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Nanotechnology brings new openings to stem cell R&D

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Polyclone Bioservices is working on application of nanotechnology in stem cell therapy. ***Naveen Kulkarni****, CEO and Founder, Polyclone Bioservices, in discussion with Sachin Jagdale, reveals various scientific aspects of this research*

Even after many years of research, stem cell therapy has a very limited success in the treatment of various diseases. Will the use of nanotechnology make stem cell therapy more effective?


Naveen Kulkarni

Stem cells hold great potential for the treatment of several injuries and degenerative diseases. However, one of the big challenges of using stem cells as a therapy is coaxing them to grow into the specific type of tissue that is required. This happens in the body, thanks to precise chemical and physical signals, not all of which are yet understood or characterised. Using chemicals to direct the fate of stem cells has worked in laboratories, but the outcomes are not always safe or predictable.

There are few other obstacles like development of advanced techniques to understand and control functions of micro environmental signals, novel methods to track and guide transplanted stem cells, long-term behaviour of transplanted stem cells in the target tissues, pluripotency/multipotency of stem cells to differentiate towards homogenous populations of specific cell types, control of transplanted stem cells to migrate to the correct micro environmental places, tracking of transplanted stem cells by labelling techniques and optimal time period for stem cell-replacement therapy for degenerative diseases are to be overcome to make stem cell therapy a successful therapeutic option.

The application of nanotechnology would be able to address those challenges since it brings new opening to stem cells R&D. Nanotechnology is the term used to cover the design, construction, and utilisation of functional structures with atleast one characteristic dimension measured in nanometers. It is well-known that the nanomaterials own four basic unique effects such as small size effects, surface effects, quantum size effects, and tunnel effects, and ultimately these effects can lead to new technological opportunities as well as new challenges. In recent years, the application of nanotechnology in stem cell research and development has made great progress.

For example, magnetic nanoparticles (MNPs) have been successfully used to isolate and sort stem cells, quantum dots have been used for molecular imaging and tracing of stem cells, nanomaterials such as carbon nanotubes (CNTs), fluorescent CNTs, and fluorescent MNPs, etc. have been used to deliver gene or drugs into stem cells, unique nanostructures were designed for controllable regulation of proliferation and differentiation of stem cells, and all these progress speed up the development of stem cells toward the application in regenerative medicine.

Has nanotechnology already been used in stem cell therapy? If yes, give more details?

Nanotechnology in stem cell therapy is well proven at research level and it has been moved to clinical trials stage. This has not been used as a therapy yet. National Cheng Kung University (NCKU - Taiwan) research team has made a breakthrough in the regeneration of new blood vessels in cardiovascular therapy by using nanofibers and vascular endothelial growth factor (VEGF). The new technology helps endogenous stem cells achieve cardiac and vascular regeneration, and is seen as a promising cure for heart diseases. The study, led by Patrick C H Hsieh, associate professor and cardiac surgeon at NCKU, sheds light on cardiovascular therapy by providing a new strategy for cardiovascular repair. The study combines tissue engineering, nanotechnology and controlled protein delivery to induce endogenous stem cells to improve cardiac function. The experiments, done on rats and pigs, led to the growth of fresh blood vessels and improved heart function without harmful side effects.

Polyclone Bio-services has signed an MoU with PSG Institute of Advanced Studies (PSGIAS) for application of nanotechnology in stem cell therapy. What will be the role of each partner in this collaboration?

PSGIAS, having state-of-the-art nanotechnology facility and highly experienced researchers, will work in the areas of biocompatible nanofiber matrix synthesis. Polyclone will be working in the areas of application of stem cells and ancillary processes like enrichment, expansion and differentiation of stem cells derived from various sources. The objective is to culture stem cells derived from various sources on the nanofiber matrix and to validate the effect of nanofiber matrix on the enhancement of adherence, proliferation and migration.

What will be the focus of Polyclone and PSGIAS in the coming years?

Our primary focus would be on collaborative R&D in application of nano-bio-technology for stem cell delivery applications in established clinical practices like ophthalmology, which would also be extended to other disease profiles such as dermatology and oncology.

Besides stem cell therapy, is Polyclone working on to introduce nanotechnology for other forms of treatments?

Being a technology-driven company, our hands are full at this point and we would like to have a focused approach towards our goal. Initial successes from these studies will lead us to understand and plan better for future.

Is Polyclone considering more such collaborations in future?

Yes, academic bonding is part of the growth plan for Polyclone and there is much to be derived for better clinical outcomes from more partners. We have already partnered with SIT Tumkur for bioinformatics platform developments and also contributing towards students' engagement with the industry. We are currently in discussions with a reputed university with large hospital and state-of-the-art clinical facilities for collaborations to complete the circle.

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