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Delivering the Goods: Creating Materials to Aid Regenerative Medicine

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Delivering the Goods

Creating materials to aid regenerative medicine

by Julie O'Connor

Imagine a time in the future when human lifespan is extended because "broken parts" are simply replaced by regenerated ones. Lives may be lengthened by several decades because of new technologies that create cells, tissues and organs for patients who may need them. Research at Wayne State is putting us closer to the day when this will happen.

The development of biomaterial scaffolds plays a central role in regenerative medicine by providing the chemical, biological and mechanical cues necessary for tissue formation or regeneration. Successful regeneration strategies require a distinct sequence of phases driven by multiple signals with appropriate spatial and temporal control. This creates a major challenge in how to design materials that direct the growth, differentiation and organization of cells in the process of forming new tissue.

A multidisciplinary team of collaborators from the Eugene Applebaum College of Pharmacy and Health Sciences and the College of Engineering is combining their expertise to develop thin DNA films that can be easily deposited onto the surface of a wide range of biomaterial "scaffolds" by a sophisticated delivery method of multiple therapeutic genes triggered by cell attachment.

"Successful tissue regeneration depends on the right combination and sequence of pieces of information that have to be provided to the cells so that they can grow, differentiate and organize themselves into a functional tissue or organ," said David Oupicky, Ph.D., associate professor of pharmaceutical sciences. "We have developed multilayered films consisting of multiple genes that serve as those pieces of information telling the cells what to do and when to do it. The films are unique in that they provide an unprecedented level of control over the sequence of the signals. The films are also universally applicable to virtually any combination of genes, which makes them applicable to a large variety of tissue regeneration strategies."

Because the study requires a wide range of expertise ranging from material synthesis and characterization to biological evaluation, it was critical for Oupicky to collaborate to nurture and develop smart biomaterials. Dr. Guangzhao Mao, professor of chemical engineering and materials science in the College of Engineering, and her research lab had the right blend of knowledge to guide the characterizing of materials.

Once Mao's group makes the DNA-containing films, they characterize them to ensure reproducibility of the film-making method. "We characterize the films to determine film thickness, surface roughness, chemical composition and mechanical properties because all these factors will impact the film's ultimate use as coatings for localized gene delivery," said Mao.

According to Mao, this collaborative team has obtained preliminary results that show the films are promoting cell attachment and gene expression, and they expect to apply this technology for regenerative medicine.

The team's future goals are to focus on incorporating multiple DNA plasmids instead of single reporter genes into the layer-by-layer thin films. These can then be transcribed sequentially into functional proteins inside human diseased cells. The newly produced proteins will play the role of treating and preventing diseases.

"We have great expectations for this technology," said Oupicky. "We are at a stage where we have confirmed in vivo feasibility and safety of our approach." The next step, according to Oupicky, is to form new collaborations with clinical researchers and start a more translational development of these films. Through their efforts, Oupicky and Mao are one step closer to providing a sophisticated delivery method suitable for regeneration of bone, neural tissue and more.

About Dr. David Oupicky:

Dr. Oupicky received a M.S. in polymer engineering from the Institute of Chemical Technology, Prague, and his Ph.D. in macromolecular chemistry from the Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic, Prague. He was a post-doctoral research fellow at the CRC Institute for Cancer Studies at the University of Birmingham, United Kingdom. He joined Wayne State University in 2002.

For more information, visit: http://cphs.wayne.edu/bio.php?id=224

About Dr. Guangzhao Mao:

Dr. Mao received a B.S. in chemistry from Nanjing University, P.R. China, and a Ph.D. in chemical engineering from the University of Minnesota. She was a post-doctoral associate of materials science at the University of Minnesota. She joined Wayne State University in 1995.

For more information, visit: http://www.eng.wayne.edu/page.php?id=507

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