

## Variations in the Morphologies and Magnetic Properties of Magnetite Crystals in Bacteria

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We have used a combination of advanced transmission electron microscopy techniques to study the physical and chemical properties of intracellular ferrimagnetic magnetite ( $Fe_3O_4$ ) crystals inside magnetotactic bacteria collected from lakes and streams.

The orientations and morphologies of the crystals in a double magnetosome chain were identified using electron diffraction, high-resolution electron microscopy and high-angle annular dark field electron tomography. The chain is analogous to beads on a string, in which biological control appears to be stricter in setting the [111] magnetocrystalline easy axis of the crystals to be parallel to the chain axis than in constraining their orientation about this direction. We have used off-axis electron holography to record magnetic induction maps from the same particles. The magnetic signal is dominated by inter-particle interactions and by the shapes of the individual crystals.

We have also studied the diversity of magnetosomes in bacteria collected from Lake Balaton. In stained thin sections of cocci, magnetite crystals appear to be anchored to the inner cell membrane. They are enveloped by stained material, apparently representing the magnetosome membrane. The cells do not contain detectable iron outside the magnetite magnetosomes.

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