Assessing the efficiency of cyanobacterium-based BLSS on Mars

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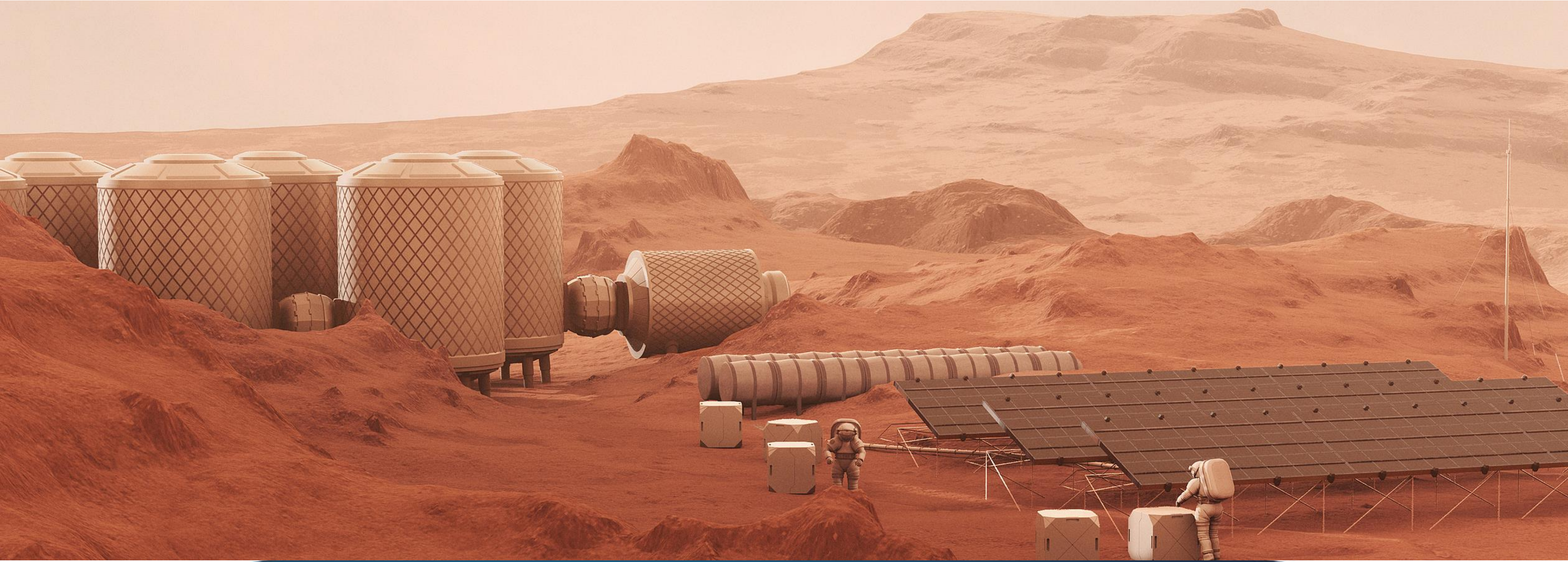
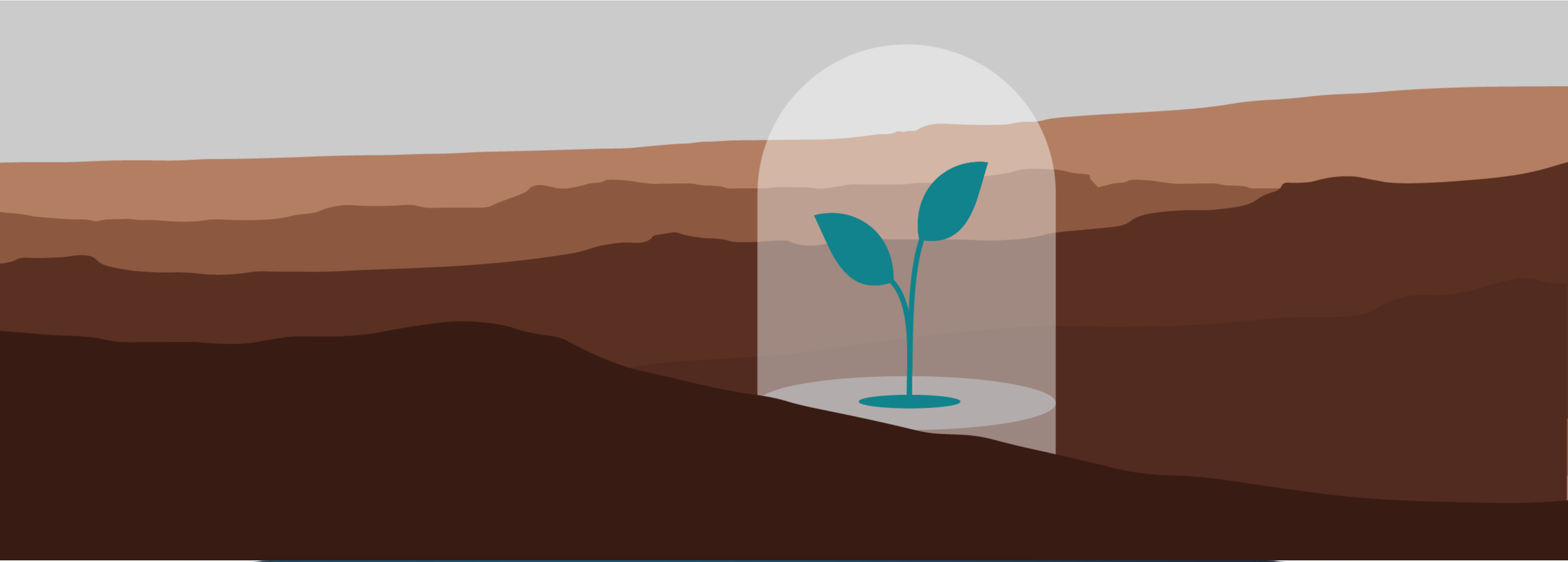
The Humans on Mars Initiative



