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CYBELE: CROP YIELDING, BIOGENERATIVE ENVIRONMENT FOR LIFE-SUPPORT AND
EXPLORATION**Abstract**

Long duration human exploration of Mars calls for the production of fresh, nutritional, and regenerative food. The Crop Yielding, Bioregenerative Environment for Life-support and Exploration (CYBELE) greenhouse fulfills the dietary requirements of a four person crew for a 600-sol mission on Mars. As an inflatable attachment to the Mars Ice Home human habitat, CYBELE uses radiation shielding in the form of water ice and carbon dioxide (CO₂) cells obtained through in-situ resource utilization. The two structures exchange gas, biomass, energy, and water to create a semi-closed system, with some input from the Martian environment. A range of crops are grown, supplying the crew with a variety of carbohydrate, protein, and lipid staples. Whatever is leftover from harvest, along with other solid and liquid waste from both the Ice Home and CYBELE are recycled in waste management systems recovering the majority of the nutrients. The greenhouse employs novel uses of hydrogels, synthetic biology, hyperspectral cameras, and AI software to alert the crew when plants are diseased or ready to be harvested. This report covers in depth how CYBELE meets the nutritional and psychological needs of the astronauts, the crop choices and growth cycles, material and architectural choices, lighting needs, waste processing, and a comprehensive list of failure modes.