Las nanotecnologías aplicadas a la salud: perspectivas de la Nanomedicina

Josep Samitier
jsamitier@ub.edu

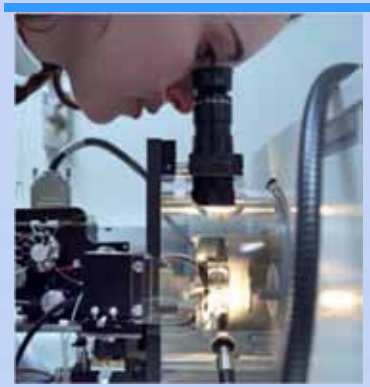
Nanobioengineering group
Institute for Bioengineering of Catalonia (IBEC)
Ciber-BBN
Universitat de Barcelona

Aula Guadiana, Badajoz 15 de Junio 2011

UNIVERSITAT DE BARCELONA

Parc Científic de Barcelona

BARCELONA SCIENCE PARK



Research Institutes

Core Facilities

Private Companies

Where I come from

www.ibecbarcelona.eu

www.pcb.ub.es

www.ub.edu

UNIVERSITAT DE BARCELONA

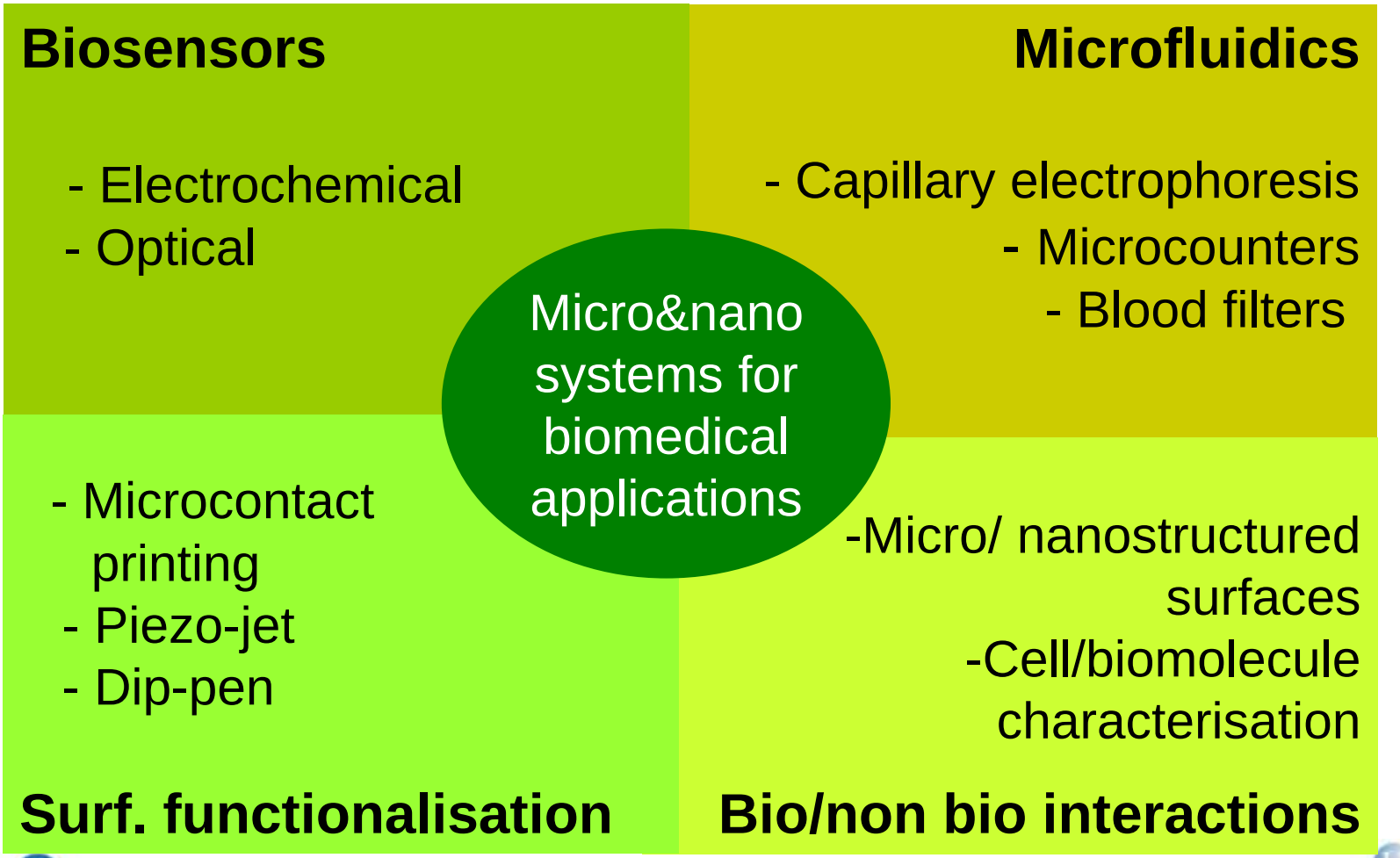
Parc Cientific de Barcelona

IBEC

Cellular Biotechnology	Biomechanics & Cellular Biophysics	Nanobio-technology	Biomaterials Implants & Tissue Engineering	Medical Signals & Instrumentation	Robotics & Biomedical Imaging
Microbial Biotechnology	Cellular & respiratory biomechanics	Nanobio-engineering	Bio/non-bio interactions for regenerative medicine	Biomedical Signal Processing and Interpretation	Robotics
Molecular and cellular neurobiotechnology	Nanoprobes & nanoswitches	Bionano-photonics	Molecular dynamics at cell-biomaterial interface	Artificial Olfaction	
Control of stem cell potency		Nanoscale Bioelectrical Characterization	Biomechanics & Mechanobiology	Neuro-engineering	

CELONA

Research activities in our Lab



- Introducción Nanomedicina
- Nanotecnología para diagnóstico
- Nanotecnología para medicina regenerativa.

Richard P. Feynman

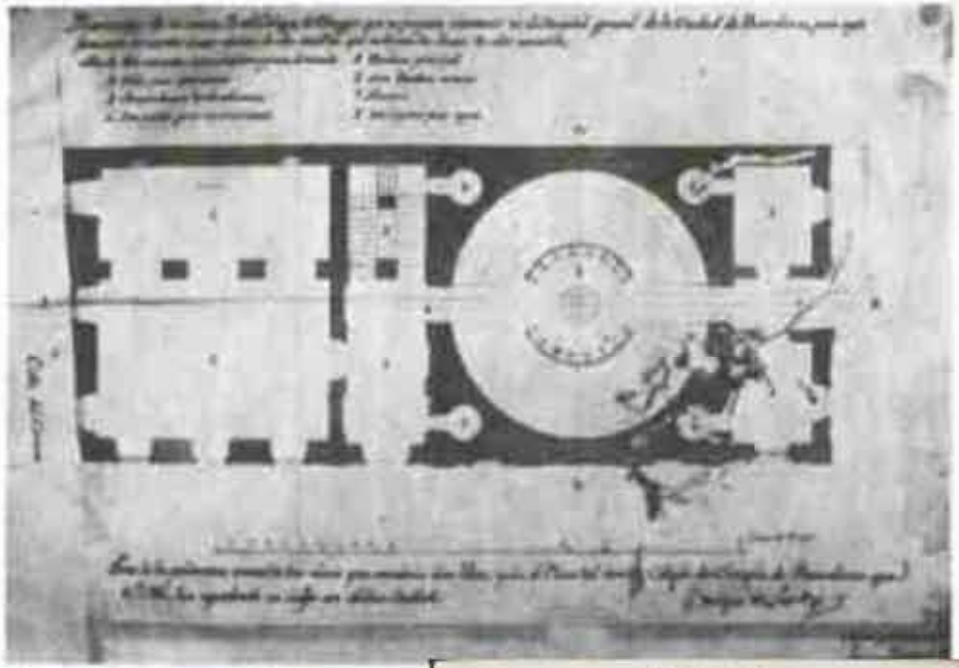
There's Plenty of Room at the Bottom

29th december 1959

Annual meeting of the American Physical Society

"The principles of physics, as far as I can see, do not speak against the possibility of maneuvering things atom by atom.
It is not an attempt to violate any laws; it is something, in principle, that can be done; but in practice, it has not been done because we are too big"

Virgili con un retrato del Marqués de la Ensenada y, los planos del Real Colegio, de Cirugía de Cádiz (Facultad de Medicina de Cádiz).



Dr. Dr. Antonio Cibat.
1798

Portada de los planos del Colegio de Cirugía. MDCCLXI.

ORDENANZAS

DE S. M.

QUE DEBEN OBSERVARSE

POR EL REAL COLEGIO DE CIRUGÍA

DE BARCELONA,

CUERPO DE CIRUGÍA MILITAR,

COLEGIOS SUBALTERNOS Y CIRUJANOS

DEL PRINCIPADO DE CATALUÑA.

DE ÓRDEN SUPERIOR.

MADRID, EN LA IMPRENTA REAL,

AÑO DE 1795.

Antoni CIBAT i ARNAUTO
(1770-1811)

Memoria sobre la necesidad de establecer la policía de sanidad en unas bases sólidas y estables, capaces de contener las epidemias y contagios desoladores, que en los pocos años que contamos de este siglo han sembrado en nuestra España el horror y el espanto, y causado su despoblacion: escrita por D. Antonio Cibat, caballero de la Orden Real de España, inspector de sanidad de la guardia de S. M., miembro de la administracion central de hospitales militares &c. &c.

Empezando por los estudios de los que se dedicaban al arte de curar, dos facultades, que la naturaleza y la razon han unido con vínculos tan estrechos, que cada una de ellas es manca é incompleta sin el conocimiento de la otra, se hallaban separadas. Las ciencias naturales, que son la base del saber, se excluyeron de los estudios de la cirugía médica, á pesar de que su conocimiento es tan indispensable, que sin la física, la química y la botánica ningun facultativo puede preciarse de ser consumado ni en cirugía ni en medicina. Final-

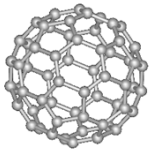
Antoni Cibat Diari de Madrid Setembre 1810

Què és Nano?

12,756 Km

22 cm

Fullerenes C_{60}



0.7 nm

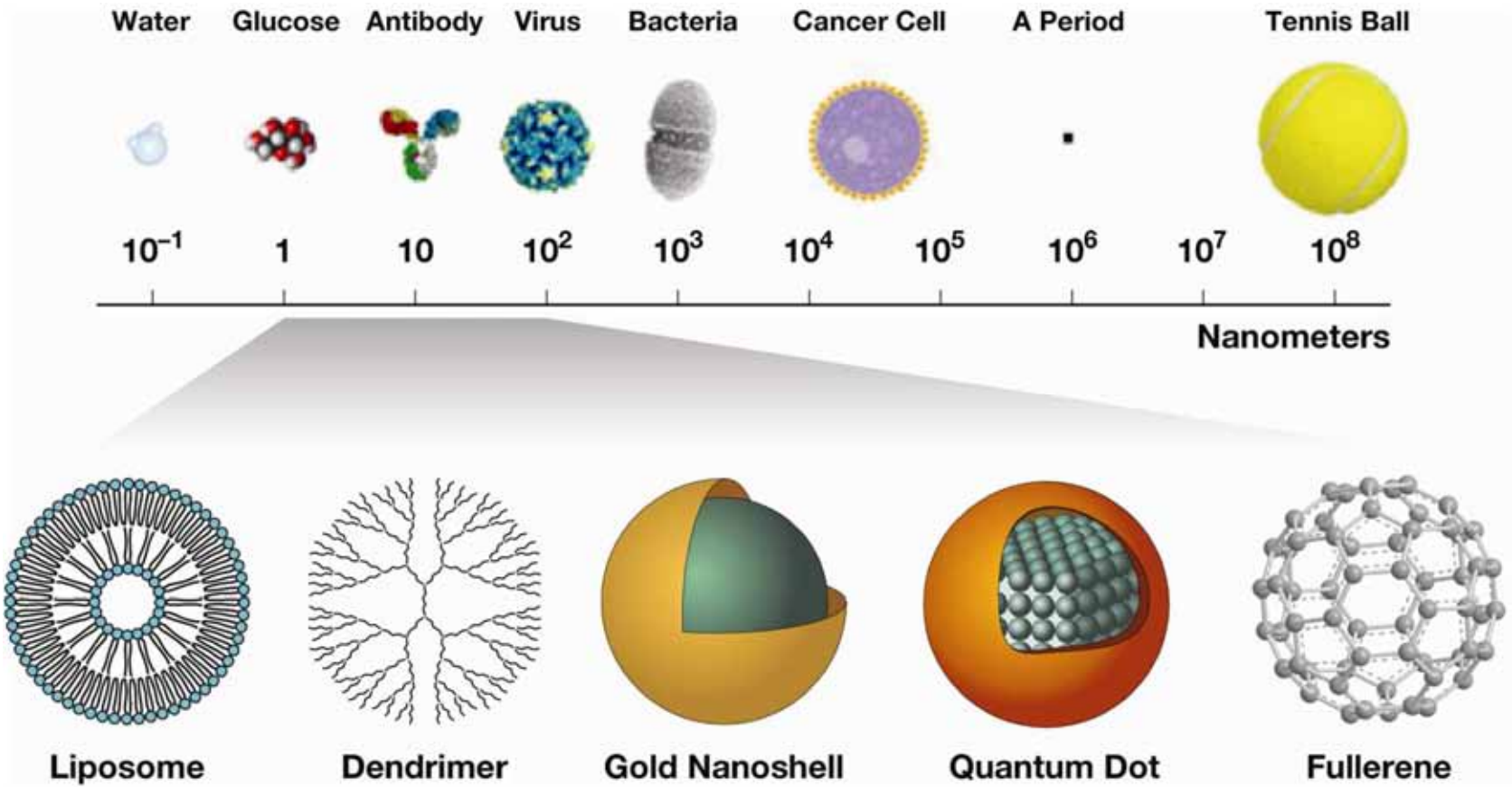
Ø 1.27 10^{7} m **0.22 m** **0.7 10^{-9} m**

10 milions de vegades més petit

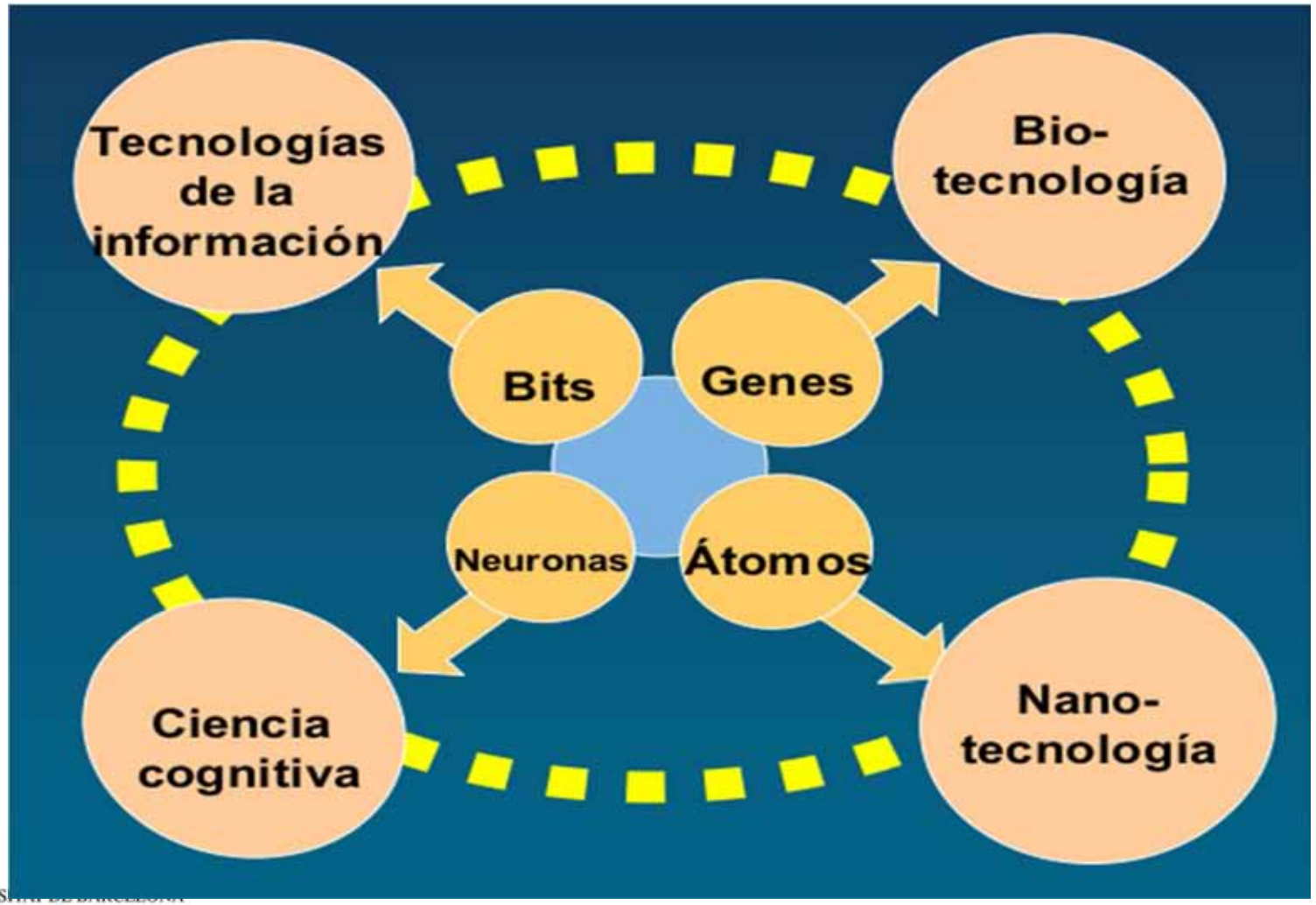
1.000 milions de vegades més petit

Nanotecnologia

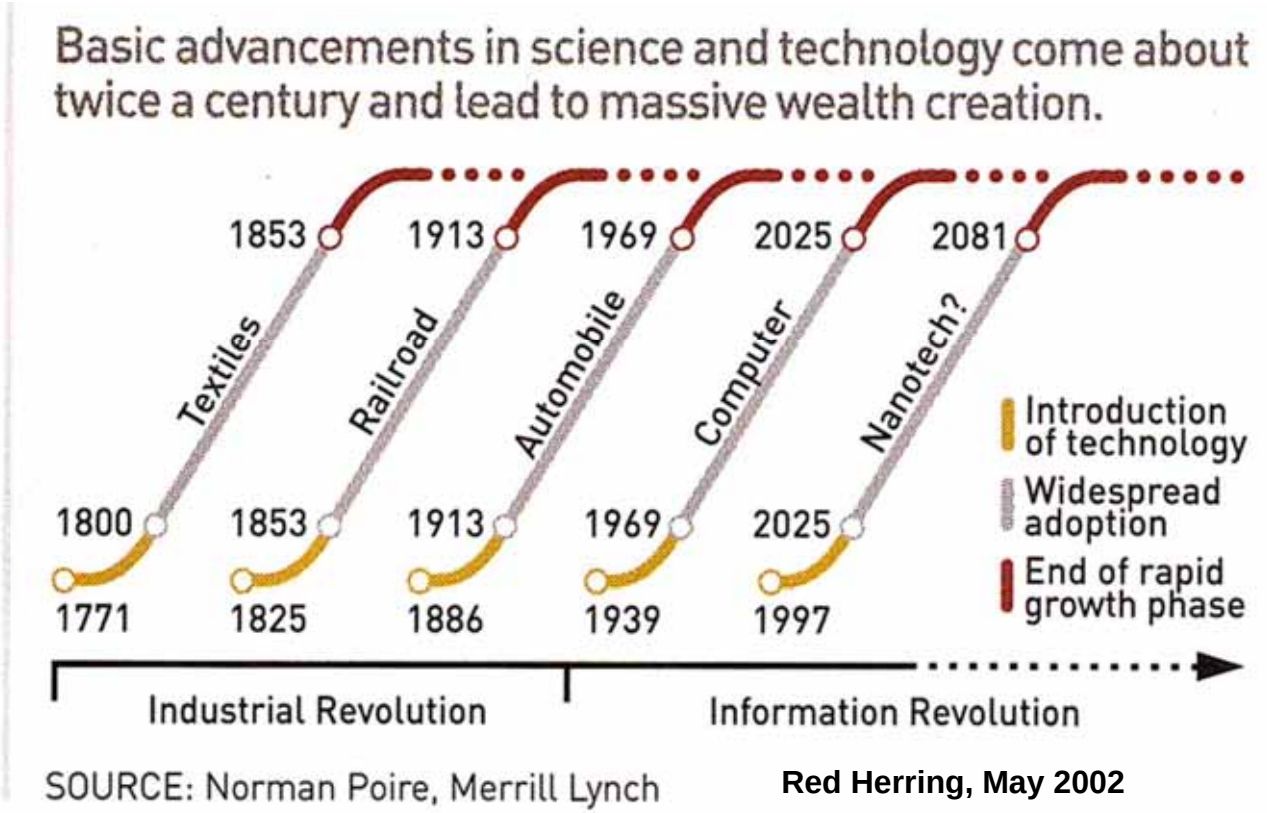
Nanotecnologia:: **“Ciència i tecnologia a nivell atòmic, molecular o macromolecular que permet l’obtenció d’estructures, dispositius i sistemes amb una longitud característica entre 1 i 100 nanòmetres.**



CONVERGENCIA DE TECNOLOGIAS

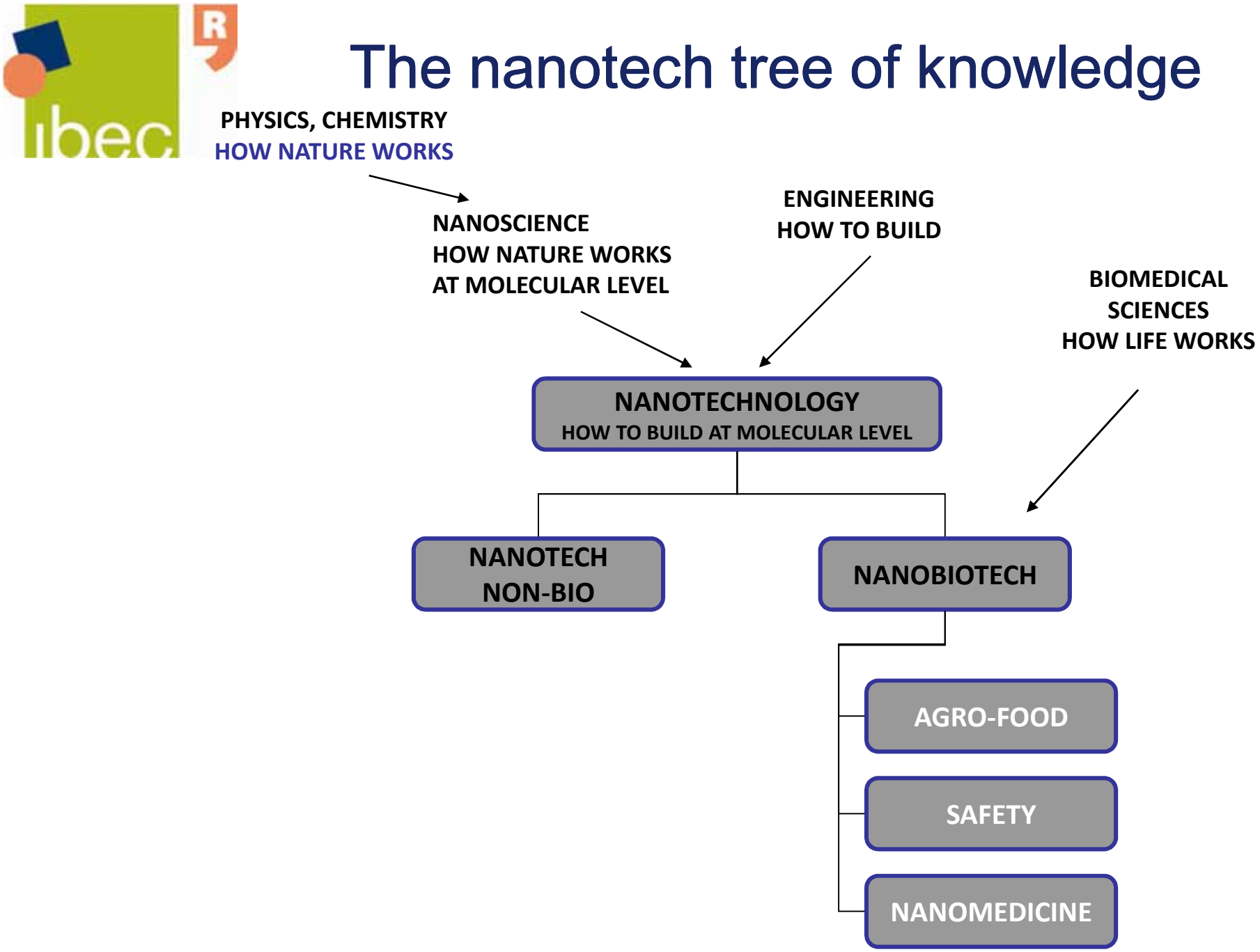


Forces Revolucionàries



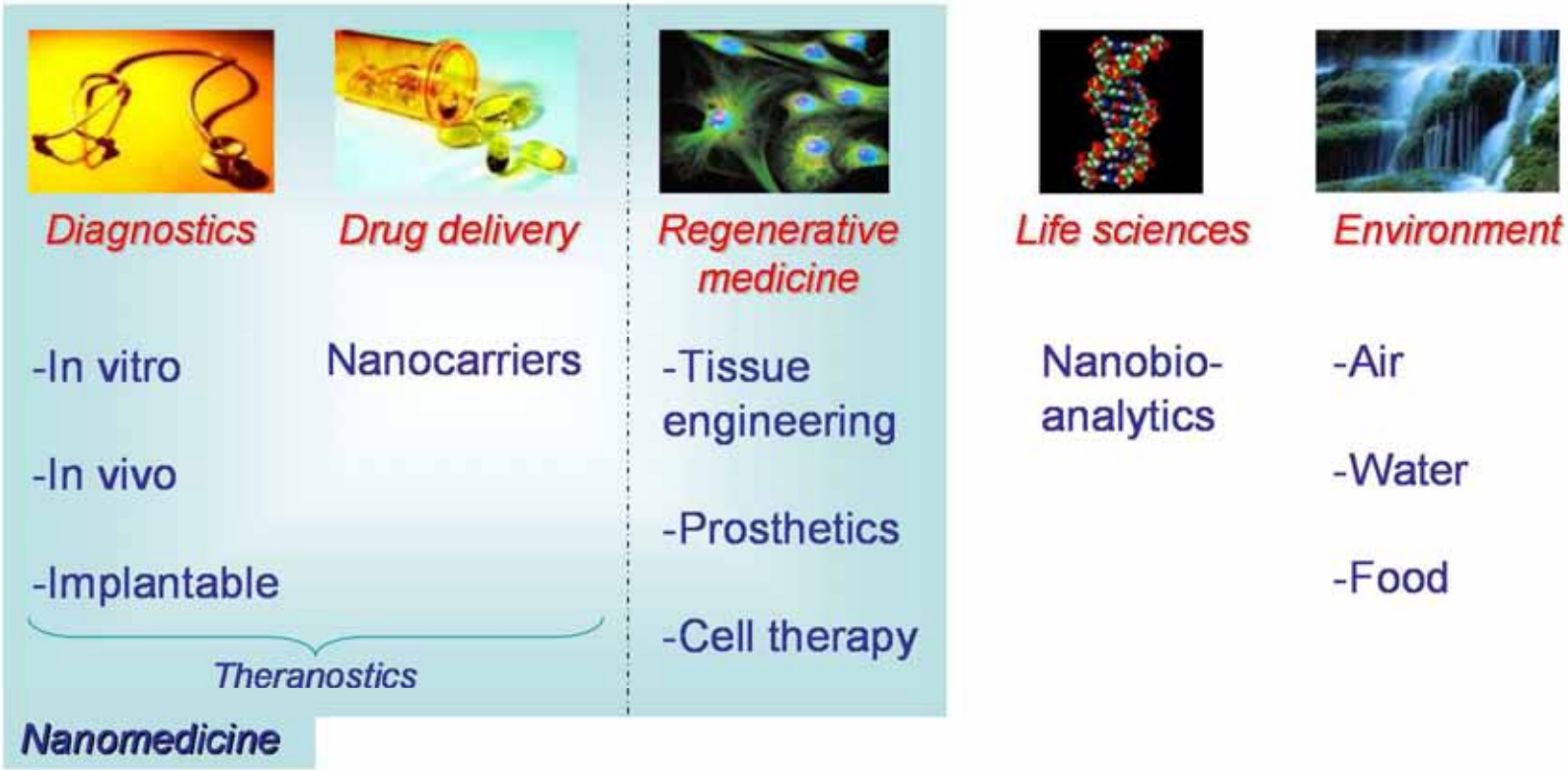
Tecnologies transversals

The nanotech tree of knowledge



Nanobiotechnology areas

Nanobiotech based applications & industries



From CSA-EuroNanoBio

Nanomedicine

EUROPEAN TECHNOLOGY PLATFORM ON NANOMEDICINE

Definition: NanoMedicine, for the purpose of this vision document, is defined as the application of Nanotechnology to Health. It exploits the improved and often novel physical, chemical, and biological properties of materials at the nanometric scale. NanoMedicine has potential impact on the prevention, early and reliable diagnosis and treatment of diseases.

