Day 7 - Water

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Water purification and conservation is a challenge both faced on Earth and a pressing concern when considering Mars travel. Water reclamation (from liquid waste and from the water vapor astronauts will breath out) will be an important priority, finding and purifying Martian water sources will also be important when consider expanding the Martian mission to sustain more human colonizers who can't bring a lifetime supply of water with them to Mars (due to the imperfection of the reclamation process).

Astronauts also dramatically reduce the quantity of water they use for cleaning themselves, sponge baths, dry shampoo, washing hands with washcloths instead of a free flowing sink all help save water.

Found water

http://science.sciencemag.org/content/early/2018/07/24/science.aar7268
Water ice and CO2 ice are both present on Mars, sometimes the water ice is exposed, other times it is trapped below a thin (max 1 m) sheet of CO2 water. Some of this ice is known to be 10-20% mars dust, but other ice/water sources have unknown compositions of dust at this time - this will prove to be a challenge for purification(predicted to be 2-20%). It is hypothesized that high mineral content (think salt). There is also evidence of liquid water at the base of the polar deposits. The reason it has remained liquid is attributed to high quantities of perchlorates which strongly suppress the freezing of water. This water might be mixed with basal soil to create a sludge or may remain above the sludge.

We have already discussed how edited bacteria can be used to remove perchlorate from water sources. Water could be warmed up to liquid form or collected and brought into the space station, water would have to be brought to a hospitable temperature for the E. Coli - which might have to be adapted to survive in perchlorate water with currently unknown quantities of other additives. Perchlorate could be broken down by the bacteria and the organisms could be filtered out to remove both the toxins and the organisms. http://2014.igem.org/wiki/images/b/bf/IGEM_human_practices.pdf. We could create a biofilm as an effective filter to slowly push water through.

Recycling water https://science.nasa.gov/science-news/science-at-nasa/2000/ast02nov_1/
https://www.sciencedaily.com/releases/2009/05/090510200001.htm
https://www.electronicproducts.com/Electromechanical_Components/Motors_and_Controllers/Recycling_Air_and_Water_Aboard_the_International_Space_Station.aspx
https://www.smithsonianmag.com/science-nature/how-humble-moss-helped-heal-wounds-thousands-WWI-180963081/
Although much of the reclamation of water can be done using our human waste management protocol, recovering water lost during breathing and with plant transportation will be important as well.
Beyond bacteria - we are going to have to use genetically engineered plants to reclaim some of our water vapor if we want to move away from the machine system we currently use. Engineering bryophytes to absorb water from the air
Not Moss, but really this is a great plan http://science.sciencemag.org/content/341/6149/1230444
But Moss could counter as bandages and paper towels or toilet paper once dried. They would need to be engineered to require even lower levels of water for growth. They already only need limited sunlight so the natural martian light will be perfect, and a slightly acidic pH is favorable. They do have limited nitrogen needs which would need to be addressed.
There are some awesome uses bonus, and it should be easy to grow. The catch will be extracting the liquid from the moss when it is needed. Compressing it/squeezing it out seems to be the most frequently recommended strategy. Compression and vacuum suction would be my recommendation, or heating in a closed container and extracting the water vapor.

Activities

K-5

Magnetic slime acting as a representation of bacteria cleaning up perchlorate - the magnetic phagocytosis sludge to talk about targeting and sucking up toxins for breakdown. It looks like phagocytosis. Although it isn't exactly how the breakdown works it could teach students about targeting molecules.

Another experiment (think baking soda and vinegar) could demonstrate the breakdown of a toxin visually (from solid to gas/liquid)

6-8 and 9-12

Extracting water from moss

Growing moss species to figure out which one tolerates lower amounts of water, which ones you can extract water from the most easily, which one would be best for alternative uses?

https://www.greenbiz.com/article/synthetic-biology-hacks-code-sustainability