MIRA
BIOMEDICAL TECHNOLOGY
AND TECHNICAL MEDICINE

MIRA MINI-SYMPOSIUM:

INTEGRATING MICROFABRICATION AND BIOLOGY

PROF. DR. IR. JAAP DEN TOONDER, TUE

MICROFLUIDIC DEVICES FOR ADVANCED 3D CELL CULTURE, APPLIED TO CANCER-ON-CHIP

AND

PROF. DR. IR. WILHELM HUCK

SIZE MATTERS - 3D MICRONICHES TO EXPLORE THE ROLE OF SIZE AND SHAPE IN CELL BEHAVIOR

DAY: FRIDAY JANUARY 26TH 2018
TIME: 1400-1600 HOURS
PLACE: ZH286

UNIVERSITEIT TWENTE.

MIRA
BIOMEDICAL TECHNOLOGY
AND TECHNICAL MEDICINE

PROF. DR. IR. JAAP DEN TOONDER, TUE

MICROFLUIDIC DEVICES FOR ADVANCED 3D CELL CULTURE, APPLIED TO CANCER-ON-CHIP

Jaap den Toonder is full professor and Chair of the Microsystems group at Eindhoven University of Technology. He received his Master's degree in Applied Mathematics in 1991 (cum laude), and his PhD degree (cum laude) in 1996, both from Delft University of Technology.

In 1995, he joined Philips Research Laboratories in Eindhoven, The Netherlands. As a senior scientist, principal scientist, and project leader, he worked on a wide variety of applications. In 2008, he became Chief Technologist, leading the R&D programs on (micro-)fluidics and materials science and engineering. Next to his main job at Philips, he was a part-time professor of Microfluidics Technology at Eindhoven University of Technology between 2004 and 2013.

Jaap den Toonder is currently leading the Microsystems group at Eindhoven University of Technology. His main research interests are: microfluidics, out-of-cleanroom micro-fabrication technologies, mechanical properties of biological cells and tissues, nature-inspired micro-actuators, and organs on chips. He has (co-)authored over 90 scientific papers (h-index=30, WoS, December 2017), as well as over 40 patents, and he has given over 50 invited lectures at conferences. He was a member of the Editorial Board of Lab on a Chip from 2009 to 2013.

MIRA

BIOMEDICAL TECHNOLOGY
AND TECHNICAL MEDICINE

PROF. DR. IR. JAAP DEN TOONDER, TUE

MICROFLUIDIC DEVICES FOR ADVANCED 3D CELL CULTURE, APPLIED TO CANCER-ON-CHIP

SUMMARY

Microfluidics technology offers the possibility to create devices in which chemical, mechanical, and physical conditions can be precisely controlled. This makes it possible to realize well-defined micro-environments to study biomechanics of single cells, to realize advanced 3D multi-cellular culture systems to investigate tissue and organ function, and to recreate aspects of diseases to understand processes and mechanisms in disease progression. In this talk, I will present our microfluidic platforms and show how we use these to characterize mechanical properties of single cells, and to understand disease progression. In particular, I will focus on our “cancer-on-chip” devices, which we have applied to study the influence of the structure of the extra-cellular matrix on the invasive behavior of a number of breast cancer cell types.

MIRA
BIOMEDICAL TECHNOLOGY
AND TECHNICAL MEDICINE

PROF. DR. IR. WILHELM HUCK

SIZE MATTERS - 3D MICRONICHES TO EXPLORE THE ROLE OF SIZE AND SHAPE IN CELL BEHAVIOR

Prof. Wilhelm T. S. Huck is Professor of Physical Organic Chemistry. He received his PhD (promoter Prof. David Reinhoudt) in 1997 from the University of Twente. After postdoctoral research with Prof. Whitesides at Harvard University, he took up a position in the Department of Chemistry at the University of Cambridge, where he was promoted to Reader (2003) and Full Professor of Macromolecular Chemistry (2007). He became Director of the Melville Laboratory for Polymer Synthesis in 2004 and in 2010 he moved to the Radboud University Nijmegen where his Professor of Physical Organic Chemistry.

