of what happens to the human body when it is in space for a long time with no gravity, and the radiation that can still reach them. The reason that they had decided to study Scott Kelly was because he is actually a twin to his brother Mark Kelly who is a retired astronaut. Because he was a twin they could compare and contrast the changes that happened to Scott. Like the bone density change, the levels of radiation that they could find, all of the cardio and muscular health differences, and even the eyesight change that he experienced (Abadie).

They used both Scott and Christina to study the mental health aspect of what could change for being in space for a long time with a small crew. Even though the

crew would rotate while Scott and Christina would have been up in space, they wanted to know how it had affected their mental health. Like if they wanted to just be done early and come home at any point and things like that. But when first going to the Moon and the eventually to Mars they will have to monitor the crew before they can go because they have to see how their mental health is, and how they react with the other crew members. Because they will be isolated with only the same crew for a long time. It's also hard to know that help is far away or if something happens with family that you can be there right away. Because right now the space station is 240 miles above earth and the moon is 1,000 times further than that and Mars being 140 million miles away and these large distances it can cause communication lag of at least twenty minutes (Abadie).



RADIATION

To journey to mars will see the crew seeing up to sixty percent more radiation going to mars then they have in their entire life. And it can cause the astronauts to get cancer. They are trying to come up with ways to protect the crew but its bulky and they have found that water is a really good source but it can be hard to transport to space so they have thought about using the water the astronauts need for survival as the protective shield (Best).

The largest concern that comes from leaving the relative safety of Earth's gravitational field and atmosphere is all the cosmic radiation that is out in space that the ship traveling through Mars will pass through. The data of radiation was collected when all the rovers were traveling to Mars. Most recently the perseverance rover, which landed on Mars February 18, 2021 (NASA), but we also have data from the curiosity rover using RAD. They also have MARIE who is another rover that stays in Mars orbit onboard the Mars Odyssey satellite and takes current data there as well. The crews have to worry about GCRs from the radiation which is what causes changes to the DNA which is what causes cancer cells to start forming. They have planned out the travel time to Mars to be around 550 days to 600 days. The time actually on Mars can be anywhere from 30 days to 180 days of a transfer time and 180 days on Mars. Which can be a total travel time of 978 days of being in space and on mars with all the cosmic radiation. An absorbed dose of 1 rad (radiation absorbed dose) is about 1 gram of absorbed 100 ergs of energy of radiation which can be a lot even if it doesn't seem like a lot from the numbers. One X-ray is about 5 rads Because the

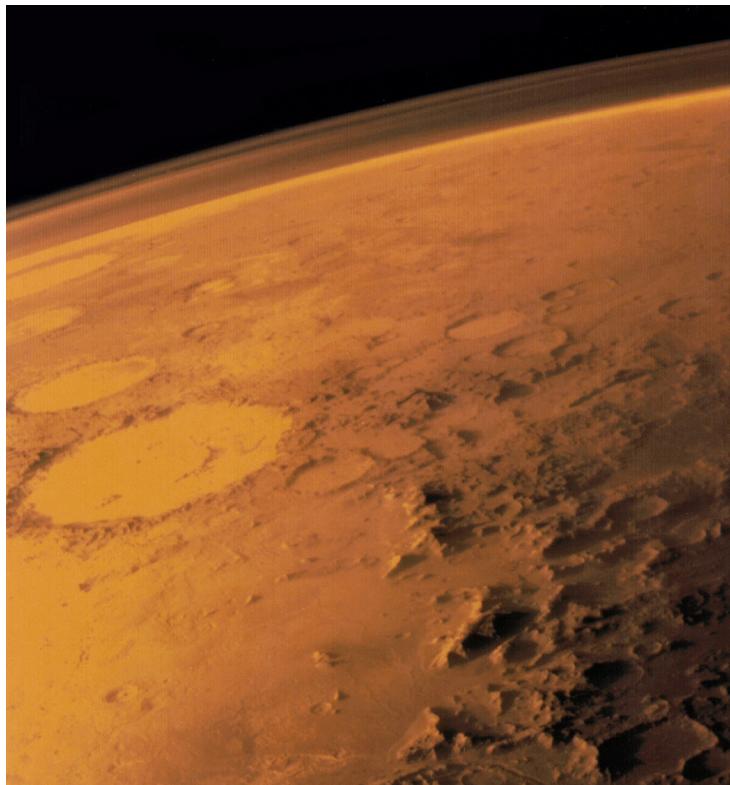
neurons can be very penetrating, they can cause deep tissue damage and you might not see the damage till it's too late. Scientists and engineers have found that water is the best protectant that they can offer the crew because it does the most protecting without creating dangerous thick layers of other technology. The other thick layers of technology can cause other problems and possibly even make the radiation worse once it gets to the body. Those are called secondaries. But also, the crew needs the water for their survival to stay hydrated anyway so it would have already had to been on the spacecraft to begin with. Which can help save space in the end (Bloshenko, et al. 0-3).

