

## **Characterization of growth and photosynthesis of *Synechocystis* sp. PCC 6803 cultures under reduced atmospheric pressures and enhanced CO<sub>2</sub> levels**

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Within planetary and astrobiological research, plans are being made for manned stations on the Moon, and manned missions to Mars. In this context there is a need to search for means of using photosynthetic organisms as a life support system for the production of molecular oxygen and organic carbon. In these situations photosynthetic organisms would be cultured in strictly contained facilities, but still, the culture conditions need to be adjusted, as far as possible, to the given extraterrestrial environments, which can be quite harsh. Thus, one would use minimal suitable atmospheric pressure and minimal suitable temperatures, and in Mars, the air would be mostly carbon dioxide with very low oxygen, and the soil would have high salinity and low pH. It is clear that the commonly used crop plants are not adaptable to such culture conditions. Instead, unicellular organisms, and in particular, different species of cyanobacteria are known to be much more adaptable. They also colonize different extreme conditions on the Earth. However, the minimal growth conditions, which still produce efficient growth have not been established for any cyanobacterial species or strain. In this work, we intend to determine the minimal physical conditions, which still allow maximal growth of laboratory strain of cyanobacteria. Later, similar minimal conditions will be sought for some non-toxic cyanobacteria species, isolated from the cool Nordic environment.

In the preliminary experiments we have used the glucose tolerant, wild-type strain of *Synechocystis* sp. PCC 6803 to test its adaptability to low atmospheric pressure, and to different CO<sub>2</sub> concentrations. Our experiments have been conducted in vacuum bottles, where the air pressure has been reduced to 0.1 bar. In the first experiment the vacuum was released at three days intervals, and the maximal photosynthetic capacity of the cells determined using oxygen electrode. In these conditions, the growth of the cells was strongly reduced as compared to the control cultures in ambient air, but the oxygen evolution activity of Photosystem II, and the photosynthetic capacity of the cells remained unaltered. The cells also resumed very rapid growth when returned to the normal air pressure after nine days. However, when the cells were kept in the reduced air pressure without opening the system in between, no total cell growth was observed over the nine days period. Monitoring of the system's CO<sub>2</sub>-content revealed that this gas was utilized to zero within first few days of the culture. When the vacuum was released on the ninth day, the cells still recovered rapidly, but when incubation in vacuum was continued up to fourteen days, the cells did not recover. In the next experiment the cultures in the 0.1bar atmosphere were continuously flushed with 1% CO<sub>2</sub>. In these conditions the cell growth was grossly enhanced, to about 3 times that of the control culture, which was maintained in the same growth conditions but in ambient air.