Nanomedisin-relaterte miljøer i Bergensområdet

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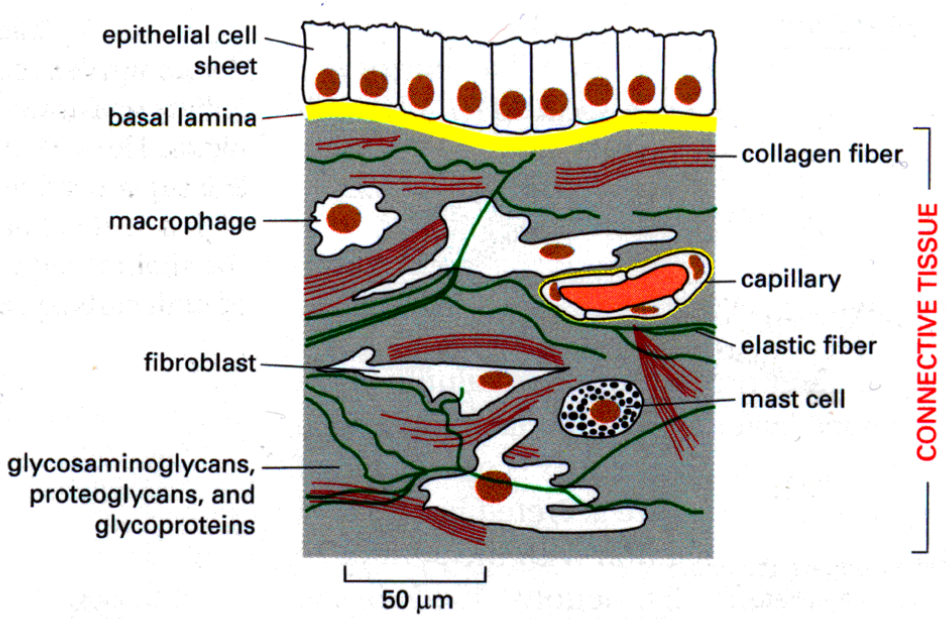
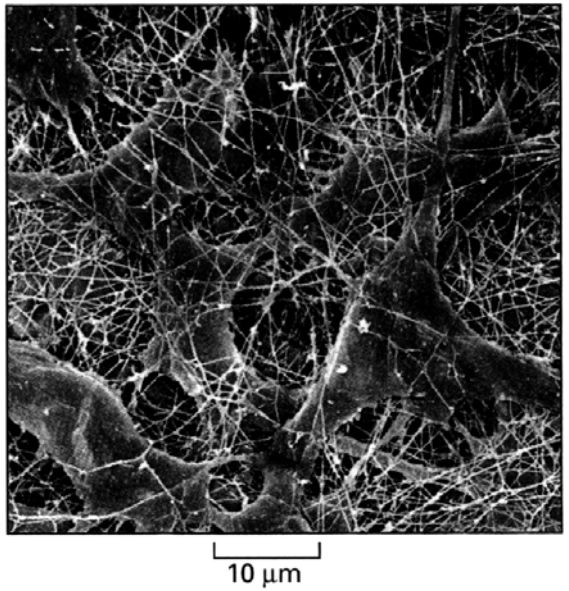
Institutt for biomedisin, Universitetet i Bergen

SINTEF/NFR Workshop om Nanomedisin i Norge
Oslo, 12.12.2007

Cells in tissue

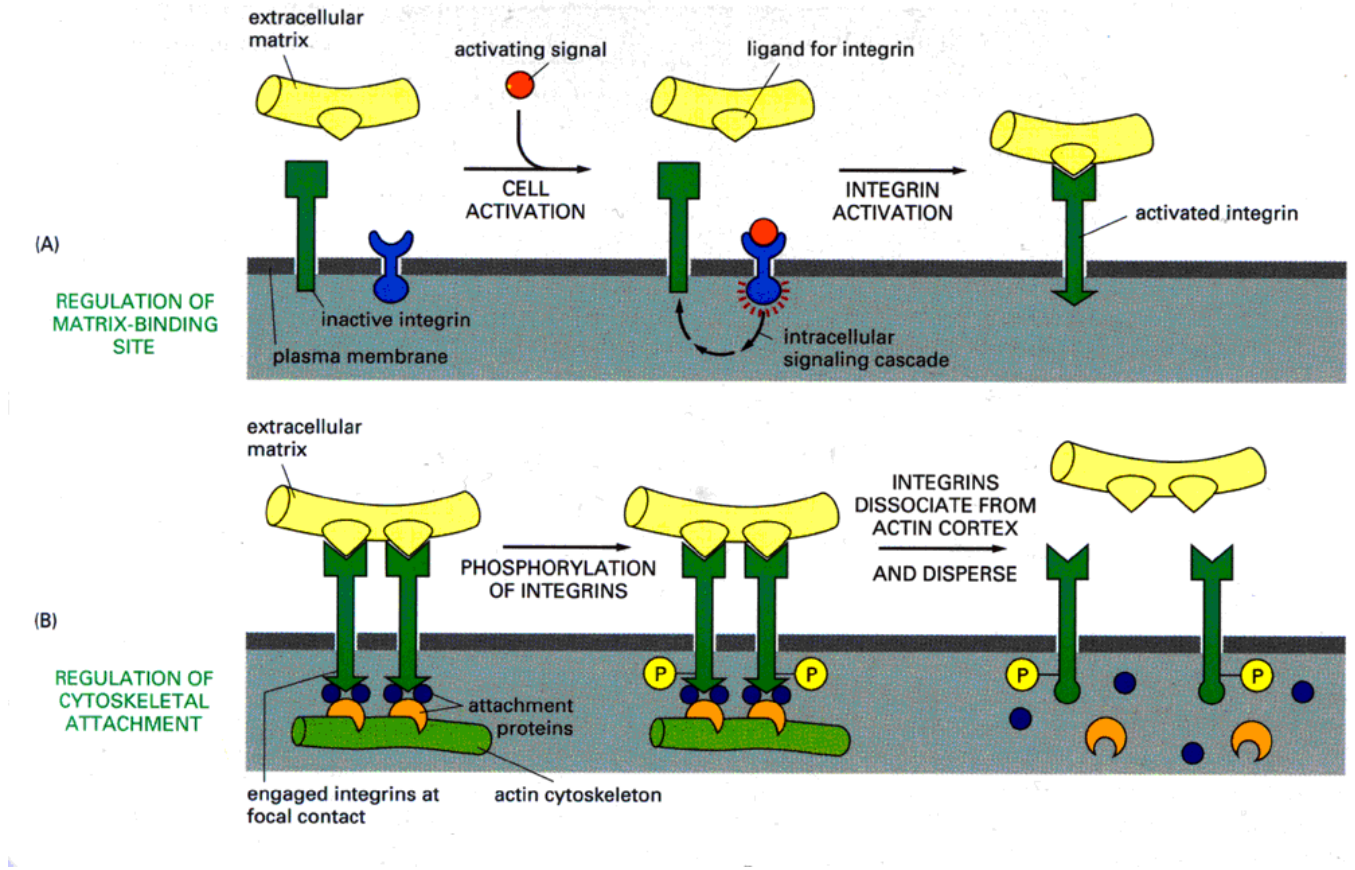




Fibroblast cells in connective tissue (SEM)

From: Alberts et al., Molecular Biology of the cell

Cells read nanostructures



From: Alberts et al., Molecular Biology of the cell

Bionano-Concept

The use of nano-patterned surfaces

- cell growth
- cell proliferaton
- cell signalling
- cell metabolism

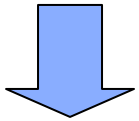
- tissue modelling
- regenerative medicine