Because Mars lost its magnetosphere there isn't as much protection from space radiation as there is on Earth so, even once they reach the surface of the planet there is still going to be exposure. It's like getting an x-ray every single day for multiple years in a row. To get to the same level that Earth is at for radiation you would have to go several miles below the surface of Mars. They determined this through the lava tubes that go below the surface. Mars atmosphere also creates plenty of other hazards like neurons which can cause the deep tissue damage and the toxicity of not being able to get oxygen without a tank. Their suits are water lined like the spacecraft is to protect from the radiation on the surface. To get the astronauts as protected as possible from the radiation and the effects that would happen later in their lives, they have this thing called career radiation dose limitations. And what that is its where they have control over how much radiation they have experienced throughout their lives in terms of x-rays

like at the dentists and doctors' offices and smoking or any other body harming activities. So, their cells haven't been exposed before and don't have more of a higher possibility of changing and becoming cancer cells (Błoszhenko, et al. 3-7).

Cancer isn't just a concern from cosmic radiation but there are concerns that can happen while they are aboard the space craft. Because damage to the central nervous

system can happen it can impair the moods, memory, how the crew is able to learn, and SANS which is spaceflight-associated neuro-ocular syndrome. It is a visual impairment that is caused from fluid building up and having nowhere to go which can cause blindness and the effects could be significant and long term. And they are starting with going to the moon so they can plan and prepare for all the possible problems that occur in going to Mars (Wall).





GROWING FOOD

The crew currently aboard the ISS were able to dine on fresh red romaine lettuce that they had grown in the VEGGIE. Which is their vegetable production system plant laboratory. They created this to make an effort to grow healthy and sustainable foods for long trips in space like to get to the Moon and Mars. Another reason this is helpful is because it boosts the crew moral (Mendoza). Dr. Gioia Massa said, “The farther and longer humans go away from Earth, the greater the need to be able to grow plants for food, atmosphere recycling, and psychological benefits.”

If they need a break from space, they can go garden it's not like being outside doing garden work at home but

it's better than nothing. The system consists of a panel that is flat and has red, blue, and green lights to stimulate the plants to create photosynthesis. The soil is inside pillows that slowly release fertilizer to provide the plant with the nutrients needed for it to have the best survival and extra nutrients for the crew. The water is slowly released from wicks so that the water isn't floating through the air that could cause problems with all the electronics on the walls that keep the spacecraft going. Before the crew could first eat the lettuce, it did have to head back to Earth for testing to make sure there weren't any toxins or dangers from being grown in space (Mendoza).

THE VEGGIE

The VEGGIE is mainly used for growing salad type crops currently. And this could potentially help save money because it takes over 10,000 dollars to send one pound of food from Earth to the space station and as the distance increases it will only get more and more expensive for the fuel and time. It was first officially started because Don Pettit grew a zucchini. They have also found that there's no problems for the plants to grow in zero and low gravity situations so it would be possible to use the same devices on the moon and on Mars (Gitau). Which would give crew members a jumpstart once they get to the surfaces because they could start growing it on the space craft and then just

move it to the greenhouses and they wouldn't have to start and have the possibility of something going wrong once they reached the surface. Food is very important for mental health as well as physical health because people tend to eat more if it's something they are craving and wanting and when it tastes good than when it something, they aren't excited to eat or something that isn't what they are craving. And this make a large difference in their physical health because they won't eat as much to keep their body weight and energy up to be able to do their jobs around the space craft when getting to Mars (McCabe).



