Selenium respiration in bacteria: does energy generation pay off?

Although thermodynamically-favorable and documented in phylogenetically-diverse bacteria, Selenium (Se) respiration appears to be accompanied by a number of challenges and numerous unanswered questions. Selenium oxyanions, $\text{SeO}_4^{2-}$ and $\text{SeO}_3^{2-}$, are reduced to elemental Se, $\text{Se}(0)$, through anaerobic respiration, the end product being solid and displaying a considerable size (up to 400 nm) at the bacterial scale. Moreover, various allotropic forms and shapes of biogenic $\text{Se}(0)$ are potentially detrimental for cellular integrity and homeostasis. Compared to other electron acceptors used in anaerobic respiration, Se is the only element whose end product is solid. Furthermore, unlike other known bacterial intracellular accumulations, $\text{Se}(0)$ has not been shown to play a nutritional or ecological role for its host nor does it display any other function. In the context of anaerobic respiration of Se oxyanions, biogenic $\text{Se}(0)$ appears to be a by-product, a waste that needs proper handling and this raises the question of the evolutionary implications of this process. Why would bacteria select for a metabolic process that is useful, in the first place, and then highly detrimental? Interestingly, in certain artificial ecosystems (e.g. up flow bioreactors), $\text{Se}(0)$ might help bacterial cells to increase their buoyancy and thus avoid biomass wash-out, ensuring survival. However, this process has only been revealed for “recent” man-made ecosystems and mixed microbial communities (granular sludge). This presentation will explore in depth the thermodynamics, enzyme systems, genetic determinants and the evolutionary implications of selenium respiration in bacteria, attempting to answer a number of questions including i) where does the nucleation process of $\text{Se}(0)$ occur in bacteria, ii) are there any viable possibilities for $\text{Se}(0)$ extracellular transport, and iii) what are the evolutionary implications for bacteria that adopted this strategy to generate cellular energy.

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All interested colleagues are kindly invited.