ETP Nanomedicine Roadmap Report 2009

- Discusión general de los aspectos críticos para la implantación clínica de la nanomedicina
- Identificación de aplicaciones relevantes a nivel industrial y formulación de hojas de ruta de desarrollo en diagnóstico, liberación de fármacos y medicina regenerativa
- Integración de las mismas en un marco conceptual y estrategia de largo plazo
- Incluyendo aspectos económicos y regulatorios
- Liderando desde el valor clínico y de negocio
- Definición de los futuros programas de trabajo PM7/PM8

Disponible: www.etp-nanomedicine.eu

23/02/2010

Table 3-2: Specific Roadmaps / Applications and R&D challenges - In vivo imaging

Roadmaps / Targeted Applications	Key R&D Priorities	Technologies	Challenges	Targeted Diseases
Magnetic Particle Imaging (MPI)	▪ Instrumentation for Imaging and Therapy ▪ Focused Thermal Ablation Unit for Tumour T... ▪ Interven...	▪ Hi-temp. Superconductive novel magnets. ▪ System ... which ... intervention ... send/receive components and ▪ High Power Amplifiers ▪ Transducer technol...	▪ new contrast agent is a crucial requirement ▪ real-time computing ▪ Nanoparticle characterisation, toxicity analysis, coating chemistry ▪ Optimizing combination contrast medium/imaging modality ▪ Reliable preparation	▪ Cardiovascular diseases ▪ Neurodegenerative diseases ▪ Cancer

Example: In vivo Imaging

PRESENTACIÓN DEL INFORME

PLATAFORMA ESPAÑOLA DE NANOMEDICINA

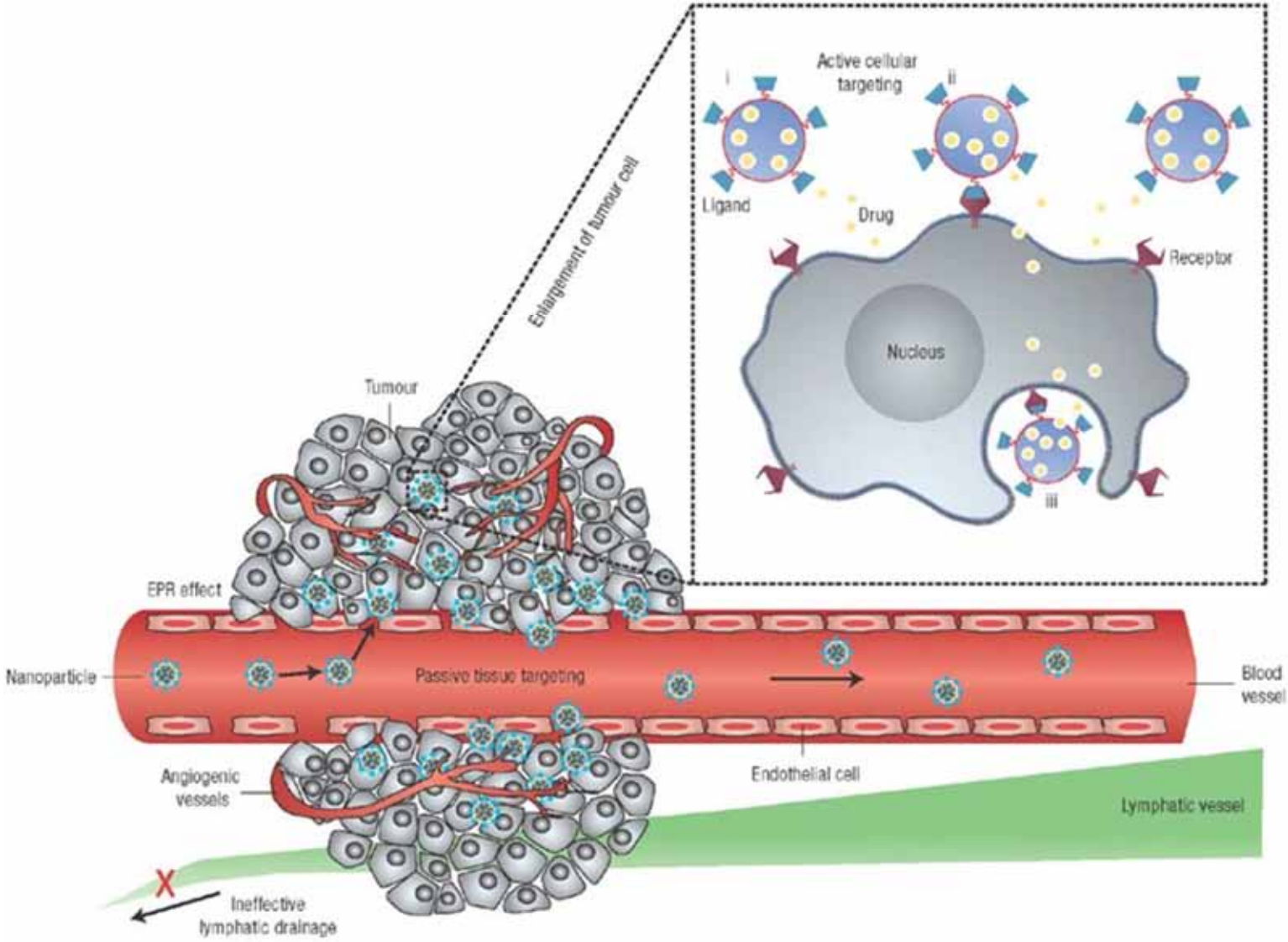
www.nanomedspain.net

Administración de Fármacos y Nanotecnología

Ventajas

- Liberación controlada: efecto terapeutico prolongado
- Distribución del fàrmaco selectivamente al òrgano, tejido o célula diana.
- Protección ante degradació n
- Mejora de solubilidad
- Mejora del transporte, paso a través de mucosas
- Reducción de la toxicidad
- Mejora de la eficàcia.Farmacocinética.

Mecanisme per alliberar un farmac en un tumor



http://www.nature.com/nnano/journal/v2/n12/fig_tab/nnano.2007.387_F1.html

http://www.gopubmed.com/web/gopubmed/

- **1,388 documents semantically analyzed nanomedicine**

Top Countries	Publications
USA	587
Spain	86
United Kingdom	82
China	76
India	62
Germany	43
Japan	35
Italy	33
Canada	30
France	22
Australia	19
Taiwan	17
Netherlands	17
Iran	14
Thailand	12
South Korea	11
Switzerland	11
Turkey	10
Israel	10
Singapore	

Top Cities	Publications
Boston	50
Barcelona	44
Omaha	41
London	34
Baltimore	31
Los Angeles	28
Houston	27
Beijing	17

Se consolidará?

The Alliance: BioNanoMed Catalonia

18 organisations (companies, researchers, clinicians) join forces in 2011 under BIOCAT and IBEC s leadership to launch BioNanomed Catalonia alliance, in order to:

- Favour synergy among research centres, industry and hospitals
- Create new business opportunities in health/life sciences markets, based upon nanotechnology applications.
- Increase the international presence
- Act as a one-stop shop to defend common interests of the participants and disseminate results

BioNanoMed Catalunya

- Introducción Nanomedicina
- Nanotecnología para diagnóstico
- Bionanomateriales para medicina regenerativa.

Nanomedicine evolution

- From “late disease” to “early health”
- Sustainability of healthcare systems.
- From “hospital-based” to “patient-centred”
  - Two main areas:
    - Preventive medicine
      - Chronic diseases management.
      - Empowering the patient (monitoring)
    - Predictive medicine
      - Molecular medicine.

Nanodiagnostics across the care cycle

Monitoring therapy

Predisposition

Therapy – treatment

Screening

Diagnosis – prognosis

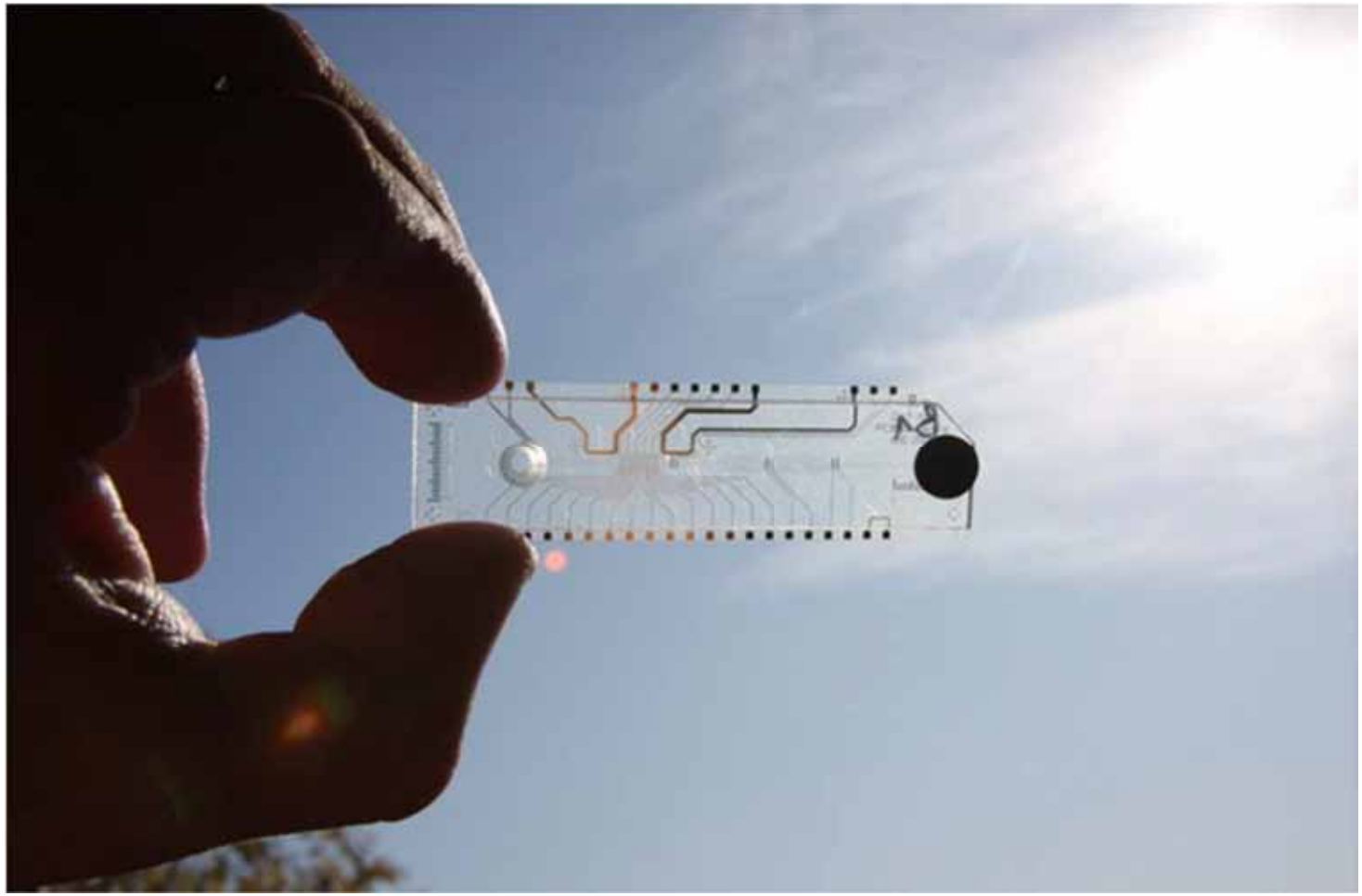
Deep Vein Thrombosis Impedimetric Microanalysis System

Project Goal

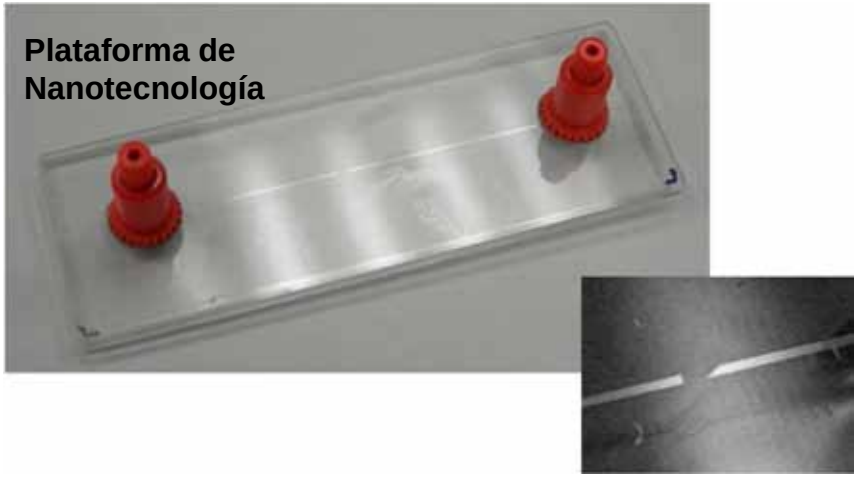
Development of a whole blood low cost D-dimer medical diagnostic device that can be used at the primary point-of-care

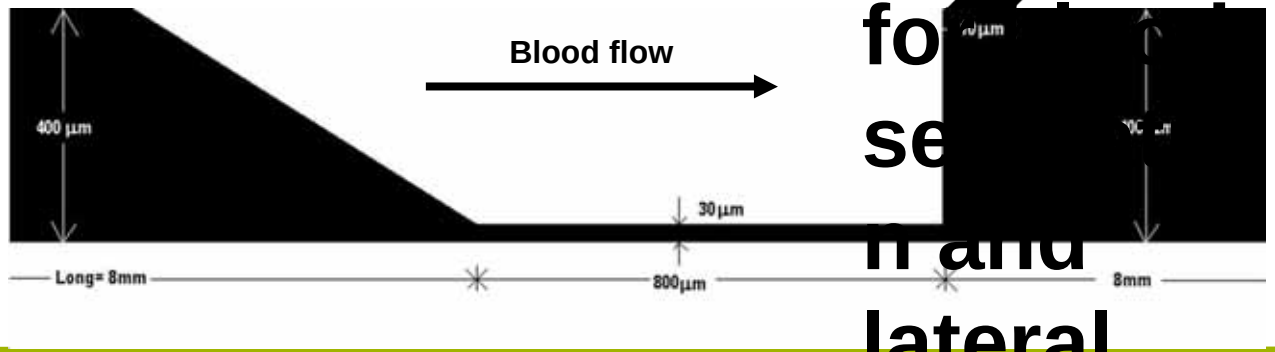
To provide quantitative and reliable measurement of D-dimer concentration levels

DVT-IMP … on to a bright future

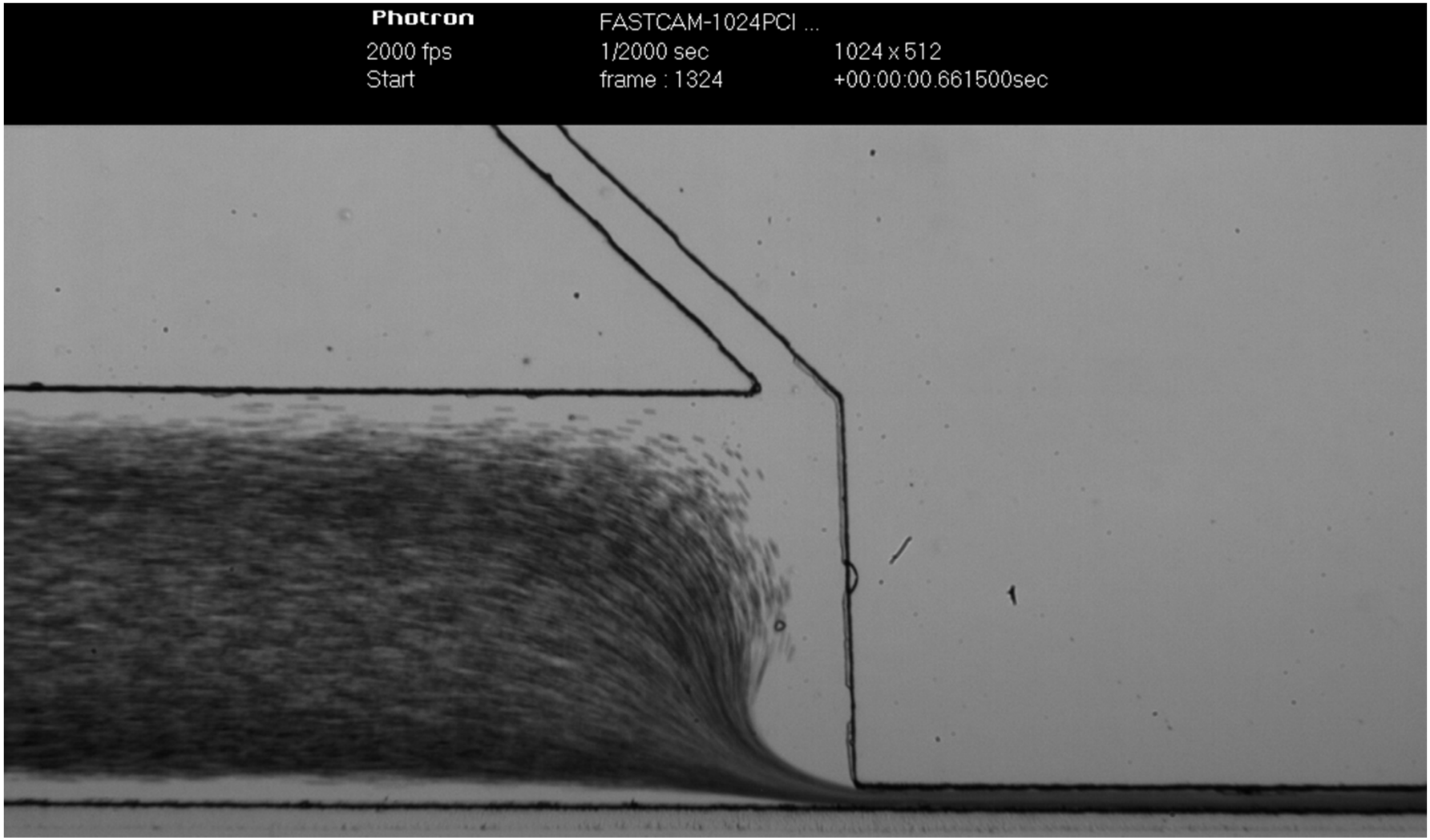


Blood Filter Chip



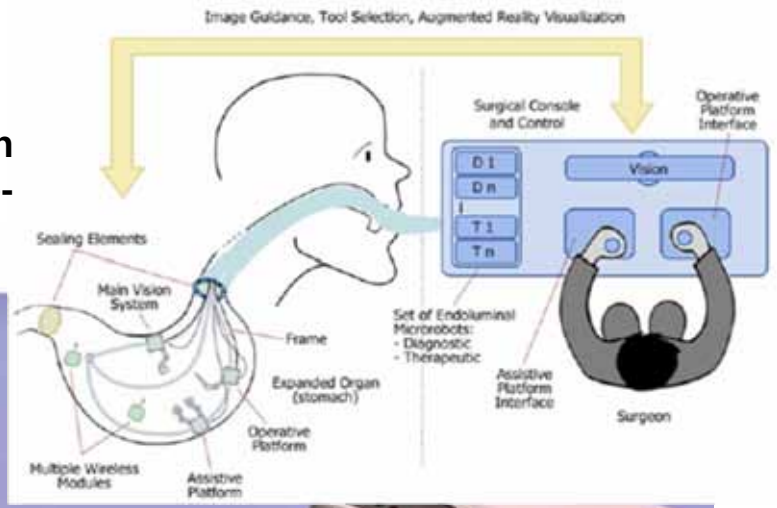


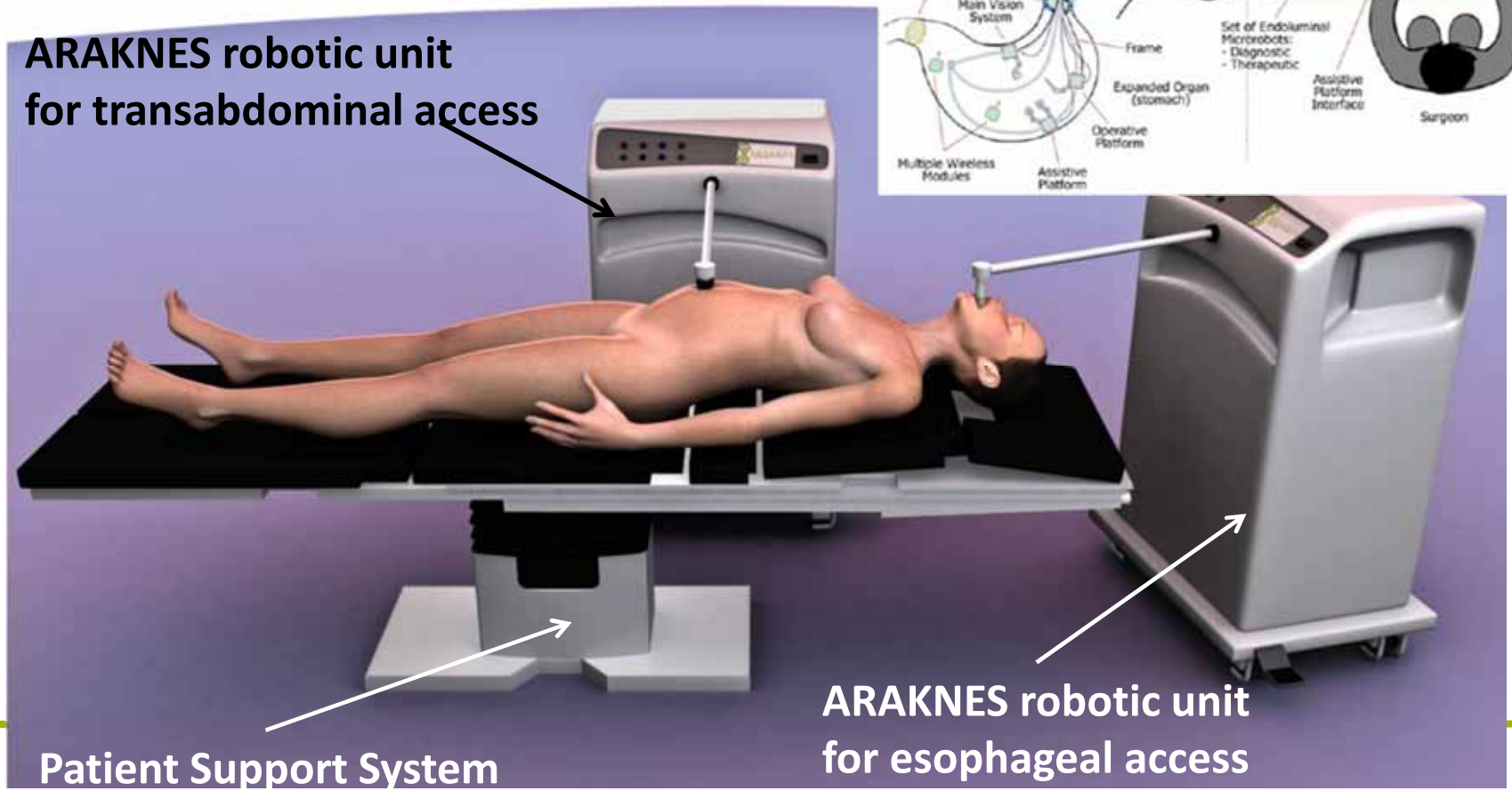
Chip design showing constricted channel for [illegible] separation and lateral channel


Photron
FASTCAM-1024PCI ...
2000 fps
1/2000 sec
1024 x 512
Start
frame : 1324
+00:00:00.661500sec

ARAKNES overview

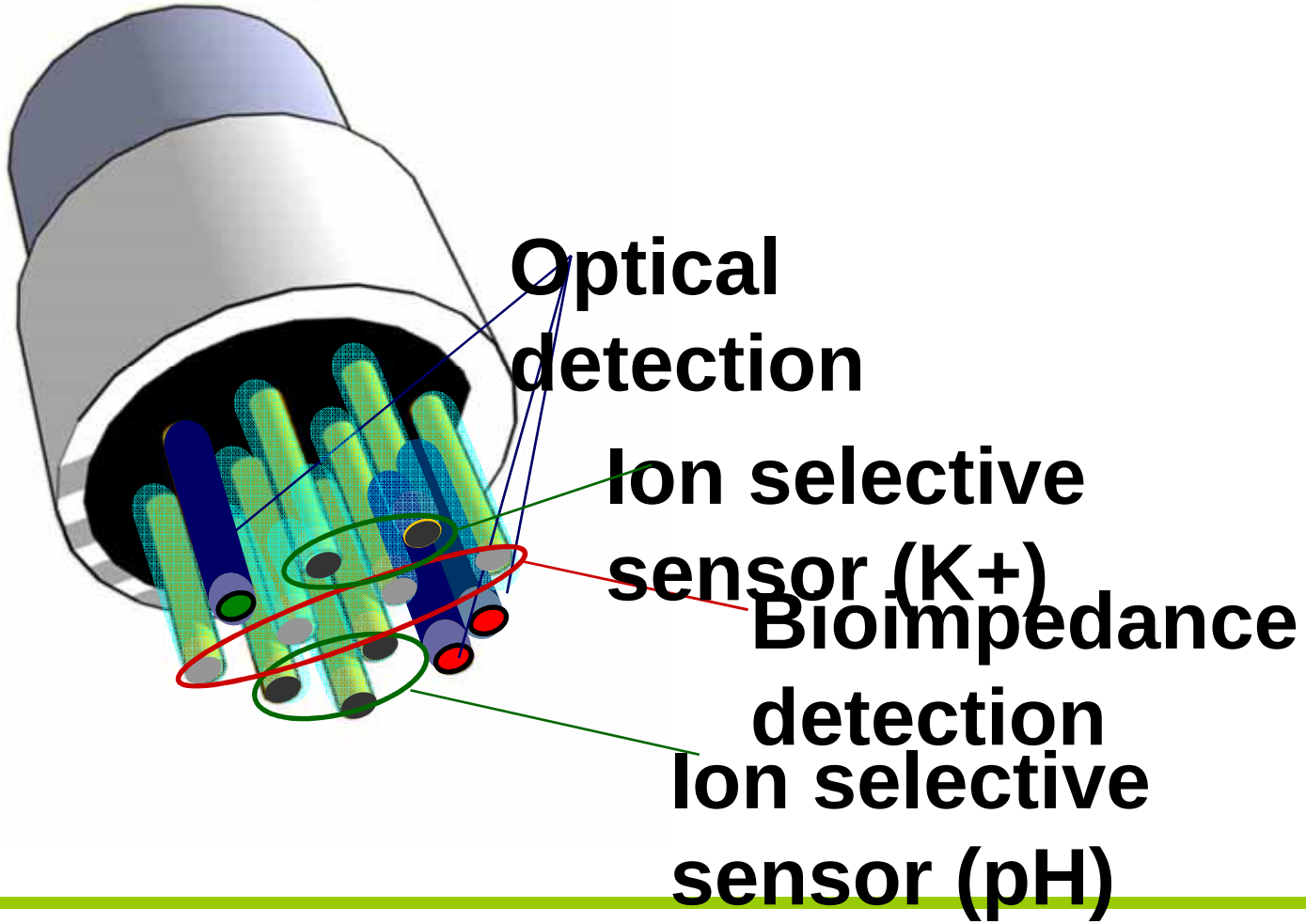
- **Robotic endoscopic scarless surgery** into the stomach for surgical treatment of morbid obesity and gastro-esophageal reflux





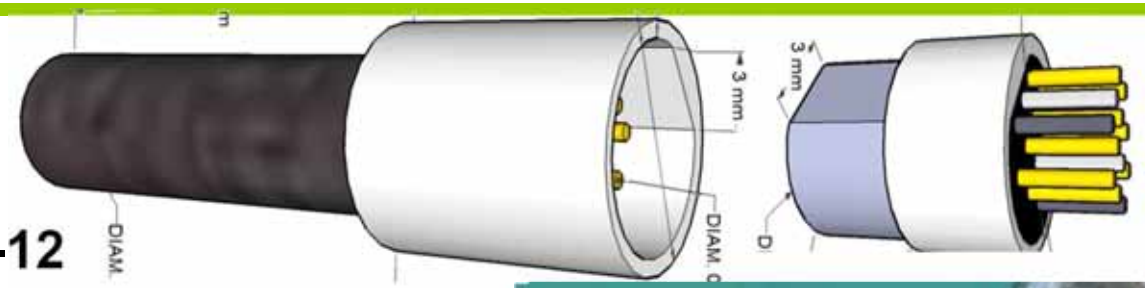
Sensor development

Integration of the optical and electrochemical sensors in the array:

