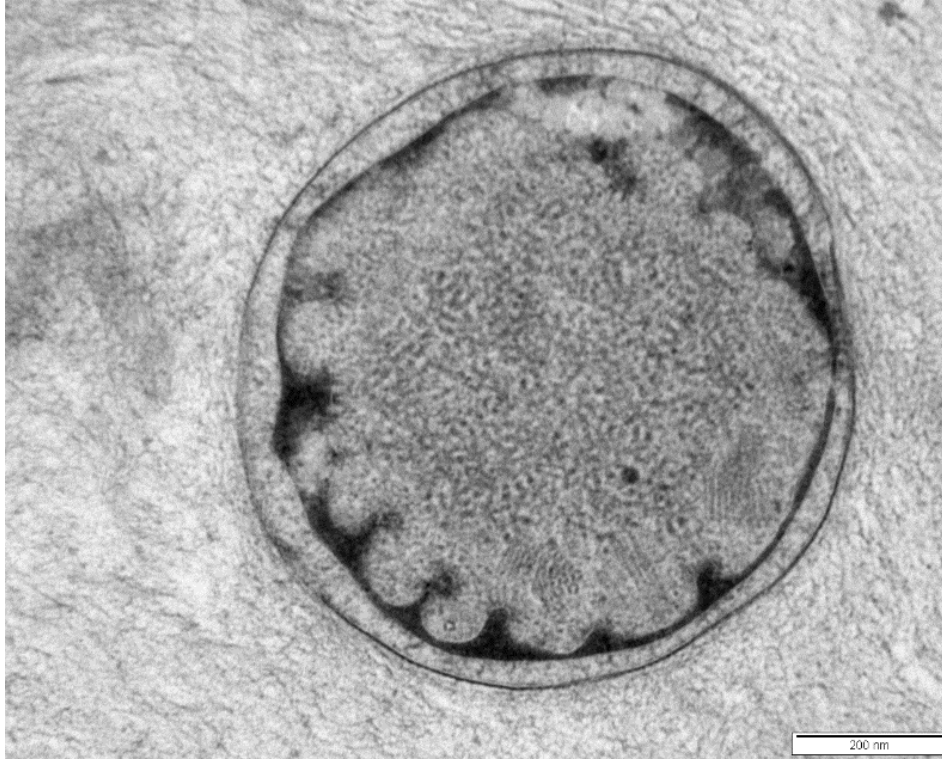


The Anammoxosome

(Laura van Niftrik)



This is a section through the middle of an anammox cell imaged with an electron microscope (as if you would cut an apple in two and look at the inside). In the inside you can see the large anammoxosome with the curved membrane – the energy factory of the cell.

Ammonia and Anammox bacteria.

Ammonia is introduced in enormous quantities into the environment, both as an agrochemical fertilizer and as animal and human urine and faeces. Where ammonia occurs in high concentrations, it can be a threat to a healthy ecosystem as it can lead to a devastating cascade of nutrient enrichment (a.k.a eutrophication), toxic algal blooms, oxygen depletion and potential fish death in aquatic environments (water systems).

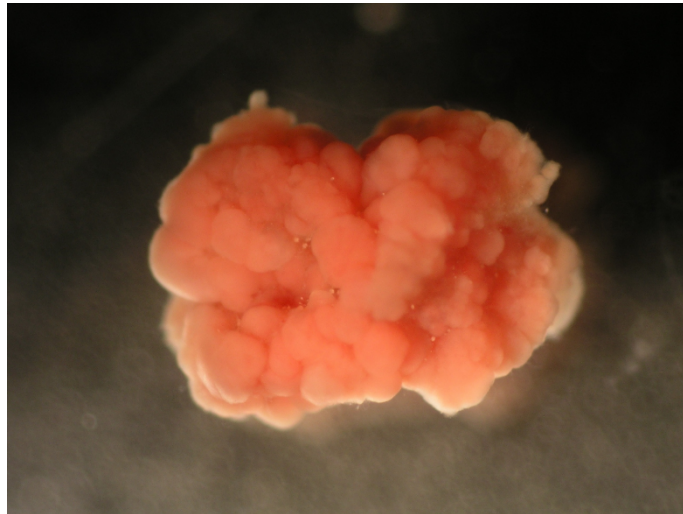
Fortunately, special bacteria – the *anammox bacteria* – live on ammonia – they use it as a fuel to power their growth and other activities – and convert it to harmless dinitrogen gas which is released into the air. They can do this because they contain a mighty machine that carries out the conversion of ammonia to nitrogen: the *anammoxosome*. When anammox bacteria use ammonia for growth, they remove it from the environment and so reduce ammonia pollution. They are friends of the environment and of us!

