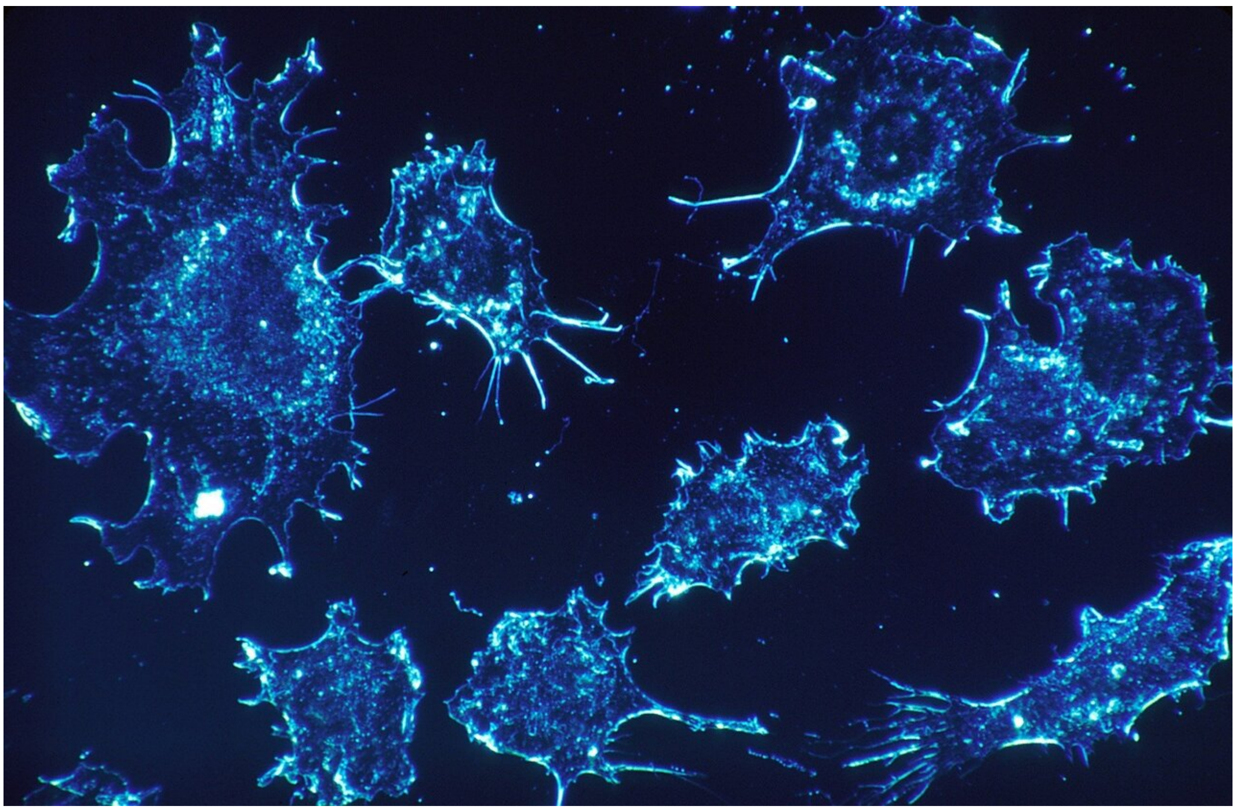
Significant leap forward in method for cancer treatment

September 11 2020, by Barry Fitzgerald



Credit: Pixabay/CC0 Public Domain

Eindhoven University of Technology Professor Jan C.M. van Hest has announced a breakthrough in non-invasive cancer treatment. His Institute for Complex Molecular Systems partnered with several Chinese research institutions to test a nanotechnology that addresses the drawbacks to photodynamic therapy, an emerging cancer treatment. A paper detailing the successful test of the methodology was recently published in the journal *ACS Nano*.

Photodynamic therapy (PDT) is a non-toxic, non-surgical cancer treatment that's on the rise in several countries, notably in the U.S. and in China. A patient is injected with a compound called a photosensitizer, which reacts to light. Once the photosensitizer is near tumorous cells, it is activated by a laser. The reaction creates singlet oxygen, which destroys nearby cells. Targeting the laser and photosensitizer allows them to destroy tumorous cells. PDT also indirectly activates the immune system, which then attacks the cancer as well.

A game changer for tumors close to the skin

PDT has the potential to be a game-changer for the treatment of breast cancer, prostate cancer, lymphomas and other tumors close enough to the skin for the laser to reach. It doesn't have the side effects of chemo or the risks of surgery. To work well, however, three problems need to be solved. First, the photosensitizer needs to be directed to accumulate around the tumor. Second, the reaction needs oxygen molecules in order to create singlet oxygen, and tumors create low-oxygen environments. Third, tumors have a defensive substance that breaks down singlet oxygen.

Professor van Hest's team of biomedical engineers designed a single nanoparticle that could solve all three problems. It's coated with polymers that are triggered by the tumor's acidic environment to attach themselves to the tumor. The polymers are held together by the photosensitizer, acting as both container and key cargo. A catalase carried by the particle breaks down hydrogen peroxide from the tumor to produce an abundance of oxygen. Meanwhile, another compound in the particle breaks down the defensive substance and, as a nice side effect, releases manganese that facilitates MRI imaging.

"It's an elegant solution in which each piece works together to disable the defense mechanisms of the tumor," says Professor van Hest. The components are either destroyed in their intended reaction or easily flushed from the system. Best of all, the particles would be relatively easy to mass-produce. Before that could happen, however, the team needed to test their theory.

Successful results, but further testing needed

Professor van Hest, who is affiliated with the Departments of Biomedical Engineering and Chemical Engineering and Chemistry, worked with Ph.D. student and China Scholarship Council fellow Jianzhi Zhu to oversee a team that included labs in TU/e Bio-organic Chemistry Group, Donghua University and Fudan University. TU/e uses this kind of international collaboration to stay on the cutting edge of research. Spearheaded in China by Donghua University Professor Xiangyang Shi, the trials proved that the particle was effective in addressing the three issues with PDT.

The team hopes that the successful results of their trials will lead to further testing of this revolutionary treatment. Before it goes into human trials, it will need to be tested in more complex systems for safety and efficacy. In the meantime, the team is looking into a light-driven motor function that would drive the nanoparticle deeper into the tumors, where it can be more effective. It's an exciting possibility, as nanomedicine and nanomotors are too frequently siloed as separate disciplines.

With the publication of their paper in *ACS Nano*, the team looks forward to further breakthroughs in the use of PDT and nanotechnology to treat cancers effectively and safely.

More information: Jianzhi Zhu et al. Surface-Charge-Switchable Nanoclusters for Magnetic Resonance Imaging-Guided and Glutathione Depletion-Enhanced Photodynamic Therapy, *ACS Nano* (2020). DOI: 10.1021/acsnano.0c03080

Provided by Eindhoven University of Technology