RESEARCHER PROFILE

TISSUE ENGINEERING:
STIMULATING CELL DYNAMICS IN 3D
PROFESSOR DR DORIS HEINRICH

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DORIS HEINRICH is Professor of Biophysics at Leiden University in the Netherlands and Head of Fraunhofer Attract 3D NanoCell in Germany. She graduated with a Master's in Physics from the University of Texas at Austin, USA, and received her PhD in Semiconductor Physics from the Technische Universität München in Germany. Her research focus lies in the biophysics of living cell dynamics.

IN ADDITION TO her role as Professor of Biophysics at Leiden University in the Netherlands, where she is head of her research group, Professor Dr Doris Heinrich is also Head of Fraunhofer Attract 3D NanoCell in Germany, which provides outstanding scientists the opportunity to translate their applications for commercialisation and the benefit of society.

Heinrich centres her own research on the biophysics of cell dynamics with the ultimate goal of applying her findings to the medical sector, particularly for tissue repair. "I dedicate my research to this field because I am fascinated by the way cells organise their adaptation and survival in any complex environment – usually in a tissue – and this is reflected in their dynamic behaviour," she explains.

Cells have intricate mechanisms that dictate how they respond to external stimuli, whether chemical, mechanical or electrical in nature. "Cells need to be able to sense these inputs with their exterior via the cell membrane and receptors, after which the signal is transmitted into the cell interior, where it can be processed by multiple interdependent feedback loops that trigger defined cascades leading to observable cell functions," elaborates Heinrich.

UNDERSTANDING CELL DYNAMICS

Whether as part of processes such as immune responses, metastasis or wound healing, cell motility through complex tissues requires an incredible amplitude of external and internal signalling mechanisms to change the shape of the cell's cytoskeleton and send the migrating cell in the right direction.

Heinrich and her group have been probing the combinations of mechanical and chemical stimuli that cells are faced with using several cell types, and the impact these have on the decisions cells 'make' about where to move and how.

To examine how cells react to mechanical stimuli as they move through the 3D structures of the body, Heinrich's team creates nanostructured tissue mimics and tests cell types using different structures. These 3D mimics are made up of 'pillar' arrangements that cells must wind their way through. Interestingly, they showed that cell migration could be controlled by the structure of the environment alone and without the need for a chemical gradient of signalling molecules.

The group does, however, also experiment with spatial and temporal gradients of chemical cues, to discern what effect these have on cell movement. Their findings with chemotactic cell types show that different chemical gradients appear to result in varying cell movement behaviours: distinctive cell shape changes emerge, especially in shallow gradients.

Enabled by profound understanding of these mechanisms, one application with far-reaching benefits would be the development of realistic 3D drug screening assays, including organs-on-a-chip and artificial tissues as models for testing drugs. This could save the pharmaceutical industry from performing expensive and unnecessary clinical trials on animals, ultimately revolutionising drug screening.

REGENERATIVE MEDICINE

Heinrich's current research builds upon her previous work on cytoskeleton dynamics and their applications in regenerative medicine. Her group focuses on the creation of smart implants and 3D scaffolds for tissue engineering. "Molecular concentration gradients and mechanical interactions with the 3D scaffold of the extracellular matrix influence the behaviour of living cells, including processes such as migration, cell division, differentiation and apoptosis," Heinrich explained in her previous interview with *International Innovation*.

The ultimate goal for Heinrich's team will be to predict cell functions that correspond with certain triggers to remotely control tissue repair.