Microfluidic Droplet for Drug Delivery and Therapeutic Applications (#6467)

A hydrogel microspheres using biocompatible synthetic material that can encapsulate viable cells and bioactive molecules using a novel microfluidic droplet system

Inventors at Georgia Tech have demonstrated that hydrogel microspheres using biocompatible synthetic material can encapsulate viable cells and bioactive molecules using a novel microfluidic droplet system. Cells, biomolecules, and drugs are suspended in liquid polymer solution and then extruded in droplet-form via microfluidics into a continuous phase solution containing an oil-crosslinker mixture. This unique method creates well-defined structures that allow for quick reactions and in situ delivery to the patient. The microspheres are comprised of biocompatible polyethylene glycol-based (PEG) polymer, and the diameter size of the beads (ranging from 10-1000 micrometers) can be fine-tuned by adjusting the nozzle dimensions and flow rates of the microfluidic droplet system. The hydrogel microspheres and their degradation by-products are non-toxic and do not elicit an inflammatory response.

Benefits/Advantages

- Viable, cellular micro-environments requiring precise control are achieved using hydrogel microspheres with diameter sizes ranging from 10-1000 micrometers
- A protective, semi-permeable capsule encases the cells and biomolecules
- Release rates of encapsulated biomolecules or drugs are controlled by adjusting the polymer parameters used to fabricate hydrogel microspheres

Potential Commercial Applications

- Injectable hydrogels integrating pancreatic islets and VEGF for islet vascularization
- Micro-coatings for immuno-isolation
- Cell-based drug delivery systems for treatment

Background/Context for This Invention

Micro-encapsulation of cells in semi-permeable polymer networks is a promising approach for avoiding immunosuppressive therapy in allogeneic, xenogeneic and genetically modified cell transplantation. Current technology uses an electrostatic droplet generator and alginate-based polymers. Major drawbacks to this system are that cellular micro-spheres are limited to larger diameter sizes (>200 micrometers) and alginate-based polymers provide minimal control over the cellular micro-environment. By utilizing advanced synthetic polymers, bioactive molecules can be chemically conjugated, and the cellular micro-environment

can be fine-tuned based on therapeutic application.

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More Information

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Publications

Protease-degradable microgels for protein delivery for vascularization, Biomaterials, January 2017

Microfluidic?Based Generation of Size?Controlled, Biofunctionalized Synthetic Polymer Microgels for Cell Encapsulation, Advanced Materials, March 11, 2014

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/microfluidic-droplet-drug-delivery-and-therapeutic-applications

Images:

The automated sequential delivery of multiple fluids. A varying number of delay gates imprinted in the branches are shown in the figure.

COVID-19 and flu saliva test on paper: (A) The automatic sequential delivery of multiple reagents required for virus test; (B) Water pouring into the device triggers the virus assay, allowing the presence of SARS-CoV-2 and influenza A & B viruses to be visually identified by the color changes in the corresponding detection spot