https://www.uni-bremen.de/humans-on-mars-initiative

Project: Sustainable bioproduction on Mars



https://www.uni-bremen.de/humans-on-mars-initiative

Cyanobacterium model

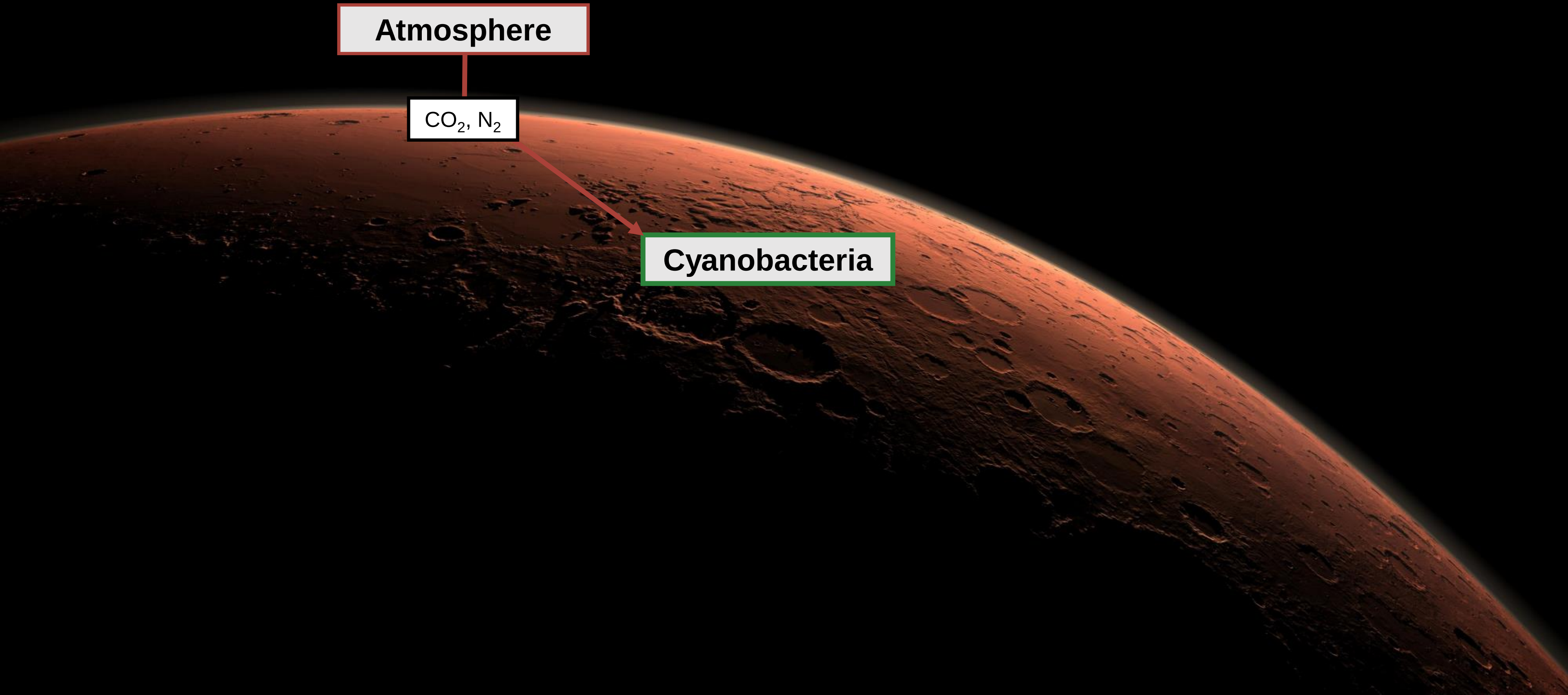
Anabaena sp. PCC 7938. Selected based on abilities to

