



ISMN - CNR - Bologna



Nanotecnologie e medicina rigenerativa

Francesco Valle
Consiglio Nazionale delle Ricerche (CNR)
Istituto per lo Studio dei Materiali Nanostrutturati

*LA MEDICINA RIGENERATIVA: approccio
multidisciplinare*

UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II
POLO DELLE SCIENZE E DELLE TECNOLOGIE PER LA VITA

Napoli, Sabato 16 aprile 2011

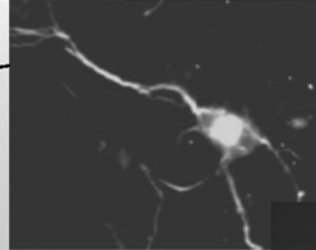
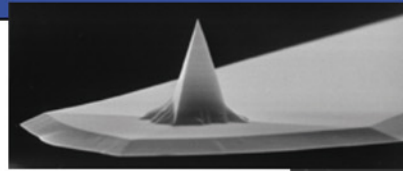


Quanto è piccolo un nanometro?

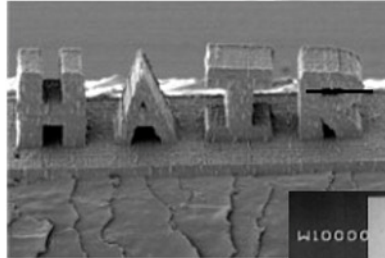
- Nanometro (nm) = 10^{-9} m



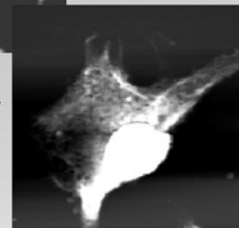
