Colonization of mars

Colonization or settlement of Mars is the theoretical human migration and long-term human establishment of Mars. The prospect has garnered interest from public space agencies and private corporations and has been extensively explored in science fiction writing, film, and art.

Organizations have proposed plans for a human mission to Mars, the first step towards any colonization effort, but no person has set foot on the planet, and there have been no return missions. However, landers and rovers have successfully explored the planetary surface and delivered information about conditions on the ground.

Mars' orbit is close to Earth's orbit and the asteroid belt. While Mars’ day and general composition are similar to Earth, the planet is hostile to life. Mars has an unbreathable atmosphere, thin enough that its temperature on average fluctuates between −70 and 0 °C (−94 and 32 °F), yet thick enough to cause planet-wide dust storms. The barren landscape on Mars is covered by fine dust and intense ionizing radiation. Mars has in-situ resources, such as underground water, Martian soil, and ore, which could be leveraged by colonists. Opportunities to generate electricity via wind, solar, and nuclear power using resources on Mars are poor.

Justifications and motivations for colonizing Mars include curiosity, the potential for humans to provide more in-depth observational research than uncrewed rovers, an economic interest in its resources, and the possibility that the settlement of other planets could decrease the likelihood of human extinction. Difficulties and hazards include radiation exposure during a trip to Mars and on its surface, toxic soil, low gravity, the isolation that accompanies Mars' distance from Earth, a lack of water, and cold temperatures.

Commitments to researching permanent settlement have been made by public space agencies—NASA, ESA, Roscosmos, ISRO, the CNSA, among others—and private organizations—SpaceX, Lockheed Martin, and Boeing.

**Mission concepts and timelines**

Since the 20th century, there have been several proposed human missions to Mars both by government agencies and private companies.

Most of the human mission concepts as currently conceived by national governmental space programs would not be direct precursors to colonization. Programs such as those being tentatively planned by NASA, Roscosmos, and ESA are intended solely as exploration missions, with the establishment of a permanent base possible but not yet the main goal.

Colonization requires the establishment of permanent habitats that have the potential for self-expansion and self-sustenance. Two early proposals for building habitats on Mars are the Mars Direct and the Semi-Direct concepts, advocated by Robert Zubrin, an advocate of the colonization of Mars.

At the February 2017 World Government Summit, the United Arab Emirates announced a plan to establish a settlement on Mars by 2117, led by the Mohammed bin Rashid Space Centre.

SpaceX has proposed the development of Mars transportation infrastructure in order to facilitate the eventual colonization of Mars. The mission architecture includes fully reusable launch vehicles, human-rated spacecraft, on-orbit propellant tankers, rapid-turnaround launch/landing mounts, and local production of rocket fuel on Mars via in situ resource utilization (ISRU). SpaceX's aspirational goal as of 2017 was to land their cargo Starships on Mars by 2024 and the first 2 crewed starships by 2026.

**Conditions for human habitation**

Conditions on the surface of Mars are closer to the conditions on Earth in terms of temperature and sunlight than on any other planet or moon, except for the cloud tops of Venus. However, the surface is not hospitable to humans or most known life forms due to the radiation, greatly reduced air pressure, and an atmosphere with only 0.16% oxygen.

In 2012, it was reported that some lichen and cyanobacteria survived and showed remarkable adaptation capacity for photosynthesis after 34 days in simulated Martian conditions in the Mars Simulation Laboratory (MSL) maintained by the German Aerospace Center (DLR). Some scientists think that cyanobacteria could play a role in the development of self-sustainable crewed outposts on Mars. They propose that cyanobacteria could be used directly for various applications, including the production of food, fuel and oxygen, but also indirectly: products from their culture could support the growth of other organisms, opening the way to a wide range of life-support biological processes based on Martian resources.