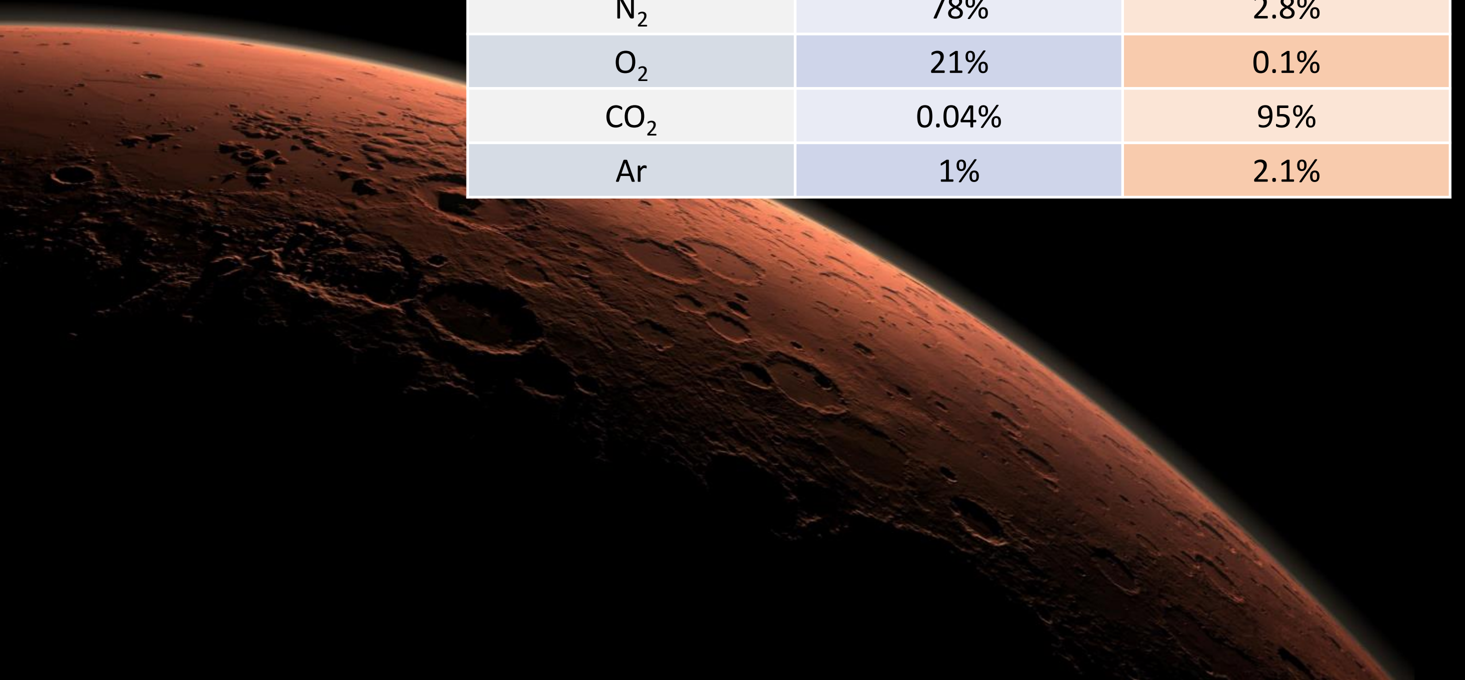
- use Martian resources and
- feed downstream processes.

Strain (PCC ID)	7120	7122	7524	7937	7938
Regolith-dependent growth	+	+	-	+/-	++
Perchlorate resistance	+/-	+	+	--	+/-
Suitability as feedstock for heterotrophs	+	+	+	+	+
Suitability as feedstock for aquatic plants	--	+	+	+/-	++
Culture homogeneity	+/-	-	+	-	+

Ramalho, T., et al. (2022). *Appl. Environ. Microbiol*. 88, e00594-22

Cyanobacteria to connect BLSS and ISRU





Parameter	Earth	Mars
Total pressure	1013 hPa (sea level)	6–11 hPa
N_2	78%	2.8%
O_2	21%	0.1%
CO_2	0.04%	95%
Ar	1%	2.1%

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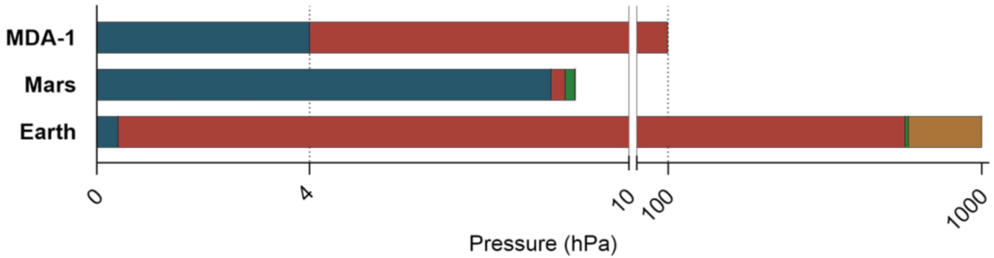
Atmosphere close to Mars-ambient: low constraints on materials and imported consumables

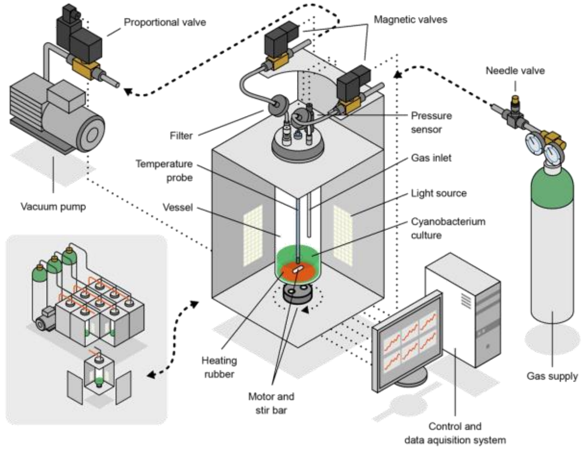
Too close to Mars-ambient: unsuitable for cyanobacterial growth (low P and pN_2)

