SCIENCE FOR THE BENEFIT OF HUMANITY

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Controlled Protein Expression Using Iron Oxide Nanoparticles

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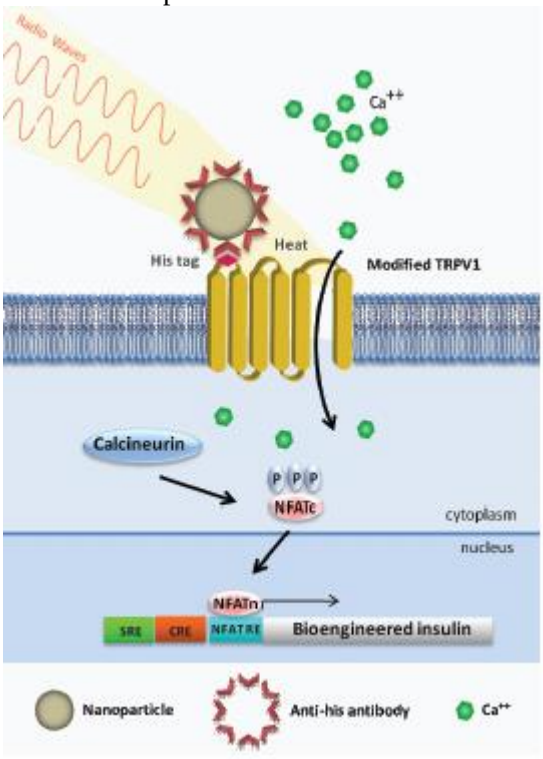
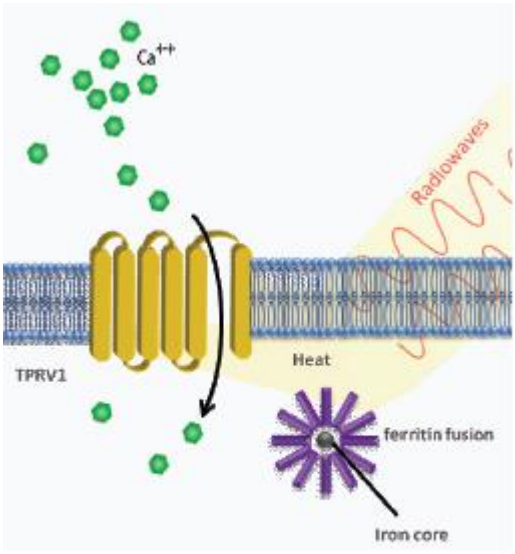
Technology Summary

The application of nanotechnology to medicine has primarily focused on the delivery of therapeutic agents to specific targets and biosensors to detect the presence of pathogens and environmental hazards. Our investigators have combined approaches in bioengineering with nanotechnology to develop a system to remotely regulate protein expression and activate specific cell populations using radio frequencies that can penetrate tissue without causing any damage yet will heat up metal-based nanoparticles to act as a stimulant to cells and cellular organelles.

In one particular case, our scientists have engineered two components of the system: 1) a temperature-sensitive transmembrane channel that is decorated with antibody-coated iron oxide nanoparticles, and 2) a bioengineered expression cassette for insulin that is driven by a calcium-sensitive promoter. The radio waves heat up the nanoparticles on the channel, which in turn allows the passage of calcium ions across the cell membrane. The influx of calcium activates the expression of insulin from the expression cassette allowing for control of blood sugar levels in the host organism (see left figure). In another experiment, bioengineered cells produce ferritin nanoparticles with an iron core, which are then heated by radio waves and stimulate the temperature-sensitive channel to open and allow calcium to enter the cells resulting in insulin release (see figure on right).





The successful results of these experiments in cell lines and mice show that this technology is a positive initial step in the use of these tools as a way to remotely regulate protein production and cell activation.

Advantage

- Radio waves used to heat the metal nanoparticles are able to penetrate tissue with minimal energy absorption – ideal for use in vivo
- Cells can be stimulated remotely; non-invasive and allows for temporal control
- Use of antibodies to coat the nanoparticles allow for specificity

Area of Application

- Platform technology for regulated protein expression and/or cell stimulation
- Potential novel method to treat diseases caused by protein deficiencies

Stage of Development

The method and materials have been tested both in vitro and in vivo in mice for regulated insulin release.

Lead Inventors

Drs. Jeffrey Friedman and Sarah Stanley

Patent Information

WO2013029025 A1 pending; PCT/US2015/051457

References

Stanley, et al. 2012. Radio Wave Heating of Iron Oxide Nanoparticles Can Regulate Plasma Glucose in Mice. Science, 336:604-608

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