Bio-Nano-Platform

Dept. of Biomedicine

Micro- and nano-patternd surfaces

Lab on a Chip



Programming of cells/tissue engineering/regenerative medicine

MIC | Bioinformatics | PROBE

Physics Department

Bio-Na…tform

Dept. c…licine

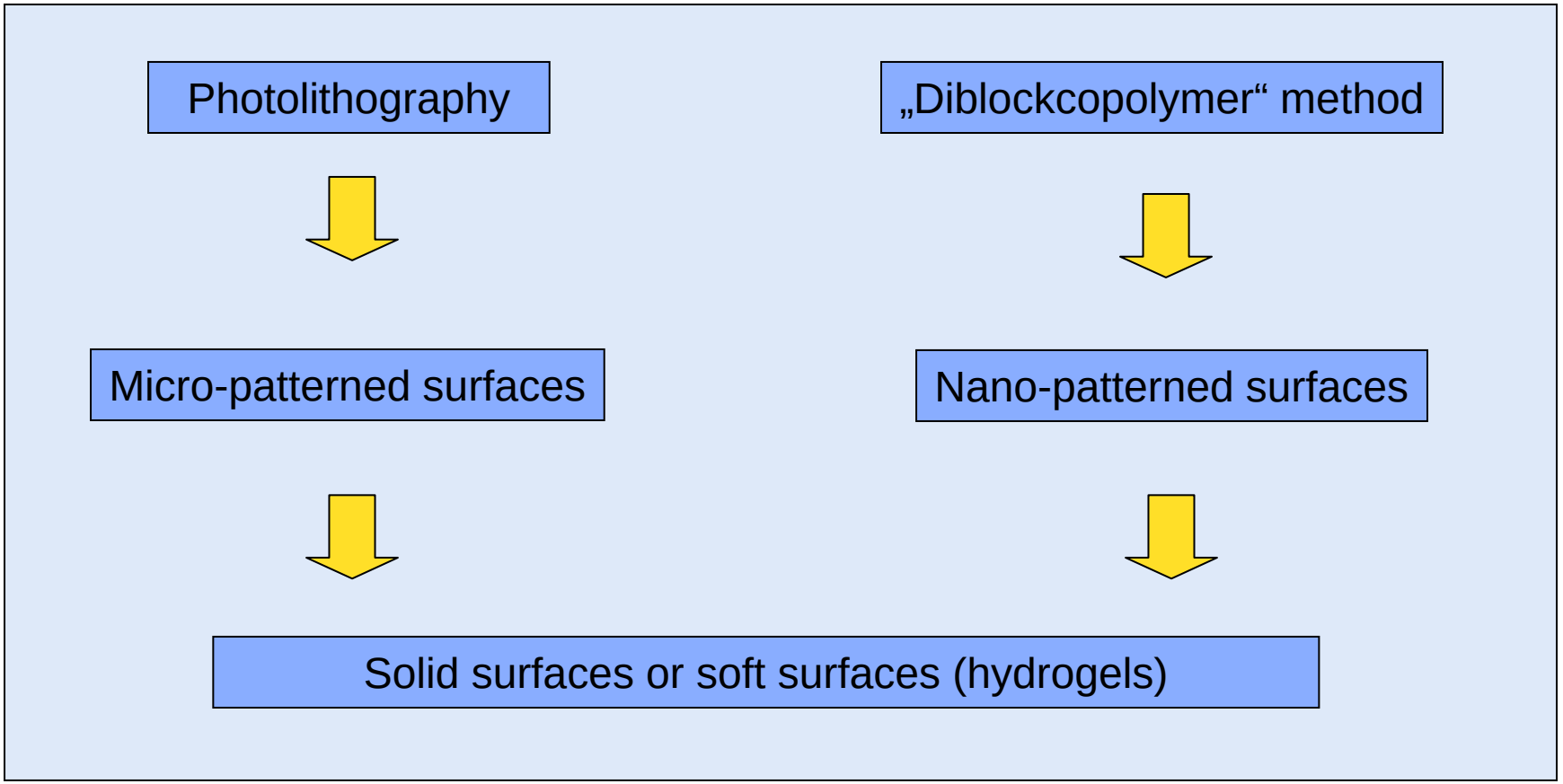
Chemistry Department

Micro- and nano-patternd surfaces

Lab on a Chip

Collaboration with Prof. J. Spatz, MPI Stuttgart/Univ. Heidelberg

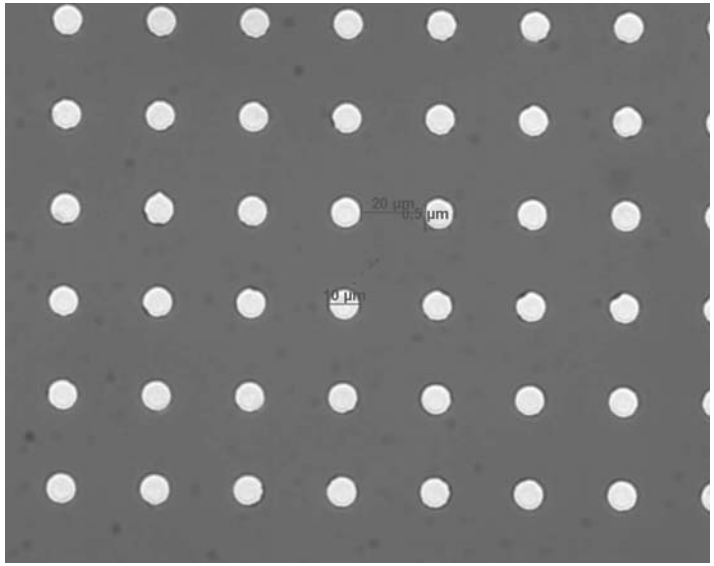
Production of micro- and nano-structured surfaces



Micro-patterned surfaces (photolithography)

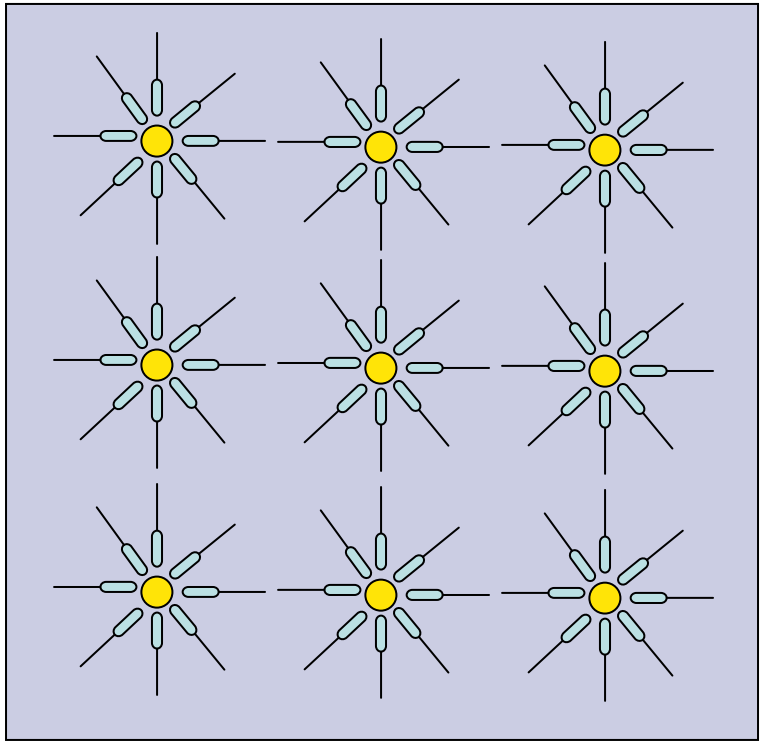
Adhesive spots:
biofunctionalization by biomimetic molecules covalently bound to gold

Repulsive area:
e. g. reactive ion etching



Size of gold-dot : 9.8 µm
Distance between gold-dots : 20µm

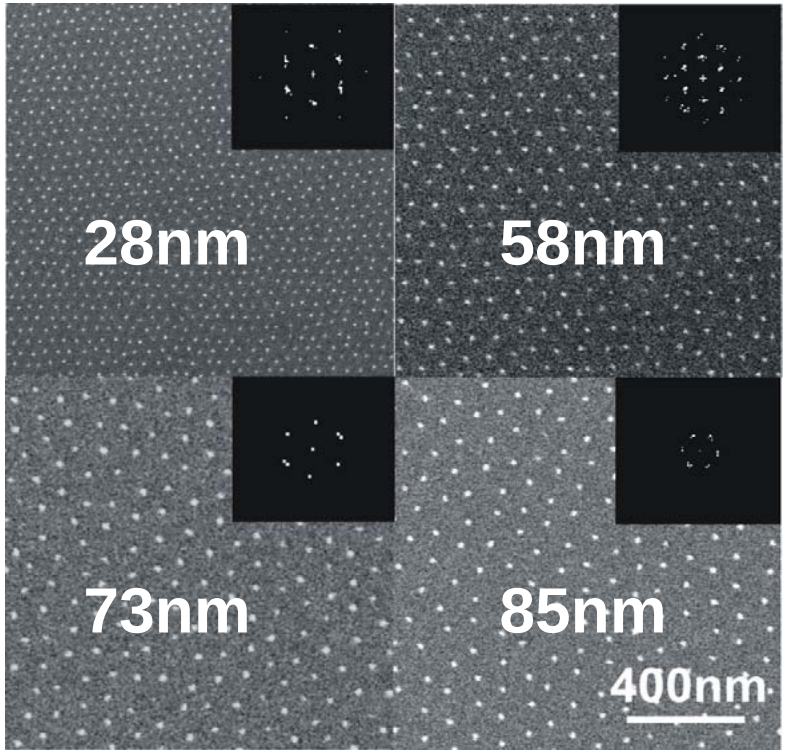
Nano-patternd surfaces (diblockcopolymer-method)