→ Compromise to be found between engineering and biology

C and N can be sourced from a low pressure, N_2/CO_2 atmosphere

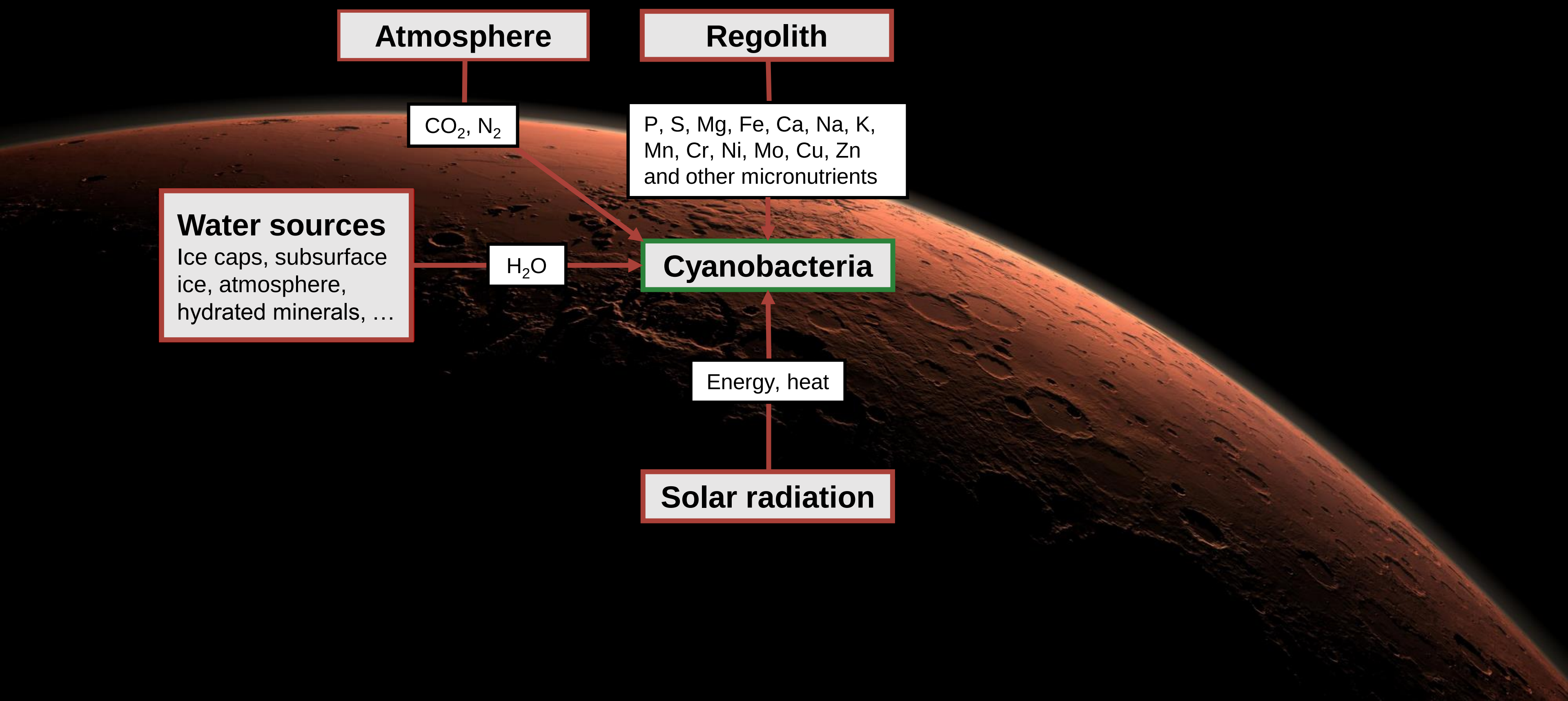
Atmosphere	Pressure (hPa)	CO_2	N_2	Ar	O_2
MDA-1	100	4%	96%	0%	0%
Mars	6–11	95%	2.8%	2.1%	0.1%
Earth	1013 (sea level)	0.04%	78%	1%	21%



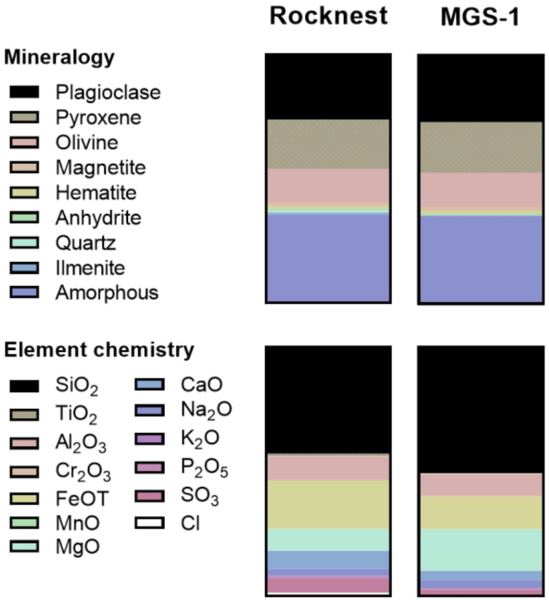


Verseux, C., et al. (2021). *Front. Microbiol. 12, 67*.