Humans have explored parts of Earth that match some conditions on Mars. Based on NASA rover data, temperatures on Mars (at low latitudes) are similar to those in Antarctica. The atmospheric pressure at the highest altitudes reached by piloted balloon ascents (35 km (114,000 feet) in 1961, 38 km in 2012) is similar to that on the surface of Mars. However, the pilots were not exposed to the extremely low pressure, as it would have killed them, but seated in a pressurized capsule.

Human survival on Mars would require living in artificial Mars habitats with complex life-support systems. One key aspect of this would be water processing systems. Being made mainly of water, a human being would die in a matter of days without it. Even a 5–8% decrease in total body water causes fatigue and dizziness and a 10% decrease physical and mental impairment (See Dehydration). A person in the UK uses 70–140 litres of water per day on average. Through experience and training, astronauts on the ISS have shown it is possible to use far less, and that around 70% of what is used can be recycled using the ISS water recovery systems. (For instance, half of all water is used during showers.) Similar systems would be needed on Mars but would need to be much more efficient, since regular robotic deliveries of water to Mars would be prohibitively expensive (the ISS is supplied with water four times per year). Potential access to on-site water (frozen or otherwise) via drilling has been investigated by NASA.

**Effects on human health**

Mars presents a hostile environment for human habitation. Different technologies have been developed to assist long-term space exploration and may be adapted for habitation on Mars. The existing record for the longest consecutive space flight is 438 days by cosmonaut Valeri Polyakov, and the most accrued time in space is 878 days by Gennady Padalka. The longest time spent outside the protection of the Earth's Van Allen radiation belt is about 12 days for the Apollo 17 moon landing. This is minor in comparison to the 1100-day journey to Mars and back envisioned by NASA for possibly as early as the year 2028. Scientists have also hypothesized that many different biological functions can be negatively affected by the environment of Mars colonies. Due to higher levels of radiation, there are a multitude of physical side-effects that must be mitigated. In addition, Martian soil contains high levels of toxins which are hazardous to human health.

**Physical effects**

The difference in gravity may negatively affect human health by weakening bones and muscles. There is also risk of osteoporosis and cardiovascular problems. Current rotations on the International Space Station put astronauts in zero gravity for six months, a comparable length of time to a one-way trip to Mars. This gives researchers the ability to better understand the physical state that astronauts going to Mars would arrive in. Once on Mars, surface gravity is only 38% of that on Earth. Microgravity affects the cardiovascular, musculoskeletal and neurovestibular (central nervous) systems. The cardiovascular effects are complex. On Earth, blood within the body stays 70% below the heart, but in microgravity this is not the case due to nothing pulling the blood down. This can have several negative effects. Once entering into microgravity, the blood pressure in the lower body and legs is significantly reduced. This causes legs to become weak through loss of muscle and bone mass. Astronauts show signs of a puffy face and chicken legs syndrome. After the first day of reentry back to earth, blood samples showed a 17% loss of blood plasma, which contributed to a decline of erythropoietin secretion. On the skeletal system which is important to support our body's posture, long space flight and exposure to microgravity cause demineralization and atrophy of muscles. During re-acclimation, astronauts were observed to have a myriad of symptoms including cold sweats, nausea, vomiting and motion sickness. Returning astronauts also felt disoriented. Journeys to and from Mars being six months is the average time spent at the ISS. Once on Mars with its lesser surface gravity (38% percent of Earth's), these health effects would be a serious concern. Upon return to Earth, recovery from bone loss and atrophy is a long process and the effects of microgravity may never fully reverse.

**Radiation**

Dangerous amounts of radiation reach Mars' surface despite it being much further from the Sun compared to Earth. Mars has lost its inner dynamo giving it a weaker global magnetosphere than Earth does. Combined with a thin atmosphere, this permits a significant amount of ionizing radiation to reach the Martian surface. There are two main types of radiation risks to traveling outside the protection of Earth's atmosphere and magnetosphere: galactic cosmic rays (GCR) and solar energetic particles (SEP). Earth's magnetosphere protects from charged particles from the Sun, and the atmosphere protects against uncharged and highly energetic GCRs. There are ways to mitigate solar radiation, but without much of an atmosphere, the only solution to the GCR flux is heavy shielding amounting to roughly 15 centimeters of steel, 1 meter of rock, or 3 meters of water, limiting human colonists to living underground most of the time.

