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# Scientific challenges to prevent the biological contamination of Outer Solar System bodies - what do we need to know for planetary protection?

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## Abstract

With increasing evidence of the presence of liquid water in the outer Solar System, the number of potentially habitable environments has increased and, in consequence, the issue of contaminating other solar system bodies has become more important and relevant. Within the current Planetary Protection framework, the challenges to prevent the unwanted biological contamination of Outer Solar System bodies of astrobiological interest, here especially Europa and Enceladus, are tightly linked to the potential of Earth organisms to arrive at and survive and replicate in an environment in the Outer Solar system that would be habitable for them ("problematic species"). The identification of these relevant groups of organisms was addressed through background research, a dedicated international workshop and the consultation of additional experts in geology, geophysics, space radiation dosimetry, radiation biology, planetology, and microbiology.

Problematic species for icy moons were identified as those that are able to survive long periods of desiccation and exposure to radiation and thereafter can replicate at low temperatures under oligotrophic anaerobic conditions in the presence of salts. There is a need for long-term microbiological research to characterise the cleanroom microbial community with respect to the presence of problematic species. The unknowns about the environment, especially the radiative environment, but also the extent of exchange processes between the moon's surface and the subsurface ocean, its composition and the temperature gradient in the ice shell also need to be explored in respect to their effects on microorganisms.

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