Terraforming Mars?

# All About Mars

Mars, the red planet, is the fourth planet from the sun in the solar system and one of the most explored bodies in the solar system. Mars is the only planet where humans have sent rovers to explore the alien planet. It is a cold and dusty desert with a very thin atmosphere. The planet’s bloody red color tells a story of destruction in its own way. Billions of years ago, Mars was just like Earth’s smaller twin, with liquid water on its surface and maybe even life. Now, it is a cold, barren desert with few signs of liquid water. But after decades of study using satellites and rovers, scientists have revealed Mars as a dynamic, windy landscape that might hold microbial life under its rusty surface.

## Mars in Ancient Astronomy

In ancient times, scholars of different cultures used to study space and take notes. Egyptians were the first to notice that the motion of the stars was fixed and the sun moves relative to the star. They discovered five bright objects in the sky; Mercury, Venice, Mars, Jupiter and Saturn. These objects moved relative to the stars just like the sun.

Because of the planet’s bloody color, the Romans named it after their god of war. In truth, the Romans copied Greeks who also named it after their god of war, Ares. Other civilizations also gave name to the planet due to its red color. The Egyptians used to call it “Her Desher” which means “the red one”, Chinese astronomers called it “the fire star” while Babylonians named it after their hero and the king of conflicts, “Nergal”.

## Potential of Life on Mars

As of now, scientist don’t expect to find life on Mars. They are looking for signs of life that existed billions of years ago, when Mars were habitable. However, according to some theories, we may find microbial life under the surface of Mars. Still, nothing has been proven yet.

## Size and Distance

Mars is half the size of Earth having a radius of 3,390 kilometers. The red planet is about 142 million miles away from the sun.

## Orbit And Rotation (Time Convention)

Earth has very similar length of day when compared to Mars. Mars completes one rotation on its axis every 24.6 hours, which is very similar to 23.9 hours of Earth. Martian days are called “Sols” which is short form of “Solar Day”. It takes 669.6 sols and 687 days for Mars to complete one orbit around Sun. Hence, one year in Mars is equal to 669.6 sols.

Mars has an axis of rotation of 25 degrees. This is also a similarity with Earth’s axis of rotation of 23.4 degrees. This axial rotation allows Mars to have distinct seasons. However, they last longer than Earth seasons. One individual season of Mars can last up to 194 sols. This longevity of seasons is due to elliptical or oval-shaped orbit of Mars.

## Surface of Mars

The Bright Red color of Mars is due to iron-rich minerals covering its surface in form of dust and rocks. According to NASA, these minerals get kicked up in the atmosphere due to strong wind currents and after oxidization and rusting of these elements, Mars appears to be bright red from a distance.

Mars is home to mountains, valleys and volcanoes just like Earth and Venus. However, Mars has the biggest and most magnificent of them in the entire solar system. Olympus Mons is the largest volcano in the entire solar system. It is approximately three times the size of Mount Everest and roughly 27 kilometers high. Some major eruptions might still occur on the planet today. Mars not only has the highest but the lowest as well. Southeast of Olympus Mons lies Valles Marineris, the iconic canyon system of the red planet. This canyon system span about 4000 kilometers and is about 7 kilometers deep. Comparing it to the Earth’s Grand Canyons, Valles Marineris is about 4 times deeper and 5 times longer.

Mars appears to have a watery past, large channel emerging from the end of some canyon systems suggest that these canyons might have been filled with liquid water once. Studies show that Mars experienced huge floods abouts 3.5 billion years ago. Today, it is impossible for liquid water to exist on surface of mars due to its thin atmosphere. However, liquid water may still lie in cracks and pores in underground rocks beneath the surface of Mars.

## Atmosphere

Mars has very thin atmosphere. According to NASA, the atmosphere on Mars comprises of 5.32% Carbon Dioxide, 2.7% Nitrogen, 1.6% Argon, 0.13% oxygen and other gases. Since most of the atmosphere is made up of Carbon Dioxide, Nitrogen and Argon, and the contributing factor of suspended dust, the sky on Mars would appear red and hazy to our eyes. Such a thin atmosphere does not provide Mars with any protection against the asteroids. The temperature on mars is as low as -153 degrees Celsius while the highest recorded temperature is 35 degrees Celsius.