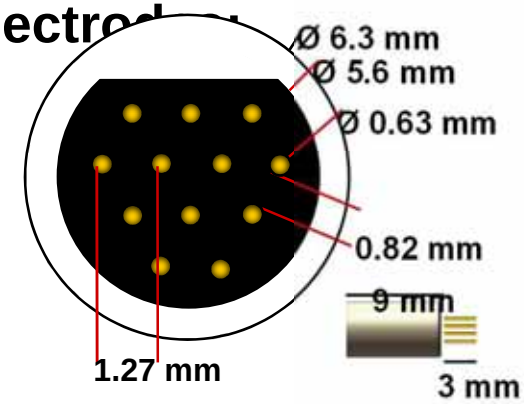


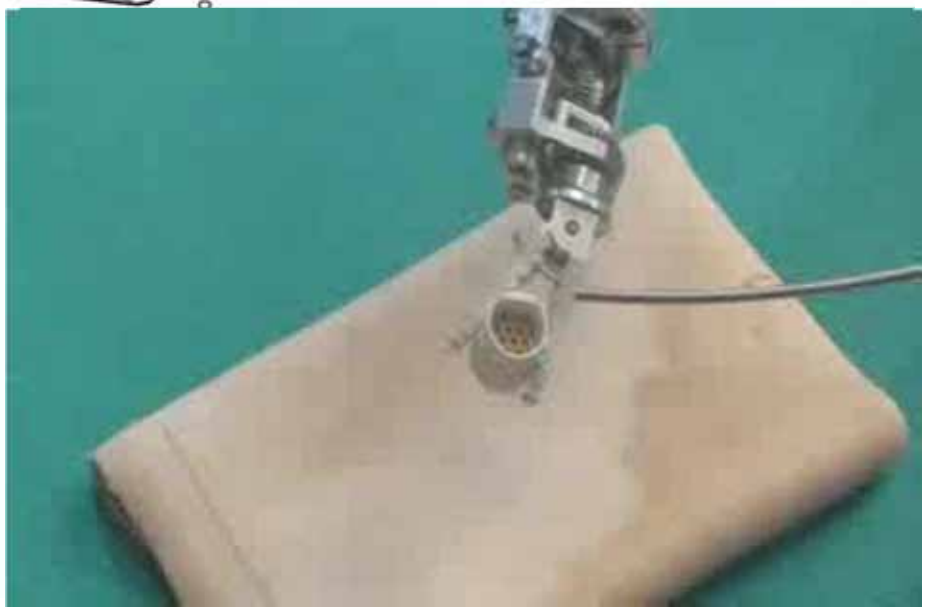
The ARAKNES Project has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement num. 224565.

eSensor fabrication: Design

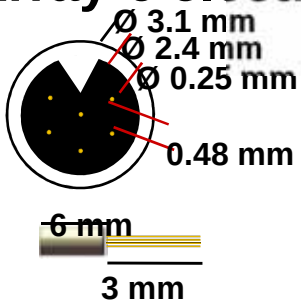


•Micro-Array-12 electrodes:





ıno-Array-6 electrodes:

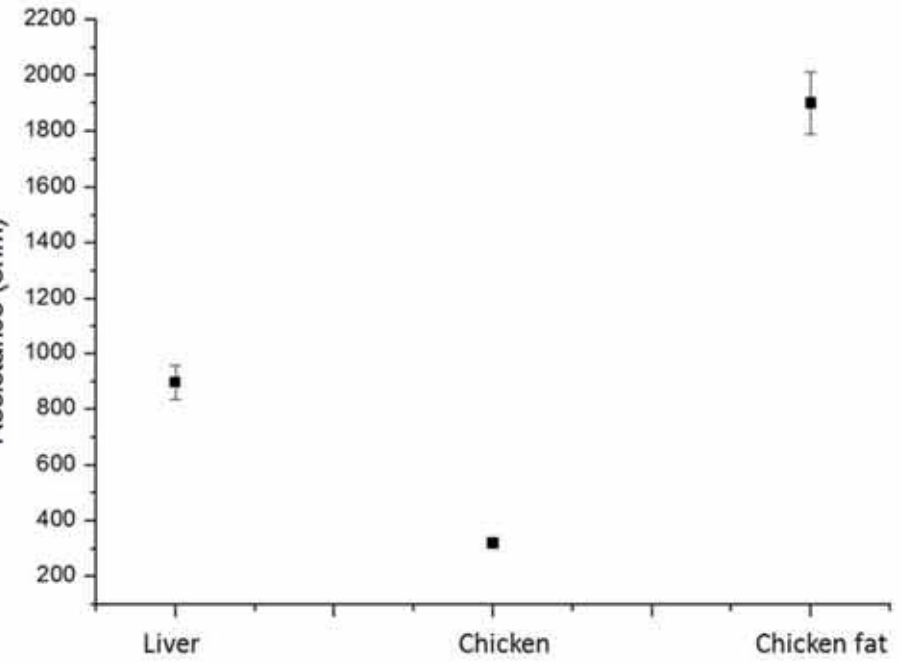


Designed to be reusable, and with appropriate size for the endoscope and

The ARAKNES Project has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement num. 224565.

Ischemia sensing with bioimpedance

- **Tissue differentiation with bioimpedance:**

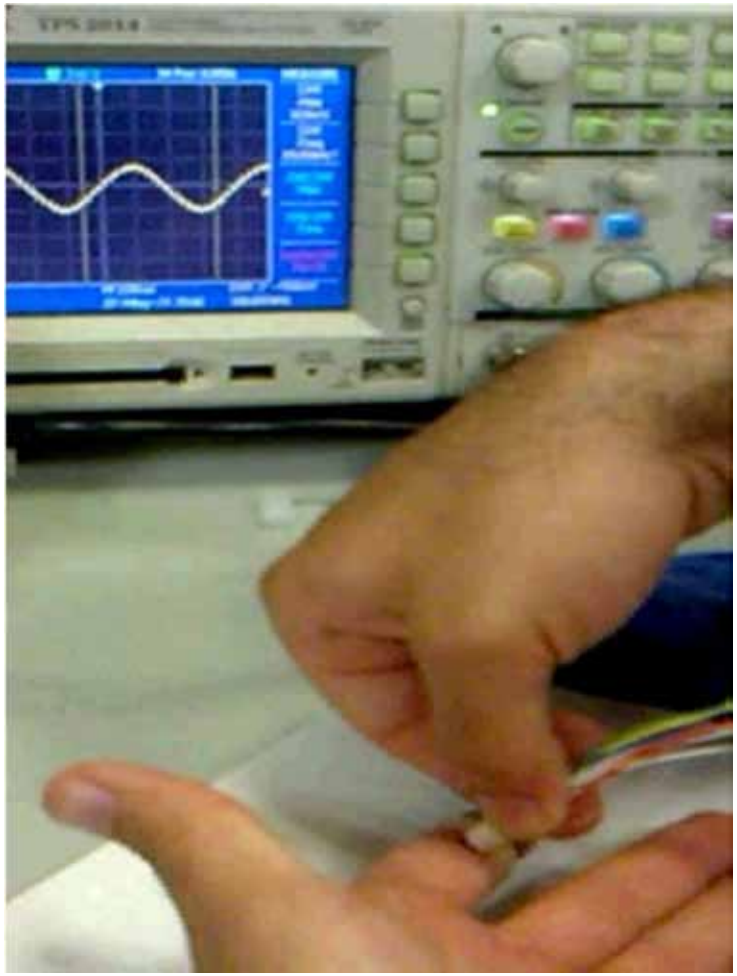


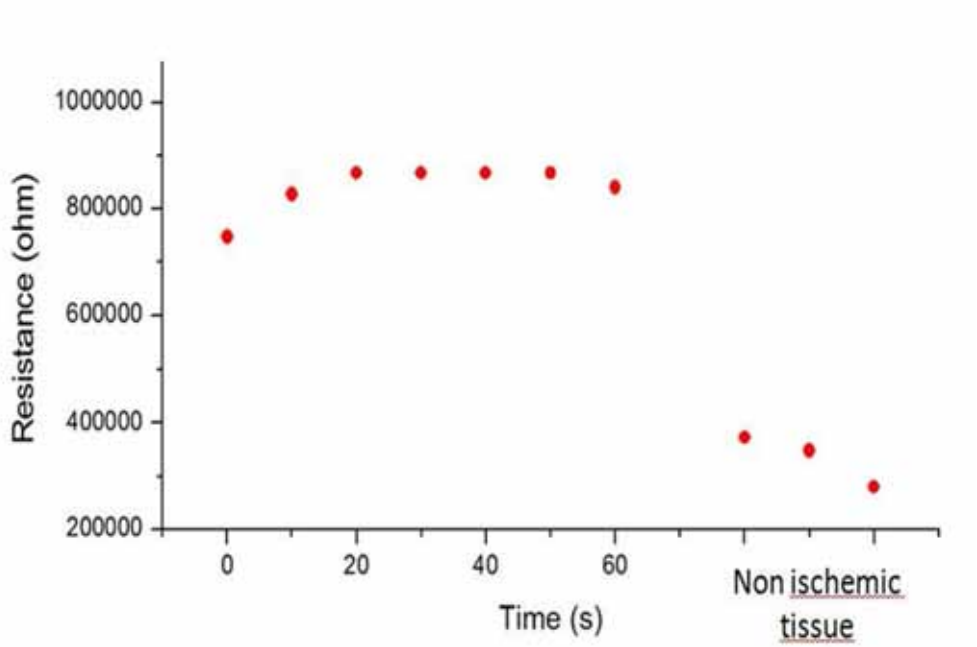
- Different current resistance was observed between liver, breast and fat from chicken

The ARAKNES Project has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement num. 224565.

Ischemia sensing with bioimpedance

Preliminary ischemia detection with bioimpedance:



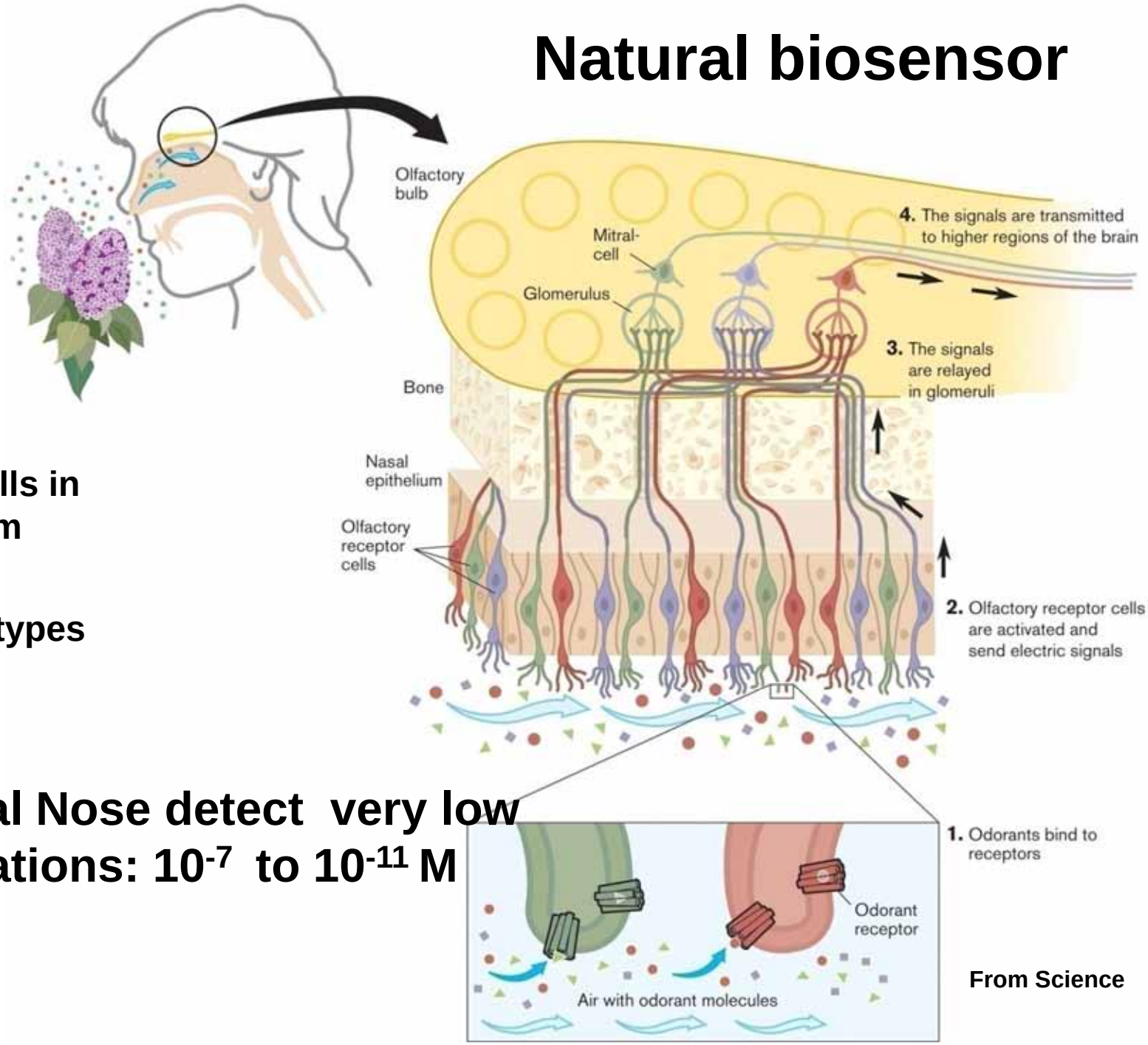


-Block of blood flow in a finger for measuring the change of ischemic conditions

- The change on the blood flow was measured and different resistance values was observed in ischemic and non ischemic tissue.

The ARAKNES Project has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement num. 224565.

Natural biosensor



10^7 receptor cells in neuroepithelium

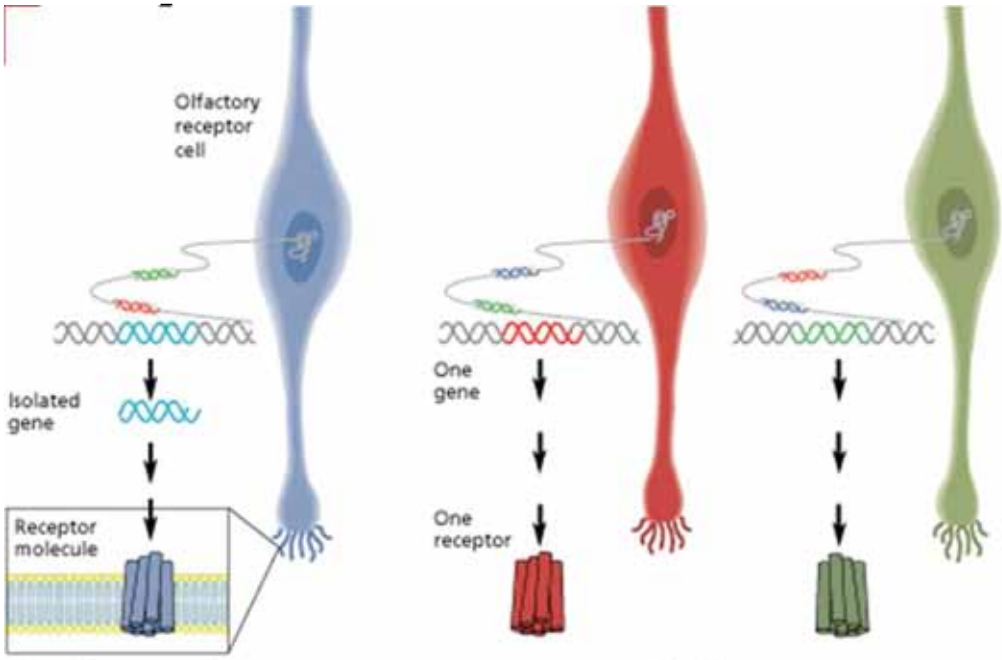
10^3 different types

Biological Nose detect very low concentrations: 10^{-7} to 10^{-11} M

From Science

Olfactory biosensors for in vitro diagnostic devices

The nex step: Bioelectronic Olfactory Neuron

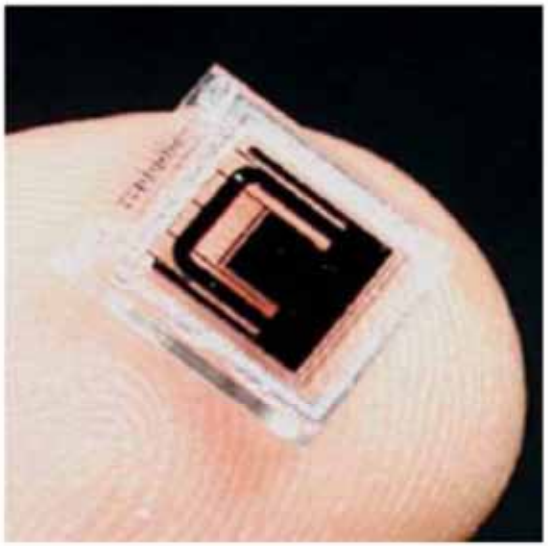


Identification of genes

The genes encoding the receptor molecules were isolated and identified.

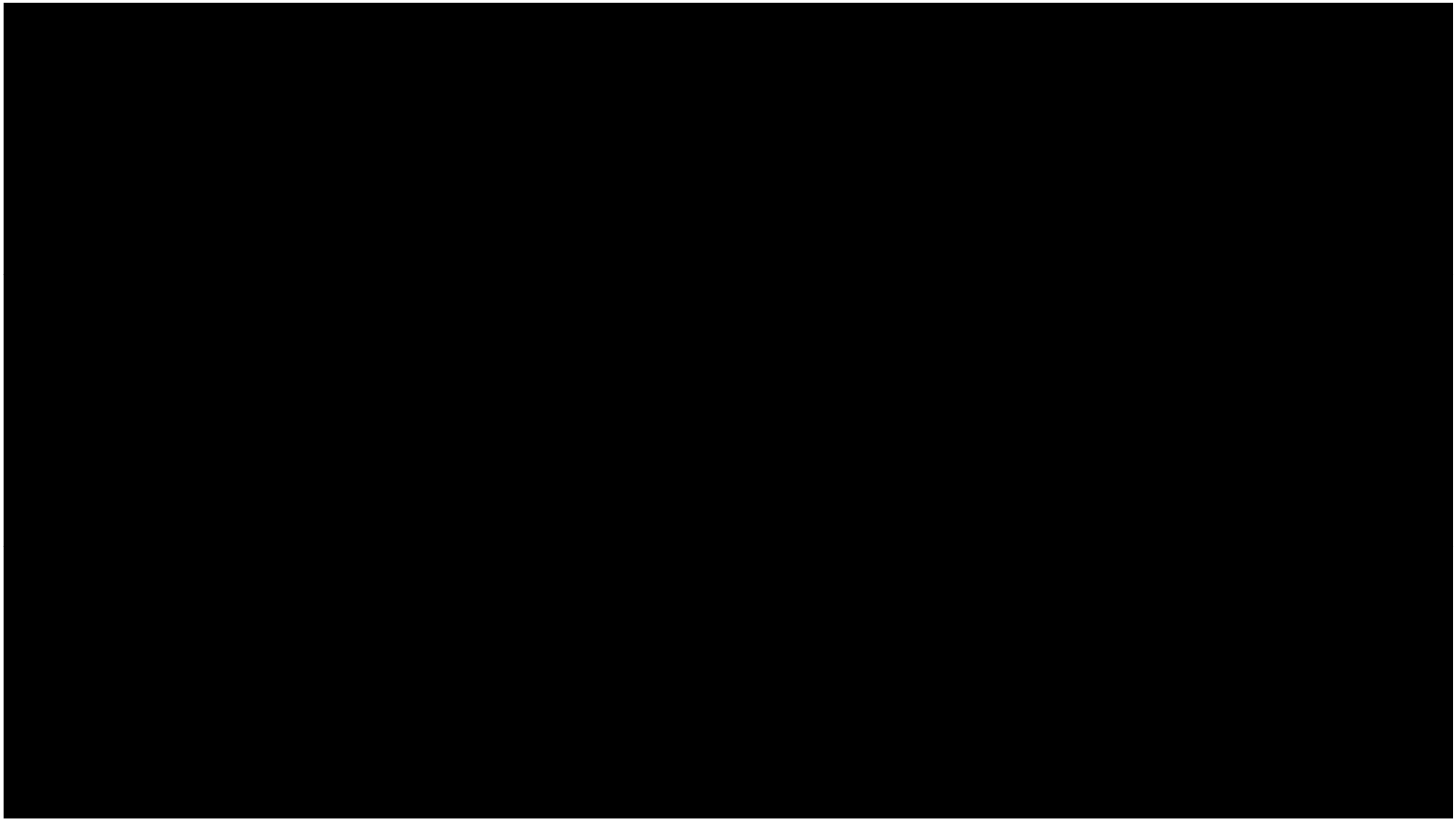
An unexpected finding!

Every single olfactory receptor cell expresses one and only one gene of all the genes that code for olfactory receptor molecules.



BOND

Bioelectronic Olfactory Neuron Device



Odorant-receptor genes on human chromosomes

Humans 400 OR

Dogs & Rats 1000 OR

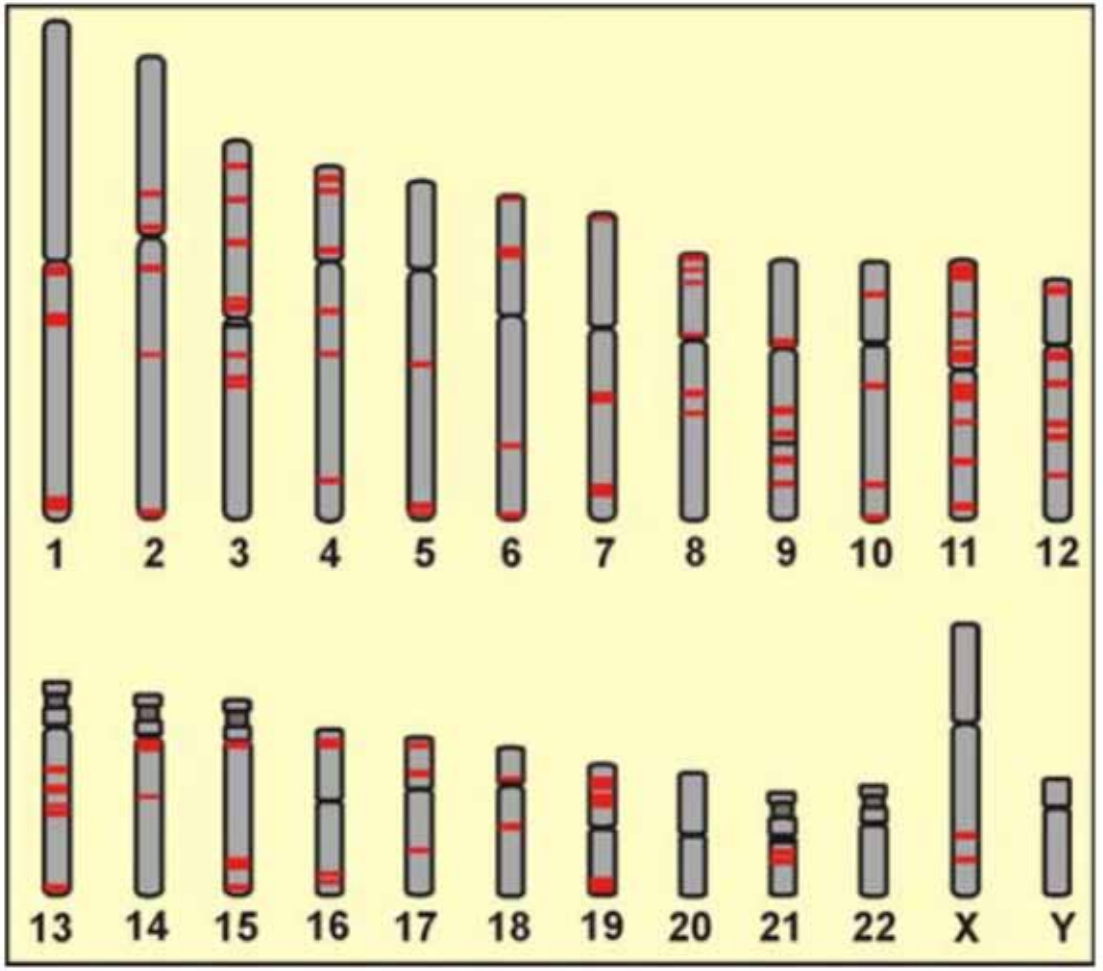
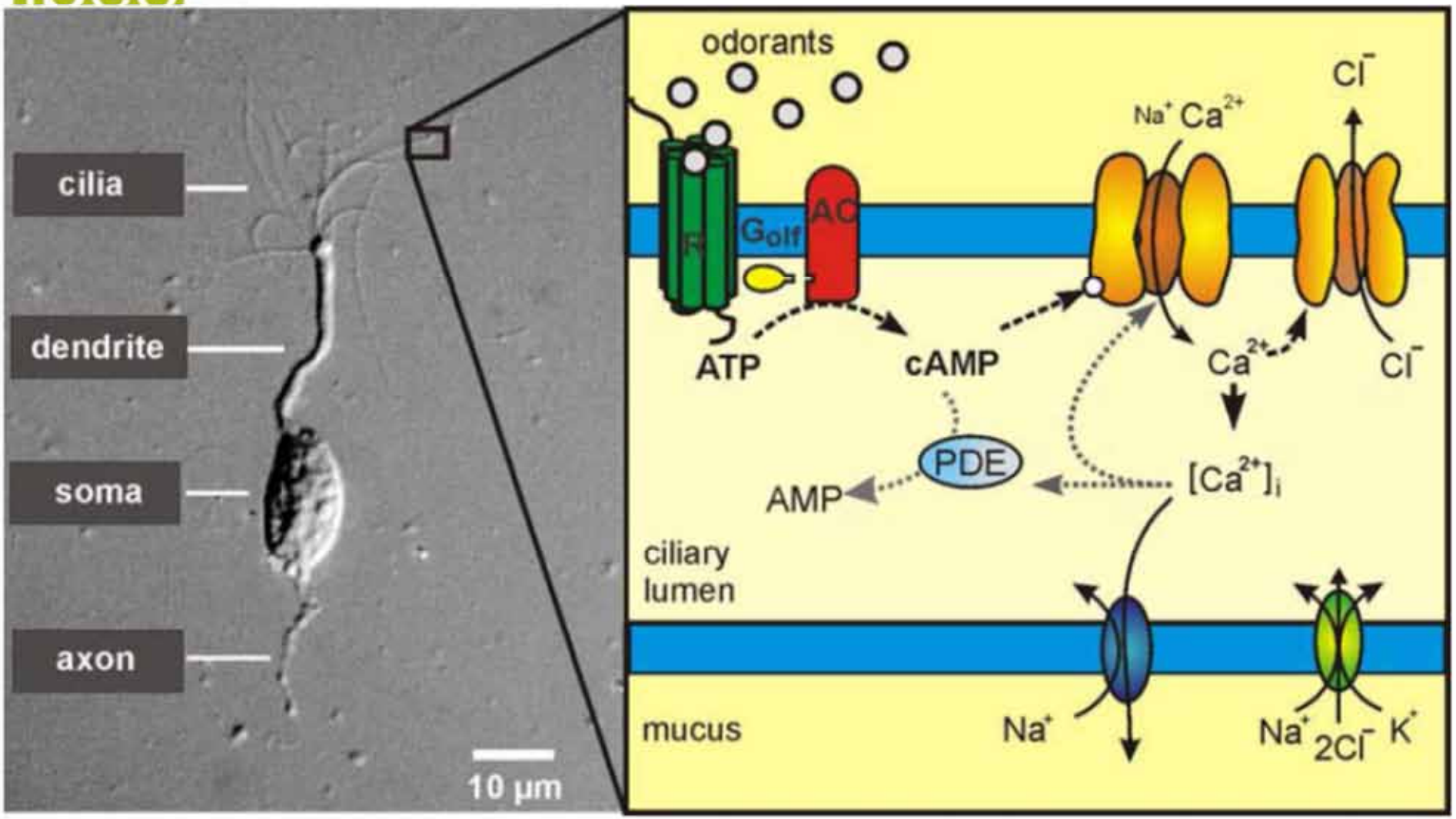


Fig. 6 Odorant-receptor genes on human chromosomes. The bands indicate gene clusters that contain groups of odorant-receptor genes. Such clusters are present on almost all chromosomes

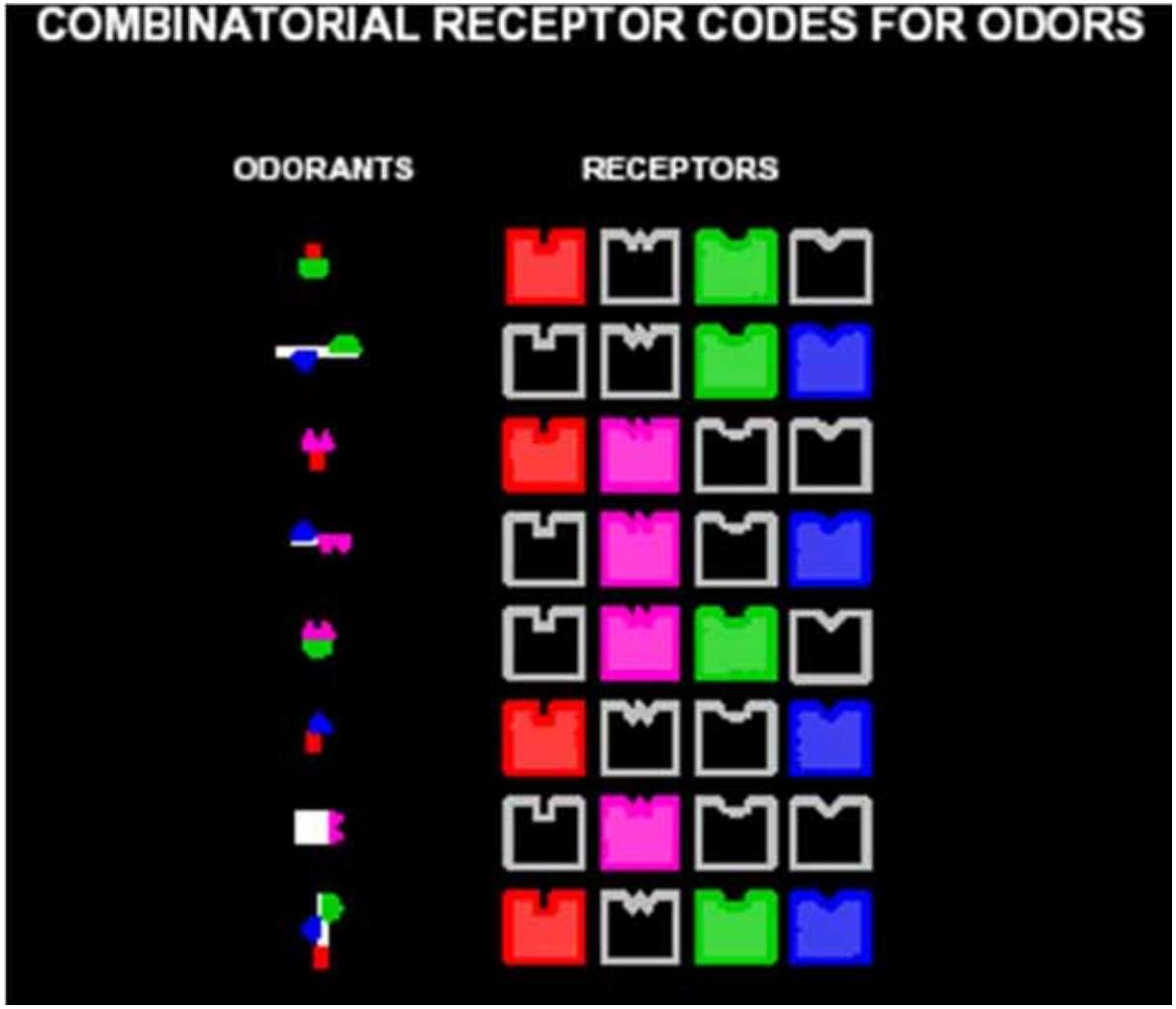
Primary process in olfactory sensory cilia



From S Frings J.Comp Physiol A (2009)

Nobel Prize 2004

Linda Buck



Richard Axel

BOND CP-FP 228685-2

Bioelectronic Olfactory Neuron Device (SMALL FP7)

Project objective:

Development of an integrated bioelectronic analytical nanoplatform for odour detection based on olfactory receptors and using micro-nano, bio and information technologies to mimic the mamalian nose.

