Astronaut Micro-organisms

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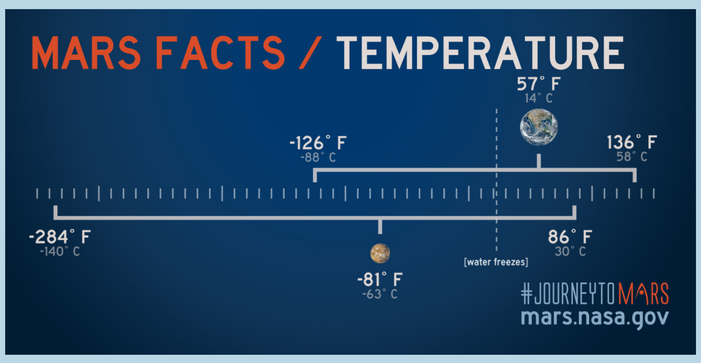
Life Conditions on Mars

Our goal is to study extremophiles capable of surviving on Mars. This would support the idea that terrestrial life can adapt physiologically to live on Mars. Here is a resume of life conditions on Mars to which the astronauts will have to adapt to.

Temperature



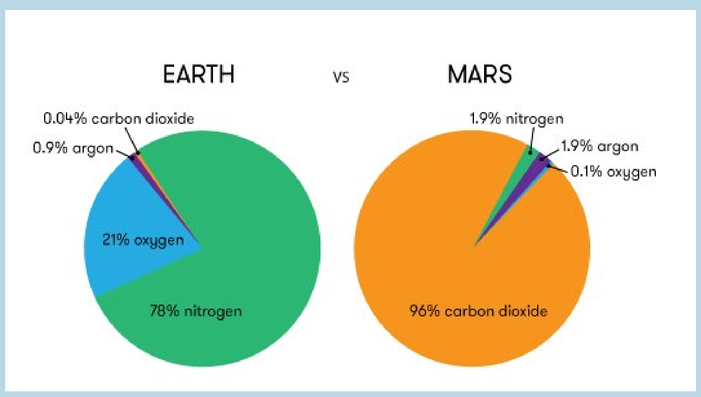
Pressur

- Pressure on Mars: 1-14 mbar (1000 times lower than on Earth!
- Consequence: inhibition of cell reproduction
- Minimum pressure for replication: 7 mbar

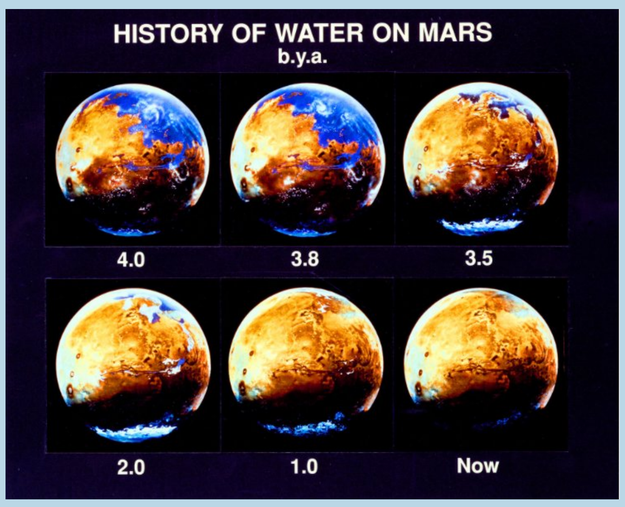
Solar radiation

- No global magnetic field: All life is vulnerable to cosmic and solar radiation.
- Radiation on Mars is 2.5 higher than in Earth
- Consequence: life is hardly imaginable on the surface
- Depth bellow surface for protection: 7.5 meters