A B

diblockcopolymer

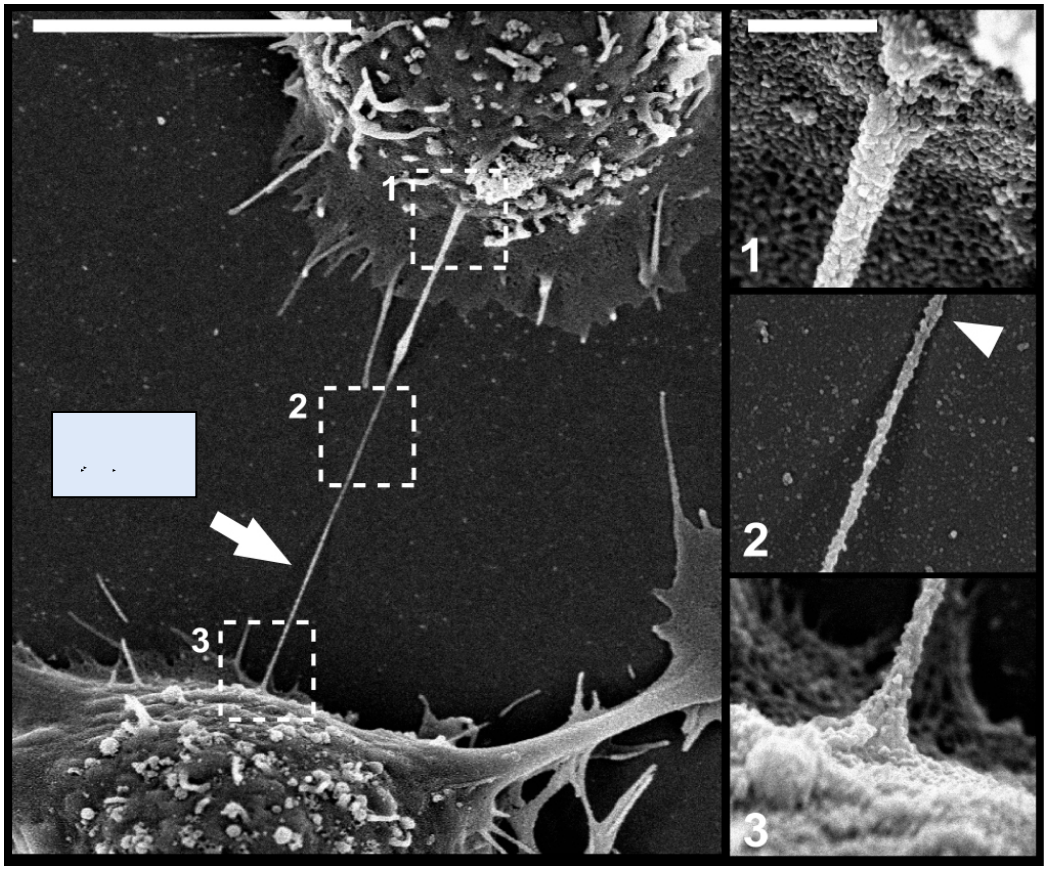
gold dot



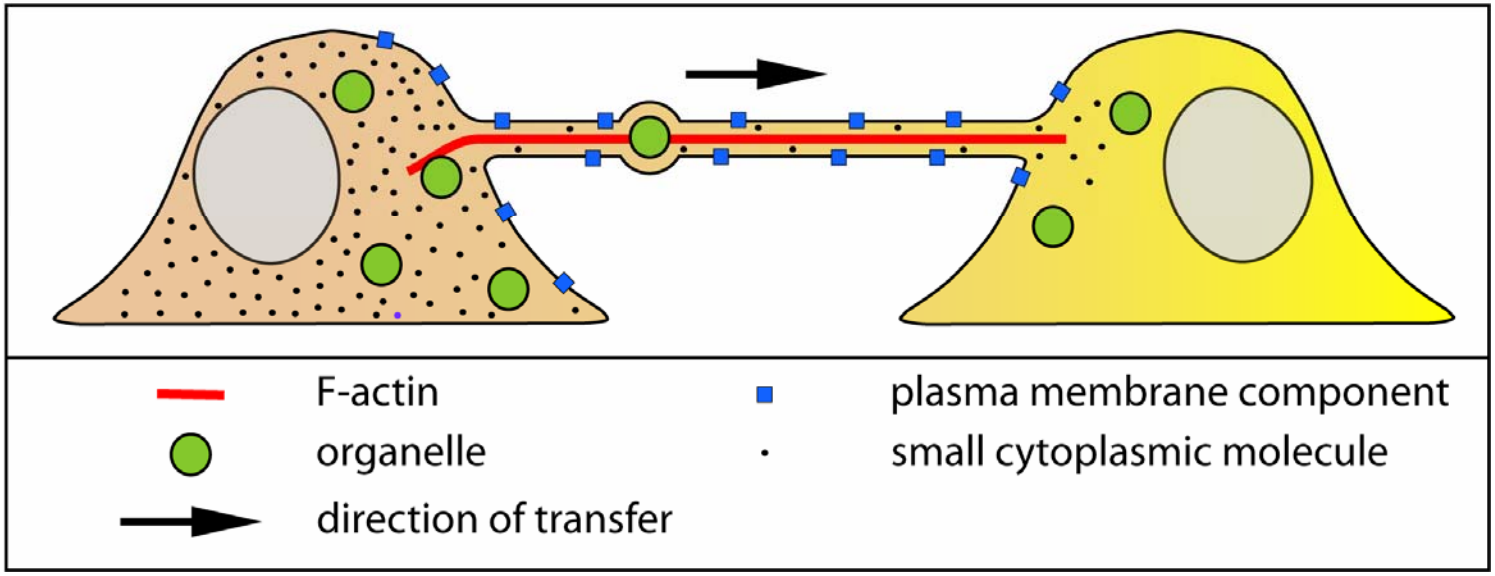
The Bio-nano Platform is a project-driven technology platform:

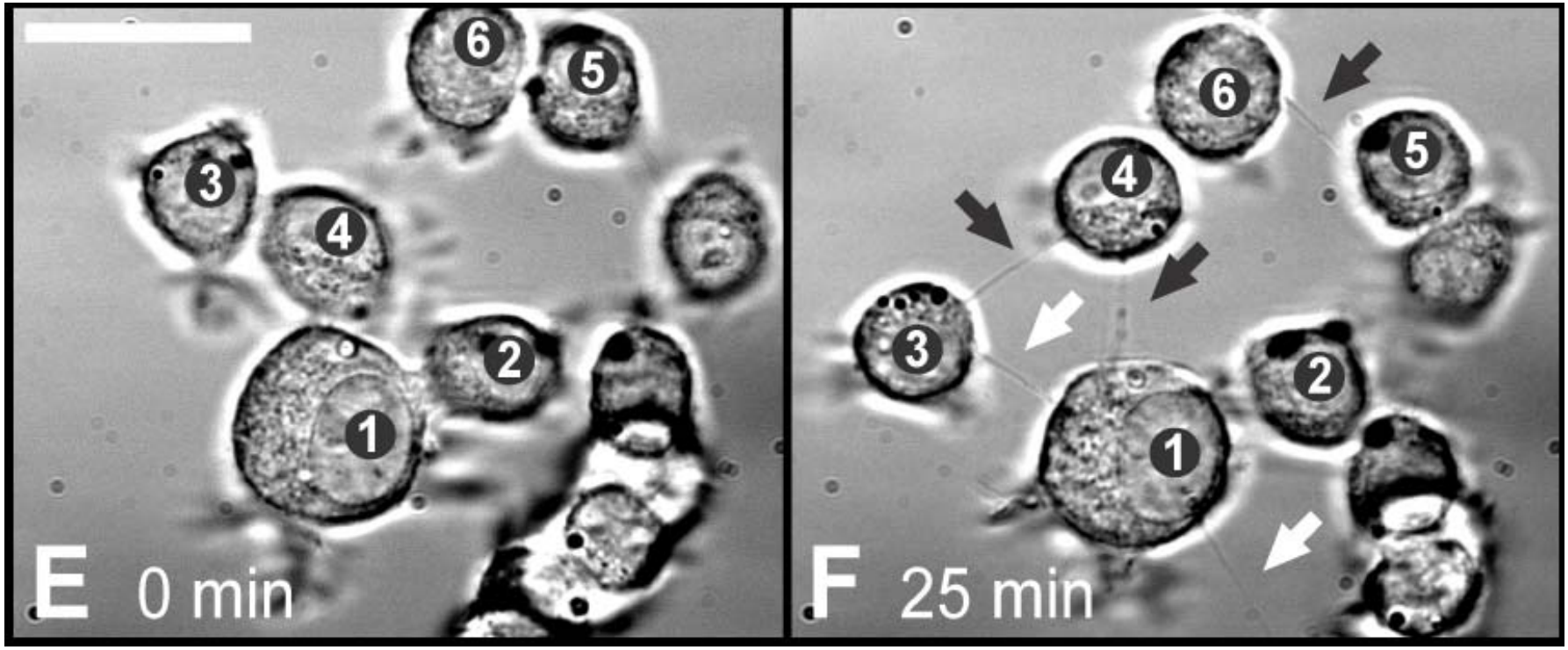
- Cell-to-cell communication with a particular focus on tunneling nanotubes (TNTs)
- Cell matrix interaction via collagen–binding integrins
- Improved vascularization of tissue engineering implants
- Development of porous copolymer scaffolds stimulating stem cell growth and bone regeneration