## Moons of Mars

Mars has two moons, Phobos and Deimos. These moons are not completely spherical, instead they have a potato-like shape. These moons were discovered in 1877 and were named after sons and chariot drivers of the god Mars in Roman mythology. There are many theories regarding the formation of these moons. Some scientists believe that these moons were asteroids, captured by the gravity of Mars while others believe that they are products of formed up debris kicked up from Mars surface after a huge impact. These moons are irregular and tiny when comparing to the Earth’s moon.

Deimos is the smaller of the two moons. It is covered by loose dust which often cover its craters. The second son of Mars, Phobos is the larger of the two moons. It has many craters on its surface which show signs of collisions with small asteroids and debris. After every 100 years, Phobos gets 1.8 meters closers to Mars. At this rate, Phobos will crash into mars and break it in half after 50 million years.

# Missions to Mars

## Past Missions

### Phoenix Mars Lander

NASA’s Phoenix landed on Mars on 25 May 2008, to study the history of water and soil on Mars and search for a habitable zone. Phoenix completed its mission in 2008 and the lander died two months later due to lack of energy.

### Pathfinder and Sojourner

NASA’s Pathfinder landed on Mars on 4 July 1997 using airbags. It was the first ever rover to drive through the surface of Mars. Sojourner successfully transmitted data to Earth till 27 September 1997 after contact with the lander was completely lost. Major findings include measurements of radius of central metallic core of Mars, magnetism of Martian dust, water ice clouds in lower atmosphere of Mars and planet’s extreme temperature.

### Mars Global Surveyor

NASA’s Mars global surveyor arrived in Martian orbit on 12 September 1997. Mars global surveyor provided with high resolution pictures of Mars surface. Contact with the orbiter was lost on 5 November 2006.

### Viking 1

NASA’s Viking 1 landed on Mars on 20 July 1976. The lander took extensive weather reading and collected soil sample. The orbiter was powered down on 17 august 1980.

### Viking 2

NASA’s Viking 2 landed on Mars on 3 September 1976 shortly after the successful landing of Viking 1. Viking 2 collected atmospheric readings and collected soil samples. Viking 2 was shut down on 25 July 1978 after lander quit operating due to battery failure. Both Viking 1 and Viking 2 returned 1400 images from the surface of Mars and their orbiter took 50000 images which are still used today as an atlas.

### Mariner 9

NASA’s Mariner 9 started orbiting Mars on 14 November 1971. It was the first orbiter to successfully orbit Mars. When mariner 9 went online, the only thing visible to it was Olympus Mons. Mission scientist waited for about a month for the Martian dust to settle down before continuing with the rest of the missions. Mariner 9 took 7,329 photos of Mars. It studied the density and compositions of the planet’s atmosphere as well as it’s gravity and topography.

### Mariner 7

NASA’s Mariner 7 flew by Mars on 5 August 1969. It helped established the mass, radius, shape of the Mars and revealed that ice cap on south pole of Mars was Carbon Dioxide.

### Mariner 3

NASA’s Mariner 4 flew by Mars on July 14 1965. It took four images and confirmed high amount of Carbon Dioxide in thin Martian atmosphere.

## Active Missions

### Perseverance

NASA’s Perseverance Rover landed on Mars on 18 February 2021. Its objective is to seek signs of ancient life and collect samples of rocks for possible return to Earth. It is the most technologically advanced rover that NASA has ever created.

### Tianwen-1 and Zhurong

China’s Tianwen-1 orbiter and Zhurong rover reached Mars orbit on 10 February 2021. Its objective is to search of pockets of water beneath the surface that could host microbial life.

### Hope

United Arab Emirate’s Hope orbiter entered Mars’s orbit on 9 February 2021. Its objective is to study Martian climate.

