An insight on Purple-B project: Hydrogen production from immobilized cells in photo-bioreactors

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Hydrogen has been widely recognized as a promising tool to address global warming problems, due to its high energy density and the sustainability of its utilization[1]. Although being currently not economically competitive[2], hydrogen production through bioprocesses is regarded as a promising approach in terms of sustainability. This is attributed to the mild operative conditions[3–4], minimal net greenhouse gas emissions[4], and the potential to exploit waste materials and wastewaters as carbon and energy source[5]. In this perspective, the Purple-B project aims to develop a two-stage sequential Dark and Photo-fermentation system for treating waste generated by astronaut crews. The implementation of a two-stage process using food waste and black water or sewage sludge, which are the primary waste streams in a space station, presents an opportunity to maximize hydrogen (H_2) recovery from these substrates. This approach creates a direct waste-to-energy nexus, simultaneously purifying the effluent and generating a supply of H_2. Moreover, the immobilization of Purple Non-Sulfur Bacteria (PNSB) on a hydrophilic matrix enables the system to function in microgravity conditions, such as on planets (e.g., Mars) or within a gravity-free environment like a space station. By employing an immobilized biomass photobioreactor, the volume of water circulating through the system is minimized, allowing for better control of biomass growth. Thus, the Purple-B reactor serves as a crucial component within the closed system of a space station, effectively transforming waste into energy.

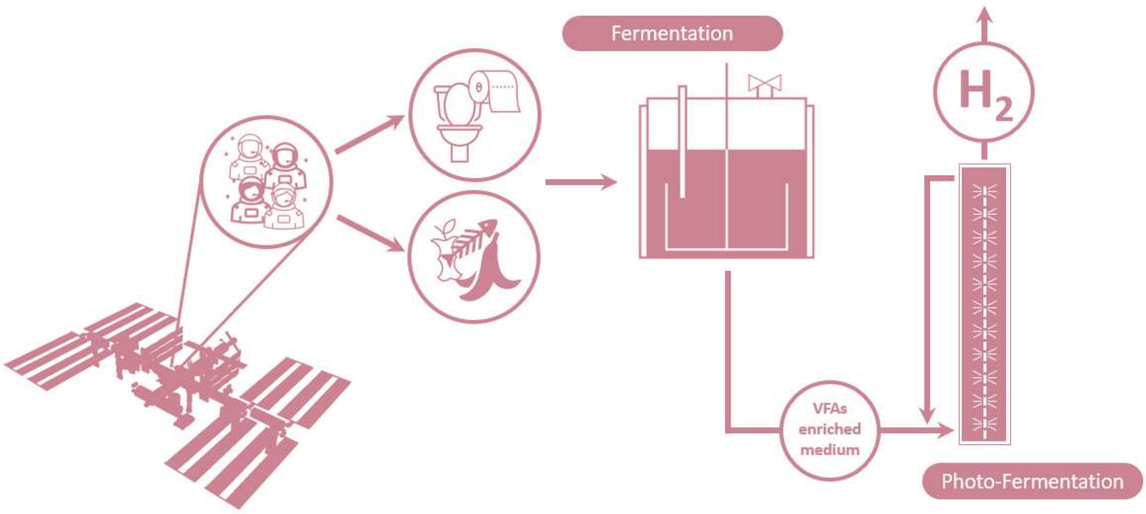

Figure 1. Schematic representation of the Purple-B project

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