Specific challenges:

- **Detection of low electric signals linked to the odorant-receptor interactions.**
- **Development of a olfactory neuron array integrating protein receptors and nanoelectronic curcuits.**

Expected impact:

A huge number of new diagnostics, security, environmental protection and quality control (food, drink, household products, cosmetics) devices, with an ability to detect any odorant molecule in samples, even in very low concentrations

McCulloch et al

Integr Cancer Ther **2006; 5; 30**

Diagnostic Accuracy of Canine Scent Detection in Early- and Late-Stage Lung and Breast Cancers

Michael McCulloch, Tadeusz Jezierski, Michael Broffman, Alan Hubbard, Kirk Turner, and Teresa Janecki

***BMJ* 2004;329;712-**

rapers

Olfactory detection of human bladder cancer by dogs: proof of principle study

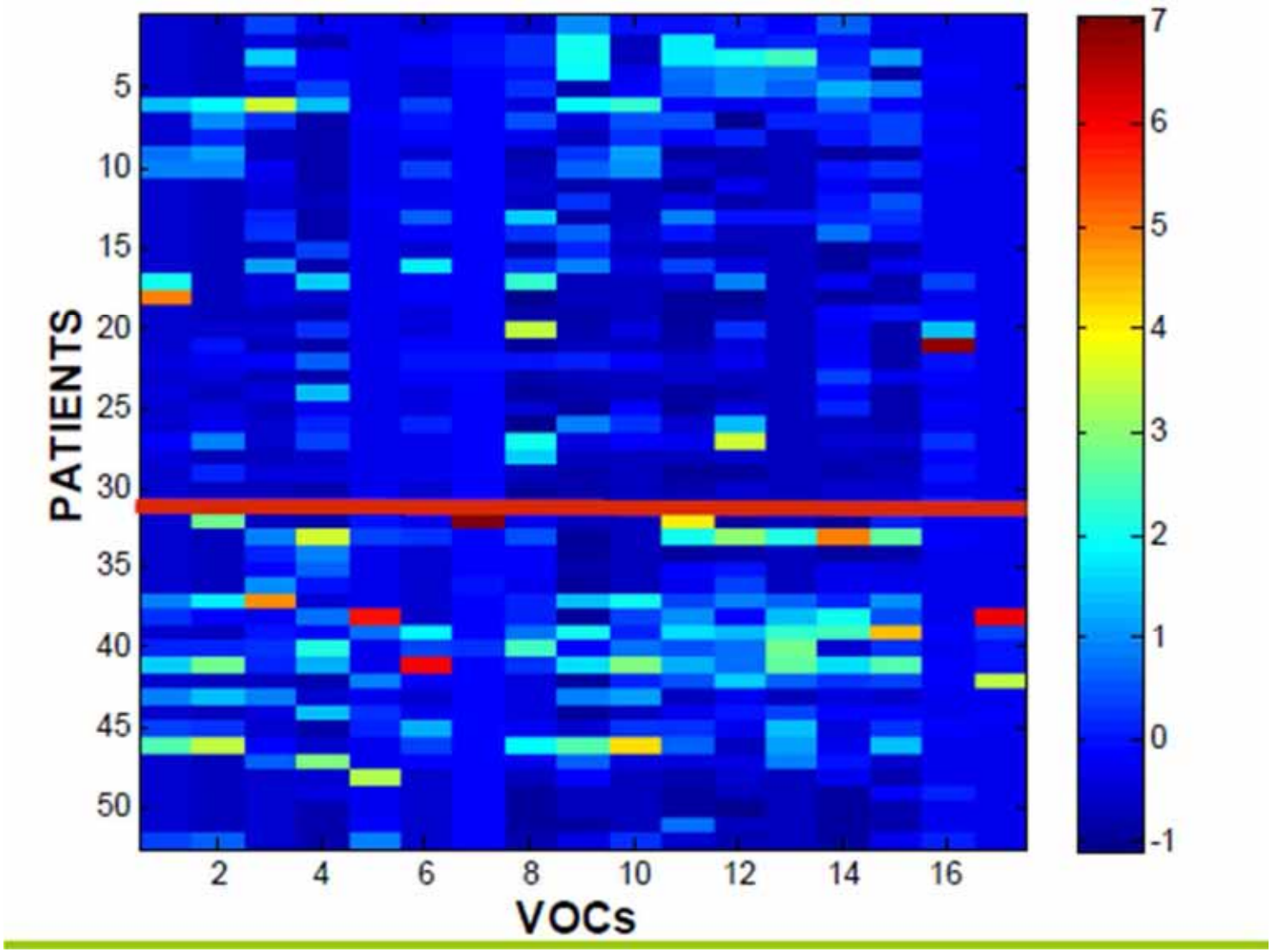
Carolyn M Willis, Susannah M Church, Claire M Guest, W Andrew Cook, Noel McCarthy, Anthea J Bransbury, Martin R T Church, John C T Church

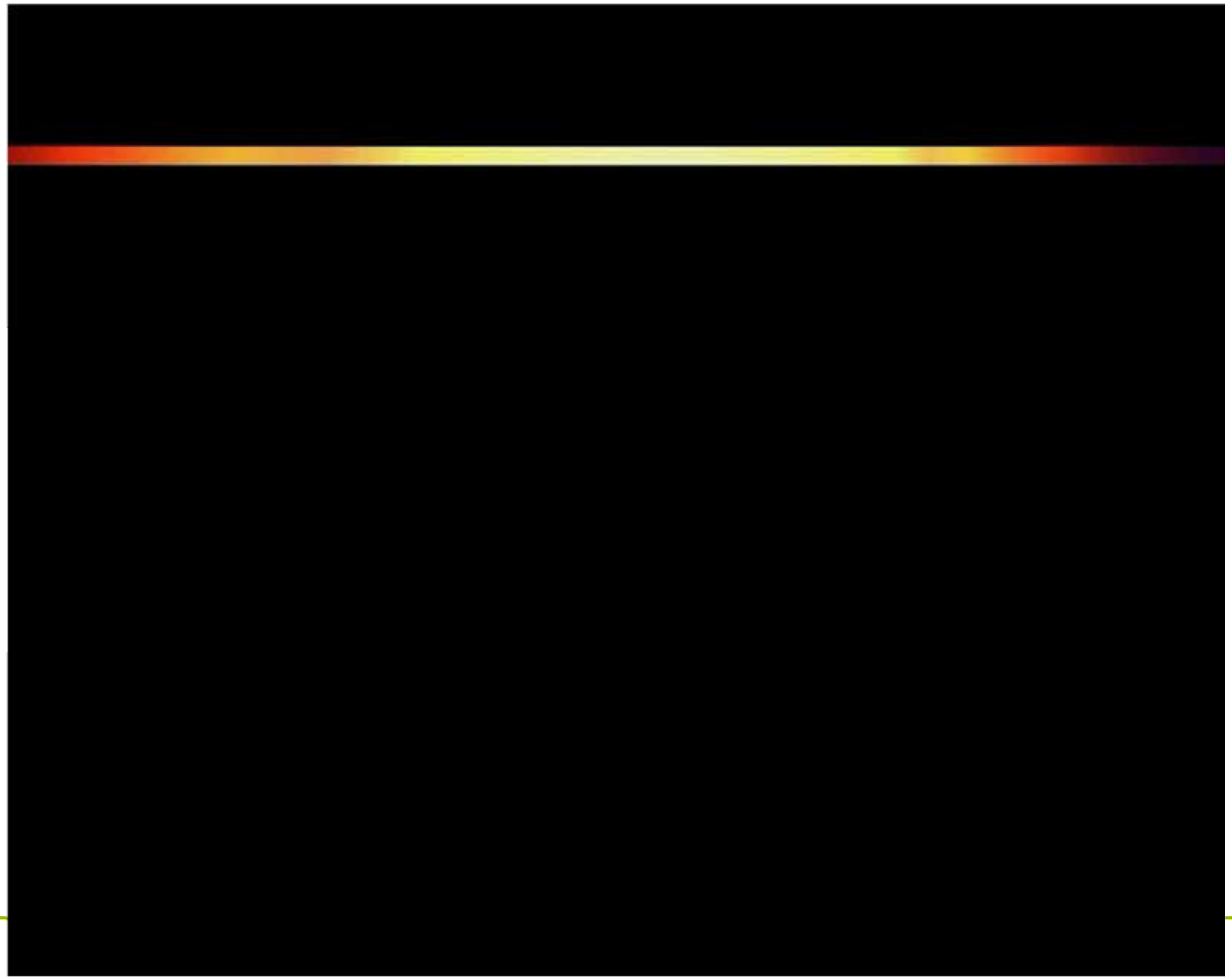
Department of Dermatology

Abstract

organic compounds are likely to have distinctive

Volatiles identification in cancer patients





Identification of specific OR

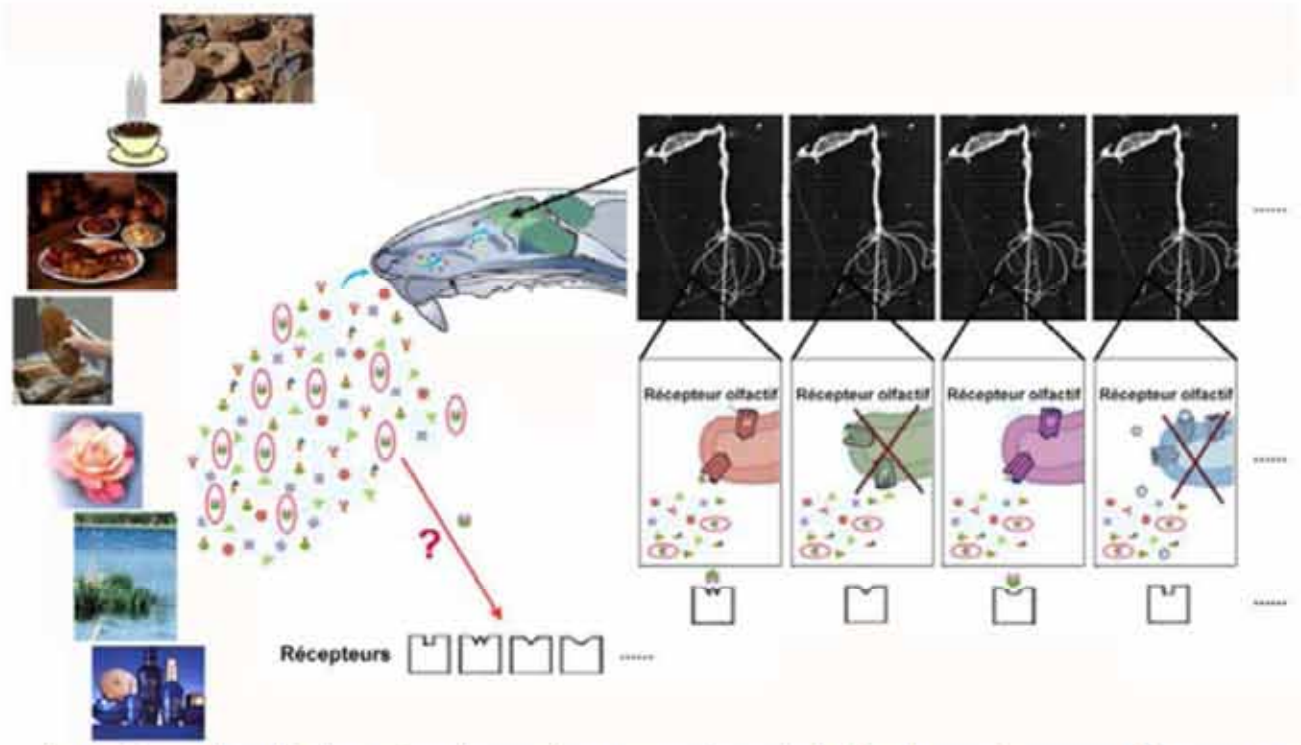


Fig. 3 Calcium imaging allows the diction of activated neurons (top right) in the rat/mouse olfactory epithelium (sagittal section, middle top) upon stimulation by odorants The cytoplasmic content of responsive neurons (down right) may be aspirated and submitted to single-cell RT-PCR in order to identify the OR present in these responding neurons.

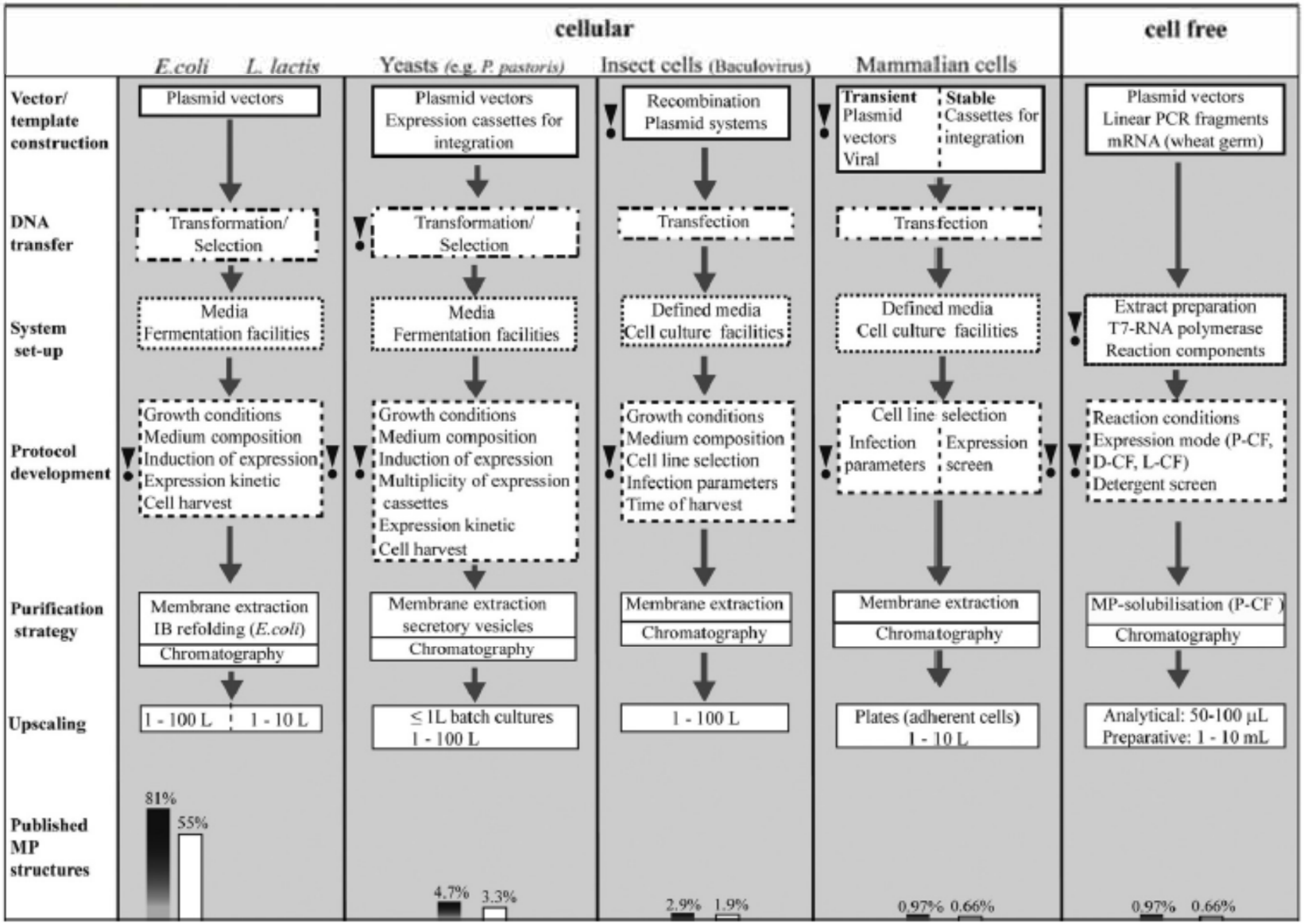
Review

Large-scale production of functional membrane proteins

F. Junge, B. Schneider, S. Reckel, D. Schwarz, V. Dötsch and F. Bernhard*

Centre for Biomolecular Magnetic Resonance, University of Frankfurt/Main, Institute for Biophysical Chemistry, Max-von-Laue-Str. 9, 60438 Frankfurt/Main (Germany), Fax: +49 69 798 29632, e-mail: ft

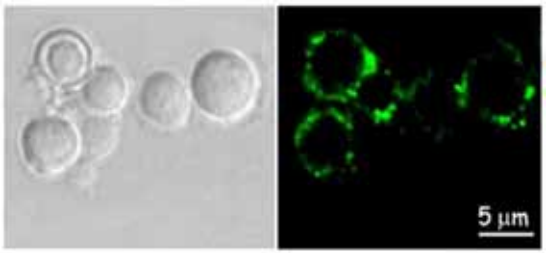
Cell. Mol. Life Sci. 65 (2008) 1729 – 1755
1420-682X/08/111729-27
DOI 10.1007/s00018-008-8067-5



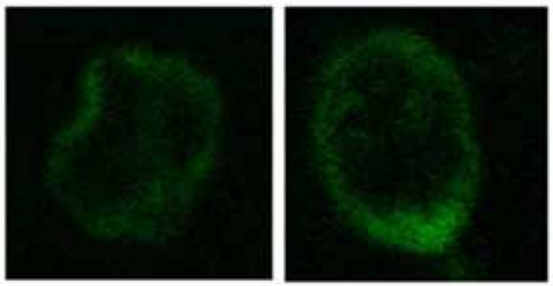
Production of ORs

Functional expression of ORs optimized (galactose, 15 C) at the plasmic membrane of yeast : ORI7, cmyc-OR1740

Confocal microscopy
Immunocytochemistry

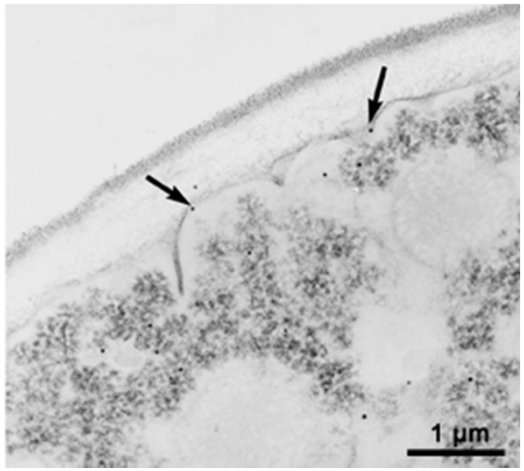


ORI7



cmyc-OR1740

Electron Microscopy
Immunogold labeling

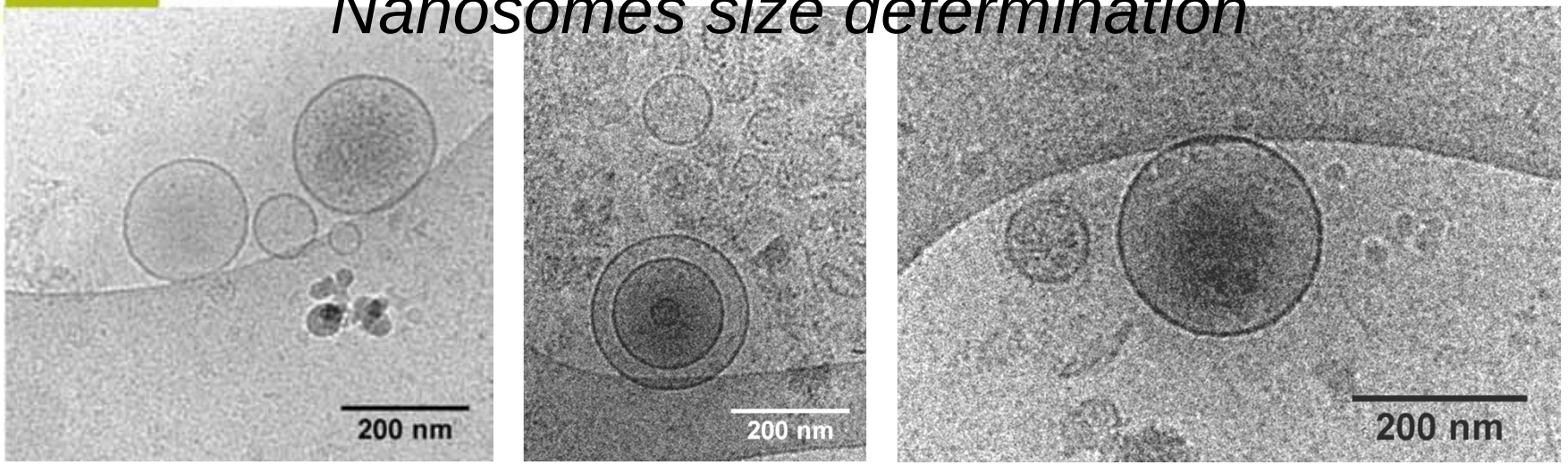


cmyc-OR1740

ELISA quantification of membrane ORs : 1.5×10^5 ORs/cell (ORI7)
0.9×10^5 ORs/cell (cmyc-OR1740)

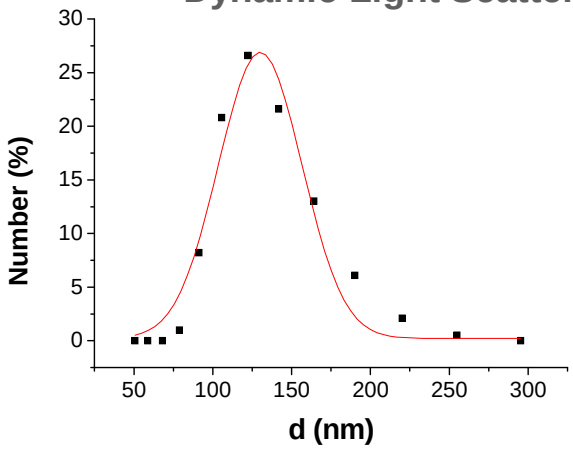
[Minic et al. FEBS J. 2005]

Nanosomes size determination



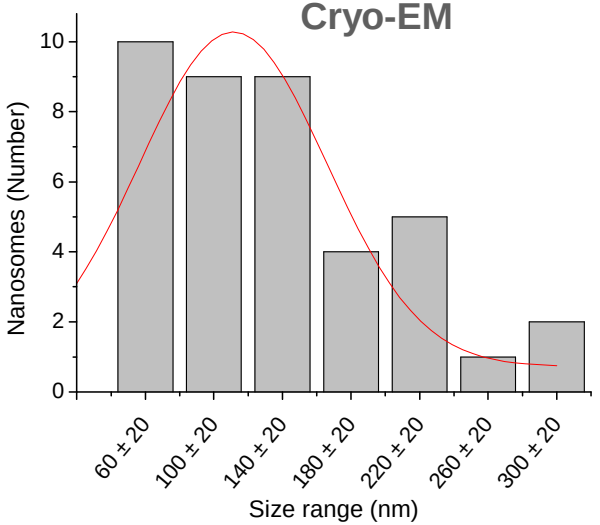
Cryo-EM images of the nanosomes population suspended in PBS buffer.