Cyanobacteria to connect BLSS and ISRU

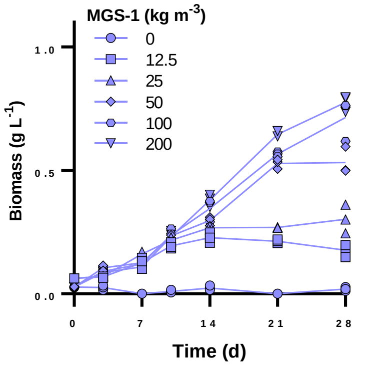


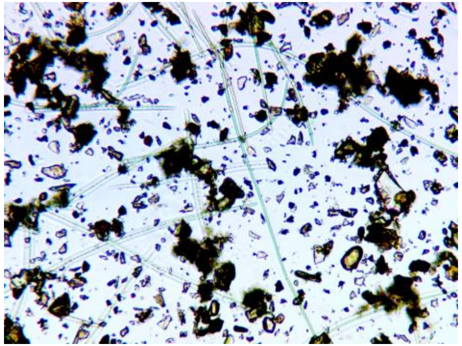
Growth of our model strain on regolith

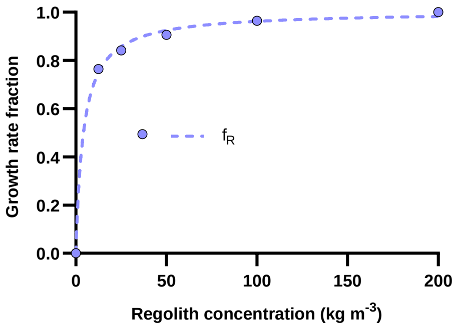


Mars Global Regolith Simulant (MGS-1)

Growth of our model strain on regolith







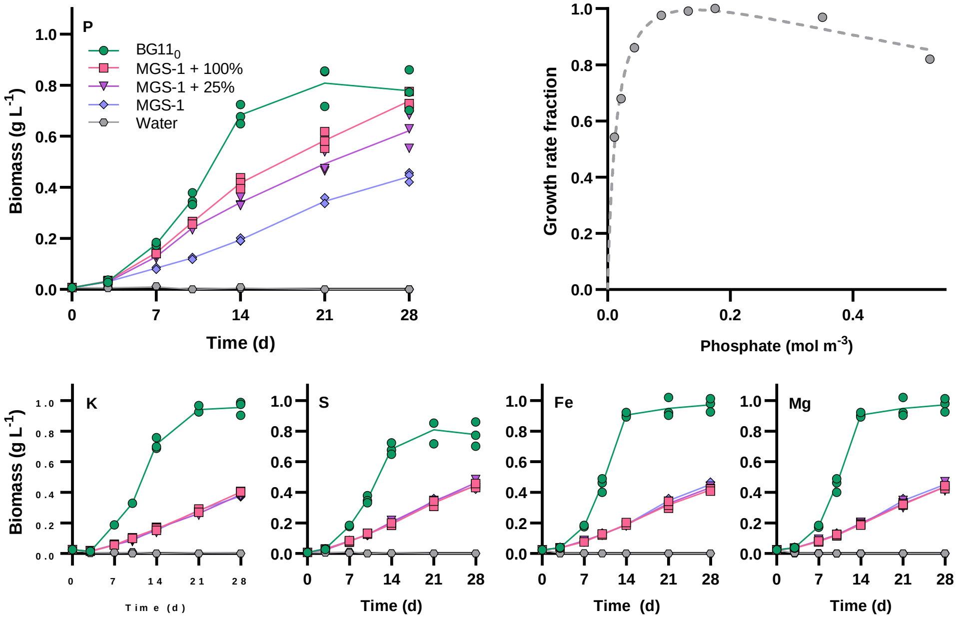
Ramalho, T., et al. (2022). *npj Microgravity* 8, 43.

Phosphorus limitation

Phosphorus:

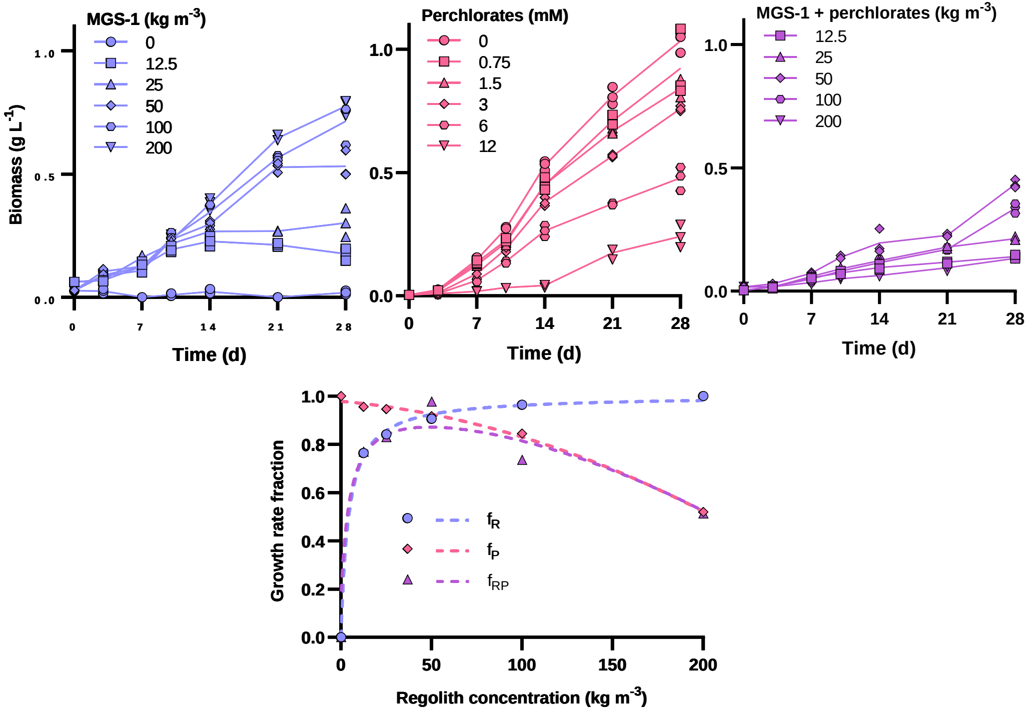
Limiting in the simulant.