2 billion nm



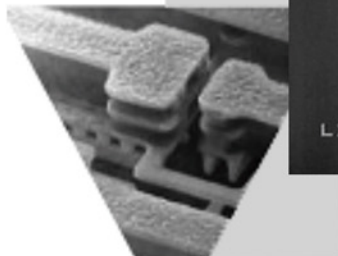
Cellule



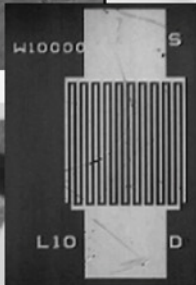
10 000 nm



Proteine



Thin Films



Circuito integrato

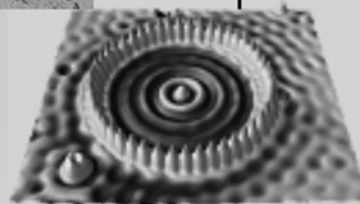


Batteri

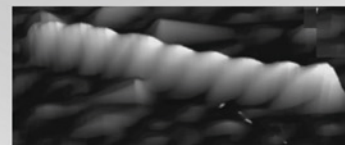
1000 nm

100 nm

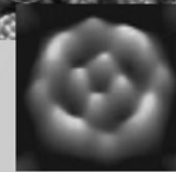
10 nm



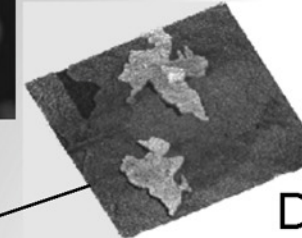
Quantum coral



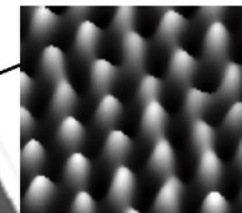
Virus



DNA

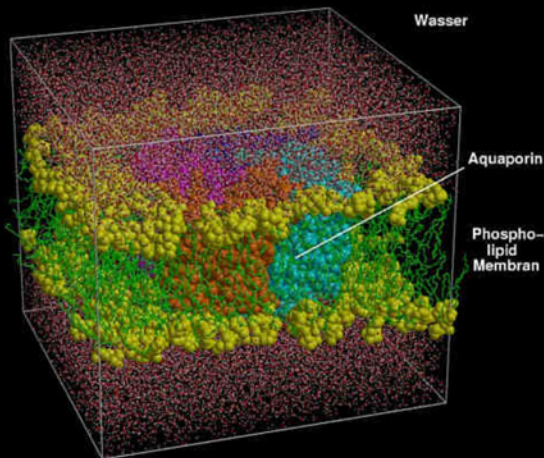
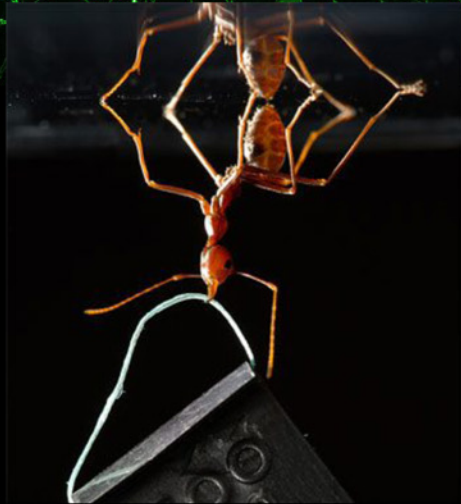
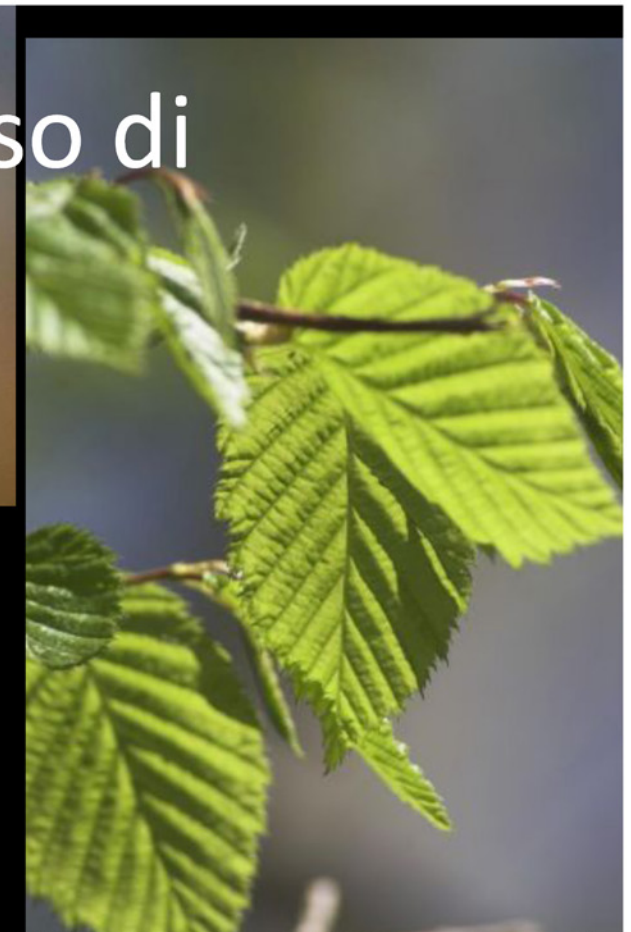