TNT-dependent cell-to-cell communication (Gerdes group, Dept. of Biomedicine)



The TNT model




6
5
3
4
2
1
E 0 min
6
5
4
3
2
1
F 25 min

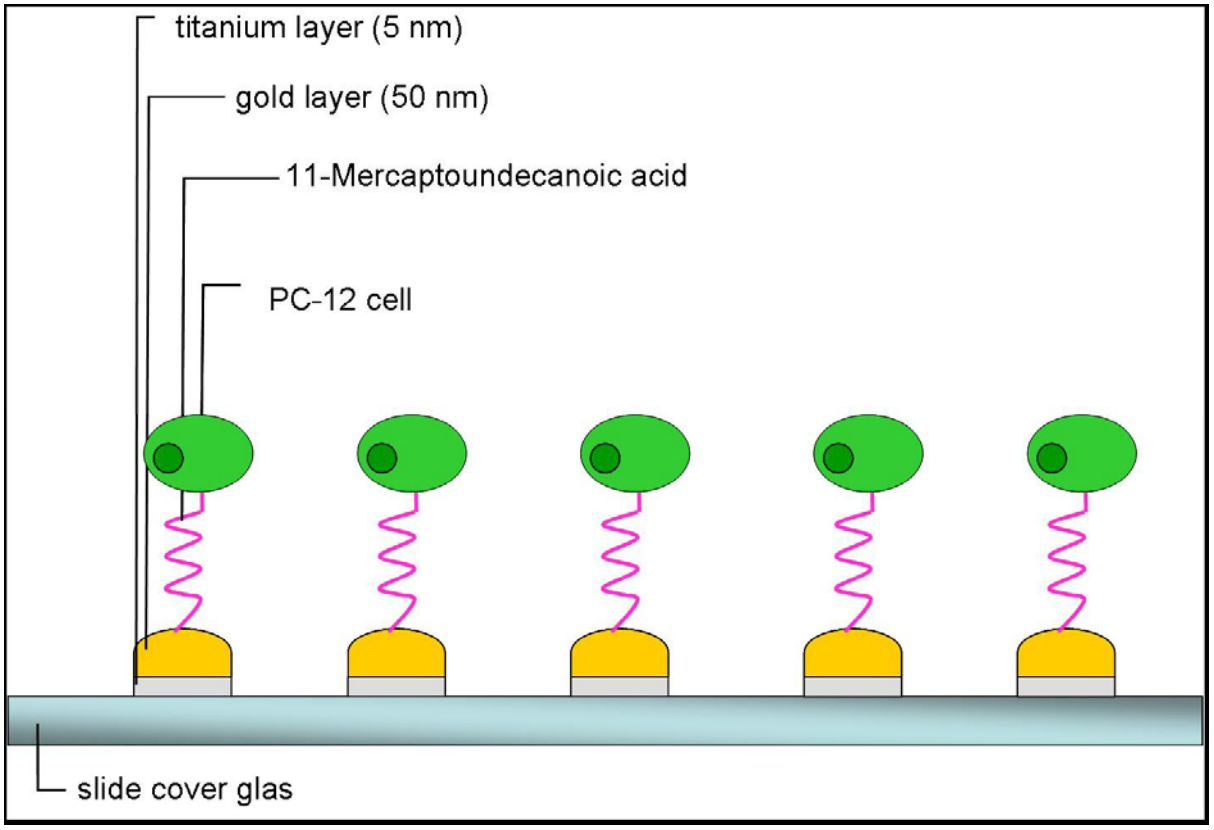
Experimental approach

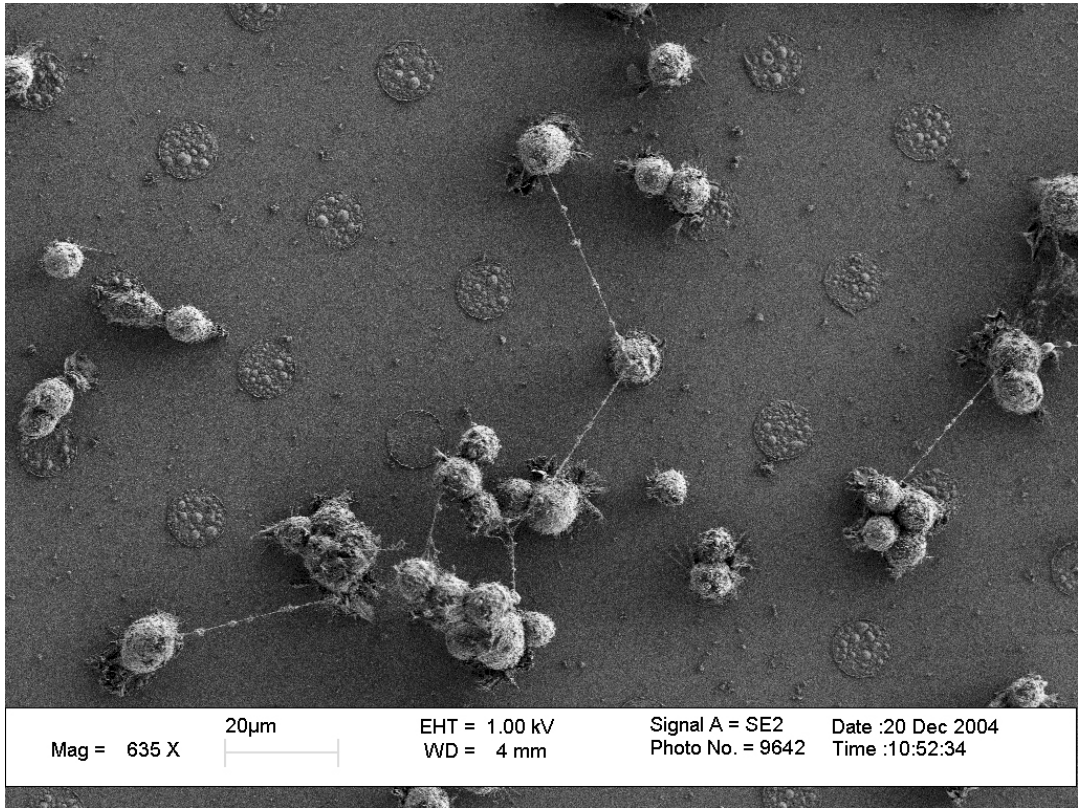
Fabrication and functionalization of micro- and nano-patterned surfaces for growth of PC12 cells

Analysis of TNT-dependent cell-to-cell communication (Live cell microscopy, microinjection, Qdots, etc.)

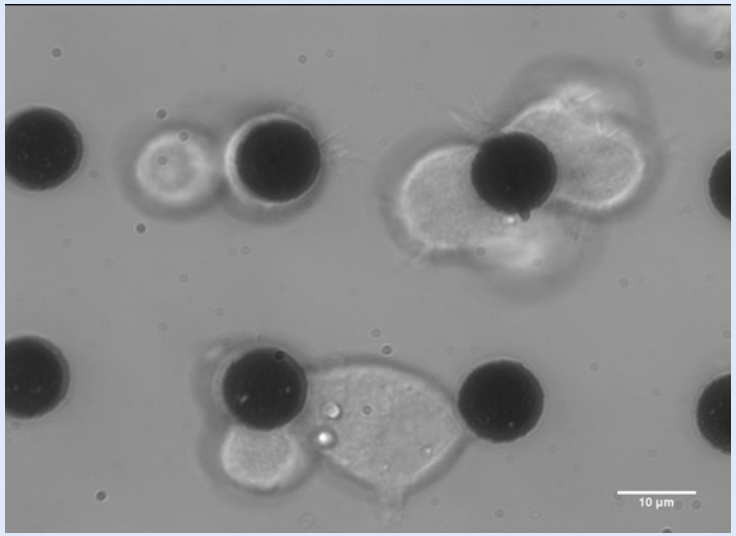
Automated detection of TNTs in cellular images and analysis of their transfer activity

