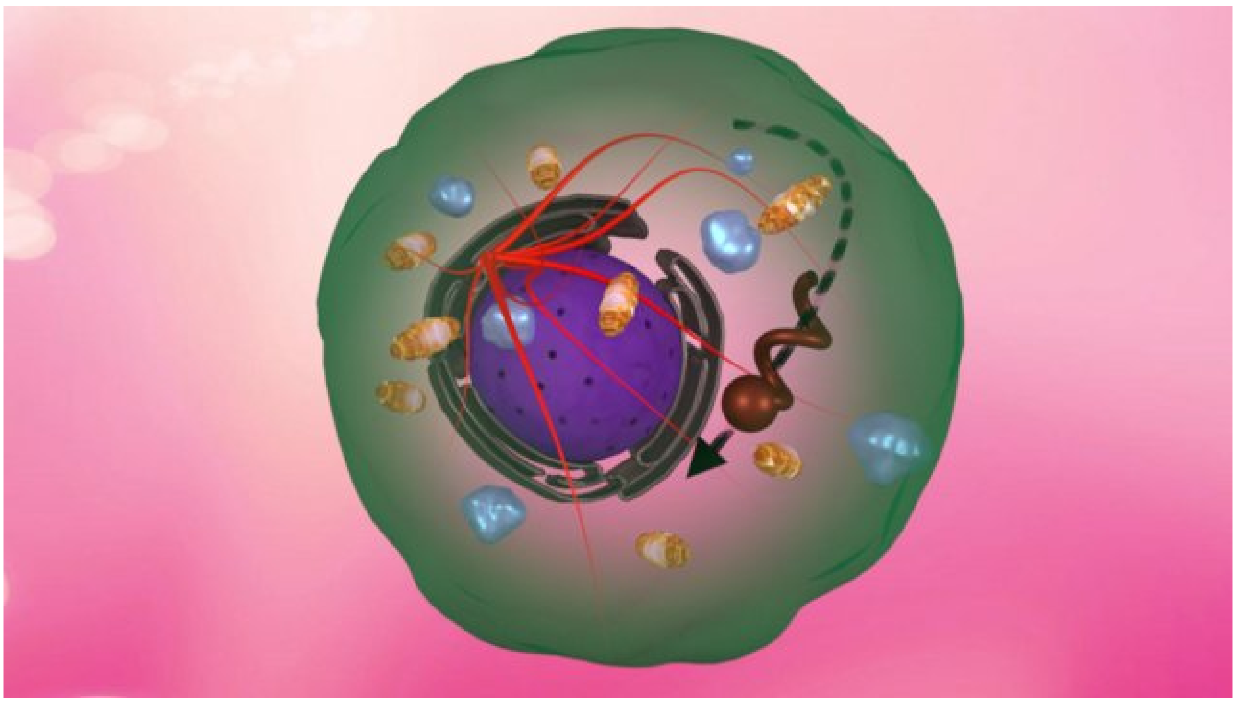
Nanomotor guided inside a living cell using a magnetic field

April 17 2018, by Bob Yirka



Schematic of the nanorobot moving through a living cell. Credit: *Advanced Materials* (2018). DOI: 10.1002/adma.201800429

A team of researchers at the Indian Institute of Science in Bangalore has developed a type of nanomotor that can be guided inside of a living cell using an external magnetic field. In their paper published in the journal *Advanced Materials*, the group describes their nanomotor, how it works, and possible uses for it.

As medical scientists continue to look for new ways to study living beings, many are studying the possibility of putting miniature objects inside of a living organism that can carry drugs or perform actions such as blocking blood vessels that feed tumors. Some have taken the science even further by creating objects small enough to fit inside a single cell. Such objects could conceivably carry drugs directly to individual parts of a cell. But, as the researchers with this new effort report, prior efforts have resulted in disruption to the cell, preventing the use of such devices. They report that they have now developed a nanomotor that can be guided to desired locations inside of a cell without causing disruptions.

The nanomotor was made mostly of silica, the team reports, but was covered with a very thin iron film to allow for control by magnetism. The nanomotor is shaped like a corkscrew, which means when it spins, it moves forward. A spinning external coil that generated a magnetic field induced the nanomotor to spin. Slight changes in the angle of the magnetic field caused the nanomotor to turn in desired directions.

The researchers made several of the nanomotors in different sizes and tested them in different types of cells, some of which were from cancerous tumors. They report that the smallest (250-nanometer) nanomotors offered the most flexibility for movement inside of the cells. To prove just how well they could steer a nanomotor inside of a cell, the team directed one along a path that outlined the letters "M" and "N." They acknowledge that their tiny motors are still in the early stages of development, but suggest their design is likely to lead to applications in drug delivery, or even nano-surgery.

More information: Malay Pal et al. Maneuverability of Magnetic Nanomotors Inside Living Cells, *Advanced Materials* (2018). DOI: 10.1002/adma.201800429

Abstract

Spatiotemporally controlled active manipulation of external micro-/nanoprobes inside living cells can lead to development of innovative biomedical technologies and inspire fundamental studies of various biophysical phenomena. Examples include gene silencing applications, real-time mechanical mapping of the intracellular environment, studying cellular response to local stress, and many more. Here, for the first time, cellular internalization and subsequent intracellular manipulation of a system of helical nanomotors driven by small rotating magnetic fields with no adverse effect on the cellular viability are demonstrated. This remote method of fuelling and guidance limits the effect of mechanical transduction to cells containing external probes, in contrast to ultrasonically or chemically powered techniques that perturb the entire experimental volume. The investigation comprises three cell types, containing both cancerous and noncancerous types, and is aimed toward analyzing and engineering the motion of helical propellers through the crowded intracellular space. The studies provide evidence for the strong anisotropy, heterogeneity, and spatiotemporal variability of the cellular interior, and confirm the suitability of helical magnetic nanoprobes as a promising tool for future cellular investigations and applications.