1 nm



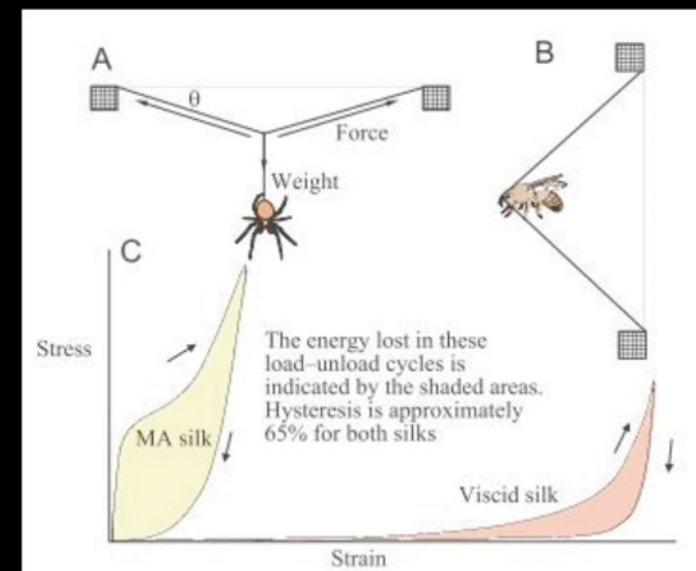
Atomi e
molecole

La natura fa ampio uso di nanotecnologie





Meccanica: Resistenza dei materiali



Fisica delle superfici/ Nano Scienze



Nelumbo
effetto loto
Superfici Super idrofobiche



Fluidodinamica

Le proprietà dipendono dalla dimensione

SUONO

violino



viola



contrabbasso



violoncello



COLORE

Gold Building Blocks

Atoms:
colorless, 1 Å



Gold clusters:
orange, nonmetallic,
<1 nm



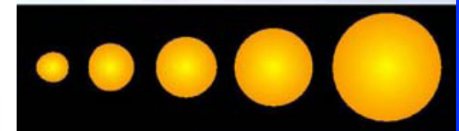
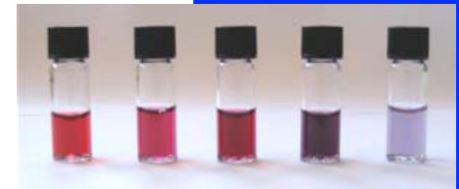
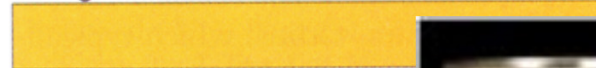
Gold nanoparticles:
3–30 nm, red, metallic,
“transparent”



Gold particles:
30–500 nm
metallic, turbid,
crimson to blue



Bulk gold film

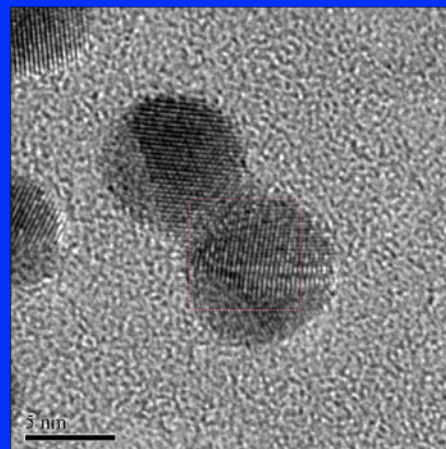
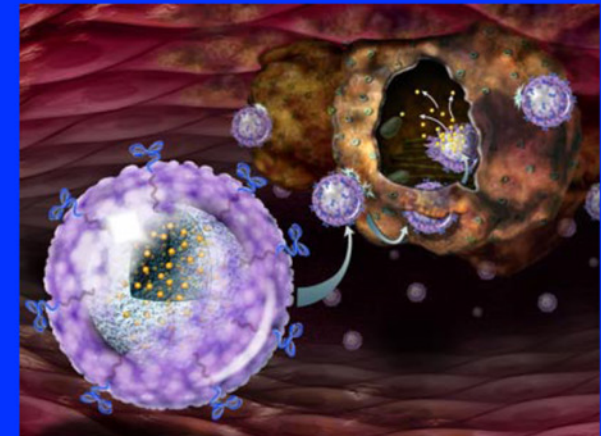
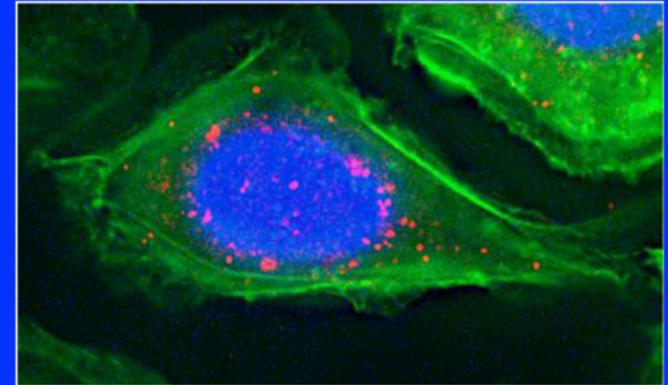


Coppa di Licurgo
4 secolo D.C.
British Museum
London



Uso delle Nanoparticelle in medicina

- diagnosi (marcatori)
- terapia (farmaco e trasporto di farmaci)
- impatto ambientale
- nanotossicologia.