Biofunctionalization

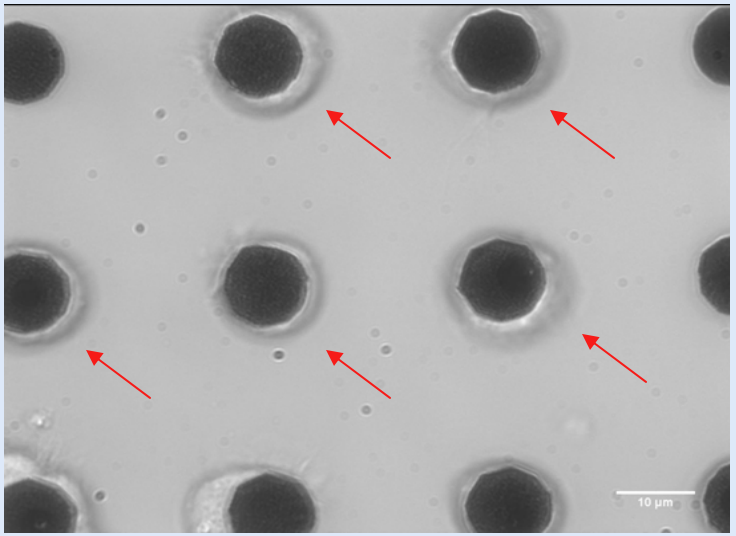



20µm
Mag = 635 X
EHT = 1.00 kV
WD = 4 mm
Signal A = SE2
Photo No. = 9642
Date :20 Dec 2004
Time :10:52:34

