

A Guide to Synthesize Magnetic Nanoparticles using Magnetotactic Bacteria

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DESCRIPTION

Nanoparticles are the sub nano-sized colloidal structures i.e., 10 nm-100 nm composed of synthetic and semi-synthetic polymers. Magnetic nanoparticles are those particles which can be manipulated using magnetic field. Magnetic bacteria which are also known as magnetotactic bacteria can produce nanosized and membrane bound magnetite particles with regular morphology and size under mild conditions at normal temperature and pressure. *Magnetospirillum gryphiswaldense*, *M. magnetotacticum* strain, *M. magneticum* strain, magneto ovoid strain, etc., are some of the examples of magnetotactic bacteria.

Formation of magnetosomes

Magnetosomes are a type of vesicles that are found in the cell and are surrounded by a lipid bilayer membrane containing magnetite and greigite. These are generally organised in linear chains and orient the cell body along geomagnetic field lines while flagella actively propel the cells resulting in magneto-taxis. Magnetosomes are present along the cells center lines which are aligned horizontally. This line-up along the central line creates a structure similar to compass needle that has the magnetic moment.

Magnetosome formation is a mineralization process performed under the control of strict biochemical mechanisms, includes 4 steps:

- Formation of magnetosome vesicles.
- Taking the iron mineral into the cell.
- Carrying the iron in the magnetosome vesicles.
- Control of magnetite or greigite biomineralisation within the vesicle.

Synthetic method of magnetic nanoparticles

Microemulsion: Electron chromatographic analysis shows that there is a filament that accompanies the magnetosome chains and the magnetosomes are connected to this filament by acidic MamJ proteins. In various electron microscopes, magnetosome crystals of various shapes were observed in MTB, such as cubic octagonal, bullet-shaped, prismatic and rectangular. Magnetite

(Fe_3O_4) is the main chemical component of magnetosomes characterized by the high chemical purity, and good biocompatibility which can be applied in many fields of magnetic materials, clinical medicine, etc.

Purification of magnetic nanoparticles

Cultured MTBs are taken in a dual vessel fermenter with the media DMZ380. The cells are harvested by centrifugation. The obtained supernatant is discarded and the pellets are washed 3 times with 10 ml HEPES buffer and 1 mM EDTA. Resuspend the pellet in 1 M NaOH and boil for 20-30 mins. Magnetic nanoparticles were collected using neodymium boron magnets.

Applications of magnetic nanoparticles

It includes magnetic separation of materials, hyperthermia, robotic technology, microchips, cancer treatment, carrier of antibiotics and drugs, eradication of heavy metals, etc.

Magnetic hyperthermia: Also known as magnetic nanoparticles mediated intracellular hyperthermia, is a thermotherapy which involve targeting of a tumor with the help of magnetic nanoparticles in the presence of external magnetic field that causes production of heat through Neel relaxation. Tumor cells are more sensitive to heat as compared to normal cells due to poor vascularization, so the survival rate of tumor cells decreases drastically by increasing temperature. This thermotherapy specifically destroys the tumor cells without the destruction of neighbor healthy cells.

Local hyperthermia treatment is used to treat the small portion of body such as tumor, regional hyperthermia is used to treat large area of body such as organ and whole body hyperthermia is used to treat metastatic cancer.

Cancer therapeutics: By using nanoimaging and nano drug delivery systems, cancer cells can be selectively targeted thus reducing undesired systemic drug toxicity, especially liposomes.

CONCLUSION

The discovery of MTB clearly showed that living beings can interact with the geomagnetic field through magnetic

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nanoparticles and became a model that has been extensively used in magnetoreception research. Modification and

manipulation of the magnetosomes has been an immense help to different to commercial sectors.