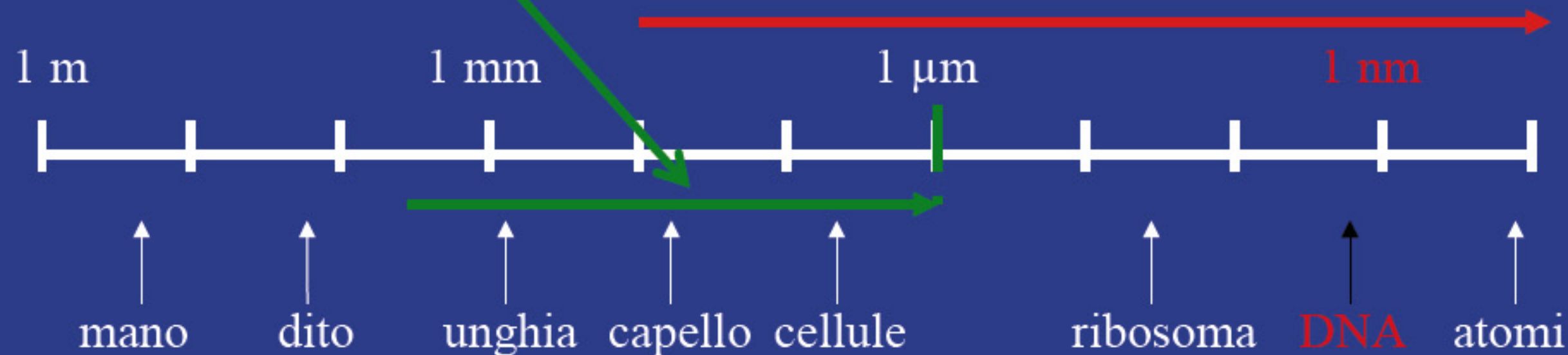
Le nanotecnologie ci offrono strumenti per **osservare** la natura sulla scala dei nanometri