LOOKING FORWARD

They have thought about possibly having a one-year space flight cap due to the high amounts of radiation because it would still allow people time to get to the red planet and other manned mission to possibly the moon. The mars mission will require so many technical and biomedical advances to be able to save space in the space craft and also create easy access to everything that will be needed on the surface of the red planet. And they need to have everything they need because early return won't be possible. But there could also need to be even more nutritional updates for once they reach the surface of Mars because they gravitational changes and the changes in the atmosphere. They have also figured out ways to make the suit great to be in to be able exit the suit easily for food and also getting a water bottle either in the suit or easily accessible which currently isn't an invention, but it could be (Enrico 13-15).

There is also very limited storage that is available when you go up to space. Because you only have the limitations of the space craft that you are on and you can't really add more room. So, you have to plan for what you can and can't bring and will you have issues due to the items that you can't bring, and you have to plan for that. They also might have to engineer new things to make thing more compact and smaller that can be used multiple ways to bring less onto the space craft.

One of the first things that they have invented is a sterilization pouch that can be used to heat food but more than that it can be reused which save space. It will also allow for the availability of more food choices for the

astronauts so they can have a higher chance of having access to the food that they actually crave. Because going to Mars is going to require 2 food sources and systems the first one is what the crew will be eating on the way their and possible back and the food that they will need once they get to mars and get their garden systems set up and ready to be self-sustainable and renewable. But this also helps prevent waste of packaging because we don't want to mess up Mars in the way that the Earth has been hurt with pollution and global warming. But it's also safer because it has its own heat source that is internal that you connect with wires so, it won't heat up the space craft in any way. They are also using high quality materials that have high melting points so they can be heated up and reused and there isn't a worry that the food will get contaminated by the materials they are heated up in. It heats evenly so the food can cook properly which will reduce risk of food born illness. (Somavat, et al. 134-142)

Ghididni also said, "We want to go to Mars in a respectful manner, and avoid the mistakes we have done on Earth. We want to go and do recycling on a massive scale – that's the way you do a mission like that, there is no other way. You have to recycle all the equipment, you have to use the resources you find in situ, and that is another lesson we need to bring back to Earth."

3D printing food to help with moral because they can print what they want to eat, but it can also be used for medical purposes as well if there is any bone shattering that happens due to bone density decreasing and stuff like that. They have already tested 3D printing a pizza. Which

would break the cycle of them eating the same things every day. It's also a way to keep them entertained (Best). One of my math professors had a 3D printer that she would use to build geometric shapes that her students in a higher level class had designed and I would get so mesmerized and calmed by watching it slowly build the layers that in the end made this huge shape so the astronauts could and probably would have some real fun with it.



MARS SIMULATION

There has been a mission to Mars trial run the has been started at the Mars Desert Research Station in the Utah desert that's near Hanksville. It has everything that they would have on Mars and they practice living their daily lives as they would on Mars. They take rock samples and study the stars and garden in their green house. They are not allowed to leave the station without all their equipment on and they also have to take the times to wait to enter and exit as they would on Mars for the pressurization. There are so many rules to follow to make the experience as realistic as possible to being on Mars. Almost anyone can pay to go do this because there are so many different space programs you technically don't need to work at NASA to have to go up into space anymore. (Kelly) There are so many people that dream of going into space and they have the means to do it. Like the money and the mental willpower to be able to go up there.



To Mars and Beyond...