Honours (selection)

- Co-PI on 18.8 M€ Gravitation Grant Building a Synthetic Cell (BaSyC)
- Spinoza Prize (highest scientific award in the Netherlands)
- Elected member of Royal Netherlands Academy of Arts and Sciences (KNAW) (2013);
- VICI award (1.5 M€) by the Netherlands Organisation for Scientific Research (NWO) (2011);
- ERC Advanced Grant (2.3 M€) (2010);
- Friedrich Wilhelm Bessel research award of the Humboldt foundation (2009);
- Dupont Young Professor Award (2004).

MIRA
BIOMEDICAL TECHNOLOGY
AND TECHNICAL MEDICINE

PROF. DR. IR. WILHELM HUCK

SIZE MATTERS - 3D MICRONICHES TO EXPLORE THE ROLE OF SIZE AND SHAPE IN CELL BEHAVIOR

Brief summary of research over last 5 years

Wilhelm Huck was initially trained as a physical organic chemist, and then moved abroad for postdoctoral training (Whitesides, Harvard University). He started his academic career at the University of Cambridge at the age of 29, where he rapidly rose through the ranks to become the youngest full professor in the department of chemistry in 2007. His research activities covered a broad range of topics, including polymer electronics, polymer thin films, and the study of cells on surfaces. He moved from the University of Cambridge to the Radboud University in 2010 to focus entirely on elucidating how the complex networks of chemical reactions in the cell combine to create something we call living. In collaboration with Fiona Watt in Cambridge, he made seminal contributions into elucidating how cells sense their environment, whether in micronscale confinement (Nat. Cell Biol. 2010) or on porous gels (Nat. Mater. 2012). These findings awoke a desire to learn more about the complex chemical processes that cells use to process information. Research in his group is multidisciplinary and incorporates microfluidics, cell-free gene expression systems, cell biology and synthetic chemistry. His research group in Cambridge was one of the first to develop microdroplets in microfluidics as a tool for studying complex reactions (Angew Chem Int Ed 2008, 2009) and he successfully transferred this technology to Nijmegen to study interfacial reactions (Angew Chem Int Ed 2012). Microdroplets have subsequently been used in his group to create cell-like environments in which transcription rates are greatly enhanced (PNAS USA 2013, Nature Nanotech 2014), and where the influence of crowding on noise in gene expression can be studied (Nature Nanotech 2016). His group is developing new methods for making monodisperse liposome compartments, and researches coacervates as alternative membrane-free protocell environments. In addition to recreating the intracellular environment, the group has a strong interest in understanding the dynamics and robustness of out-of-equilibrium systems. His group has published the first rationally designed oscillating enzymatic reaction networks (Nature Chem. 2015), where small molecules can be used to alter the individual rates in the network (JACS 2015). This work is now expanding to identify how minimal complex systems can arise from mixtures of coupled reactions, and, ultimately, how life arose out of chemical reaction networks of increasing complexity.

MIRA
BIOMEDICAL TECHNOLOGY
AND TECHNICAL MEDICINE

PROF. DR. IR. WILHELM HUCK

SIZE MATTERS - 3D MICRONICHES TO EXPLORE THE ROLE OF SIZE AND SHAPE IN CELL BEHAVIOR

SUMMARY

Geometrical cues have been shown to alter gene expression and differentiation on 2D substrates. However, little is known about how geometrical cues affect cell function in 3D. One major reason for this lack of understanding is rooted in the difficulties of controlling cell geometry in a complex 3D setting and for long periods of culture. Here, we present a robust method to control cell volume and shape of individual human mesenchymal stem cells (hMSCs) inside 3D microniches with a range of different geometries (e.g., cylinder, triangular prism, cubic and cuboid). We find that the actin filaments, focal adhesions, nuclear shape, YAP/TAZ localization, cell contractility, nuclear accumulation of HDAC3, and lineage selection, are all sensitive to cell volume. Our 3D microniches enable fundamental studies into the impact of biophysical cues on cell fate, and have potential applications in investigating how multicellular architectures organize within geometrically well-defined 3D spaces.

Recent publication:

3D microniches reveal the importance of cell size and shape
M. Bao, J. Xie, A. Piruska and W.T.S. Huck
Nature Communications, 2017, 8: 1962