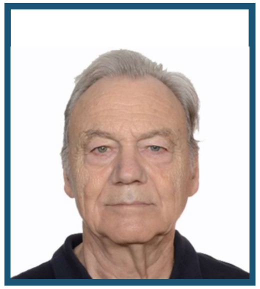
JORNADA PCI/CBPF
APRESENTAÇÃO DE PÔSTER – 2019/2020

CBPF Centro Brasileiro de Pesquisas Físicas – UNIDADE DE PESQUISA DO MCTI

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÕES

PÁTRIA AMADA BRASIL – GOVERNO FEDERAL



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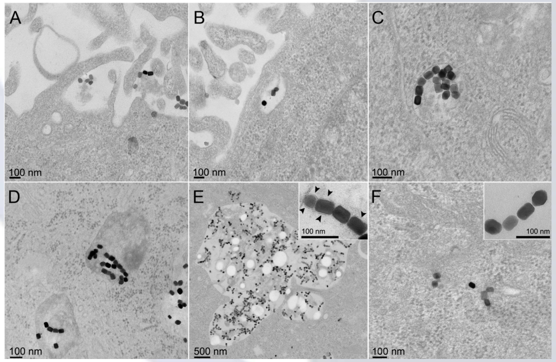
TÍTULO DO PROJETO:	**Bacterial magnetite magnetsosome and their application in biomedecin**

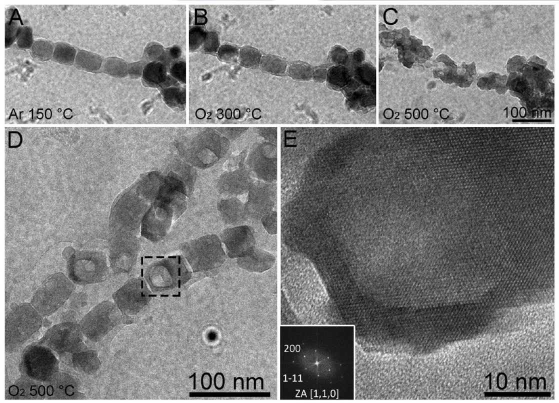
Magnetotactic bacteria biomineralize intracellular magnetic nanocrystals surrounded by a lipid bilayer called magnetosomes. Due to their unique characteristics, magnetite magnetosomes are promising tools in biomedicine and paleomagnetism.

First study (1) The endocytic pathway of magnetite magnetosomes and their effects on human cervix epithelial (HeLa) cells were studied by electron microscopy and nano-analysis techniques. Transmission electron microscopy of HeLa cells after incubation with purified magnetosomes showed the presence of magnetic nanoparticles inside or outside endosomes within the cell, which suggests different modes of internalization, and that these structures persisted beyond 120 h after internalization. Cytotoxicity and microscopy analysis showed that magnetosomes did not result in any apparent effect on HeLa cells viability or morphology. Based on our results, magnetosomes have significant biocompatibility with mammalian cells and thus have great potential in medical, biotechnological applications.

Second study (2) Because of the stability of these structures in certain environments after cell death and lysis, magnetosome magnetite crystals contribute to the magnetization of sediments as well as providing a fossil record of ancient microbial ecosystems. Here we evaluated the thermal stability of magnetosomes in a temperature range between 150 and 500 °C subjected to oxidizing conditions by using **in situ transmission electron microscopy**. Results showed that magnetosomes are stable and structurally and chemically unaffected at temperatures up to 300 °C. Interestingly, the membrane of magnetosomes was still observable after heating the samples to 300 °C. When heated between 300 °C and 500 °C cavity formation in the crystals was observed most probably associated to the partial transformation of magnetite into maghemite due to **the Kirkendall effect at the nanoscale**. This study provides some insight into the stability of magnetosomes in specific environments over geological periods and offers tools to investigate biogenic nanomaterials .



Conventional transmission electron microscopy images of stained ultrathin sections of HeLa cells showing internalization of magnetite magnetosomes purified from strain MV-1.A) Magnetosomes at the surface of cells showing the first steps in endocytosis. B; C; D; E) Endocytic vacuoles in the cell cytoplasm containing magnetosomes, some of them smaller without lysosomes, close to cell membrane (B), deep inside cell cytoplasm (C), and (D), or in large endocytic vacuoles with magnetosomes and lysosomes (E), the inset shows magnetosomes in endocytic vesicles in detail (arrowheads indicate the magnetosome membrane). F) Magnetosomes in the cytoplasm of the cell, the inset shows magnetosomes from this region in detail, showing the absence of the magnetosome membrane.



Conventional transmission electron microscopy images of magnetosomes during *in situ* heating experiment when subjected to 150 °C until500 °C and exposed to Ar and O_2. From (**A**) to (**C**) in irradiation condition, (**A**) CTEM image of a chain of magnetosomes at 150 °C with Ar; (**B**) CTEM image of the same chain shown in (**A**) after heating to 300 °C and exposed to O_2; (**C**) CTEM image of the same chain shown in (**B**) after heating to 500 °C and exposed to O_2 and irradiated by the electron beam; (**D**) CTEM image of magnetosomes at 500 °C exposed to O_2 obtained in a region that has not been irradiated by the electron beam. (**E**) Enlarged image of the boxed area in Fig. D (see also the showing a cavity in the magnetosome structure due to **the kikendall effect**. Inset shows the FFT corresponding to this high-resolution image. The corresponding zone axis can be assigned to magnetite or maghemite but also to a mixed structure.

References:

(1)Jefferson Cypriano, Jacques Werckmann et al. PLOS ONE (2019)
(2) Jefferson Cypriano,…………, Jacques Werckmann, SCIENTIFIC REPORTS (2020)