Higher levels on Mars.



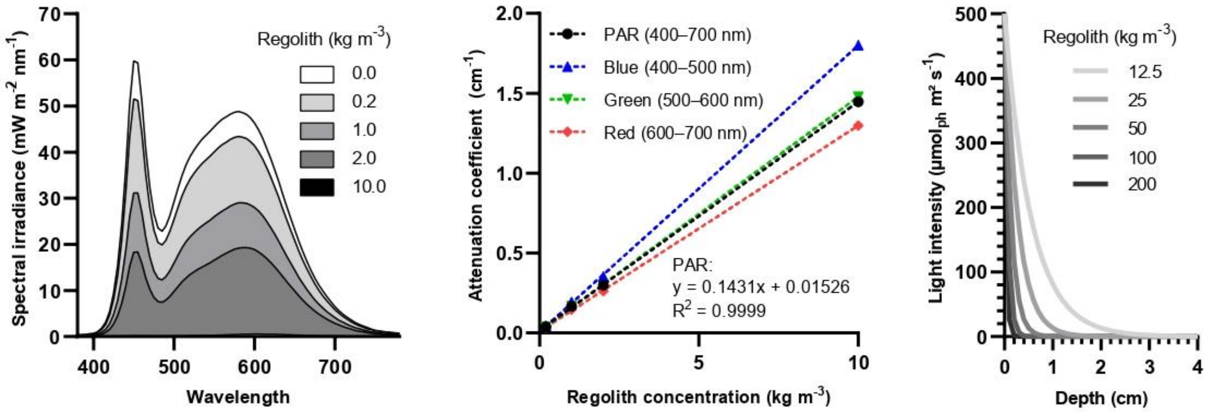
Ramalho, T., et al. (2022). *npj Microgravity* 8, 43.

Regolith: Feedstock and source of toxicity



Ramalho, T., et al. (2022). *npj Microgravity* 8, 43.

Regolith shading



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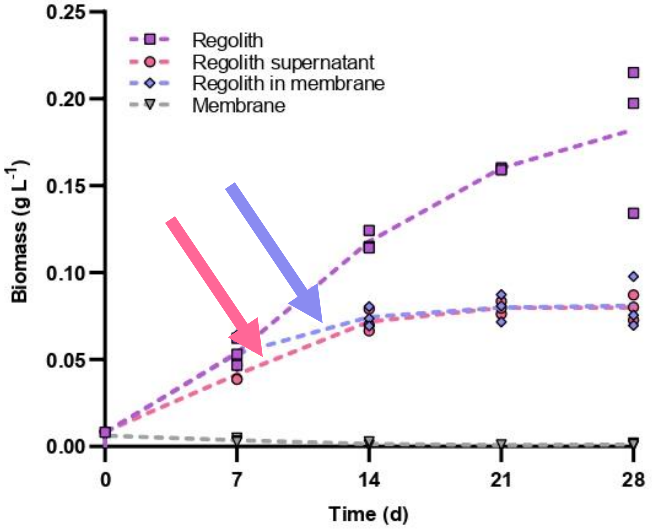
Regolith shading



