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Anammox bacteria: microbes with identity issues

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Anammox bacteria convert ammonium and nitrite to nitrogen gas to obtain energy for growth. The anammox reaction was deemed impossible until its discovery in the early 1990s. Now, anammox is recognized to contribute significantly to oceanic nitrogen loss and is estimated to be a major source of gaseous nitrogen on Earth. In addition, anammox bacteria are extremely valuable for wastewater treatment where they are applied for the removal of ammonium. Besides their importance in industry and the environment, anammox bacteria defy some basic biological concepts. Whereas most other bacteria have only one cell compartment, the cytoplasm, anammox bacteria have three independent cell compartments, from out- to inside; the paryphoplasm, riboplasm and anammoxosome. The anammoxosome is the largest cell compartment and is proposed to be dedicated to energy transduction. As such it would be analogous to the mitochondria of eukaryotes. The riboplasm contains the nucleoid and ribosomes and the paryphoplasm has a yet unknown function. Having three cellular compartments poses challenges to protein sorting, substrate transport and cell division and it is largely unknown how anammox bacteria achieve these functions. In addition, anammox bacteria are proposed to have an atypical cell wall devoid of both peptidoglycan and a typical outer membrane. We use cell fractionation, proteomics and immunolocalization studies combined with advanced (cryo)electron microscopy techniques (such as (cryo)electron tomography) to study the ultrastructure and function in anammox bacteria.