Atmospheric composition



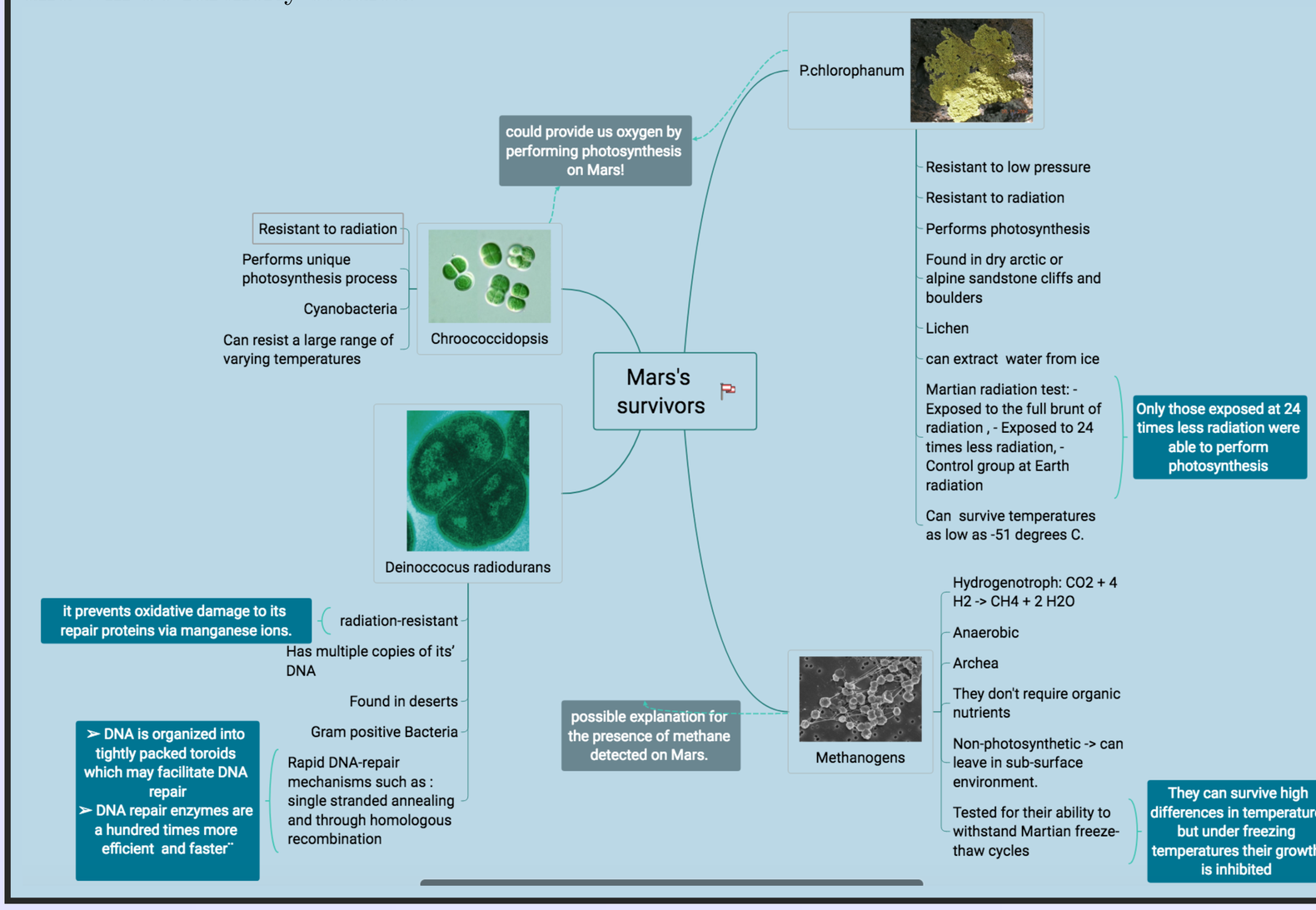
Presence of water



- No liquid water at the surface, but proof of liquid water on Mars in the past has been found.
- Ice form is favored by low pressure.
- It is believed that the disappearance of liquid water is the result of the loss of atmospheric protection over time.

Extremophiles capable of surviving on Mars

We study microorganisms that could potentially cope with the extreme conditions on Mars. In the map below, only four examples are given but many others may exist. Each of these microorganisms can survive to one or multiple challenging conditions such as the *low temperatures*, the *low pressure*, the *intense radiation* or the of *lack water*. *P.chlorophanum* seems to be a particularly good candidate and will be furtherly studied.



Adaptation of P.chlorophanum to Martian niche conditions

P.chlorophanum is capable of performing photosynthesis when located in niches that protect it from radiation. A recent research has demonstrated its capabilities under a simulation of Martian conditions.