A child-centric microbiology education framework

The Anammoxosome.

Anammox bacteria are single, sphere- (or ball-) shaped cells with a typical diameter of 800 nm (this is 0,0008 mm...!). Each cell contains one anammoxosome which occupies the major part of the cell and measures about 600 nm in diameter (0,0006 mm). The anammoxosome, which is the power house, or energy-generating machine, of anammox bacteria, is thus a major subcellular structure.

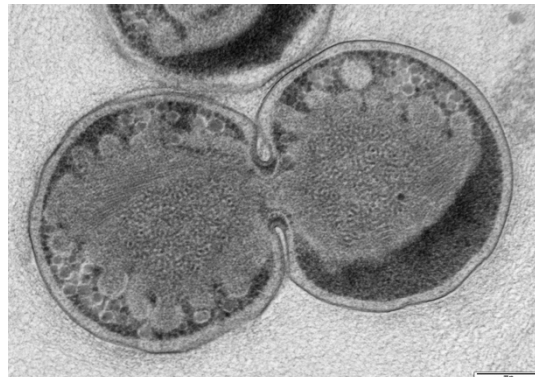
In order to carry out conversion of ammonia to nitrogen, the anammoxosome needs a lot of electron-transfer proteins called cytochromes which have a red colour. For this reason both anammoxosomes and anammox bacteria have a bright red colour which we can see when we have enough bacterial cells together.



These are millions of anammox bacteria together forming a clump. The image is taken with a normal camera and the width of the clump is a few mm.

The anammoxosome is surrounded by a lipid membrane that is highly curved and wavy, which provides it with extra surface. Since ammonia must enter the anammoxosome, and nitrogen must leave it, via the membrane, the membrane serves as a sort of stock exchange. So the larger the membrane surface area, the greater the exchange and the more efficient energy production is!

When an anammox cell divides into two daughter cells, the anammoxosome is equally divided among the two daughter cells as well.

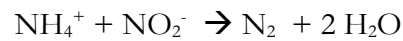


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The anammoxosome is one of a kind and it is quite unusual that a bacterium has such a complex subcellular structure. In fact, this type of cell compartmentalization is reminiscent of that of higher microorganisms (eukaryotes) that have a more complex cell organization than the simpler bacteria and archaea (prokaryotes). The anammoxosome may be considered to be analogous in function to the mitochondria of eukaryotic cells (see Mighty Machine - The Mitochondria).

So what actually does the anammoxosome do?

Like said before, anammox bacteria live of the nutrient ammonia and convert it to dinitrogen gas. The bacteria obtain energy from this conversion. The conversion of ammonia is executed in the anammoxosome and by doing so, the anammoxosome conserves the energy that was trapped in this reaction to a free currency for the cell called "ATP". The energy molecule ATP can be freely used to pay for (or fuel) other cellular processes such as growth.



And we can use anammox bacteria/anammoxosomes in biotechnology to reduce the environmental burden of ammonia.....

Since the anammoxosome is the energy factory of the cell it is essential to the anammox bacteria. And as anammox bacteria help us clean the natural environment and our wastewater from toxic nitrogen by using the anammoxosome it is also of utmost importance to us!

The Anammoxosome is a Mighty Cellular Machine!