Dynamic Light Scattering



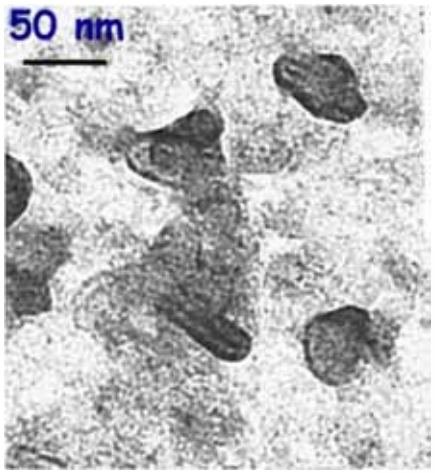
Size: 130.04 nm ± 39.89 nm

Cryo-EM

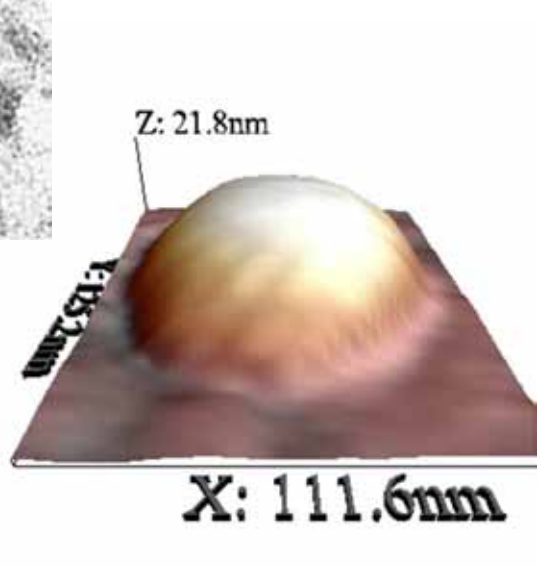


Size (40 nanosomes): 138 nm ± 67.80 nm

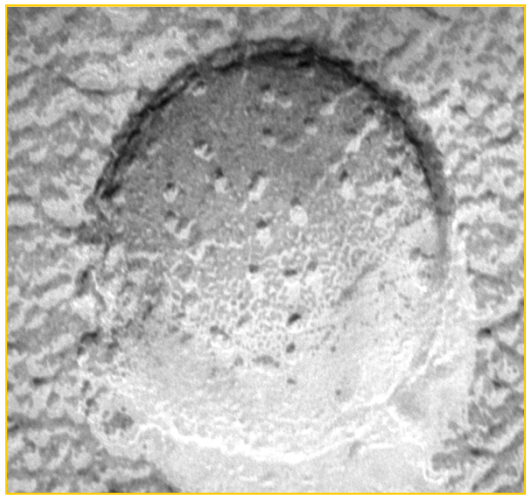
Characterization of nanosomes



Transmission electron microscopy
Negative staining



AFM
Nanosomes adsorbed on golg



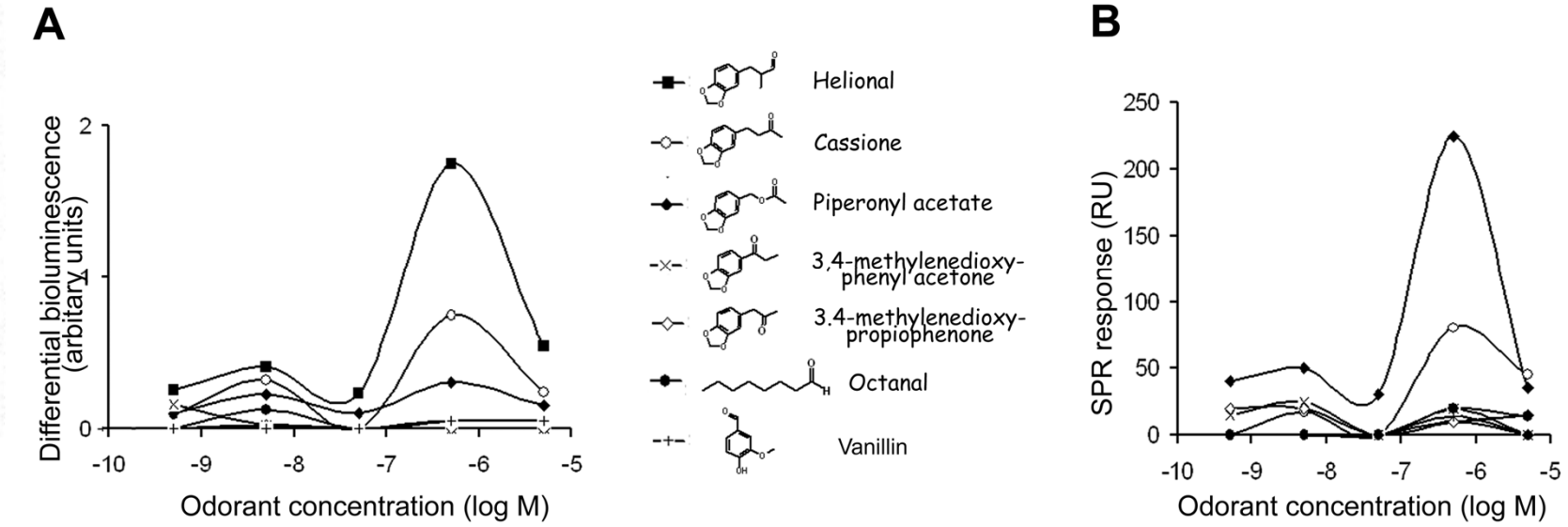
Transmission electron microscopy
Cryo-fracture (200 x 200 nm)

[Casuso et al. Biosens. Bioelectron. 2007]

SPR response of OR17-40 to odorant stimulation

Whole yeast
Bioluminescence

Nanosomes
Surface Plasmon Resonance

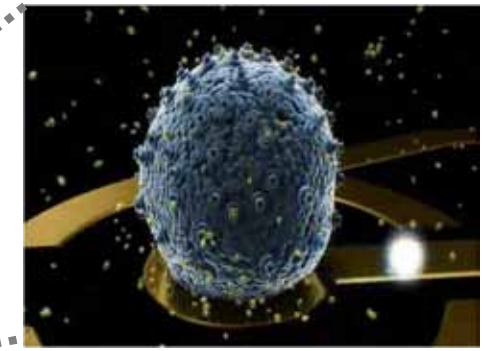


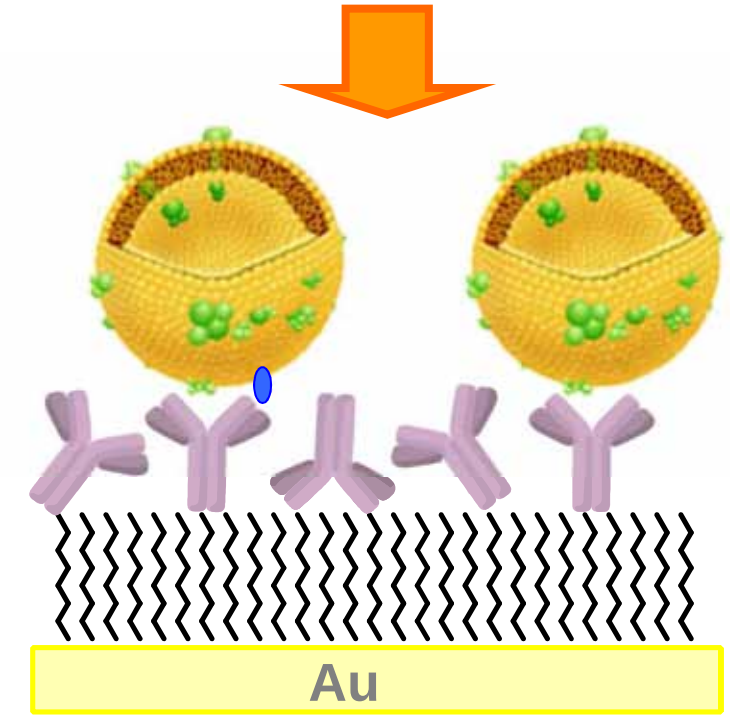
Same functional response, odorant-specific, and dose-dependent

--> results from the behavior of the receptor itself upon odorant stimulation

[Minic et al. Lab on a Chip]

How to immobilize the nanosomes on the gold surface



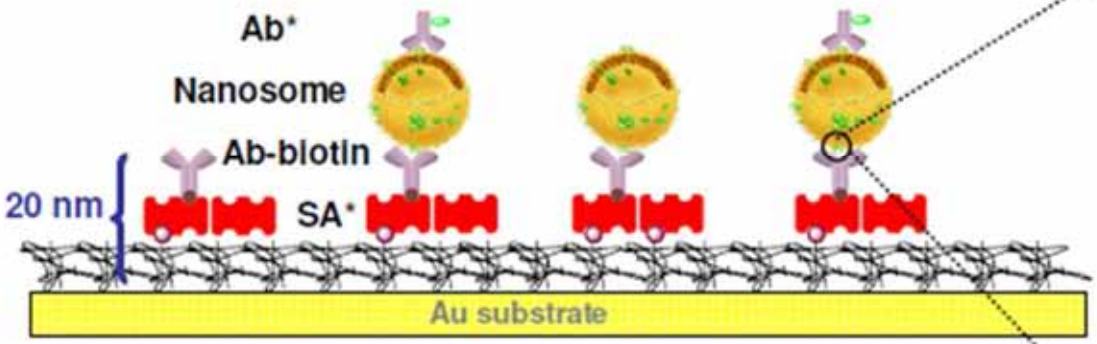


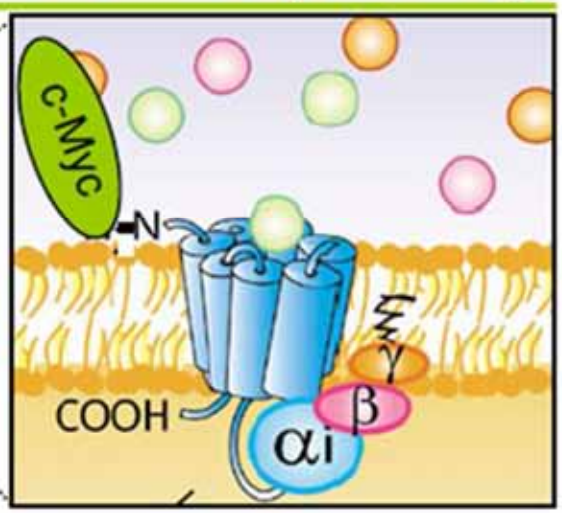
Immobilization with the mAb anti-c-myc or anti-HA:

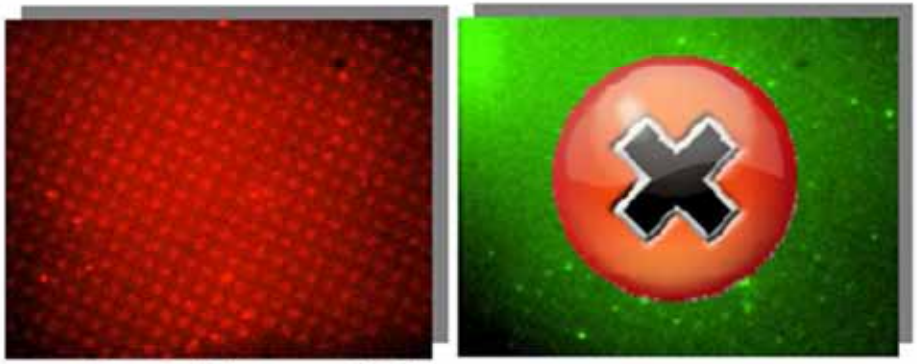
- **Specific adsorption by the tag ( )**

- **Unspecific adsorption againts the nanosome membrane or BSA (2%)**

PLL-g-PEG-biotin: μcontact printing

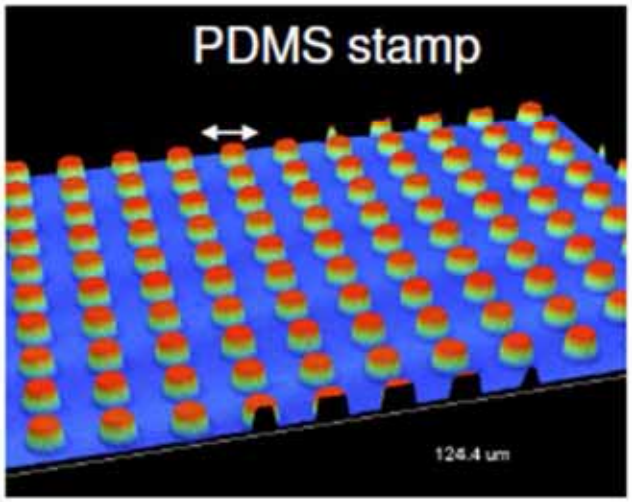






Streptavidine (SA*)
Texas-red

Anti c-myc-FITC

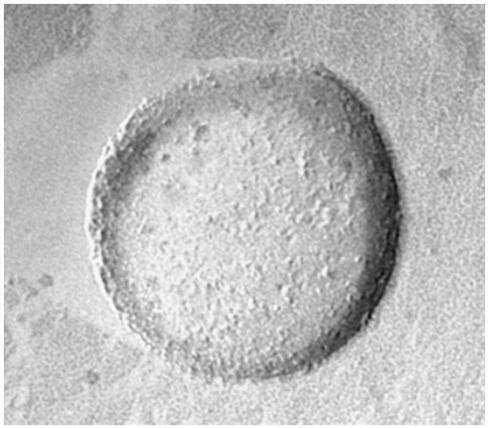


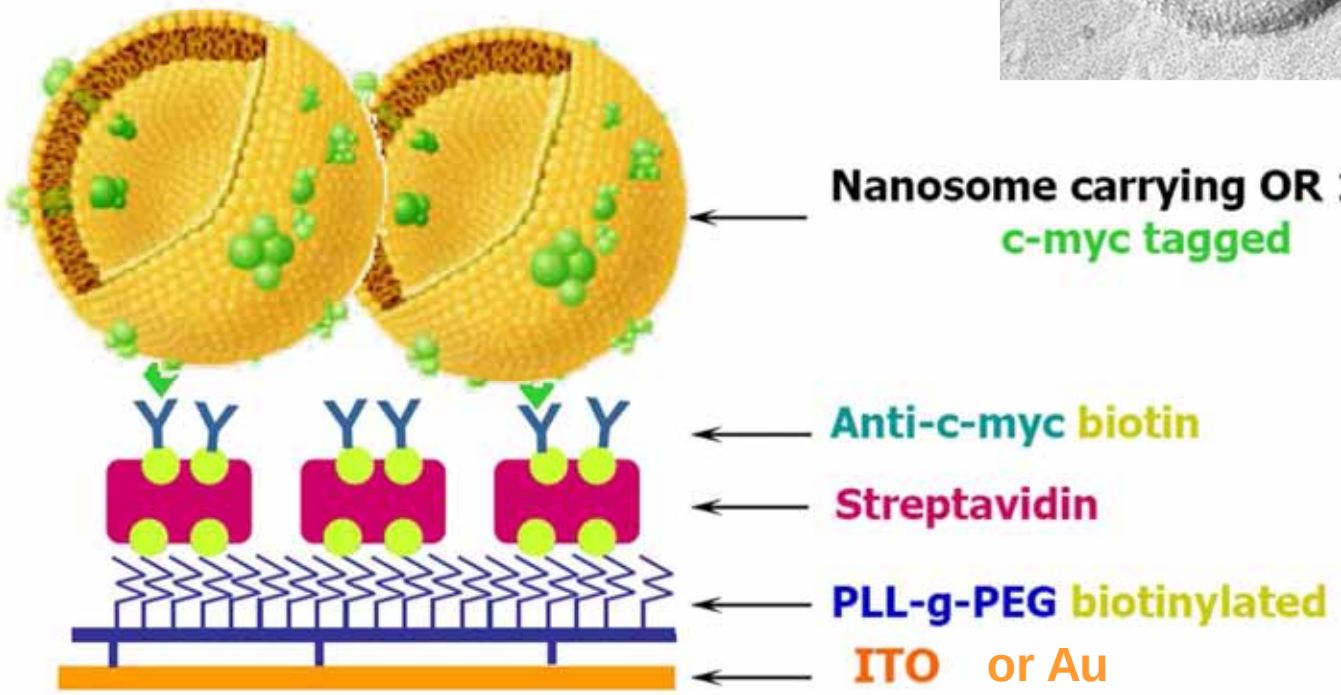
Nanosomes-Electrode functionalization:

AFM

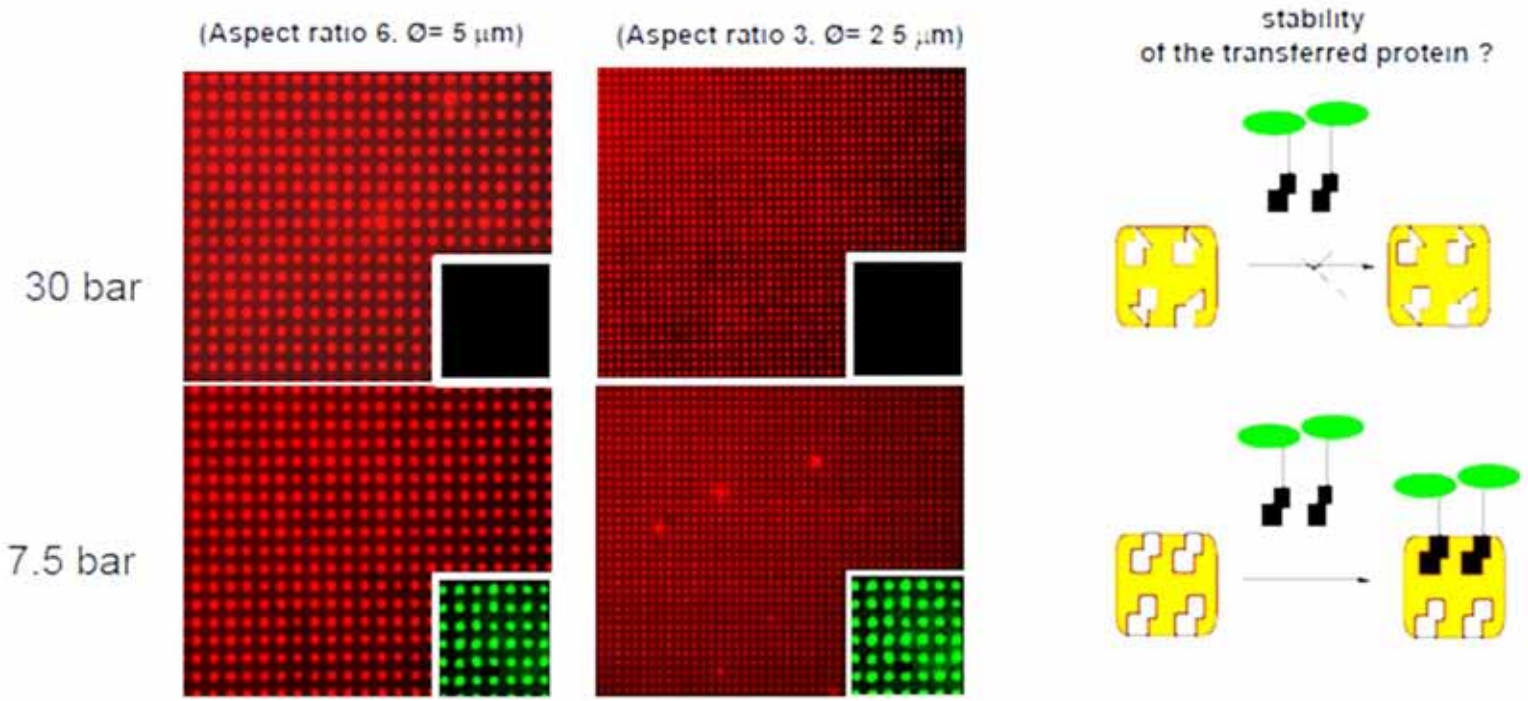
Nanosomes solution: 30µg/ml, 2min

Functionalisation on ITO





PMMA microcontact printing

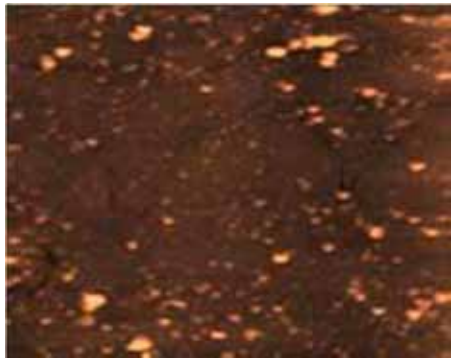


No disruption of the protein at 7.5 bars during the transferring procedure

M. Pla-Roca,J. Samitier et al, Langmuir 23 (2007)

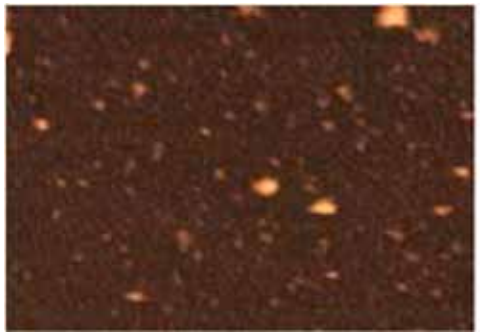
Nanosomes immobilization on gold substrate

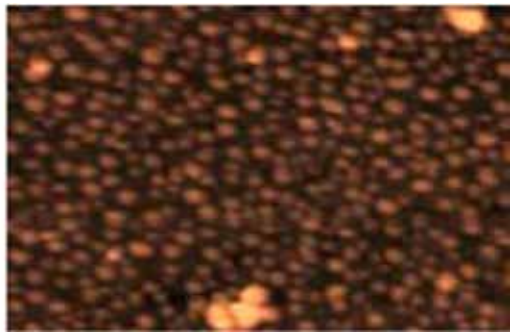
Structural characterization of nanosomes in liquid medium



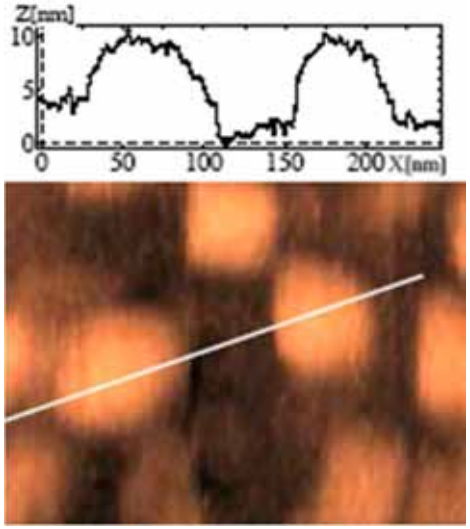
- Nanosome sizes: most around 50 nm
- Surface coverage increases / larger nanosomes
- Functionalization tends to diminish coverage

Sonicated Nanosomes on thiol functionalized gold (coverage 10%)



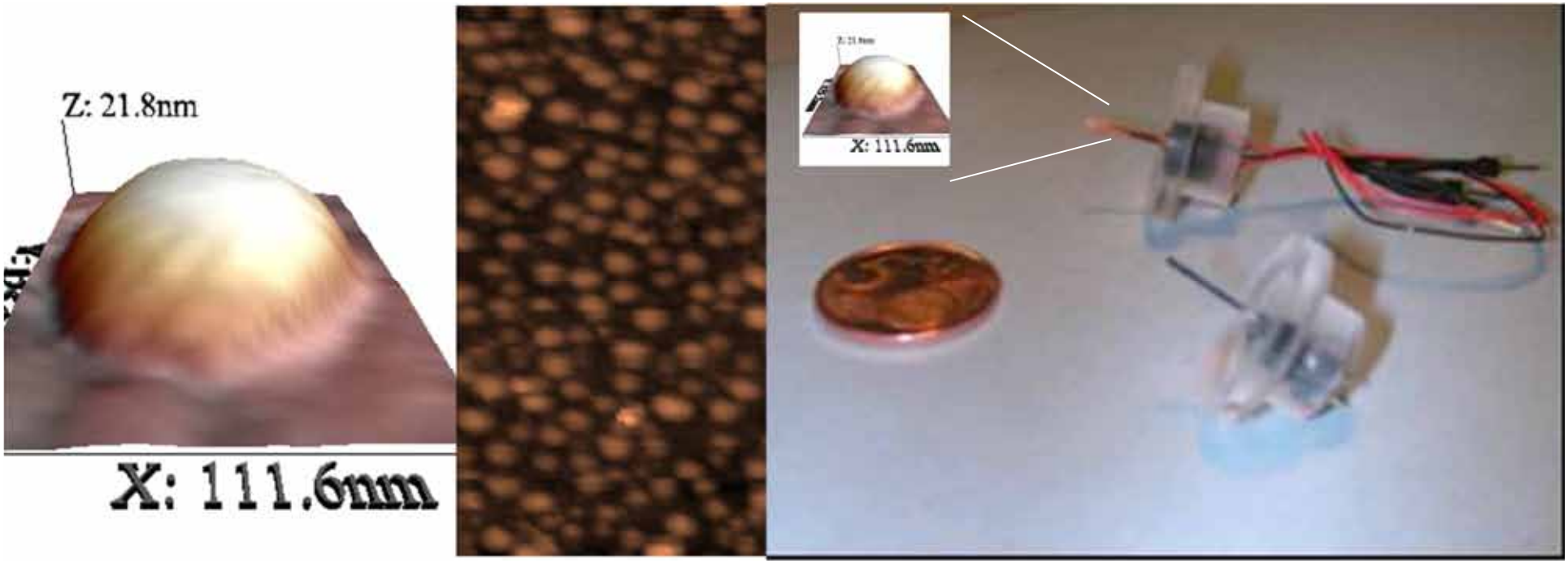


Sonicated Nanosomes on bare gold (coverage 50 %)

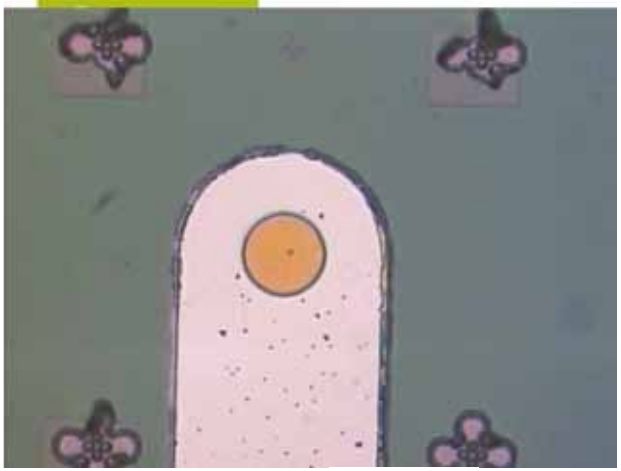


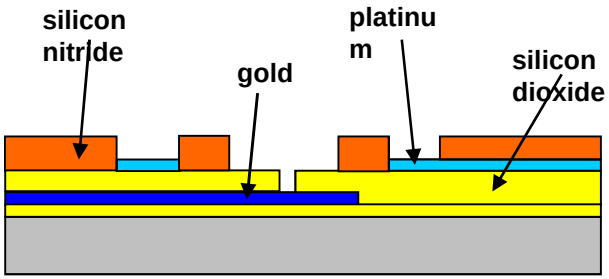
Casuso, Samitier et al. Nanotechnology 2007]