DIC microscopy of PC12 cells grown on micro-patterned surfaces

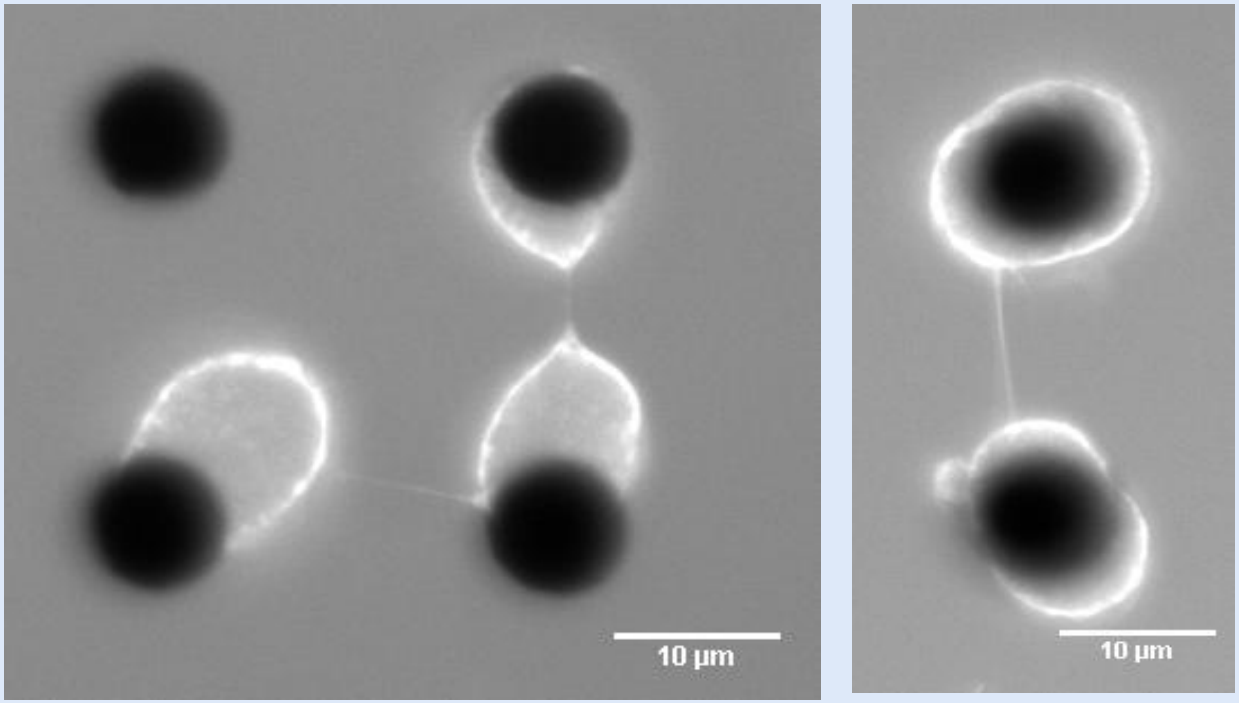


11-Mercapto-undecanoic acid

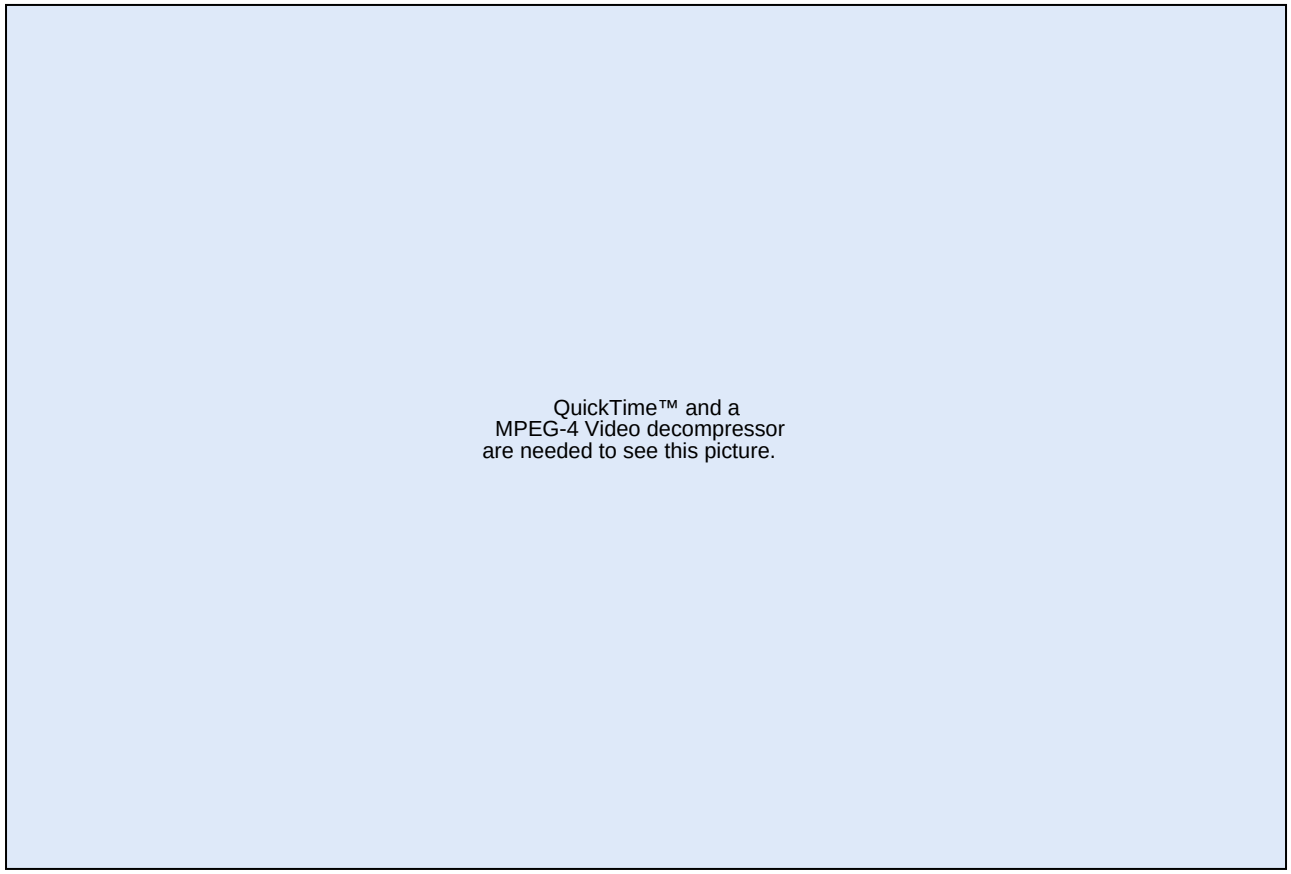


IKVAV-peptide

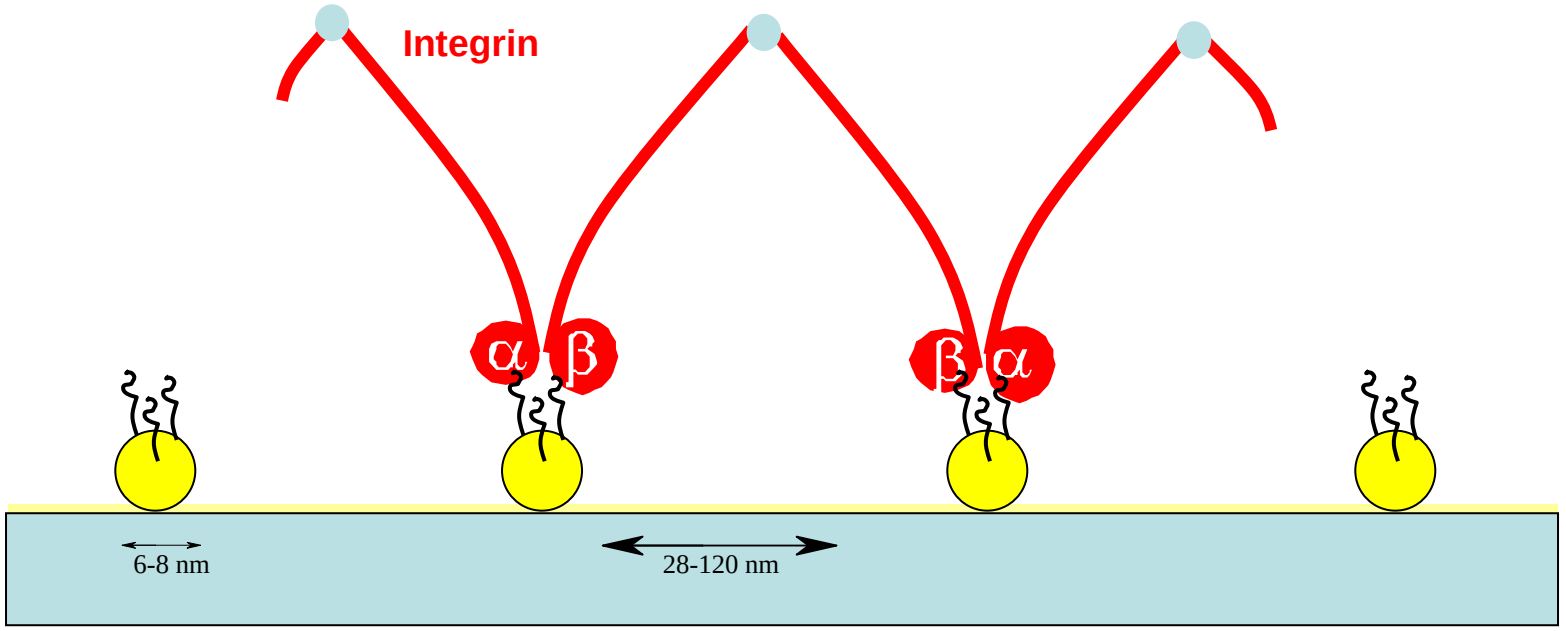
Monitoring TNT-formation between PC12 by fluorescence microscopy



Perspective

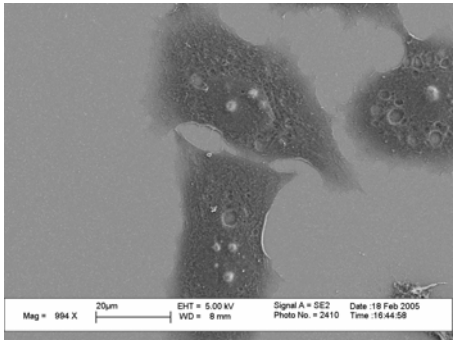


Biomimetic approach for integrin-clustering & activation as a tool to examine apoptosis on nanostructured surfaces

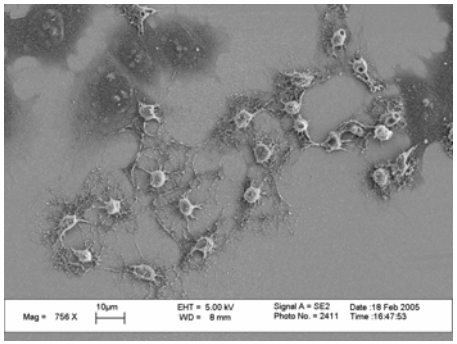


Apoptotic signaling

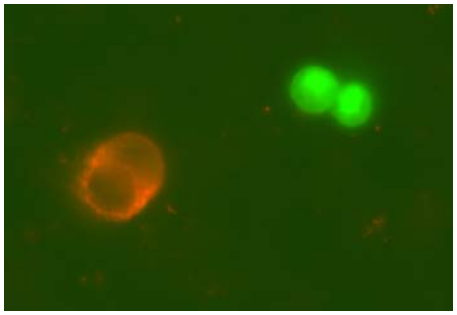
58 nm
(non-apoptotic)



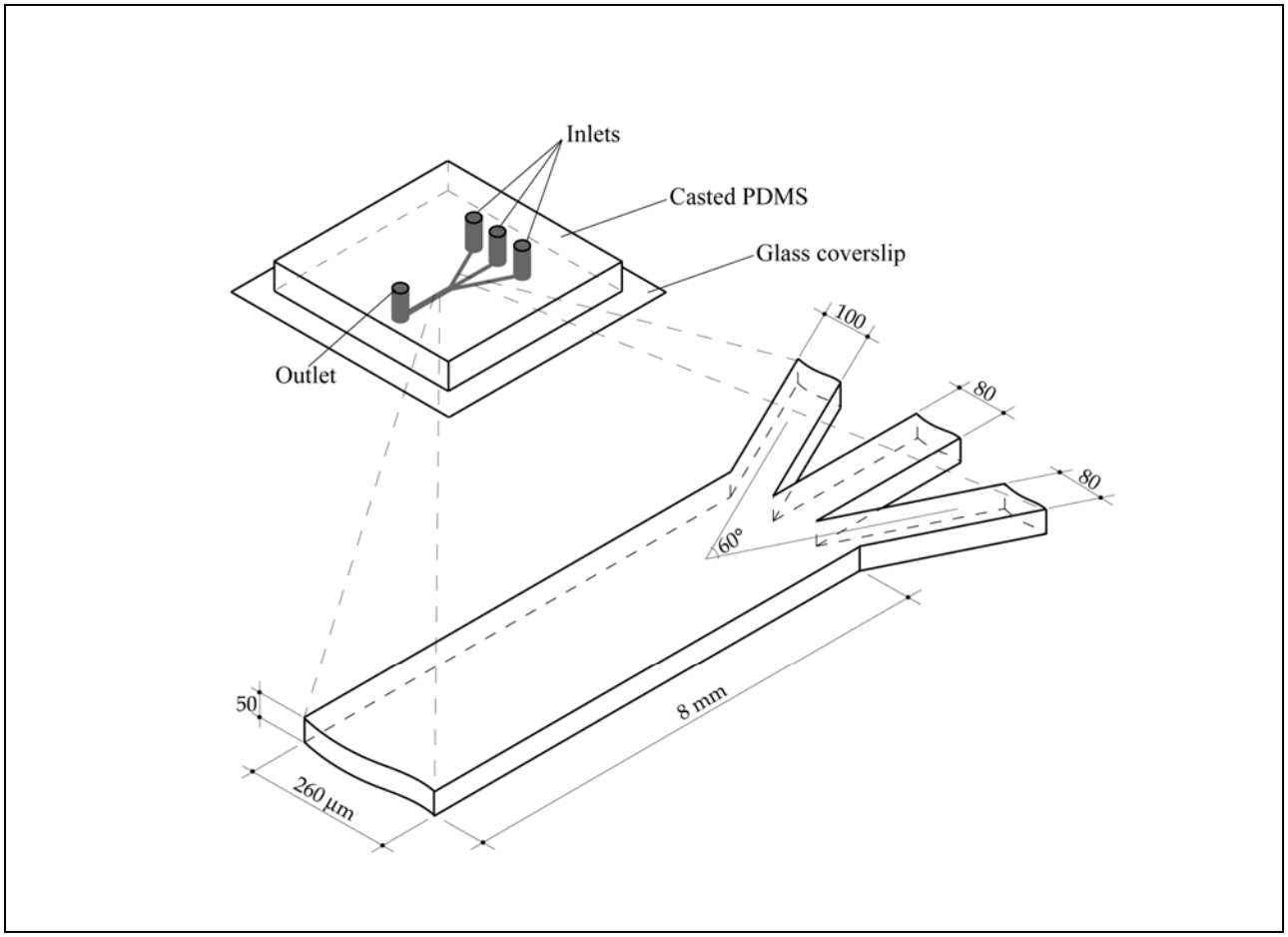
85 nm
(apoptotic)