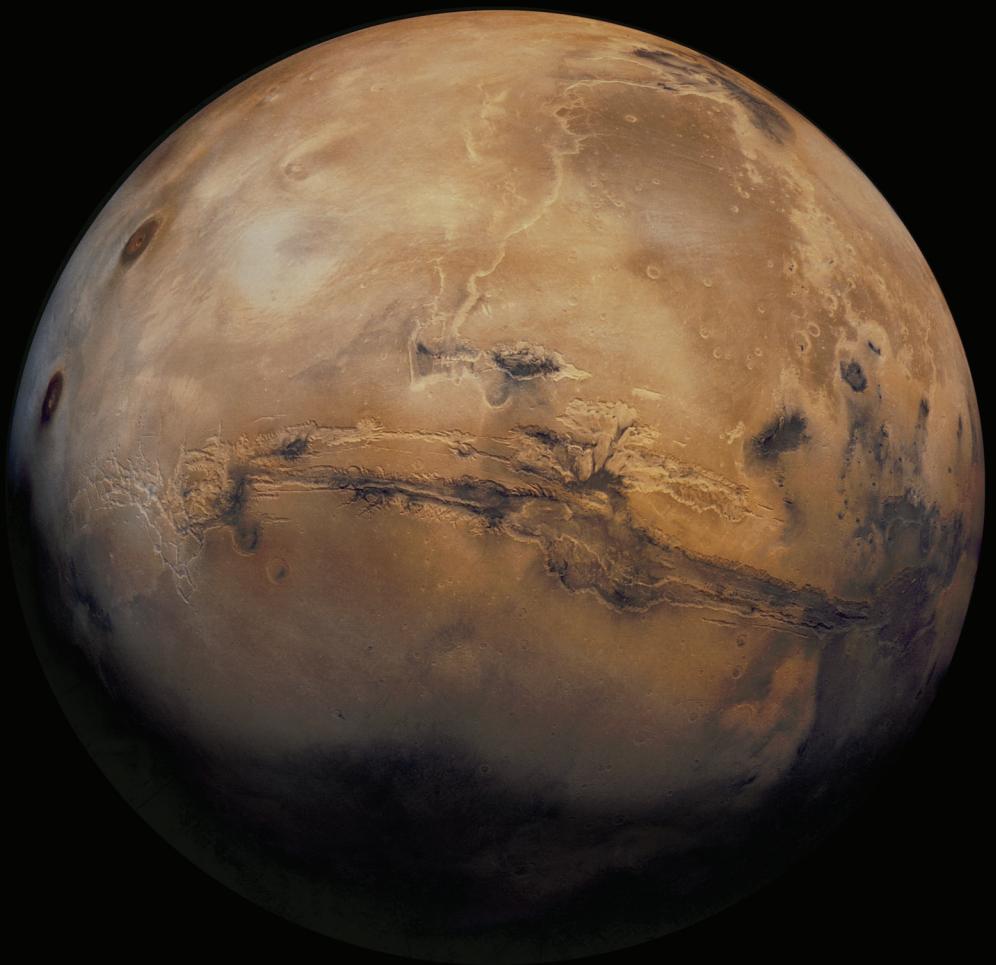
Robert Zubrin said, "Those that are successful will attract others," he said. "I don't want Mars to be the 51st state. I want Mars to be Martian. Mars isn't the destination; Mars is the direction."

This is so important because if America gets to Mars first, it shouldn't just be another state it is its own planet so it should probably be its own country. A lot of people want Mars to be a new beginning they want us to treat it the way we haven't treated Earth we should go there with the means to fix the environment.

In conclusion, when you become an astronaut or take advantage of NASA's endless possibilities, when working to help NASA teams, this is their mission. Everyone working with the NASA programs will be required to spend a lot of time researching and gathering information for ways to provide improvements to astronauts' lives. Astronauts are required to do the same thing, to spend a lot of time preparing and training to adapt to life in space from Earth by getting plenty of sleep, exercising, managing personal and oral hygiene, and receiving proper food nutrients

that will aid in staying strong for any long-term missions in deep space. Indeed, there are a lot of things going on, knowing the risks on astronauts' health and safety in space are different from Earth when NASA sends their first manned mission to Mars.

Yes, there are a ton of risks of going into space let alone going into space for very long periods of time and also being far away. But just imagine all of the possibilities of what could happen when we are successful. Just imagine that one day you could be living on Mars and you would have never known the difference or all of the effort that it took in getting to that point. NASA and other space programs are putting in so much research and time and money to make sure that they can get this right and in a safe matter. So yeah, they have to think about everything that could possibly go wrong and they keep testing and testing till they get it right. But it's all for the future and it's amazing. All of the possibilities and everything that they're coming up with that could make life now even greater.



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