Electrochemical Biosensor

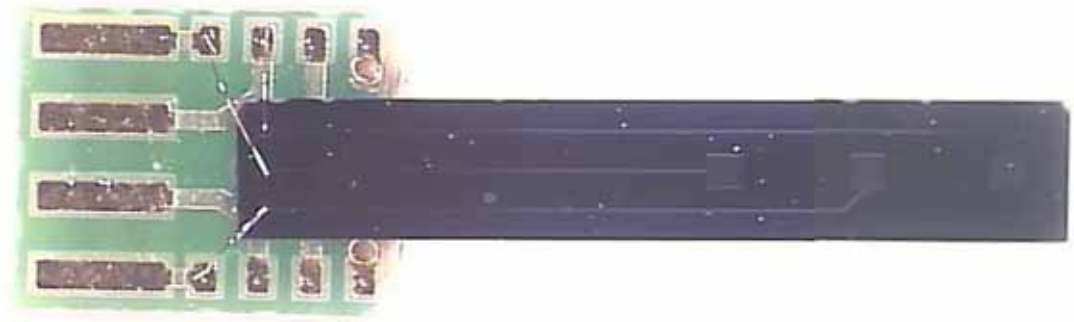


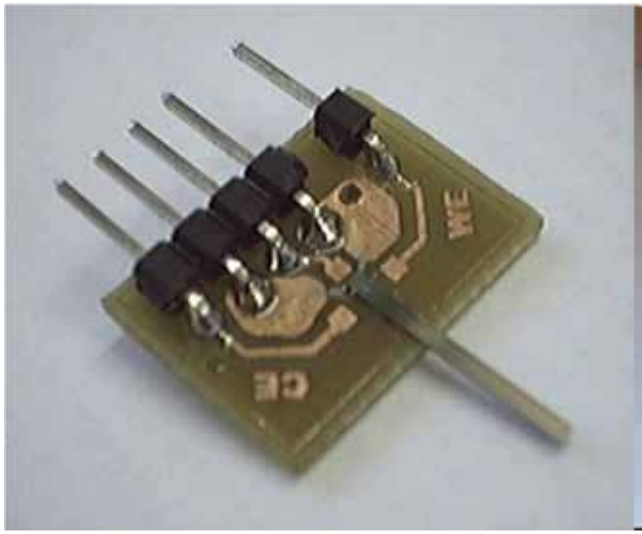
Biosensor devices

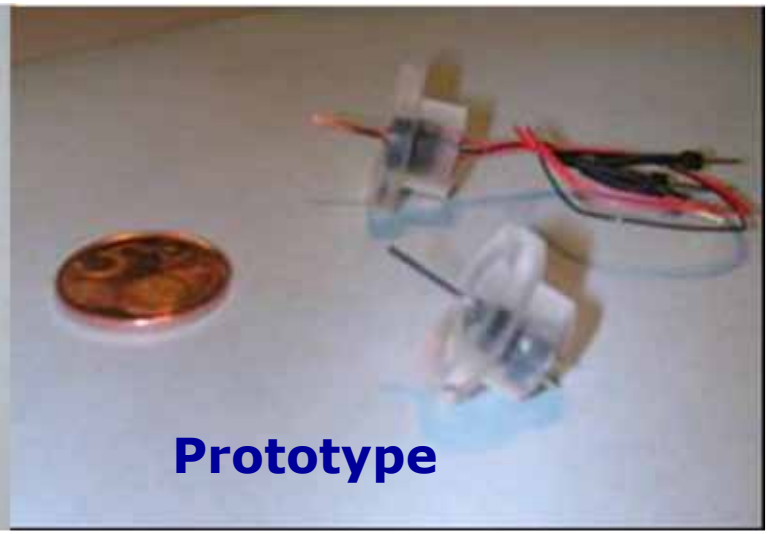




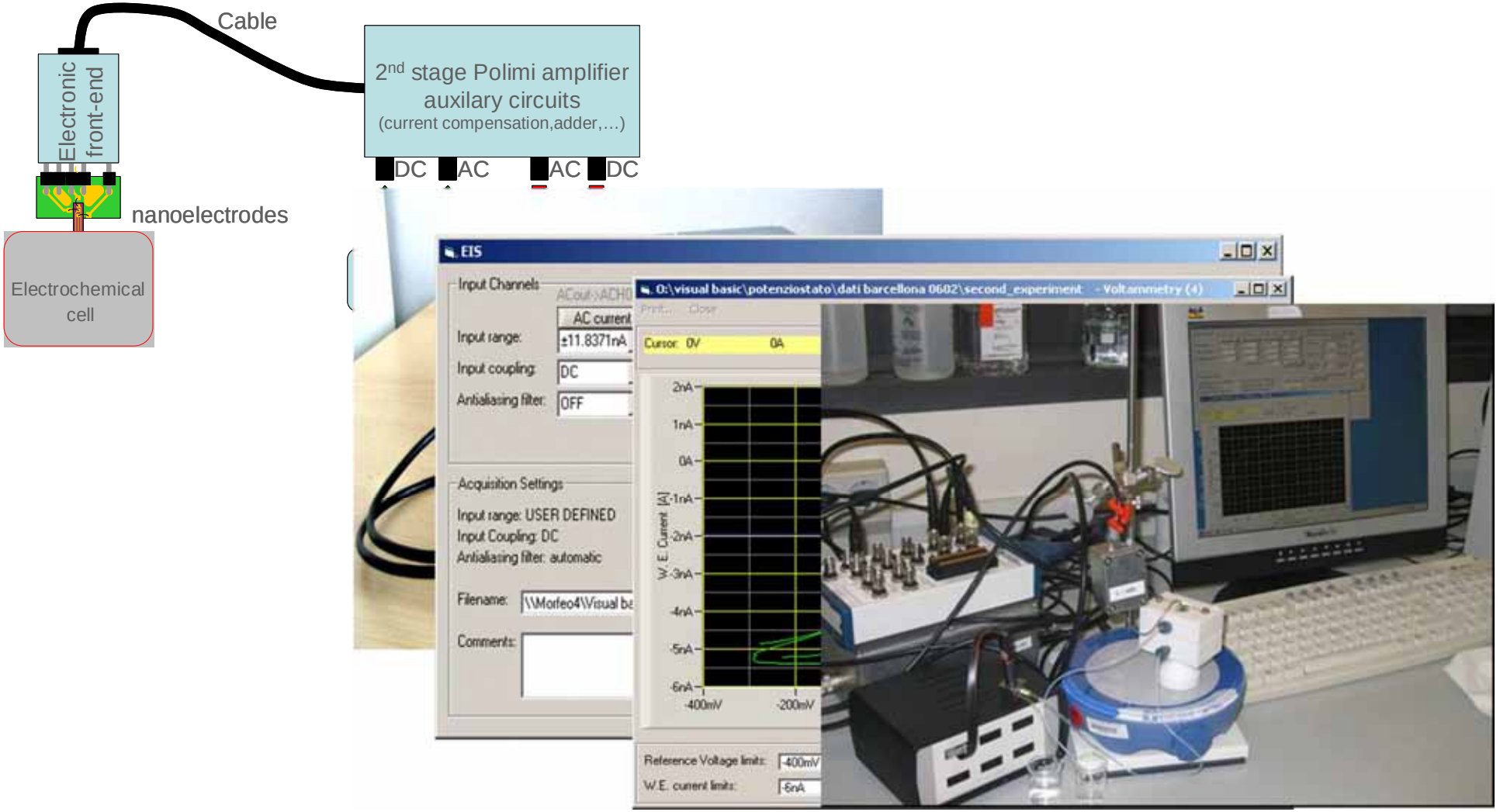
Sensors & Actuators B 116, 66-71 (2006)







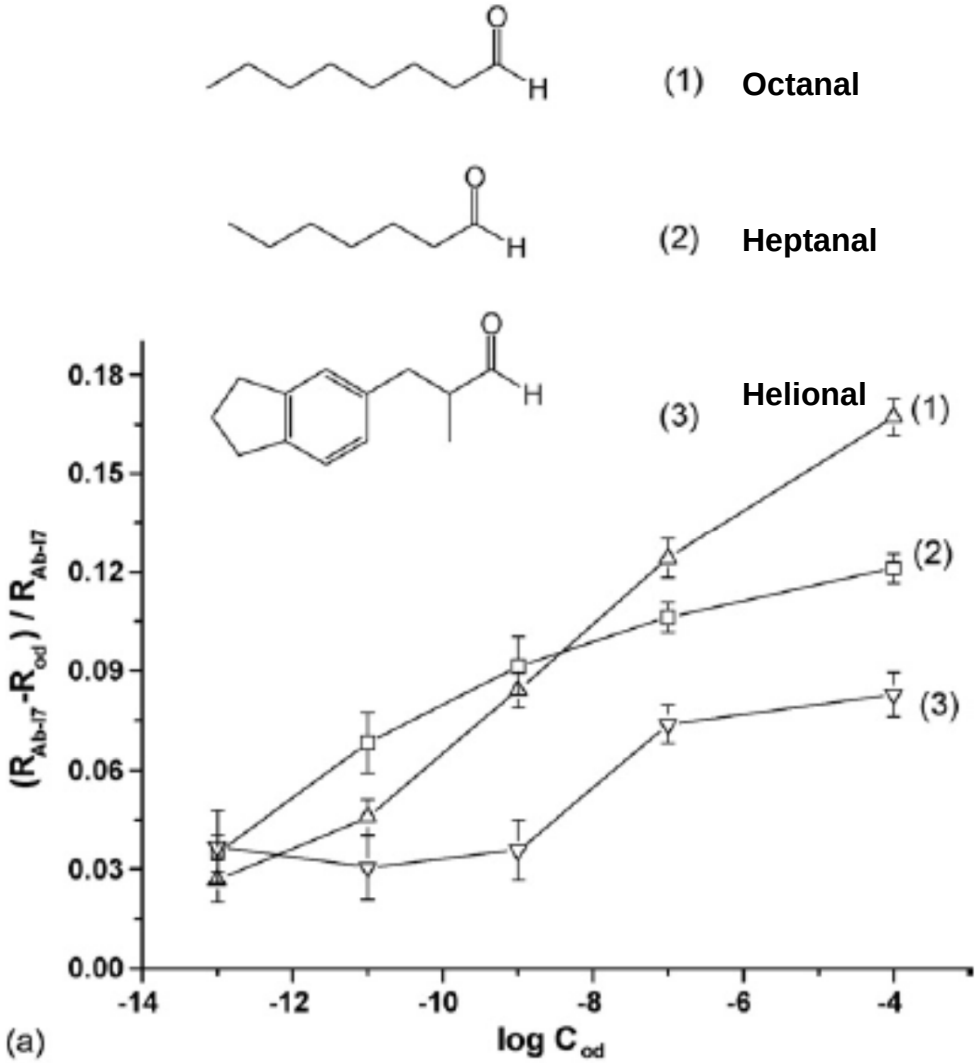
Biosensor Instrumentation

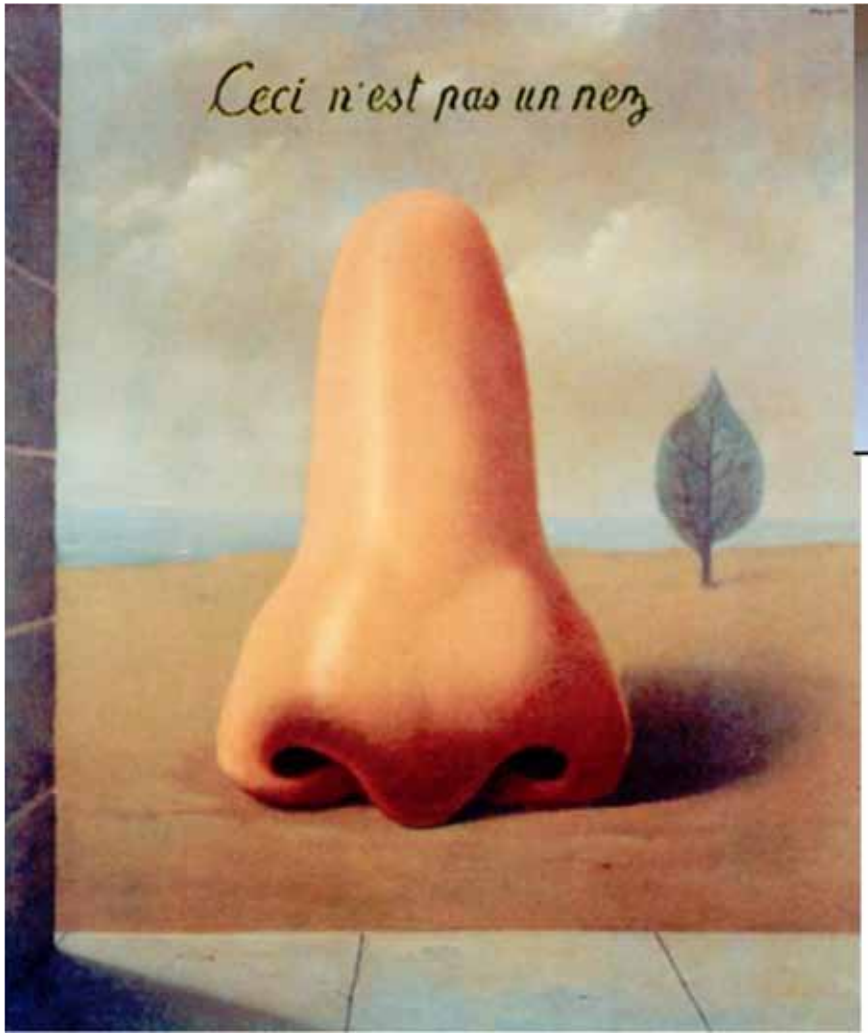


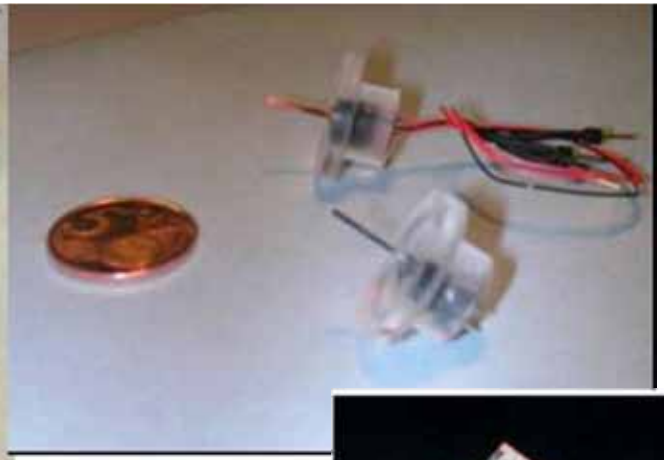
Biosensor test

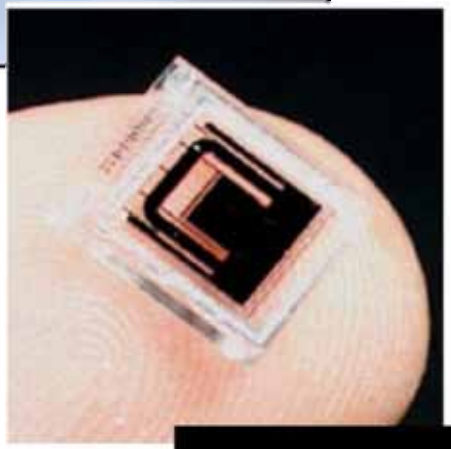
J. Samitier et al. Biosensors & Bioelectronics 21 (2006) 1393-1402

J. Samitier et al. Biosensors & Bioelectronics 22 (2007) 1550-1555









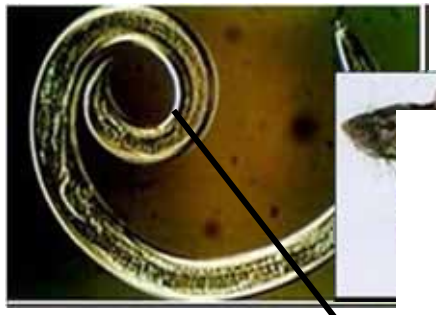
But our device is near…!

BOND

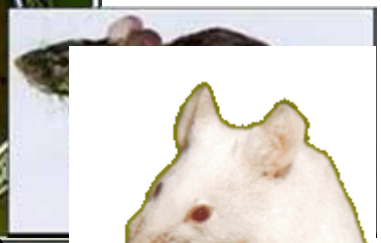
Bioelectronic Olfactory Neuron Device

- Introducción Nanomedicina
- Bionanomateriales para diagnóstico
- Bionanomateriales para medicina regenerativa.

Cells – universal basic unit of all organisms

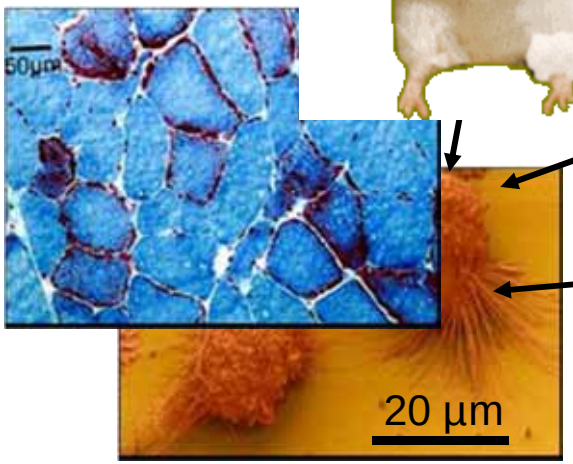


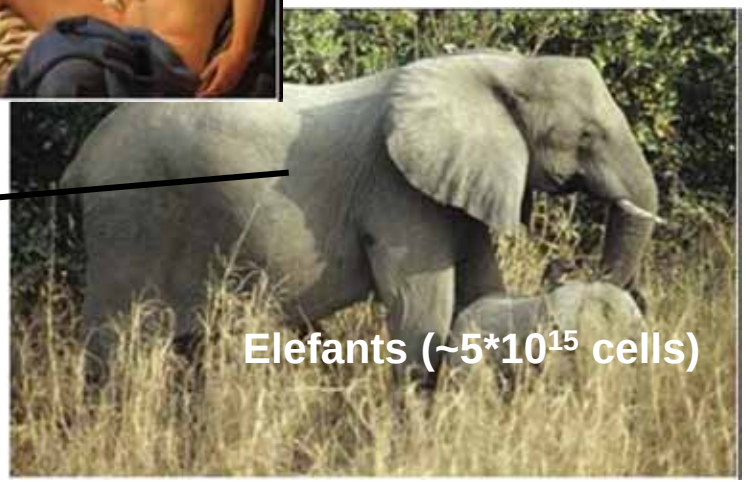
Nematodes (959 somatic cells + ca. 2000 germ cells)



Mice (~10^{12} cells)

Humans (~10^{14} cells)





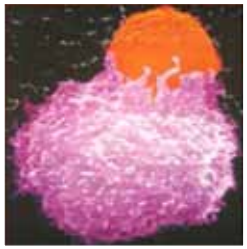
Some Open Questions in Cell Biology

1. What are the basic principles of cell organisation?
2. What is a cell state?
3. How much and what type of surface interactions do cells need?
4. What is “biocompatibility”?

The Immune System Controls Billions of Cells per Day

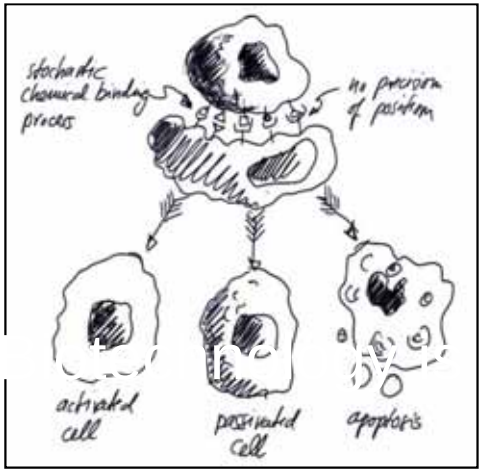
Problem:

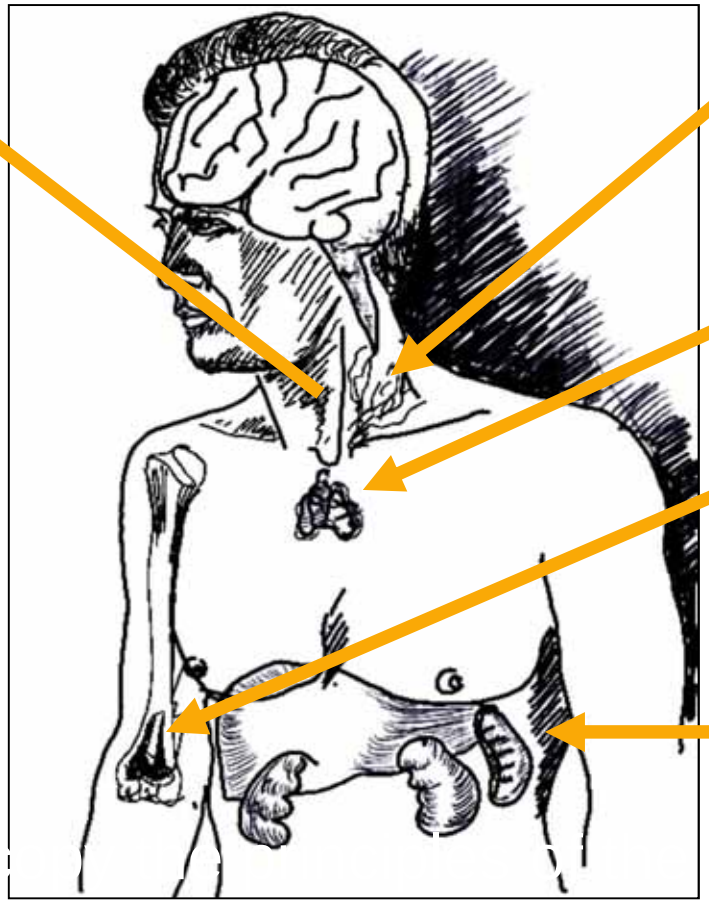
Each surface contact is a receptor-ligand process and can change the cell state



Solution:

Not to avoid but to intensify surface contacts. Imprinting of cells!





Lymphatic system:
Memory cells
Cell activation

Thymus:
Cell controlling

Bone marrow:
Cell proliferation
- Differentiation
- Cell evolution

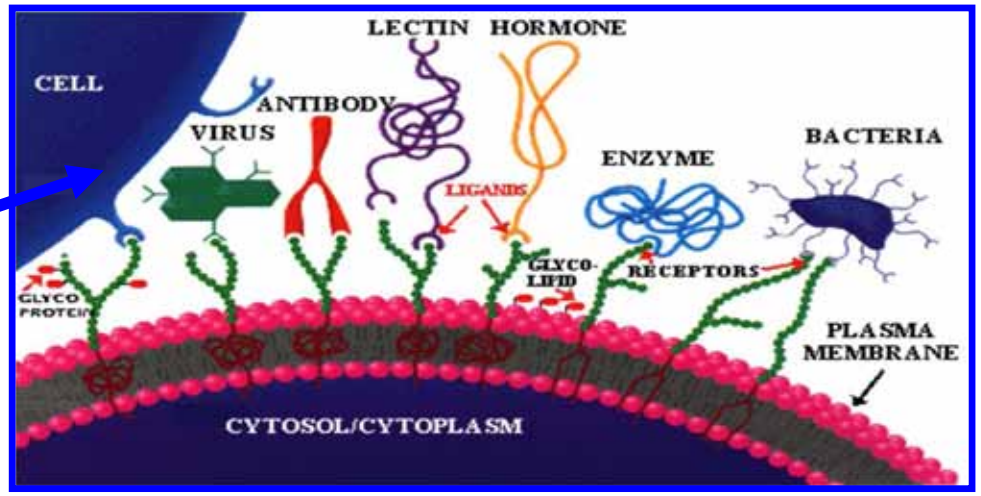
Spleen:
Cell elimination
Cell modification

UNIVERSITAT DE BARCELONA

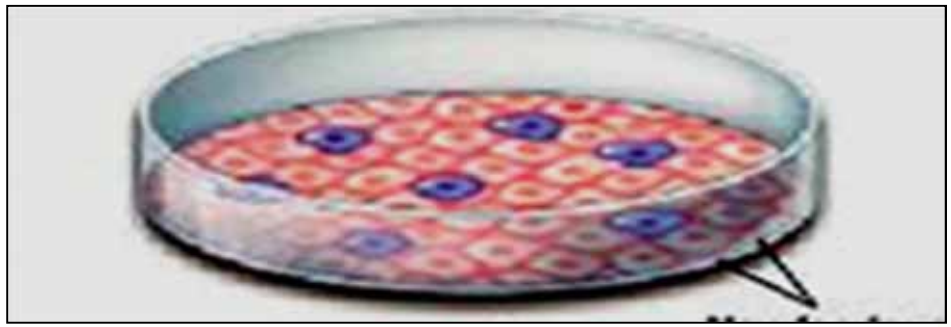
Parc Científic de Barcelona

Cell-to-cell interaction

Cell-to-cell interaction

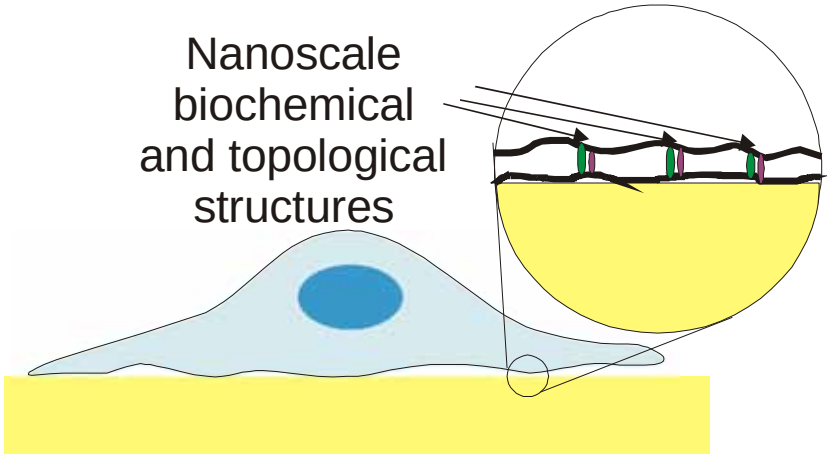


In vitro culture - always the same neighbours,
→ an ocean of uniform properties!



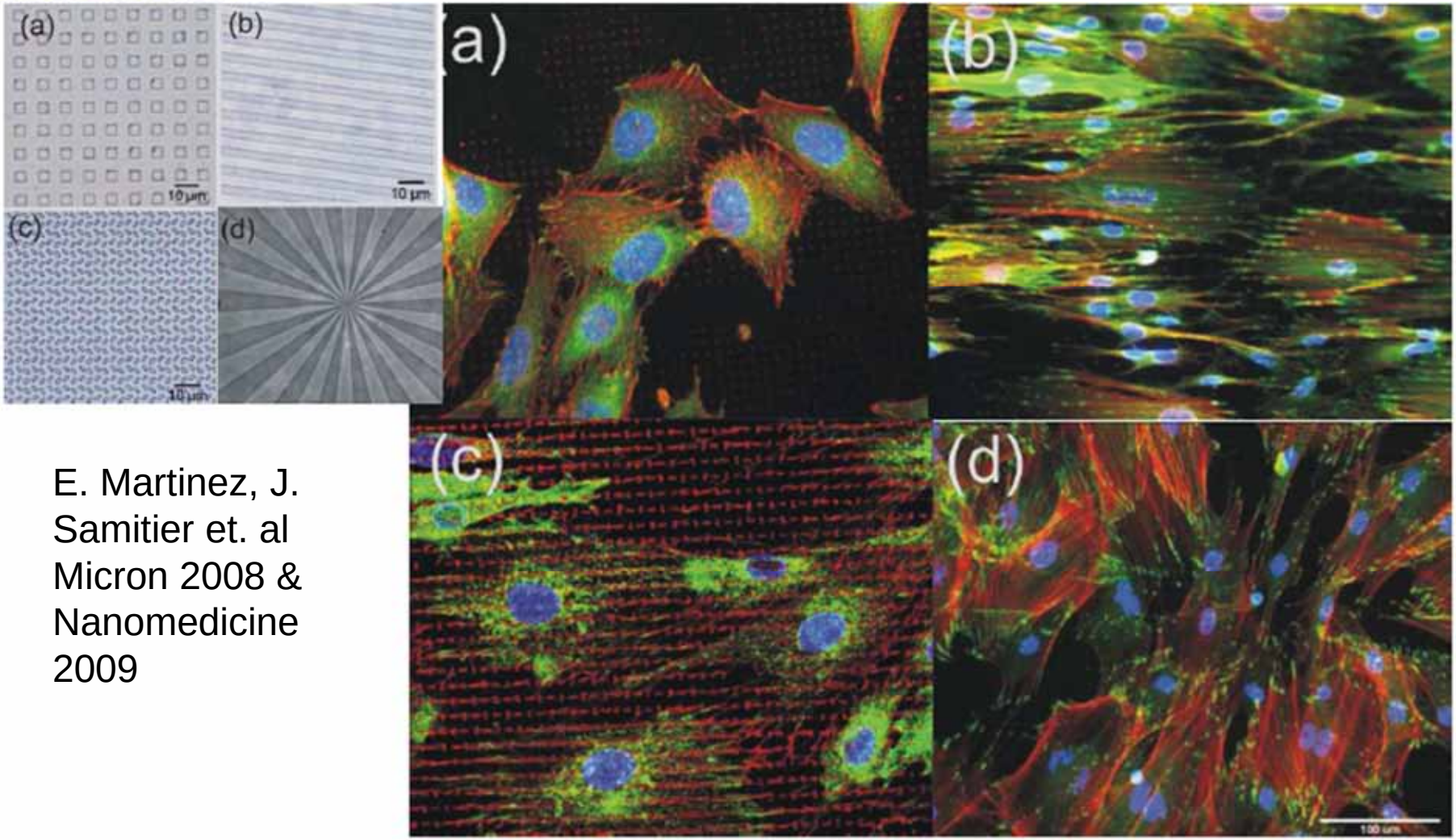
Why nanostructured substrates?