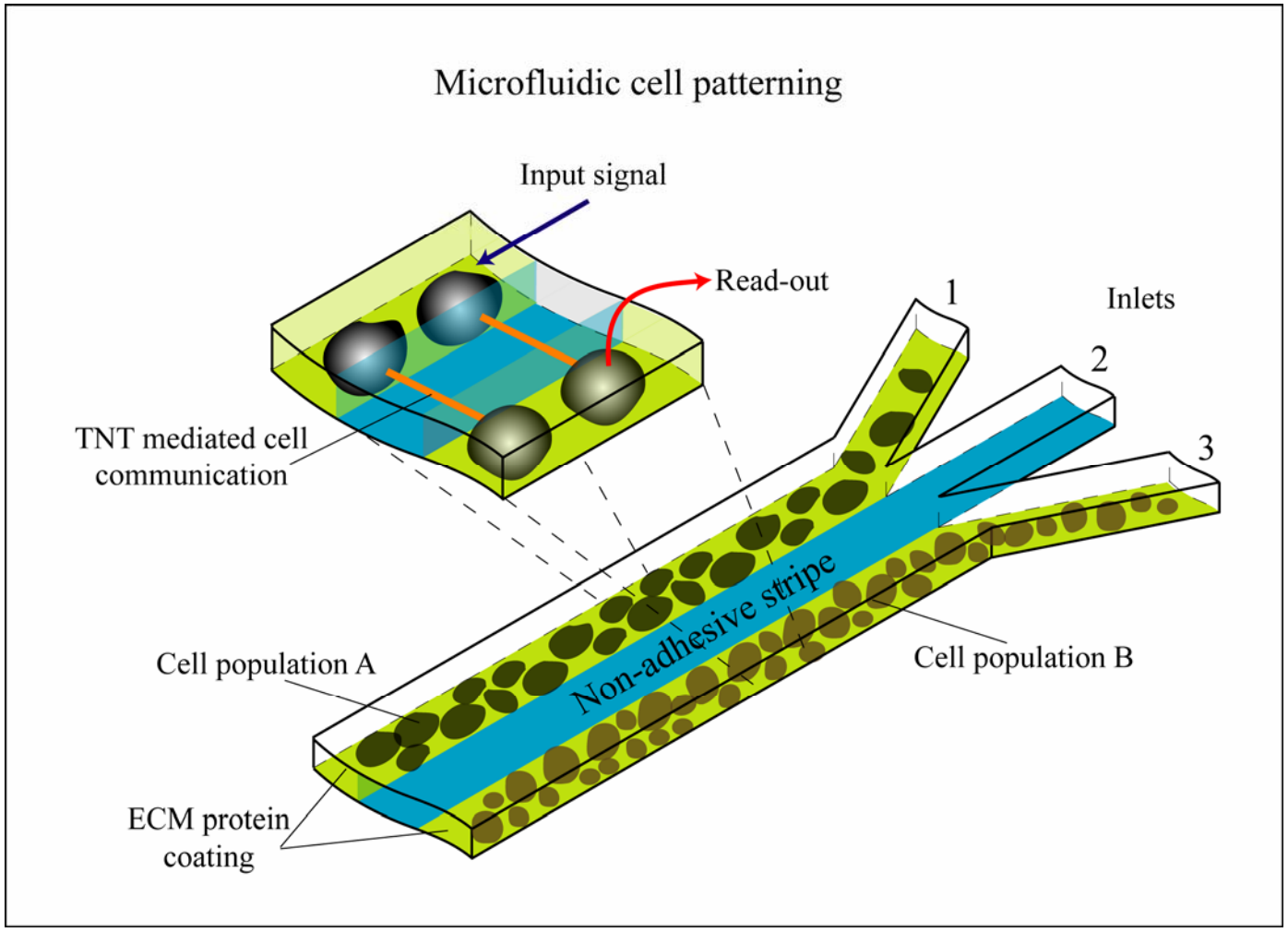


Staining with annexin V →

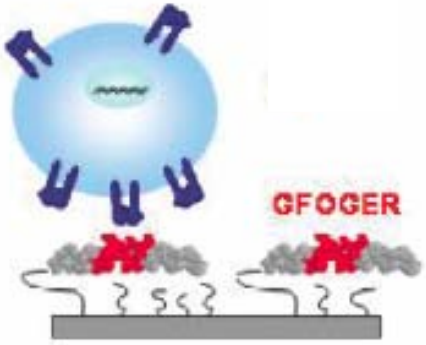


Microfluidic set-up




Microfluidic cell patterning
Input signal
Read-out
1
Inlets
2
3
TNT mediated cell communication
Non-adhesive stripe
Cell population A
Cell population B
ECM protein coating

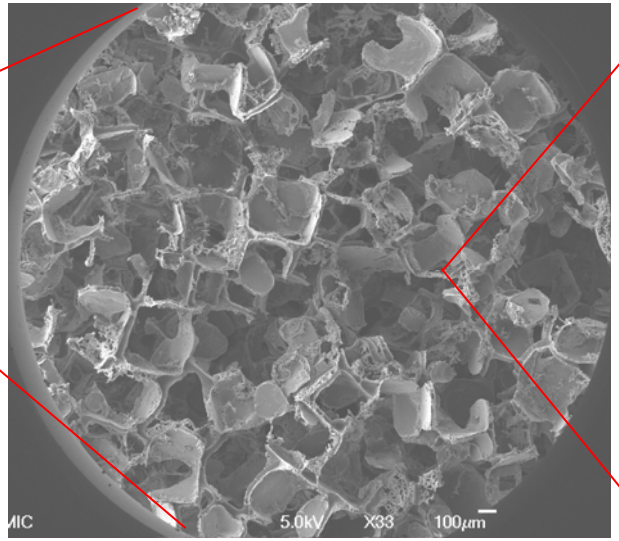
Cell matrix interaction via collagen–binding integrins (Gullberg group, Dept. of Biomedicine)

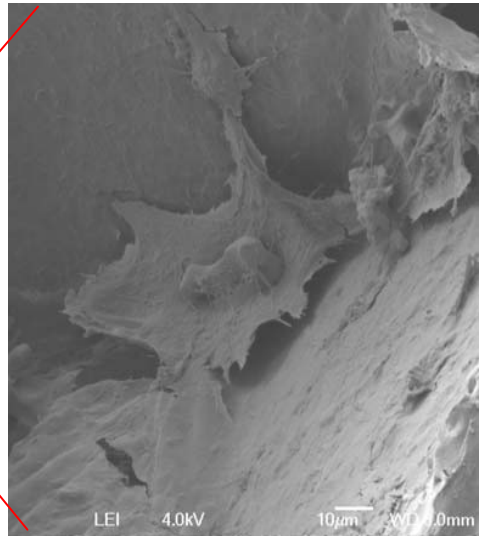


Integrins: dark blue
GFOGER peptides: red

Improved vascularization of tissue engineering implants

Lorens group, Dept.of Biomedicine





MRI of a vascularized scaffold implant

SEM of the porous of a PLLA scaffold

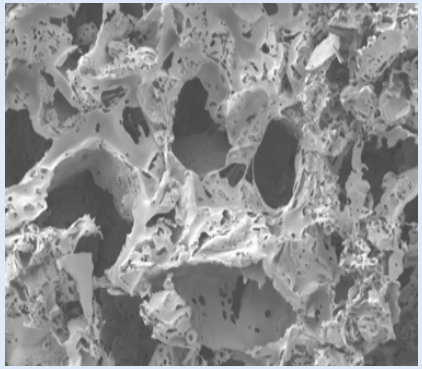
SEM of an endothelial cell within a PLLA scaffold pore

Development of well-defined scaffold for bone regeneration

Ass. prof. K. Mustafa, Center for Clinical Dental Research

Copolymers of:

- L-lactide (LLA)
- trimethylene carbonate (TMC)
- caprolactone (CL)
- 1,5-dioxepan-2-one (DXO) monomers



Aim: Optimization of porosity and nano/microstructure to improve integrin interaction, cell proliferation and differentiation, bone regeneration.

