ISSN: 0067-3064

Want to be a Martian? Be a photoautotrophic human

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Abstract

Cyanobacteria had taken 2.7 billion years to change O_2 content to a habitable level on the Earth. In terraforming Mars, producing O_2 and food, and creating tolerable radiation are challenging. Here, we argue that, with the available advancements of science today and perhaps in years to come, the maximum, humans would be able to do on Mars in the future is to live inside a chamber with controlled conditions. But, no one would be able to be a real Martian who can walk freely on Mars soil. Thinking outside the box, there is a great possibility for us to do that by getting ourselves changed a little bit to be adaptable to Martian conditions, which is much more achievable than changing a whole planet. Here, we suggest that by being photoautotrophic humans, like the spotted salamander, and having the ability to tolerate radiation, we would be able to be real Martians.

Keywords: Mars, Photoautotrophic human, Terraforming mars

Martian atmosphere is ca. 100 times thinner than Earth's, and it contains ca. 95% CO_2, 2.7% N_2, and 0.13% O_2 (NASA, 2018). A thin atmosphere and greater distance from the sun created Mars much colder than Earth. The average temperature is ca. -60 ^{o}C and it can vary from -125 ^{o}C near the poles during the winter to as much as a comfortable 20 ^{o}C at midday near the equator (Sharp, 2017).

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Several in-situ resource utilization aspects on Mars are proposed such as CO_2 plasma dissociation (Guerra, 2017), regenerative solid oxide stack system approach (Vilekar, 2018), and cyanobacteria in Mars-specific bioregenerative life-support systems (BLSS) (Verseux, 2016) for the production of food and O_2. Further, it is argued that creating a higher degree of biodiversity consisting of symbiotic interacting elements that may be required to assemble self-sustaining ecological systems capable of human life support is essential to colonizing other planets (Gatti, 2018; Johnson, 2019). However, it would take ages to achieve the goals concerning today's available technology. Further, changing the whole planet to make it habitable may not be possible within a century or even several centuries. Thus, with the current proposals, making true the dream of a self-sufficient Martian human is too far from here, because the current technological capability and social, political, financial, and mental scope of humanity are premature to do so (Szocik, 2019).

The only way out of this trap is to get ourselves changed a little bit to be adaptable to Martian conditions. If we can use the profusely available CO_2 in the Martian atmosphere to get our food and O_2 needs to be produced to some extent in our body itself, it would help a lot for humans to be free-living Martians. The needed technology/mechanism is already available in the spotted salamander on the earth, now it is just a matter of revealing it and applying it for the purpose.

The spotted salamander (*Ambystoma maculatum*) has an association with a single-celled green alga (*Oophila amblystomatis*) (Petherick, 2010). The invasion of the alga into salamander host tissues and cells shows a unique association between a vertebrate and a eukaryotic alga. Many algal cells naturally invade the embryo while the majority of algal symbionts remain within the egg capsule fluid and outside embryonic tissues (Kerney, 2011). These cells are capable of doing active photosynthesis, while those cells inside the opaque salamander embryo presumably do not receive the necessary sunlight. The large population of ectosymbiotic alga within the egg capsule may provide the greatest benefit to the embryo by generating

ISSN: 0067-3064

excess dissolved oxygen through photosynthesis (Kerney, 2011). Algal cells have somehow bypassed the salamander's adaptive immune system when invading. Further, the alga has not been found anywhere in the world except salamander eggs. The mechanisms which are responsible for those two phenomena are yet to be revealed. Once discovered, it will facilitate to incorporation of this technology into humans to make a ‘photoautotrophic human’. On the earth, the photosynthate that would be produced in a similar creature, would not be enough to be self-sufficient due to the lesser surface area we have, but on Mars, it may be adequate due to the elevated CO_2 concentration (Kaiser, 2017). If we can make the alga transmitted from one human to the other, like in the salamander, that would be an added advantage for Martians (Kerney, 2011). In this manner, we can make our human body ecosystem itself rich in biodiversity with symbiotic interacting elements for assembling self-sustaining life support.

If successfully adopted, this salamander technology may be developed in two different ways for people who want to be Martians forever, and those who want to visit Mars and come back. Though too ambitious, we can insert *O. amblystomatis* into the human zygote (as in spotted salamander) to produce photoautotrophic humans compatible with Martian conditions. Once produced, their offspring will be similar to them. For the visitors who wish to come back, we can give an injection that is capable of producing algal biofilm (spread like a tattoo) in the skin as preparation for the journey to Mars. When they come back we can give the counter injection to heal the skin invasion. Furthermore, coupling O. *amblystomatis* with radiotrophic fungi like *Cladosporium sphaerospermum* (Shunk et al., 2021) to form fungal-algal biofilm will be an added advantage in developing this technology as the biofilms would perform better than monoculture forms (Resch *et al*., 2005; Premarathna et al., 2022). From that, the photoautotrophic Martians will tolerate the high radiation on Mars while utilizing it for their survival as well.

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