- Importance of cell – substrate interaction (cell guidance)
  - Adhesion
  - Proliferation
  - Morphology
  - Migration
  - Differentiation



- In their natural environment, cells are surrounded by a nanoscale topography

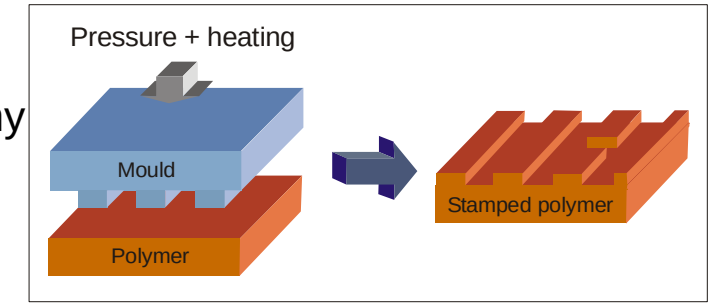
Cell-Patterned polymers interaction



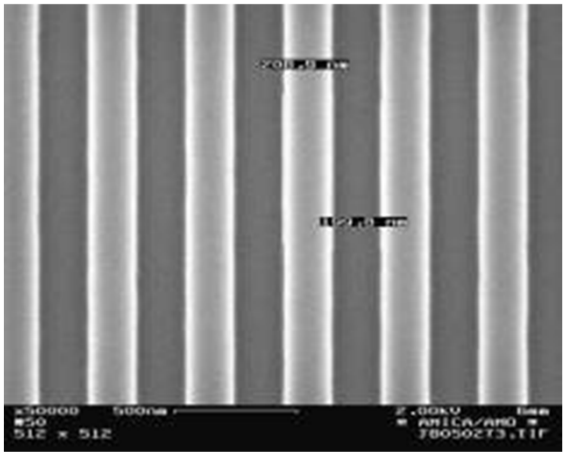
E. Martinez, J. Samitier et. al Micron 2008 & Nanomedicine 2009

Polymer Hot Embossing

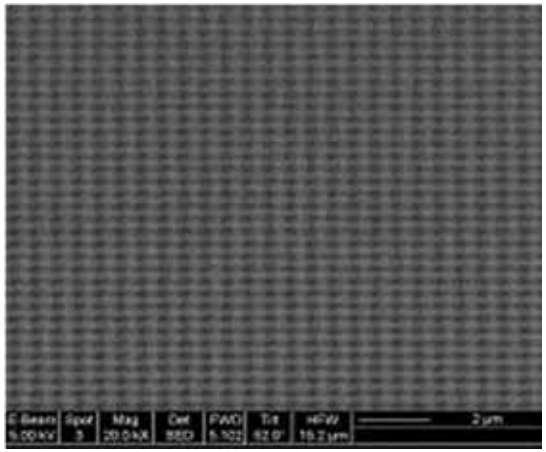
- Fabrication techniques:
  - Nanoembossing (polymer replica)
  - E-beam and Focused Ion beam lithography

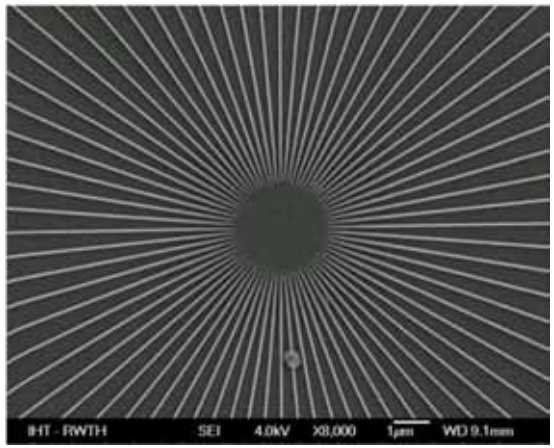


200 nm lines



300 nm posts



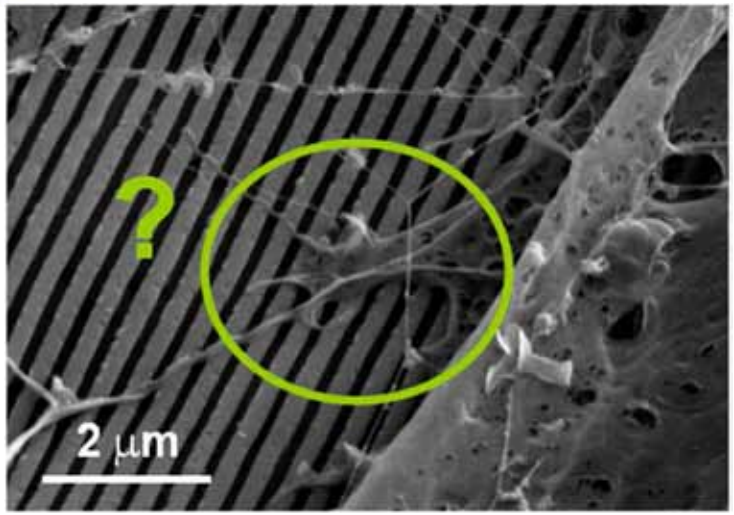


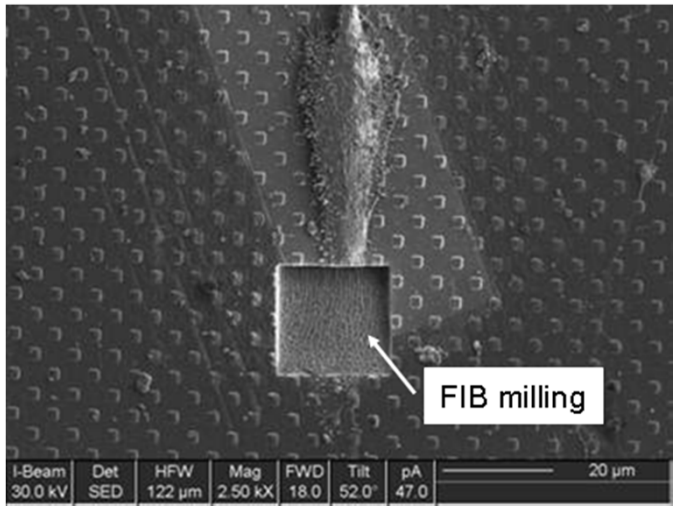
Mills, Samitier et. al. *Nanotechnology* 16 (2005) 369-375
Mills, Samitier et. al. *J Biomed Mater Res 76,781-787*(2006)
Mills,Samitier et al. Microelectronic Eng 85(2008) 1897-1901

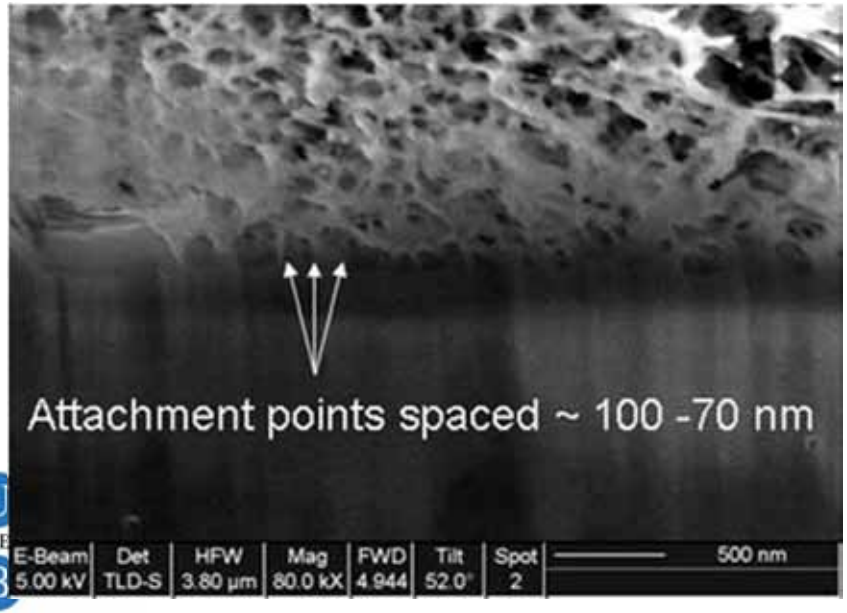
UNIVERSITAT DE BARCELONA

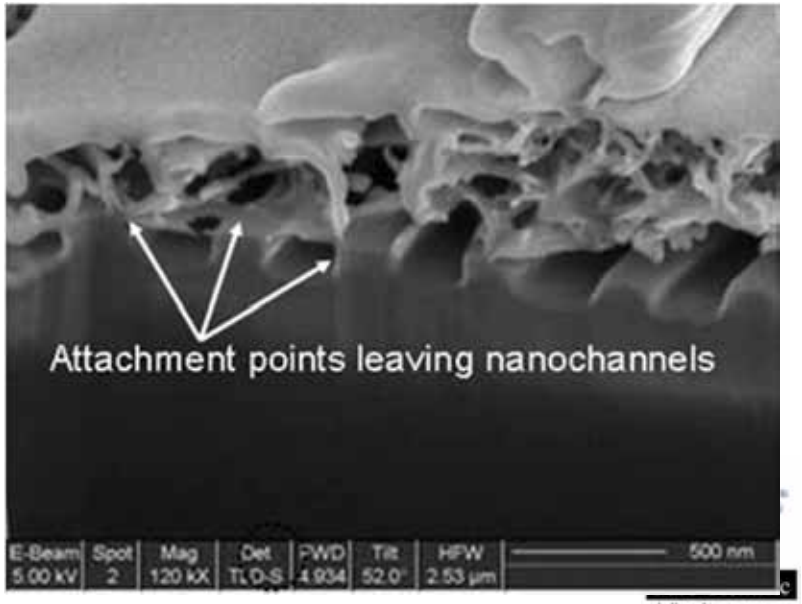
Parc Científic de Barcelona

Cell-material interface characterisation by FIB/SEM

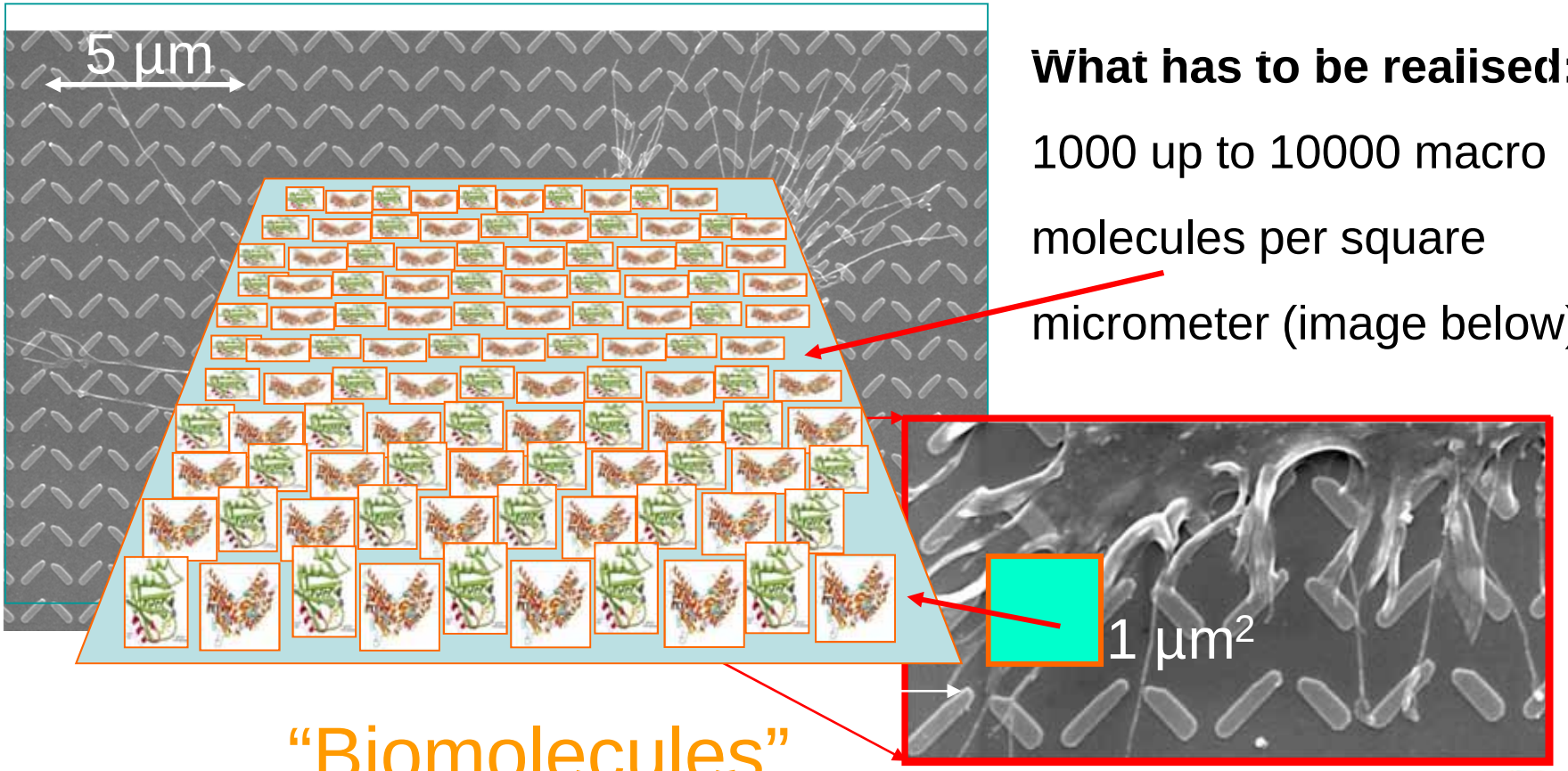








Structurisation alone is insufficient. Artificial imitations of cell surfaces are required!



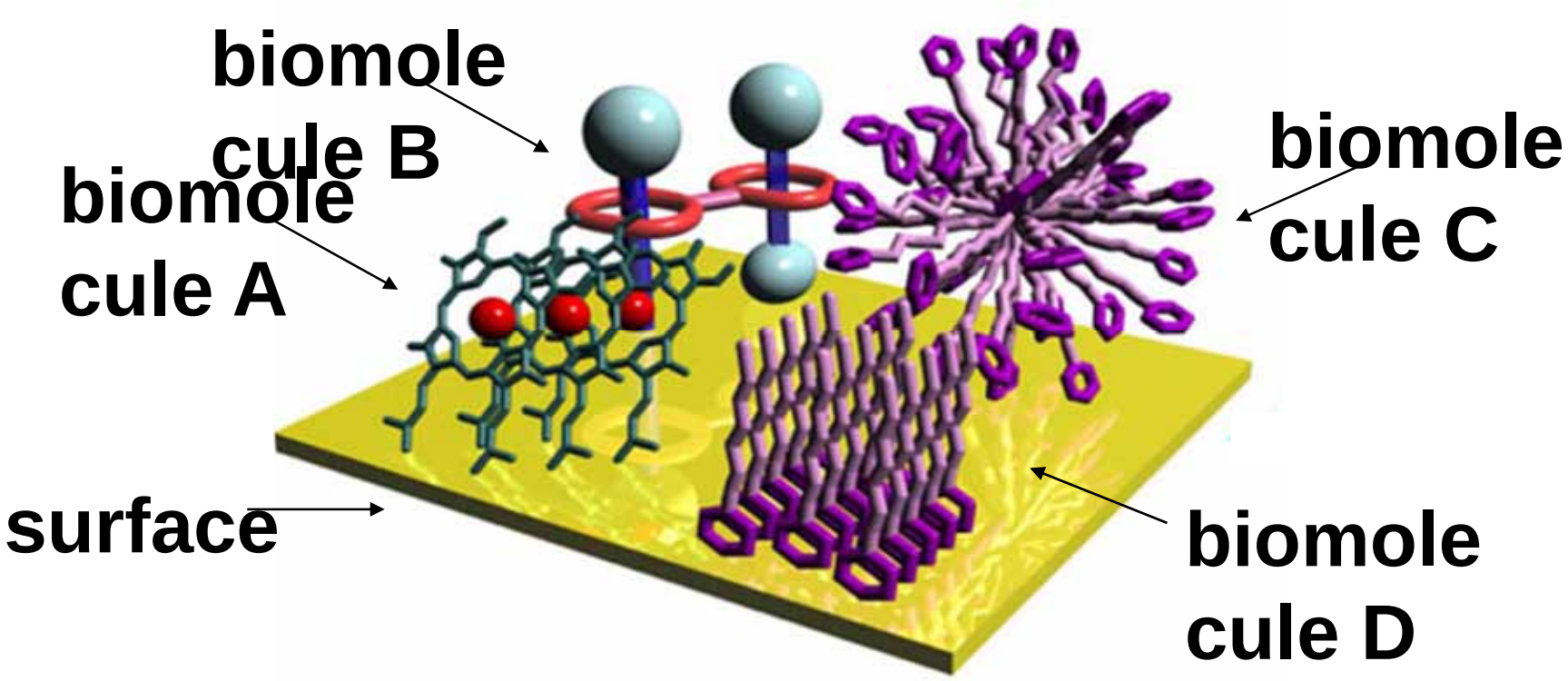
What has to be realised:

1000 up to 10000 macro molecules per square micrometer (image below)

"Biomolecules"

Introduction
Bio-MEMS/NEMS & functionalization

✓ **Interactions occurs on interfaces** → **surface modification** → **functionalization**



✓ **Surface functionalization introduces suitable functional groups to a surface.**

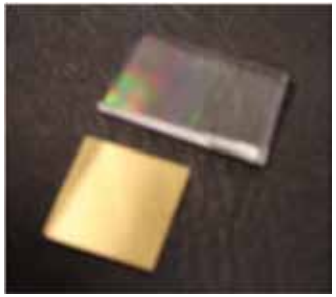
Patterning techniques state-of-the-art

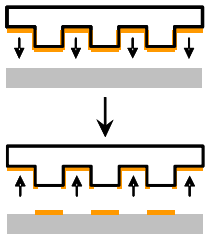
✓ **A variety of techniques have been developed to site-specifically immobilize (bio)molecules onto surfaces.**

ink-jet

✓ large area
× large spots

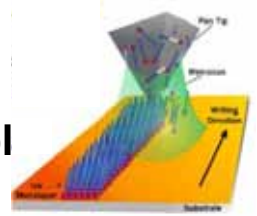
soft-lithography





✓ large area
× ink diffusion
× pressure control

Dip-Pen™



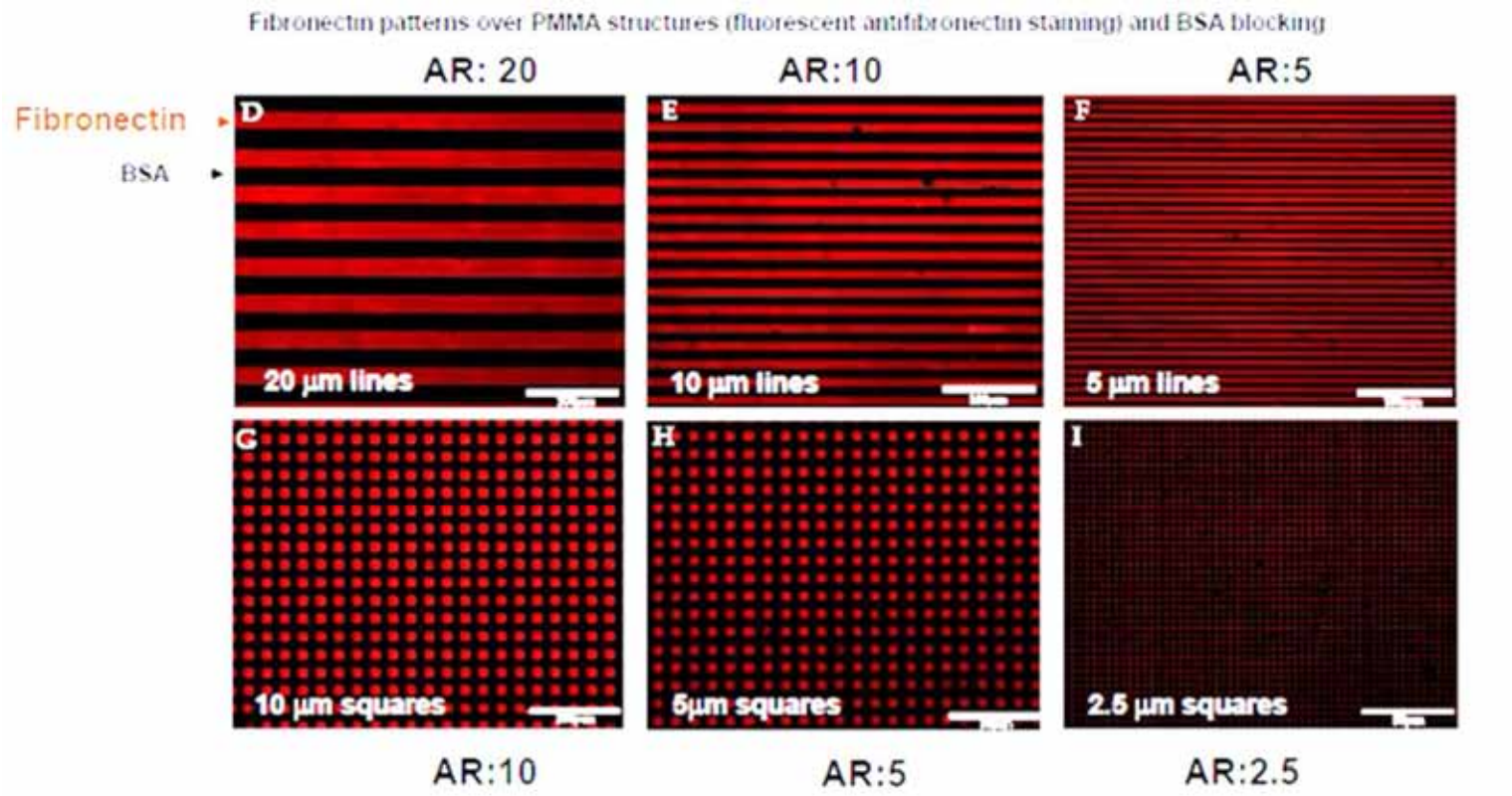
✓ nanoscale
✓ position/pressure control
× time consuming

✓ **Biochemical patterning of surfaces has multiple applications in biochemical sensing and biomolecular electronics.**

UNIVERSITAT DE BARCELONA

Parc Científic de Barcelona

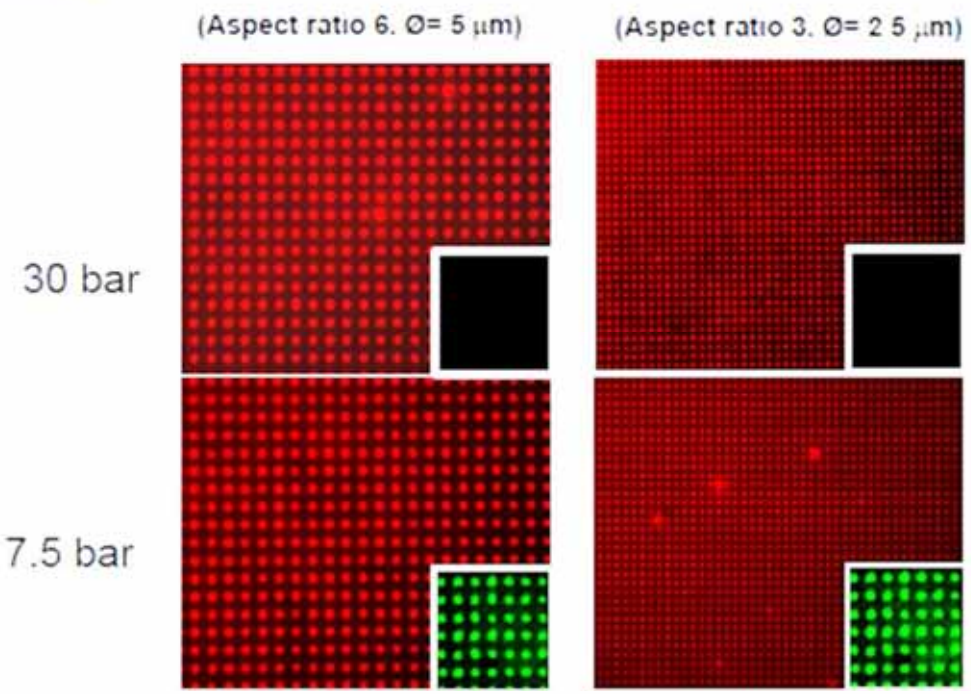
Inverted microcontact printing

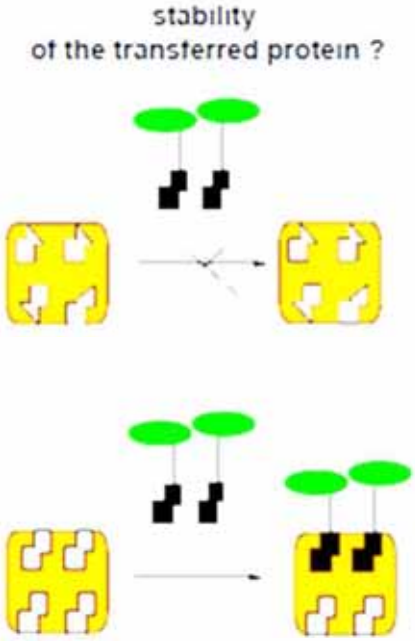


Inverted microcontact printing
- No double printing
- Aspect ratio limitation

E. Martínez,J. Samitier et al, Nanomedicine 2007

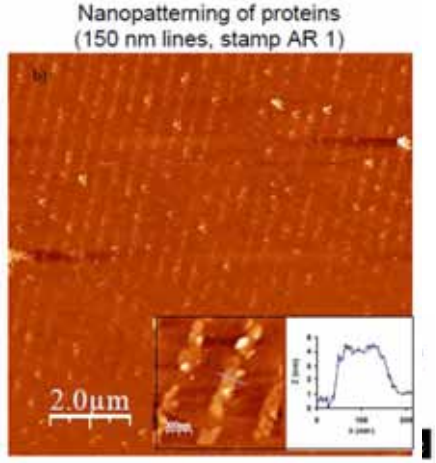
PMMA microcontact printing



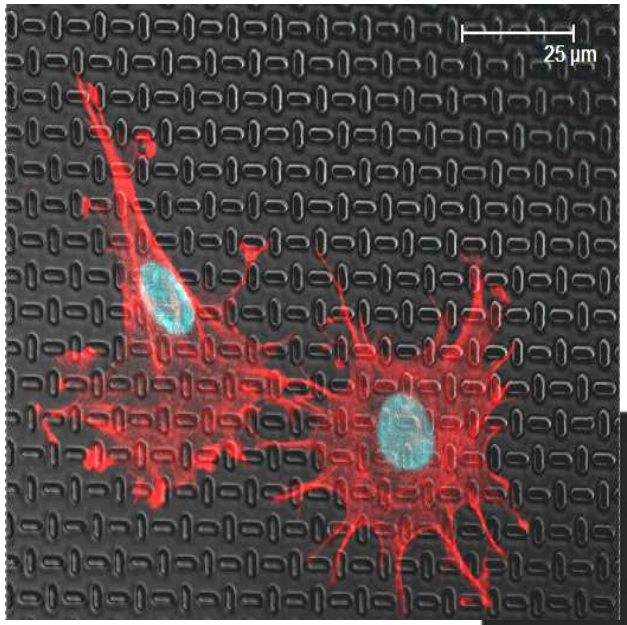


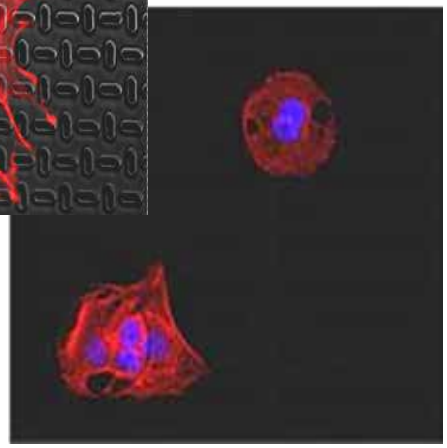
M. Pla-Roca,J. Samitier et al, Langmuir 23 (2007)

No disruption of the protein at 7.5 bars during the transferring procedure



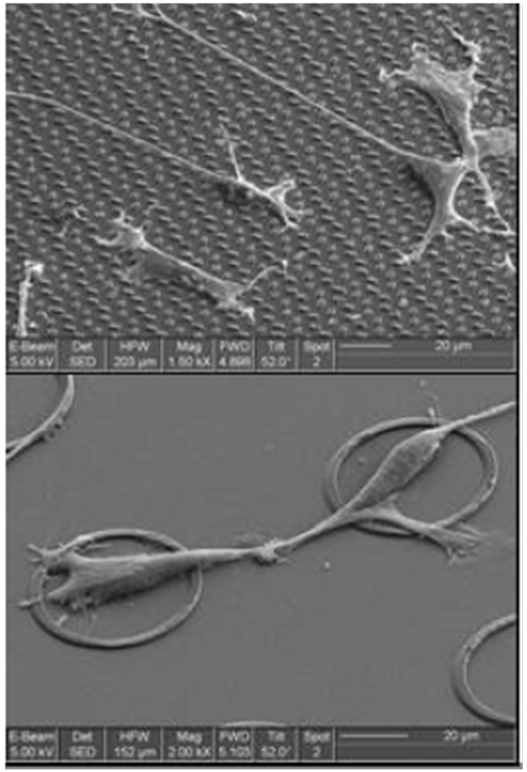
Evaluation of cell-patterned polymer interactions



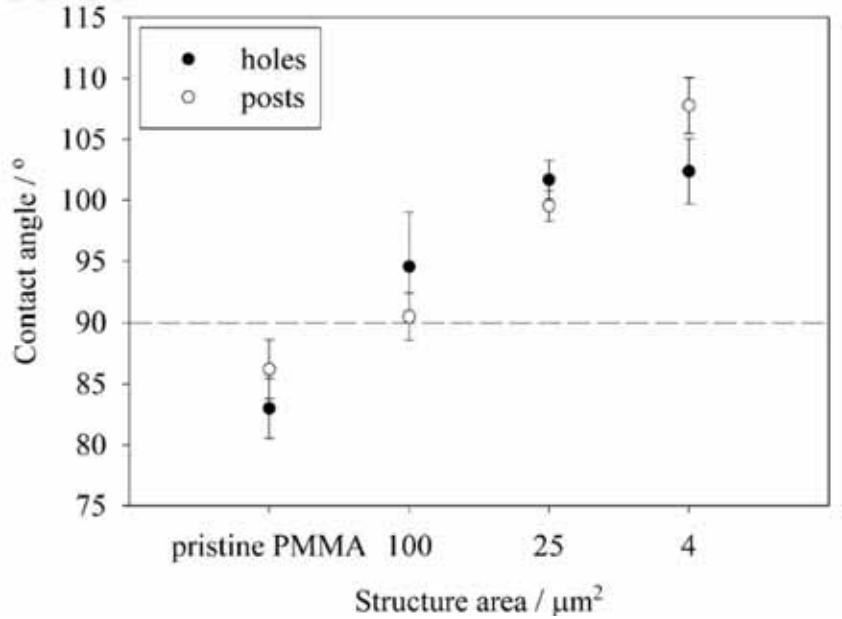


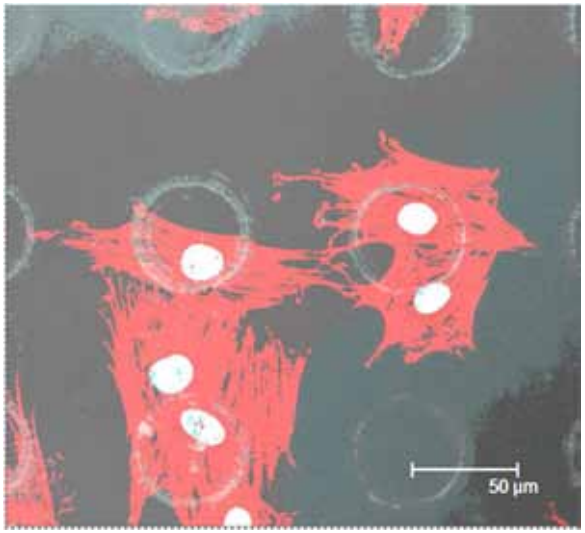
Confocal pictures of MSC cells cultured on microstructured PMMA with irregular structures and 50 donut structures.