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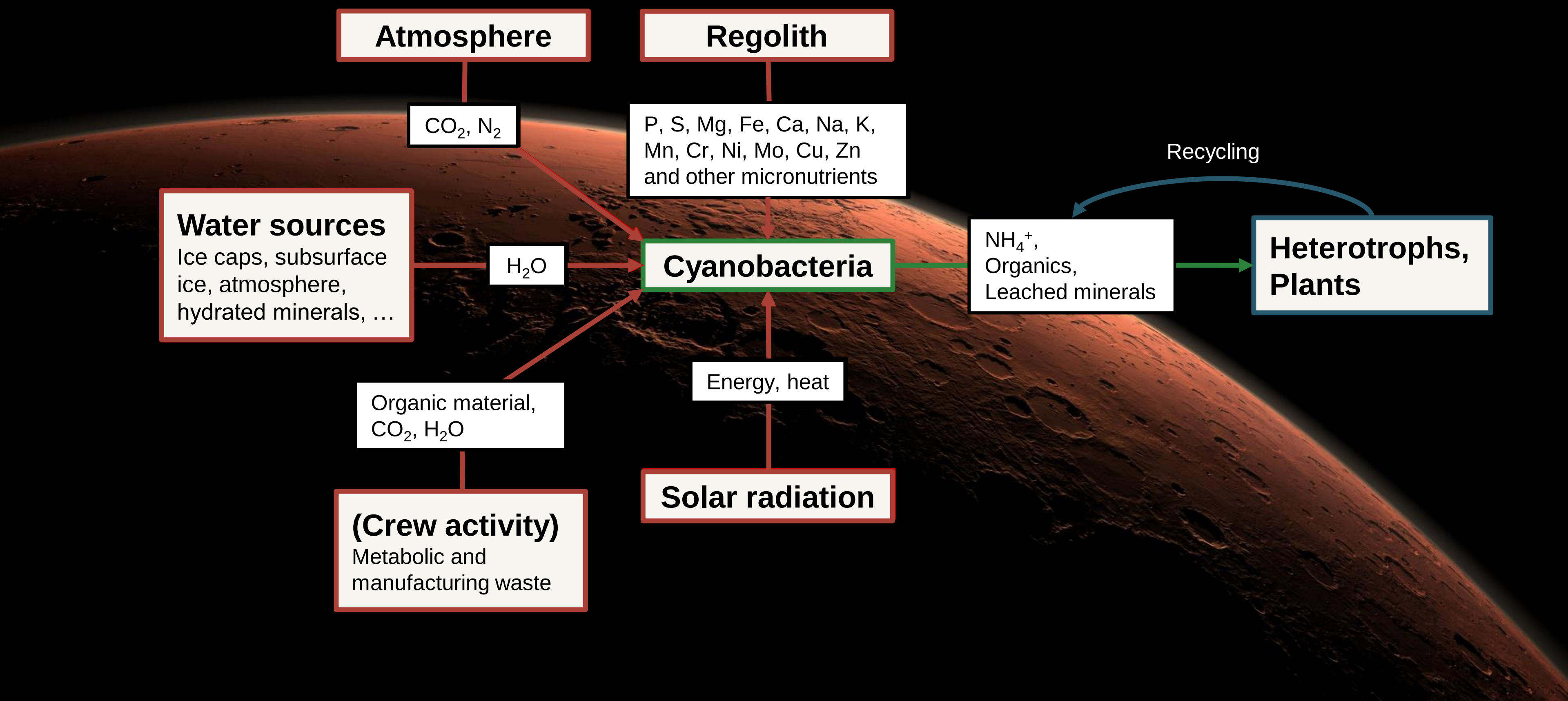
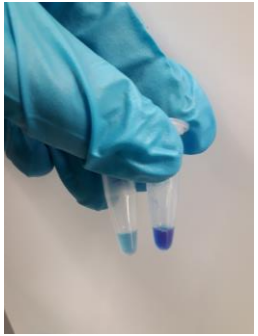
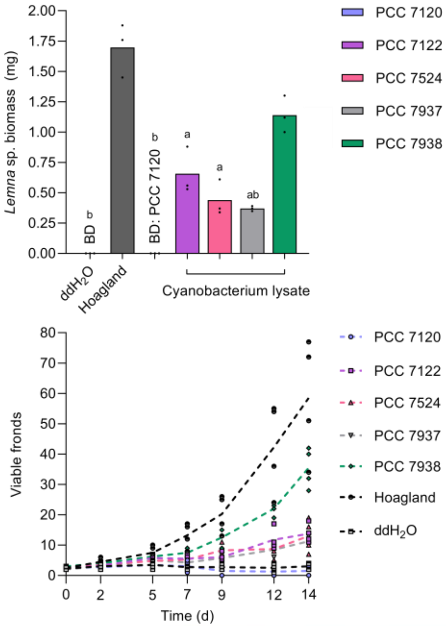
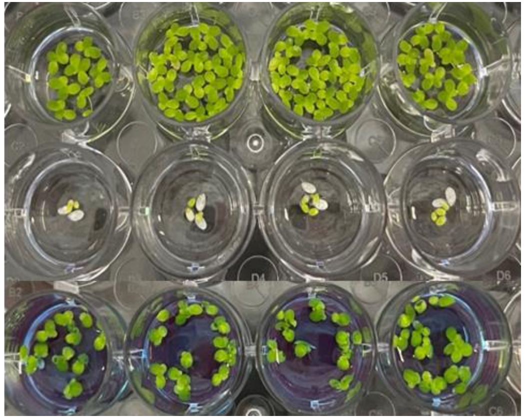
Cyanobacteria to connect BLSS and ISRU



