Controlling and Directing Neural Growth Using Nanostructured Polymeric Scaffolds

2021-12-25

Nanostructured scaffolds produced at the UPV/EHU-University of the Basque Country induce aligned migration of stem cells and accelerate their neuronal differentiation.Collaboration between different UPV/EHU departments has achieved a promising advance for future cell therapy: nanostructured scaffolds based on bioresorbable polymers and graphene derivatives that induce aligned migration and accelerate the neuronal differentiation of neural stem cells. This system has the potential to restore the connectivity of spatially oriented neural precursor cells and is a promising tool even in nerve tissue regeneration.

Regeneration of the nervous system remains a major challenge due to its limited plasticity and poor ability to heal and recover function after injury. Research is therefore needed to develop effective strategies for guided neural regeneration and the restoration of lost nerve connectivity. In the field of neural tissue regeneration, it is essential to source and optimise biomaterials that meet the complex requirements of this specific biomedical application.

Thanks to collaboration between the UPV/EHU’s Department of Cell Biology and Histology and the Science and Engineering of Polymeric Biomaterials-ZIBIO Group (BERC POLYMAT), a significant advance in cell therapy has been achieved: "We have constructed bioresorbable elastomeric matrices or scaffolds that combine an ordered nanostructured topography (by way of grooves)together with surface functionalisation with graphene derivatives," explained Dr Aitor Larrañaga, an expert in the design and characterisation of nanomaterials. These scaffolds have enabled "neural stem cells to attach to each other without the need for any other adhesive coating on their surface. Neural stem cells are able to differentiate themselves on the nanostructured scaffolds in vitro, which promotes their aligned migration in cell clusters by following the nanostructured grooves", added Dr José Ramón Pineda, an expert in the field of stem cells.

An optimal tool that is easy to produce

As Dr Pineda explained, "a stem cell is a cell with the capacity to give rise to a multitude of different cell types. We have seen that stem cells of the nervous system can differentiate themselves, in other words, become neurons, but in a more accelerated manner, thus reducing the time needed for their differentiation when in the presence of a developed device. Moreover, instead of having a random scattering in all directions, as happens in other cases, by seeding the cells in these devices, we can group them together and align them in a row by directing them in any direction we want. So, in terms of cell therapy, this is very promising".

"The main novelty of this study," explained Dr Larrañaga, "is being able to modulate the behaviour of stem cells, get them to adhere to a substrate, in this case the nanomaterial, and grow aligned in a certain direction. This opens the door to the future possibility of being able to position these matrices in a damaged region of nerve tissue and promote regeneration in a way that is more effective compared with current strategies.

When cells are transplanted into any type of injury, there are usually many hostile elements hampering regeneration: there is inflammation, cell death, etc. These are a whole catalogue of signals that can affect the survival, development or proper differentiation of cells. "In addition to positioning the cells attached to a nanostructured scaffold that is already inducing the right signals in them and keeping them there, the scaffold itself could also be equipped with elements that can modulate the inflammation of the lesion by actively interacting with the surrounding cells and tissue. We believe that this is a step further, and that this is the future of cell therapy in these types of lesions," said Pineda.

This system achieved at the UPV/EHU has the potential to restore the connectivity of spatially oriented neural precursor cells in particular, and constitutes a promising tool for future cell therapy, including the regeneration of nervous tissue. "The high efficiency displayed by these nanostructured supports, even under long incubation periods compatible with standard differentiation protocols, turns them into an optimal tool that is easy to produce. However, it has to be said that this is only the beginning. The science is very slow, and we are laying the groundwork for what we will see over the coming decades," concluded the two researchers.

Read the original article on University of the Basque Country.