### Insight

NASA’s Insight landed on Mars 28 November 2018. Its objective is to study Mars’s interior to give a better understanding of how other worlds are made.

### ExoMars TGO

European Space Agency’s ExoMars Trace Gas Orbiter entered Martian orbit on 19 October 2018. Its objective is to trace methane and other atmospheric gases that could give evidence of biological or geological processes.

### Maven

NASA’s Maven (Mars Atmosphere and Volatile Evolution missions) entered Martian orbit on 21 September 2014. Its objective is to deeply study Martian climate and habitability.

### Mangalyaan

India’s Mars Orbiter Mission also called Mangalyaan entered Martian Orbit on 24 September 2014. It is providing us with stunning full globe pictures of mars.

### Curiosity

NASA’s Curiosity Rover landed on Mars on 6 August 2012. The objective of this mission was to determine if Mars was ever able to support microbial life. Curiosity rover found that conditions on Mars were once fit for supporting life. It also found traces of organic compounds present in Martian soil.

### Odyssey

NASA’s Odyssey orbiter entered Martian orbit on 24 October 2001. Its objective was to search for signs of water on the red planet, make detailed maps of the Martian surface and determine radiation levels.

# Terraforming

History has shown us that life is not eternal. Just like the extinction of dinosaurs, humans might also disappear from the face of Earth. Hence, some scientist believe that humanity must become a ‘multi-planet’ species in order to survive. Mars is the first obstacle in our path towards becoming a multi-planetary species.

However, going to Mars is not a simple task. It is an expensive and dangerous journey as many things can go wrong along the way. Astronauts can starve, freeze, run out of oxygen or die due to radiations coming directly. Rescuing people from Mars would be an extremely tough exercise as it would take almost 2 years for another spacecraft to reach Mars. Astronauts in need of help would be stranded on the red planet. Due to this vulnerability, scientist have suggested to terraform Mars before sending humans to colonize the red planet.

“Terraforming of a planet, moon, or other body is the hypothetical process of deliberately modifying its atmosphere, temperature, surface topography or ecology to be similar to those of Earth to make it habitable by humans.”

## Habitability Requirements

Mars has the most similarities with Earth in the entire solar system. It was once a habitable planet with liquid water flowing on its surface. The first and most prior requirement for habilitation of Mars is to somehow bring back liquid water back on its surface. This might be possible by making carbon dioxide in Martian atmosphere react with iron-rich soil. Secondly, we would need a strong magnetic field that would protect us from the harmful radioactive rays coming directly from the Sun. Finally, a thin atmosphere would make things a lot easier. A thick atmosphere will considerably increase Martian temperature and allow it easier for life to dwell on Mars. This would also allow liquid water to exist on Martian surface.

## Methods of Terraforming Mars

### Nuclear Weapons

“Nuke Mars” – Elon Musk, CEO SpaceX

By detonating thermonuclear weapons over the poles, we could effectively trigger a greenhouse effect on Mars. The bombs would release heat, which in turn would melt the carbon dioxide frozen at the poles and, in theory, help to immediately thicken Mars' thin atmosphere. As sunlight is trapped by the C02, the temperature would rise, more ice would melt, and so on.

As one might expect, not all scientists agree with this quick and dirty method for terraforming Mars. For one, we would irrevocably change a large portion of the surface of the planet and two, we might actually cause the opposite effect of what we're looking for. Scientists not in favor of the theory argue that this would create so much dust that would block sun light and cool down the planet even more.

### Giant Orbital Mirror

One of the more common terraforming ideas involves the construction of a giant array of mirrors to reflect the sun's heat towards Mars' poles. Roughly 270 kilometers across and covering an area larger than Sri Lanka. Since this entire reflector would weigh more than 200,000 tons, it likely would have to be constructed in space, a massive. Nonetheless, once in place at an altitude of nearly 133,000 miles above the surface, the energy directed back on Mars would be enough to vaporize the trapped CO2 and potentially trigger a greenhouse effect.