Nutrient transfer example: Duckweed







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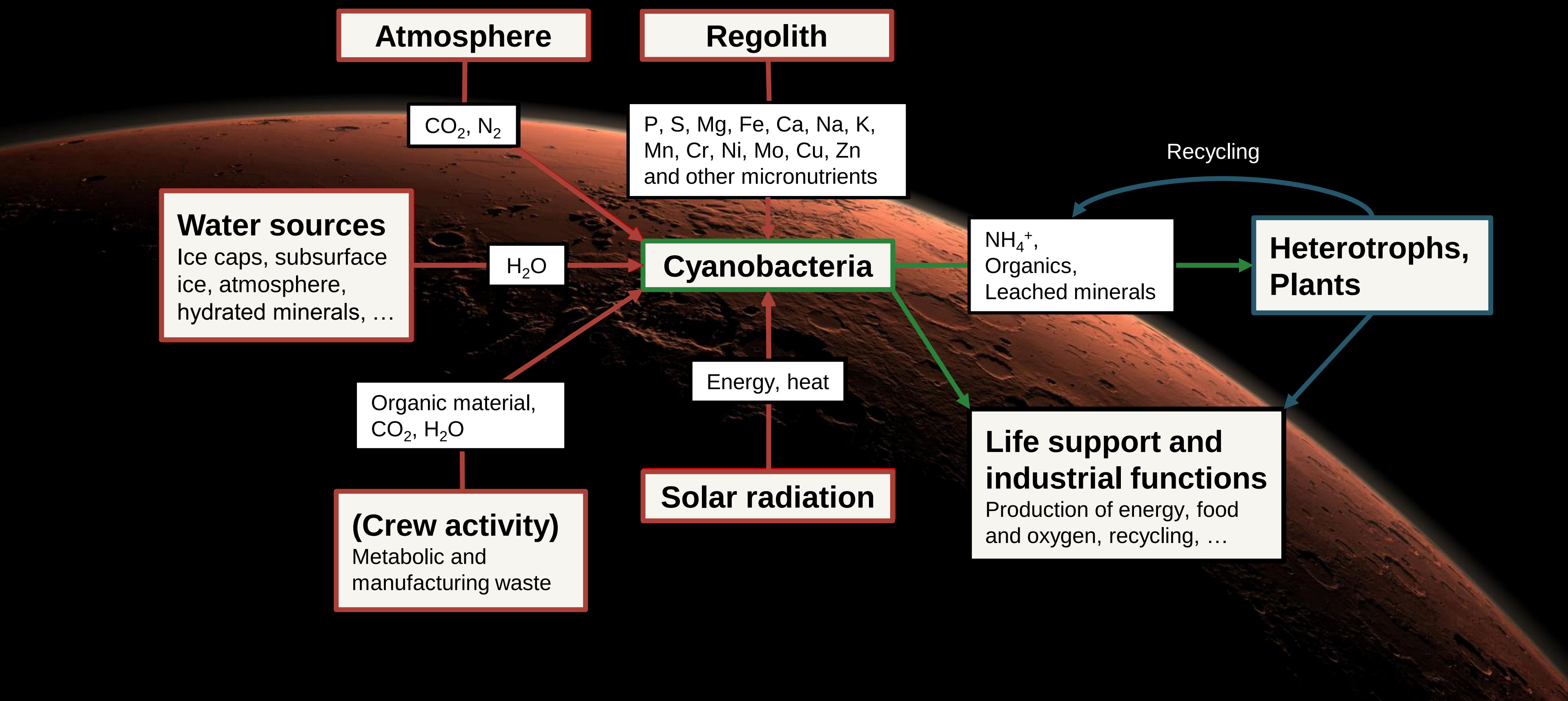
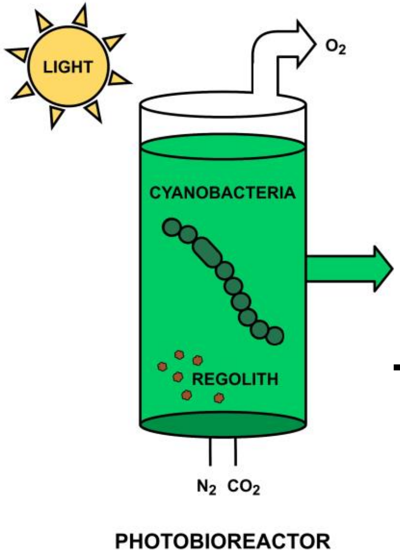
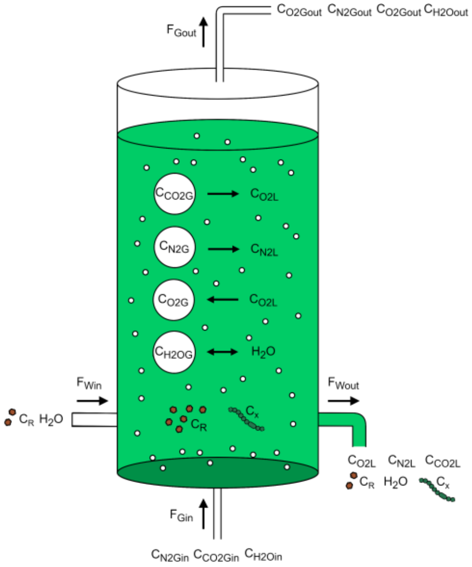
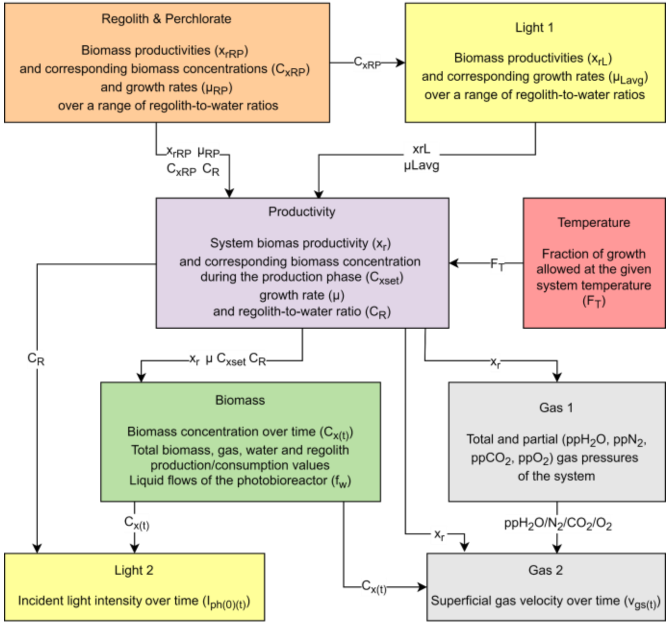


Assessing cost-efficiency







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Universität Bremen

CENTER OF APPLIED SPACE TECHNOLOGY AND MICROGRAVITY

ZARM

Thank you

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