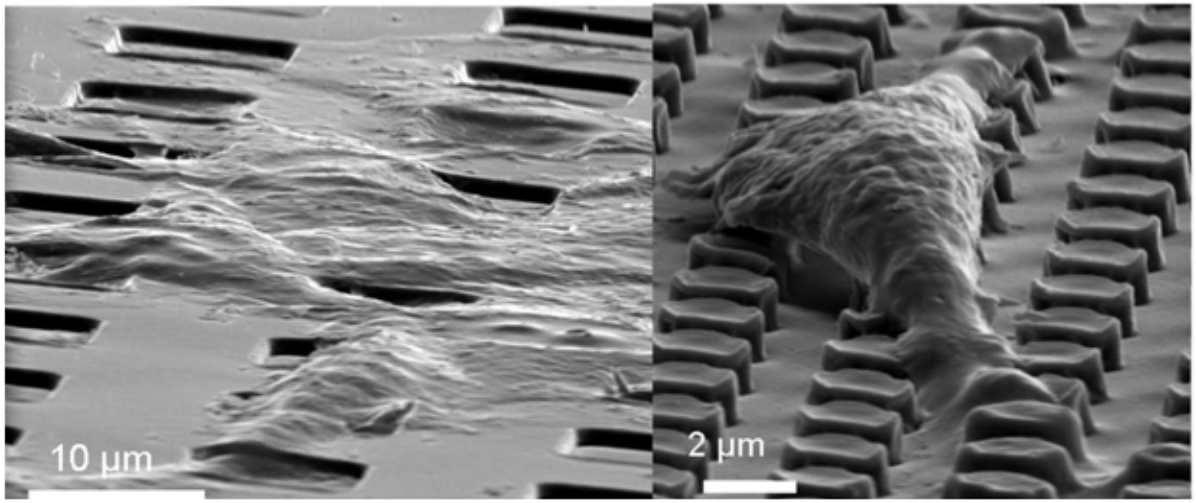
SEM pictures of MSC cells cultured on microstructured PMMA



Changes in contact angle and cell morphology



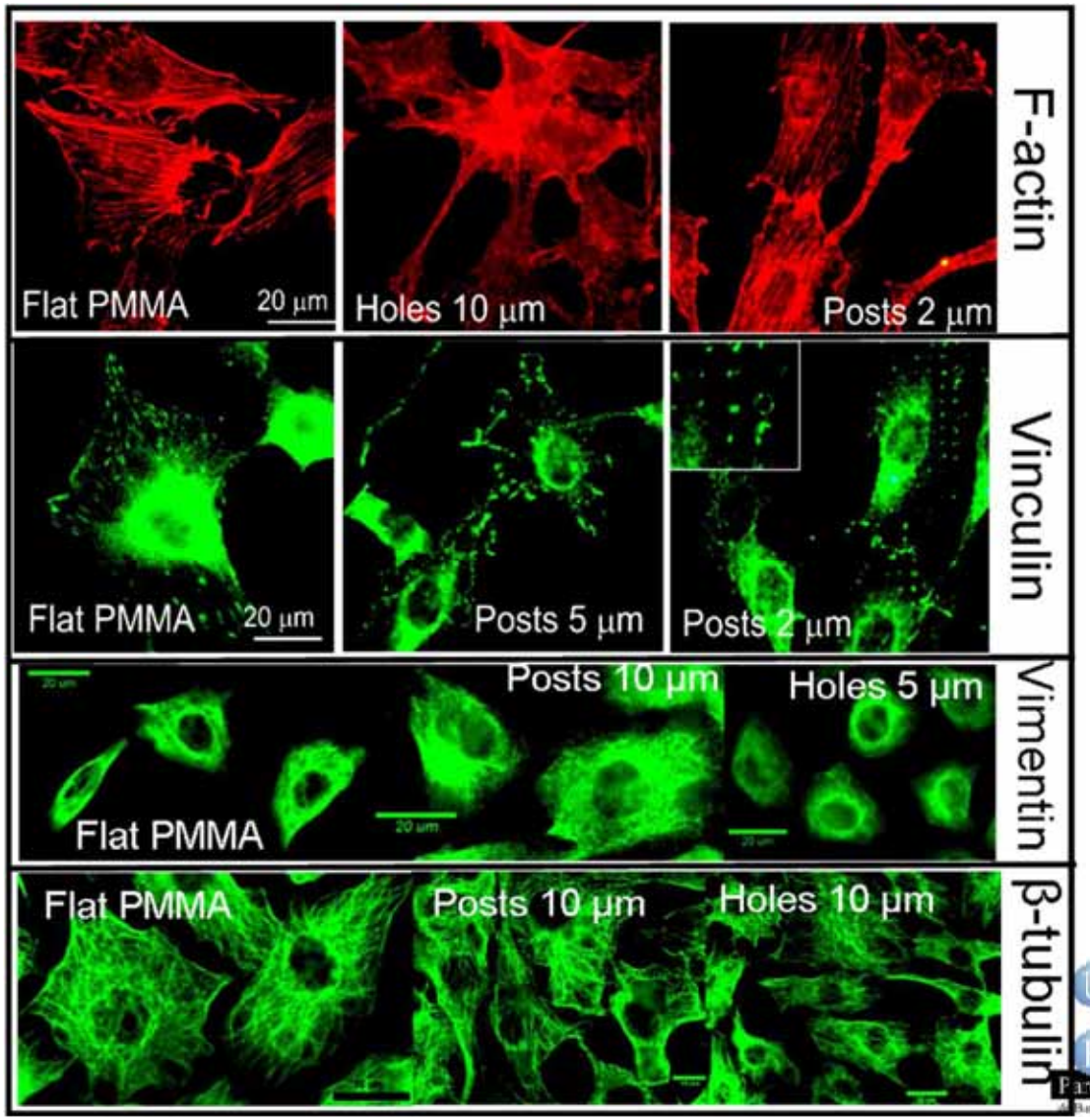




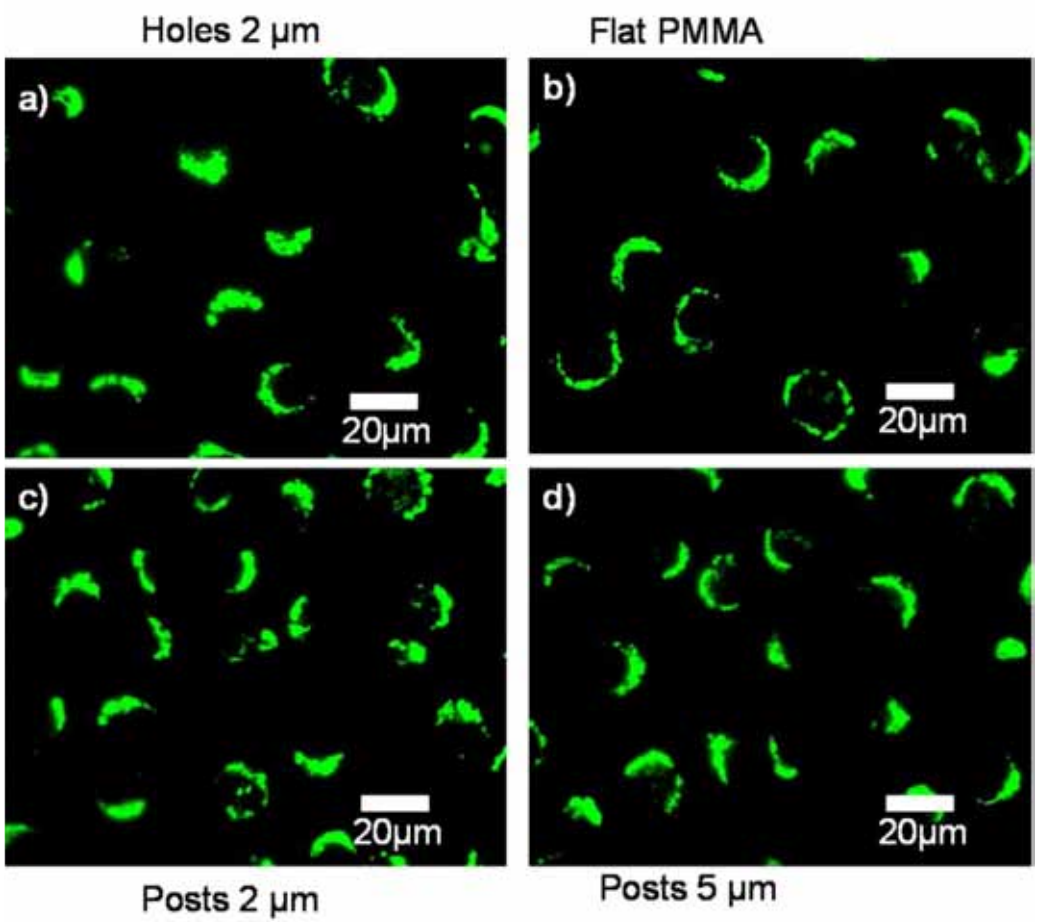
C. Mills,J. Samitier et al, Small 2007
E. Engel, J. Samitier et al, Annals of Anatomy, 2008

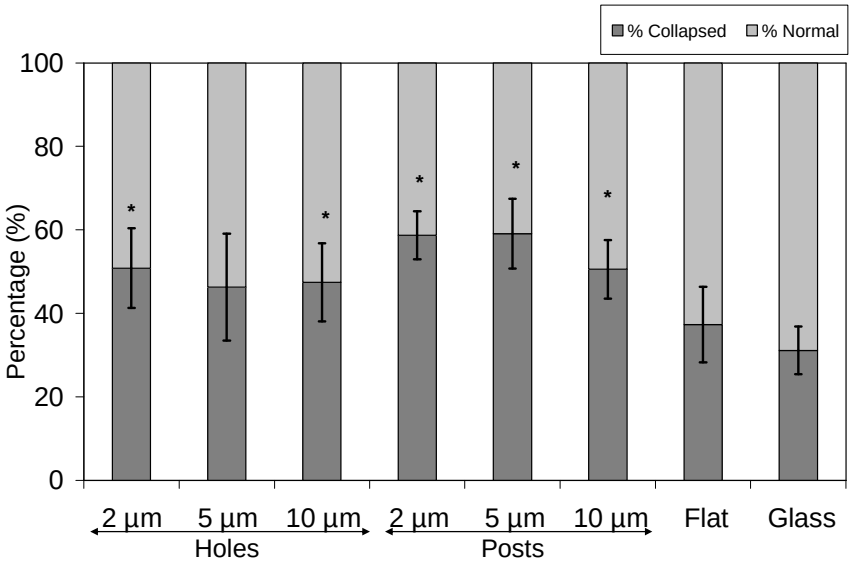
Changes in cell cytoskeleton

In collaboration with Prof. Gustavo Egea (UB-Hospital Clínic)



Alteration in Golgi complex





- Compact Golgi complexes increase on micropatterned samples

M. Estévez ,J.Samitier et al, Small 2010

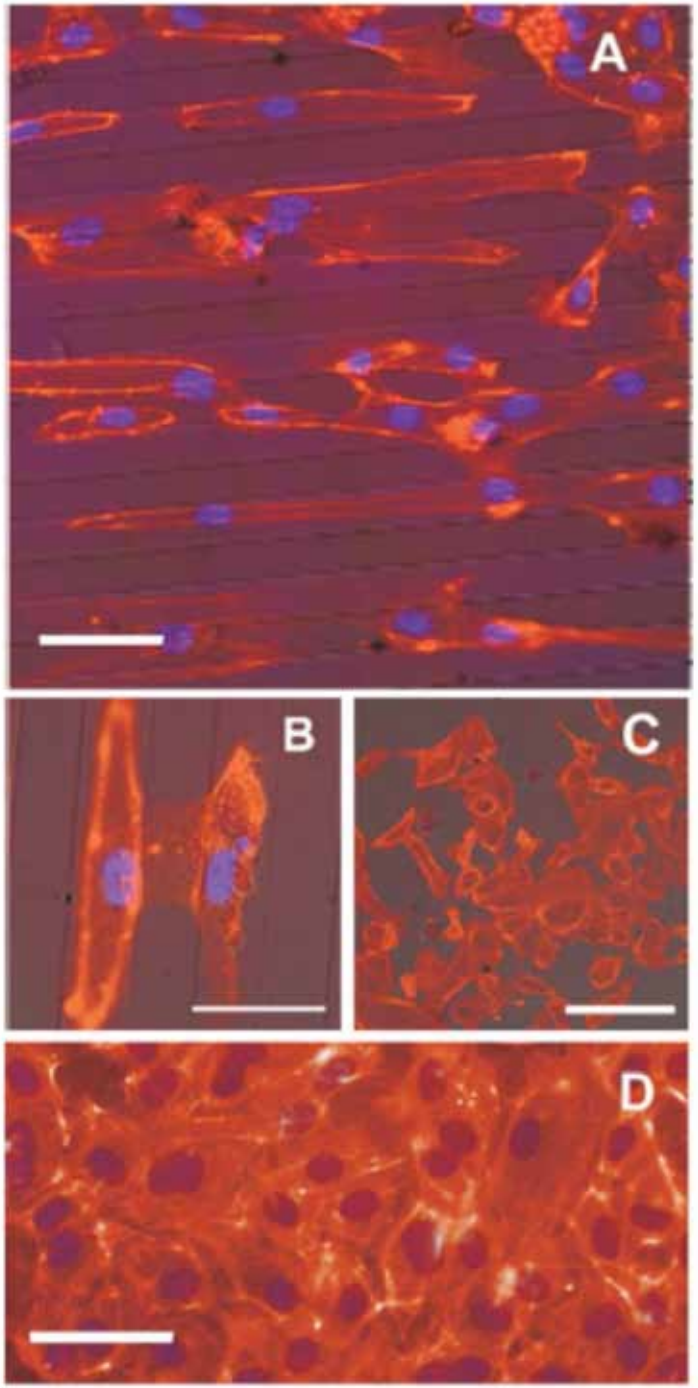
3D Structures

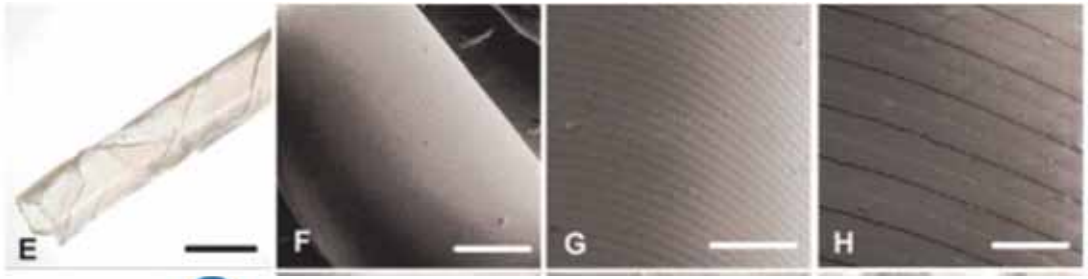
(A) Human umbilical vein endothelial cells cultured on the inner surface of a 1 mm diameter Chitosan tube structured with 17 µm wide, 1µm deep channels positioned perpendicular to the long axis of the tube [bar = 45 µm]. The cells can be seen to align to the direction of the channels.

(B) Cells positioned in separate channels extending their ECM over the adjoining 1 µm tall wall to contact their neighbor [bar = 30 µm].

(C) Cells cultured on the non-structured areas of the tube display random alignment [bar = 120µm].

(D) Confluent cells on the structured support after four days culture [bar = 50 µm].





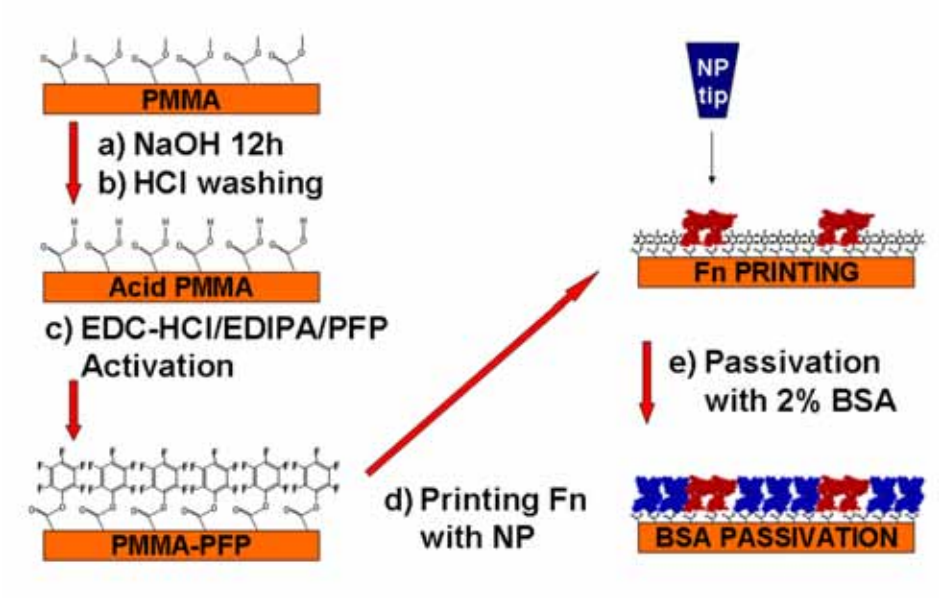
UNIVERSITAT DE BARCELONA

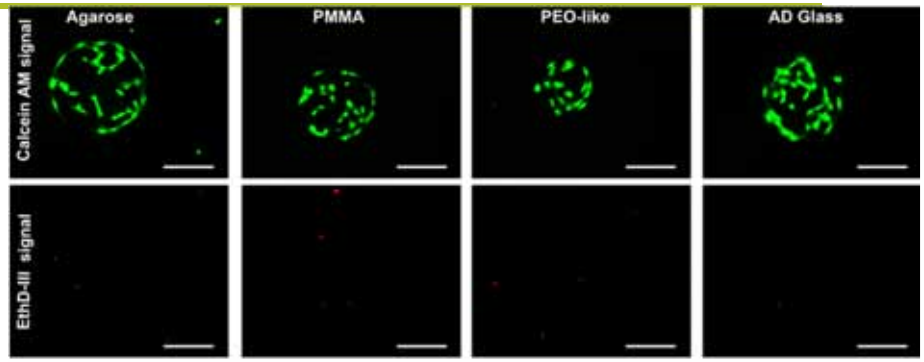
J.G.Fernandez, Mills, Samitier Small 5 (2009)

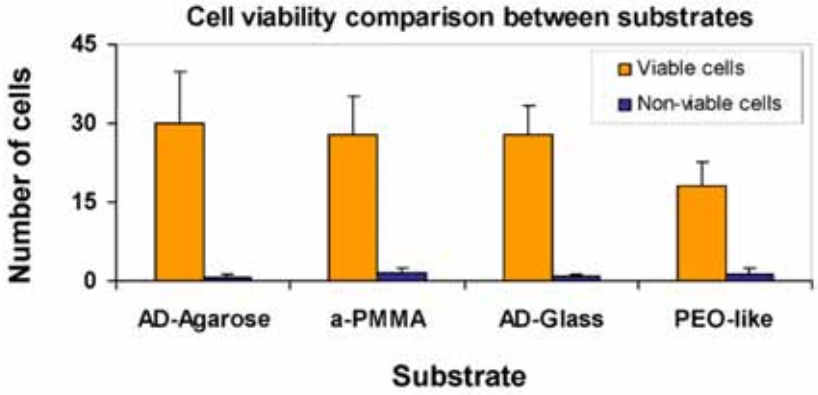
cellular microarray applications

Santiago

PMMA chemical activation protocol and protein printing.







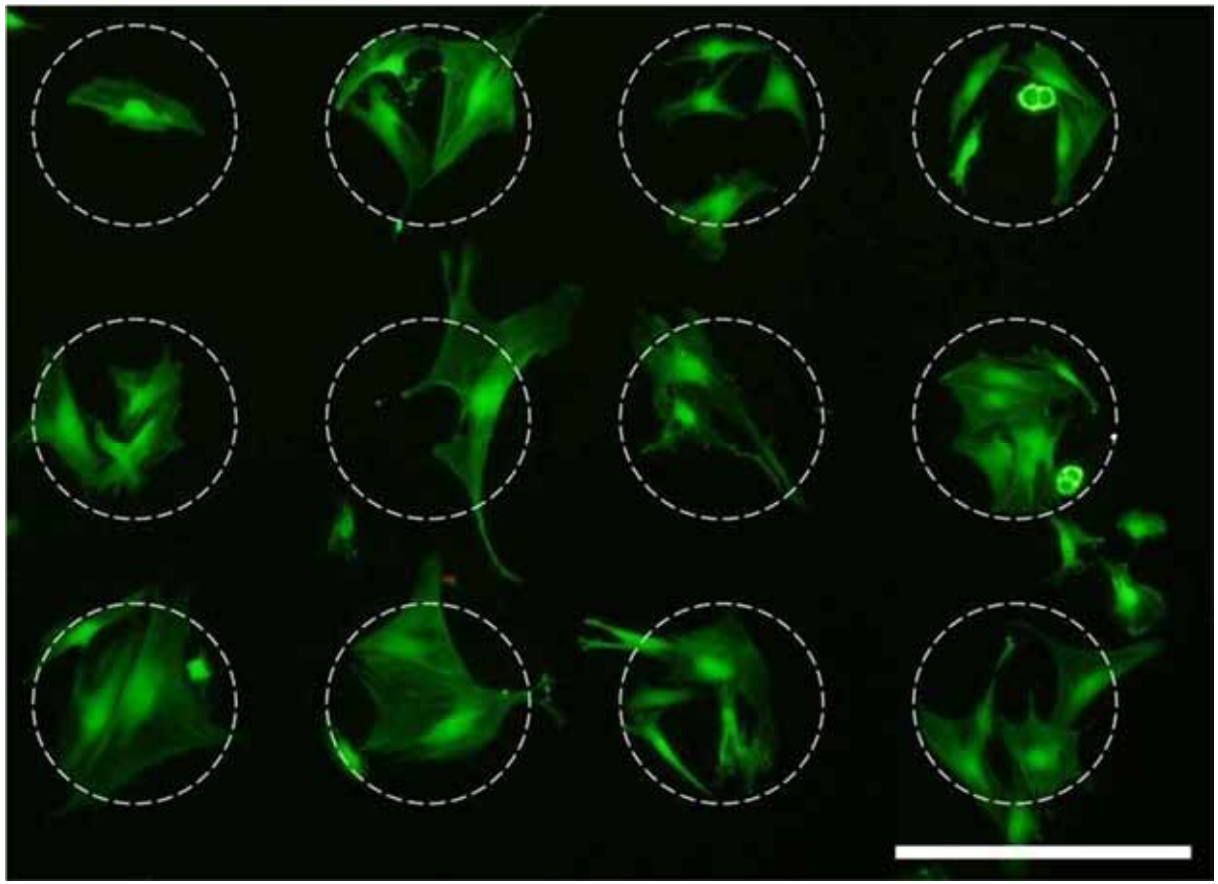
Fluorescence images of cell viability for cells growing on spots with Fn360 1% A555 in PBS (10 drops spot size) for the four substrates assayed (up) and plot for viable and non-viable cells (down). Bars represent the mean values from 10 spots, and the standard deviation associated. Calcein signal, in green, stains viable cells EthD-III signal ,in red, indicates non-viable cells.

UNIVERSITAT DE BARCELONA

Parc Científic de Barcelona

Test of the optimised parameters with MSCs

After 8 days of cell culture



Cell viability higher >99%

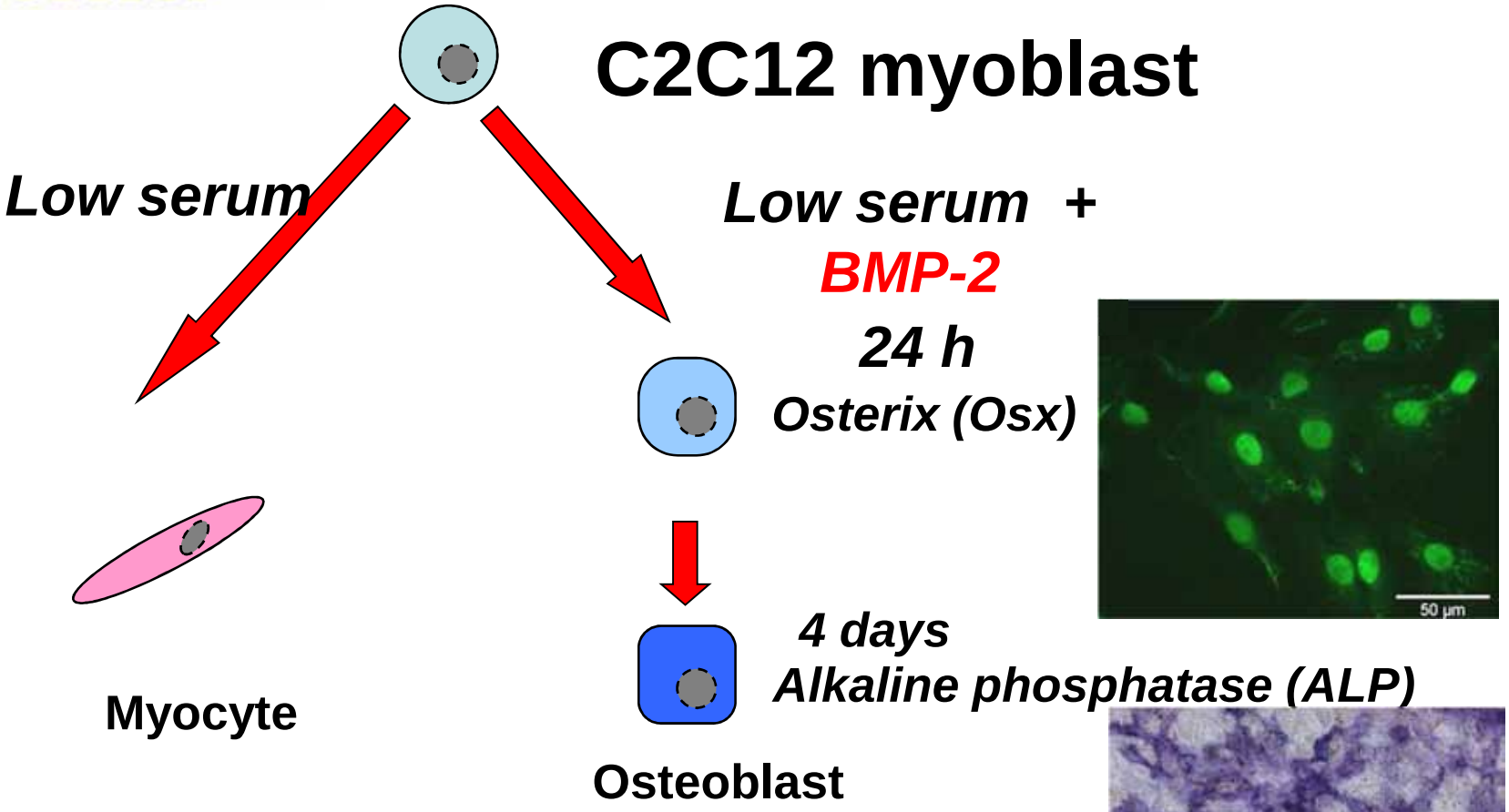
(green staining, calcein AM)

Successful cellular microarray formation

500 µm

Rodriguez-Segui et al. "Influence of fabrication parameters on cellular microarrays for stem cell studies", J Mat Sci: Mat Med, 2009.

C2C12: Differentiation pathway



UNIVERSITAT DE BARCELONA

Next challenges

- Smart Biomaterials
  - Drive tissue regeneration and minimize immune response and inflammation
  - Develop smart biomaterials, with desired properties and precisely tuneable biological functionality

- Cell based therapies
  - Use of nanotechnologies for developing appropriate and stable cells and tissues

Perspectiva 2020

En els propers 10 anys la nanomedicina possibilitarà tractaments innovadors per malalties cardiovasculars, càncer, enfermetats neuro-degeneratives i diabetis.

Muchas Grácias!

Nanobioengineering Group

They are the protagonists!

UNIVERSITAT DE BARCELONA

Parc Científic de Barcelona