Graph **A** compares how well photosynthesis works in niche conditions, in the laboratory before the simulation, in Martian conditions and in Martian conditions after 34 days of adaptation. Photosynthesis performance is measured by the activity of Photosystem II. When the lichen is initially put in Martian conditions, there is a "shock effect". This means that a lot of energy is ineffectively transformed into heat. As it adapts to the new environment, this loss of energy from the shock effect decreases with time. So, an increase of the photosynthesis activity after 34 days is expected.

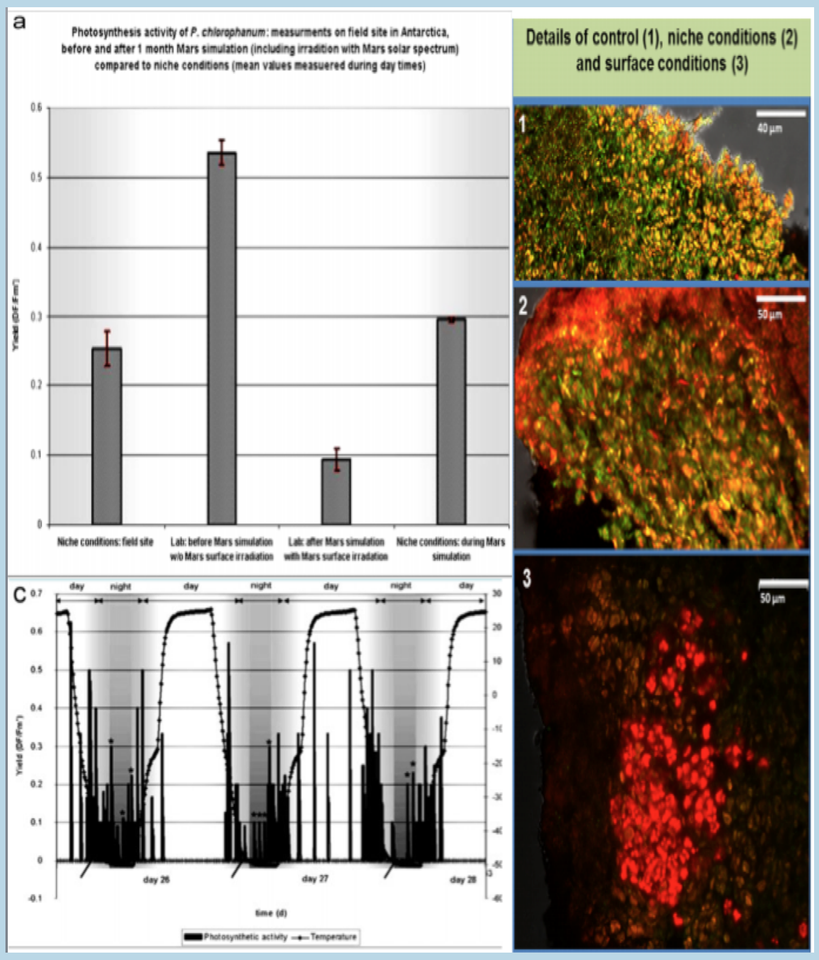


Figure **B** (on the right) illustrates the lichen's survival when the radiation is as high as on Mars. The dye used is called LIVE/DEAD-staining dye FUN I. It stains in green metabolic inactive thallus, in red metabolic active thallus. The yellow colour shows the metabolic activity of the cells changing from green to red. Dead cells are unstained. The results show little vitality difference between the control and niche conditions. However, in surface conditions in which the radiation is higher, between 1/3 and 1/2 of the thallus is vital and the rest of the symbionts died. Fungal cells were less capable of surviving to the intense radiation than the algal cells. The reason is that the fungal cells surround the algal cells, so the algal cells are protected.

Graph **C** shows the influence of the temperature on photosynthesis. The results have shown that photosynthesis is increased at low temperatures but impossible without light.

So, the lichen's highest photosynthetic rates occur at sunrise and sunset. It looks as though photosynthesis occurs all night but a (*) indicates that it stops once there is no more light.

In a nutshell, the fungal cells' activity is influenced by the UV while the algal cells' photosynthesis activity is influenced by the temperature. In their teamwork, the aerobic fungal cells provide protection and the CO2 consuming algal cells "pay back" by producing oxygen.