Acknowledgements

Marcus Abel
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Prof. J. Spatz

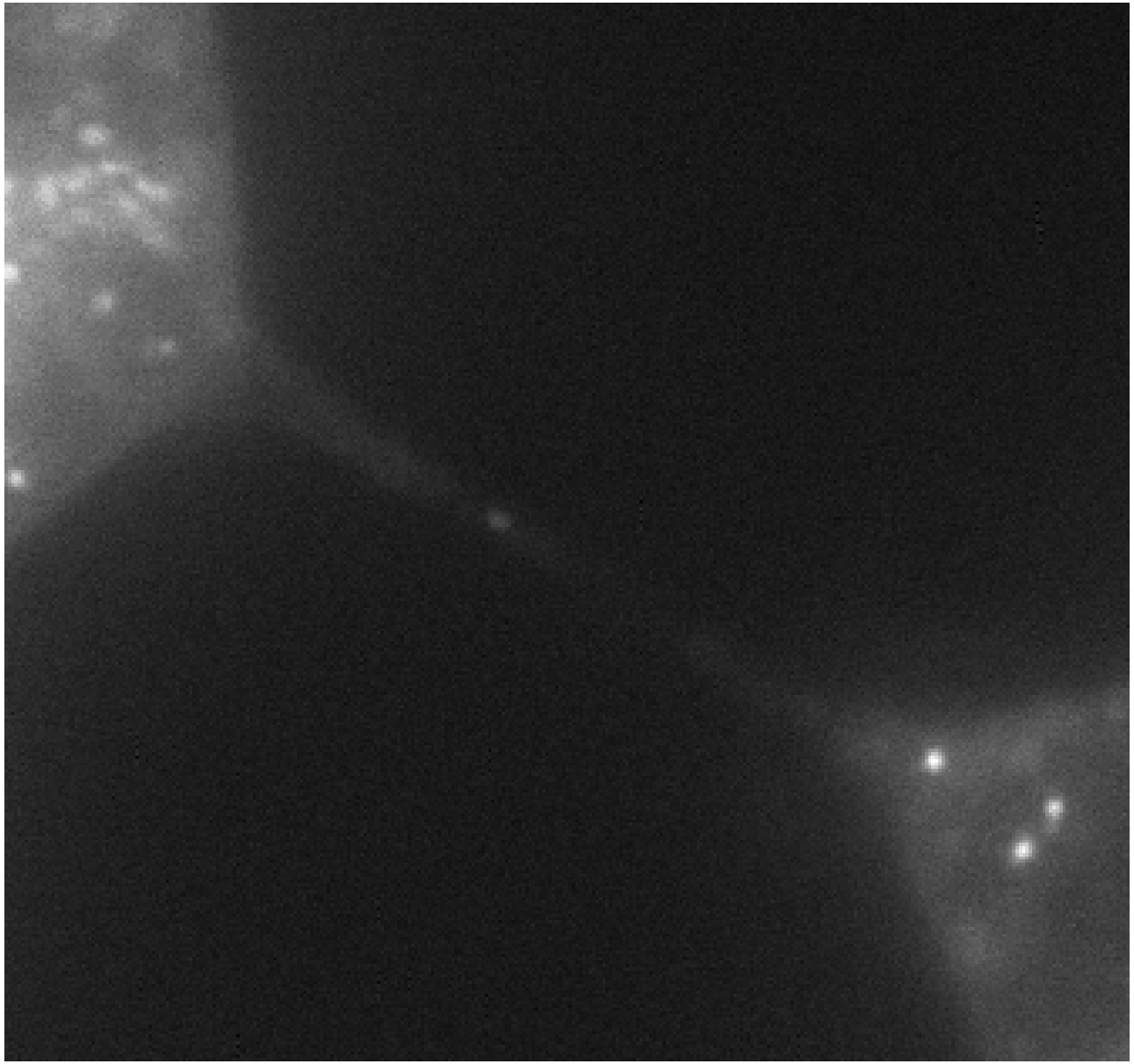
Ivan Rios-Mondragon
Xiang Wang

Prof. J. Lorens
Prof. D. Gullberg
Ass. Prof. K. Mustafa

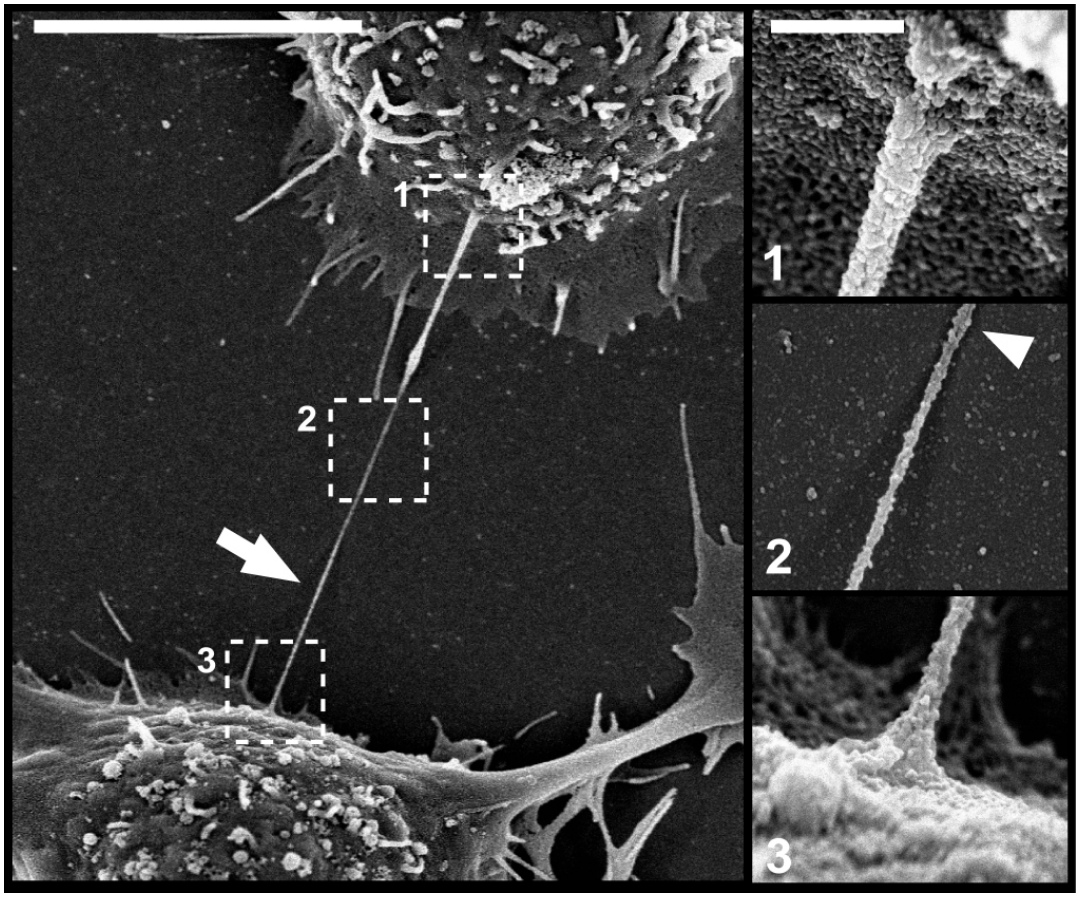
Norwegian Research Council, University of Bergen, Helse Vest

Bionanotechnology at UiB

Understanding cell biology through nanotechnology



QuickTime™ and a
None decompressor
are needed to see this picture.


1
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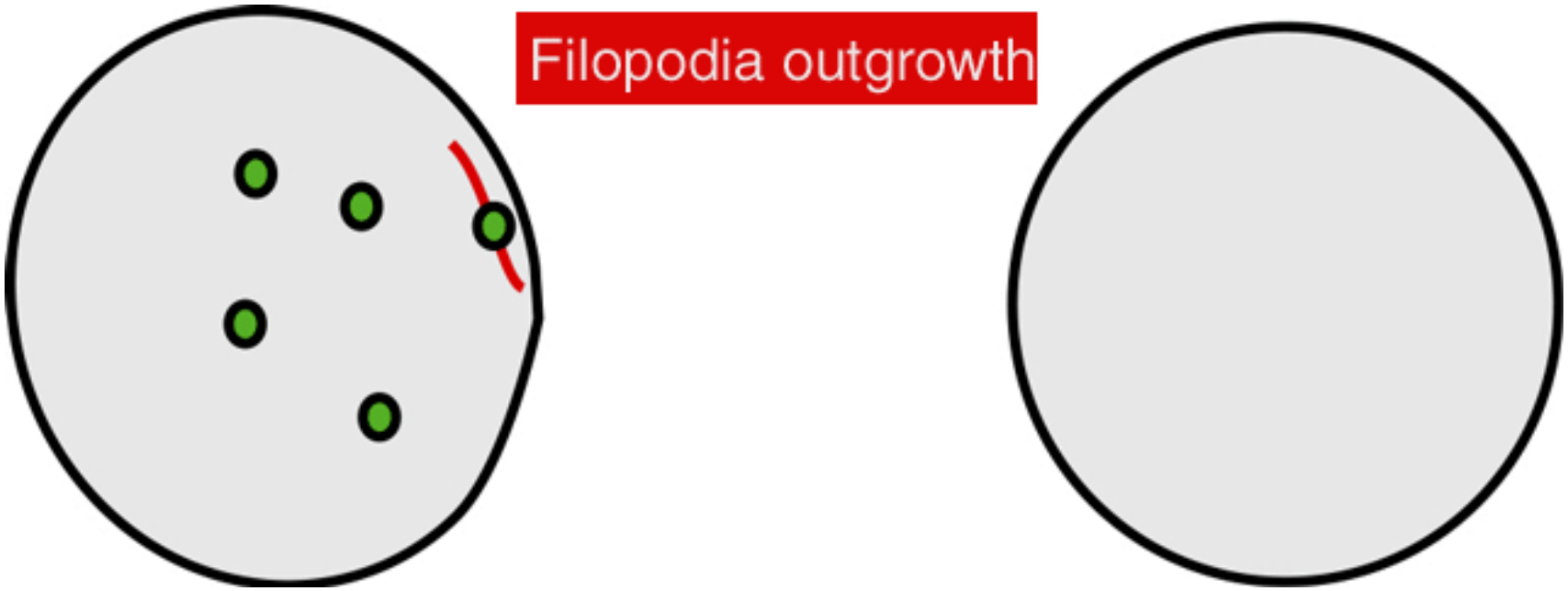
Filopodia outgrowth