LS-6-IN-5834 Microbes with identity issues: the energy-conserving prokaryotic organelle and (atypical) cell wall of anammox bacteria

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Anaerobic ammonium-oxidizing (anammox) bacteria are recognized as major players in the global nitrogen cycle and estimated to be responsible for up to 50% of the nitrogen in the air that we breathe. In addition, anammox bacteria are extremely valuable for wastewater treatment where they are applied for the removal of nitrogen compounds. Besides their ecological and industrial importance, anammox bacteria defy some basic biological concepts. Whereas other bacteria have only one cell compartment, the cytoplasm, anammox bacteria have three independent cell compartments. The innermost, major, cell compartment is called the anammoxosome and is the location of the anammox reaction. We propose that the anammox reaction is coupled to the anammoxosome membrane, leading to the establishment of a proton motive force and subsequent ATP synthesis. To test this hypothesis, we have isolated the anammoxosome from the cell and investigate its role as the energy factory of the cell. In addition, anammox bacteria are proposed to have an atypical cell wall devoid of both peptidoglycan and a typical outer membrane. The anammox cell wall thus does not seem to resemble that of other known bacteria but instead resembles the cell wall of Archaea; with an energized outermost (cytoplasmic) membrane and a surface protein layer on top. Both anammoxosome and cell wall projects combine molecular and protein toolboxes with (cryo-)electron microscopy techniques. The results will add new insights to the fundamentals of bacterial cell biology. In addition, understanding how anammox bacteria work is important for global climate change and development of sustainable wastewater treatment systems.