### Covering the poles in dark dust

Like wearing dark clothing on a cold day to capture the sun's heat, another proposal for warming up Mars involves covering the poles in a layer of dark dust. Such a large amount of dust can be acquired by mining Mars' two moons, Phobos and Deimos. According to scientists, the amount of dark dust would need to average nearly 3 feet and, unbelievably, be replaced each year due to the planet's frequent dust storms.

### Human-Engineered Microbes

The best method for terraforming Mars might be to simply engineer microorganisms to do all the terraforming of Mars for us. While the red planet's current habitat is (maybe) a death sentence for life, NASA revealed earlier this year that they might be able to come up with something that will allow them to build new life from the genes of different microorganisms. This could result in genetically engineered plants, algae and other organisms that could survive, thrive and maybe even heat up Mars.

### Crashing Asteroid on Mars

It's widely believed by the scientists that asteroids and comets played an instrumental role in forming Mars' previously warm and wet climate. Assuming we could capture or direct these giant bodies moving through our solar system, it's possible we could angle them to enter Mars' orbit and then burn up in the atmosphere, releasing massive quantities of greenhouse gases. Like nuclear weapons, the other more destructive method would be to have several 10-billion-ton asteroids smack directly into the planet. Just one would result in a global temperature spike of 37 degrees Celsius. Some have even suggested to crash Phobos into Mars.

### Greenhouse Gas Factories

The idea behind building factories powered by renewable energy on the red planet with the sole purpose of releasing methane, carbon dioxide, CFCs, water vapor and other greenhouse gases into the atmosphere. These factories will be just like the ones we have on Earth. While this process would take centuries to warm Mars, it would allow humans plenty of time to settle the planet and help prepare it for its future role as a "new Earth."

### Creating a biosphere around Mars

This method proposes to make small self-dependent biosphere societies on Mars. Over the passage of time these societies would be merge together, eventually creating a humongous biosphere around entire planet.

## Problems with Terraforming

### Ethical

There has been a debate whether terraforming other planets is an ethical thing to do. The first point of view is that we should terraform other planets in order to preserve humanity and become a multi-planetary specie. This idea suggests that there is nothing morally wrong with terraforming as it does not affect any other life form. The opposing argument is that given humanity’s past treatment of Earth, other planet would be better without human interference.

### Economical

Technology to terraform another planet is not financially feasible at the moment. The cost of terraforming Mars would be ginormous. We would have to build the entire infrastructure from scratch. The government or any other investor is most likely to reject the proposal.

## Science fiction or Reality

Despite what we can do today, terraforming is still just a hypothesis. It hasn’t been done in the past and probably we won’t be seeing it in future due to its extremely high cost and limitation of modern-day technology. Still, scientists continue to present their methods to terraform Mars believing that one day this science fiction would become reality.

# Conclusion

So, How close are we to terraforming Mars. Today the emphasis is on getting a first human mission on Mars. That in itself is a huge obstacle. Then we would need to establish a scientific proposal to establish that there is some level of sustainability on Mars for Human life before we even think of living there. The difficult part is getting from a small scientific mission of 10 to 20 people to a big colonization mission of ten thousand people that it would take to start a terraforming project and that would really require a city on Mars/. That might be a 100 years or 500 years in the future, we still don’t know yet. To some anything just beyond 50 years in future is science fiction.

I think the people who ultimately terraform Mars would be Martians. They would have adapted living generations and generations in lower gravity. They will be a lot taller than us, they might have different blood chemistry, they will ultimately start to diverge somewhat as a specie from us and evolution would take over. A martian would be easilty identifiable seperable from Earth humans.

# Abstract

With towering volcanoes, swirling dust storms and plumes of sublimating dry ice at its poles the surreal landmass of Mars has captured the earthly Imagination for centuries. But what would it take to make it habitable As in, a place where we could breathe, walk around without our blood boiling or even grow crops and enjoy sunsets. There have been some wild proposals on how to make mars suitable for human life from nuking the poles and crashing asteroids on its surface in order to kickstart a new climate. So how close are we to terraforming mars?