The Mars Odyssey spacecraft carries an instrument, the Mars Radiation Environment Experiment (MARIE), to measure the radiation. MARIE found that radiation levels in orbit above Mars are 2.5 times higher than at the International Space Station. The average daily dose was about 220 μGy (22 mrad)—equivalent to 0.08 Gy per year. A three-year exposure to such levels would exceed the safety limits currently adopted by NASA, and the risk of developing cancer due to radiation exposure after a Mars mission could be two times greater than what scientists previously thought. Occasional solar proton events (SPEs) produce much higher doses, as observed in September 2017, when NASA reported radiation levels on the surface of Mars were temporarily doubled, and were associated with an aurora 25-times brighter than any observed earlier, due to a massive, and unexpected, solar storm. Building living quarters underground (possibly in Martian lava tubes) would significantly lower the colonists' exposure to radiation.

Comparison of radiation doses—includes the amount detected on the trip from Earth to Mars by the RAD on the MSL (2011–2013).

Much remains to be learned about space radiation. In 2003, NASA's Lyndon B. Johnson Space Center opened a facility, the NASA Space Radiation Laboratory, at Brookhaven National Laboratory, that employs particle accelerators to simulate space radiation. The facility studies its effects on living organisms, as well as experimenting with shielding techniques. Initially, there was some evidence that this kind of low level, chronic radiation is not quite as dangerous as once thought; and that radiation hormesis occurs. However, results from a 2006 study indicated that protons from cosmic radiation may cause twice as much serious damage to DNA as previously estimated, exposing astronauts to greater risk of cancer and other diseases. As a result of the higher radiation in the Martian environment, the summary report of the Review of U.S. Human Space Flight Plans Committee released in 2009 reported that "Mars is not an easy place to visit with existing technology and without a substantial investment of resources." NASA is exploring a variety of alternative techniques and technologies such as deflector shields of plasma to protect astronauts and spacecraft from radiation.

**Psychological effects**

Due to the communication delays, new protocols need to be developed in order to assess crew members' psychological health. Researchers have developed a Martian simulation called HI-SEAS (Hawaii Space Exploration Analog and Simulation) that places scientists in a simulated Martian laboratory to study the psychological effects of isolation, repetitive tasks, and living in close-quarters with other scientists for up to a year at a time. Computer programs are being developed to assist crews with personal and interpersonal issues in absence of direct communication with professionals on Earth. Current suggestions for Mars exploration and colonization are to select individuals who have passed psychological screenings. Psychosocial sessions for the return home are also suggested in order to reorient people to society.

**Terraforming**

Various works of fiction put forward the idea of terraforming Mars to allow a wide variety of life forms, including humans, to survive unaided on Mars' surface. Some ideas of possible technologies that may be able to contribute to the terraforming of Mars have been conjectured, but none would be able to bring the entire planet into the Earth-like habitat pictured in science fiction.

Questions:

1. What effects can colonization of Mars cause to a human health?

Answer: physical, psychological effects and radiation exposure.

1. What is surface gravity on Mars compared to gravity on Earth

Answer: 38% of Earth’s gravity

1. What is the temperature on Mars?

Answer: between −70 and 0 °C

1. What would human need to survive on Mars?

Ancwer: human survival on Mars would require living in artificial Mars habitats with complex life-support systems

1. By when do United Arab Emirates plan to establish a settlement on Mars?

By 2117

1. What are motivations for colonizing Mars?

Answer: curiosity, the potential for humans to provide more in-depth observational research than uncrewed rovers, an economic interest in its resources, and the possibility that the settlement of other planets could decrease the likelihood of human extinction.