Microscopi

Ottico

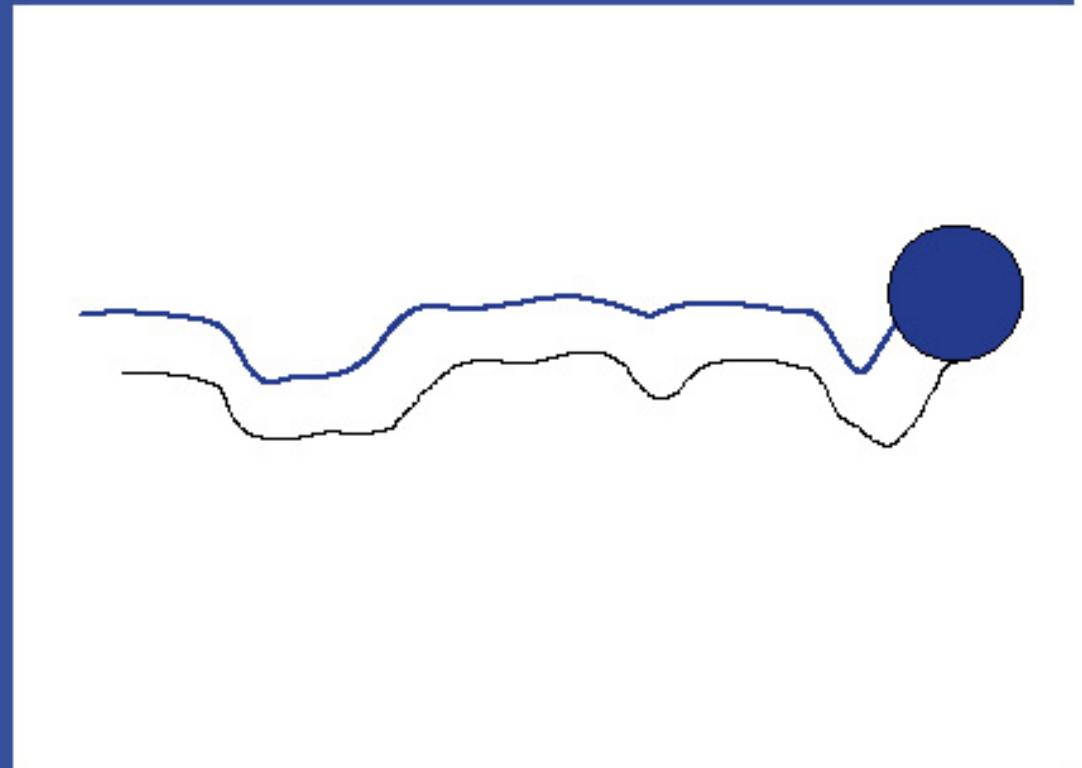
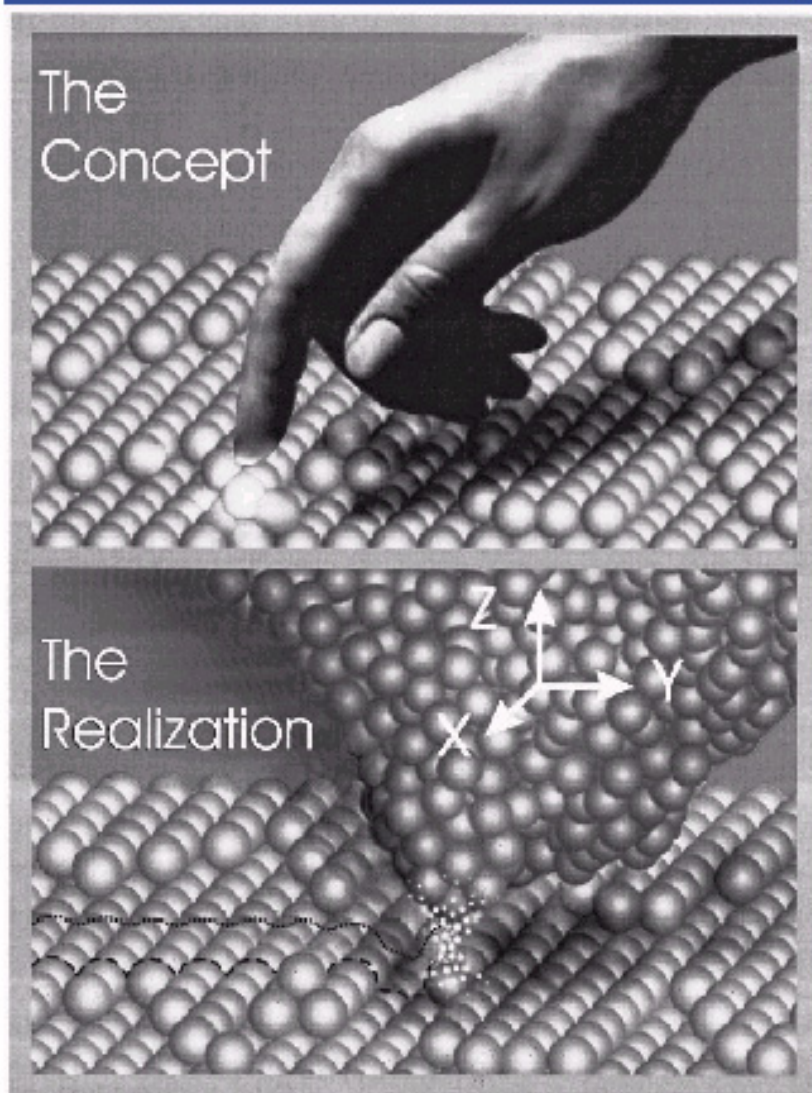


Microscopio a Scansione di Sonda



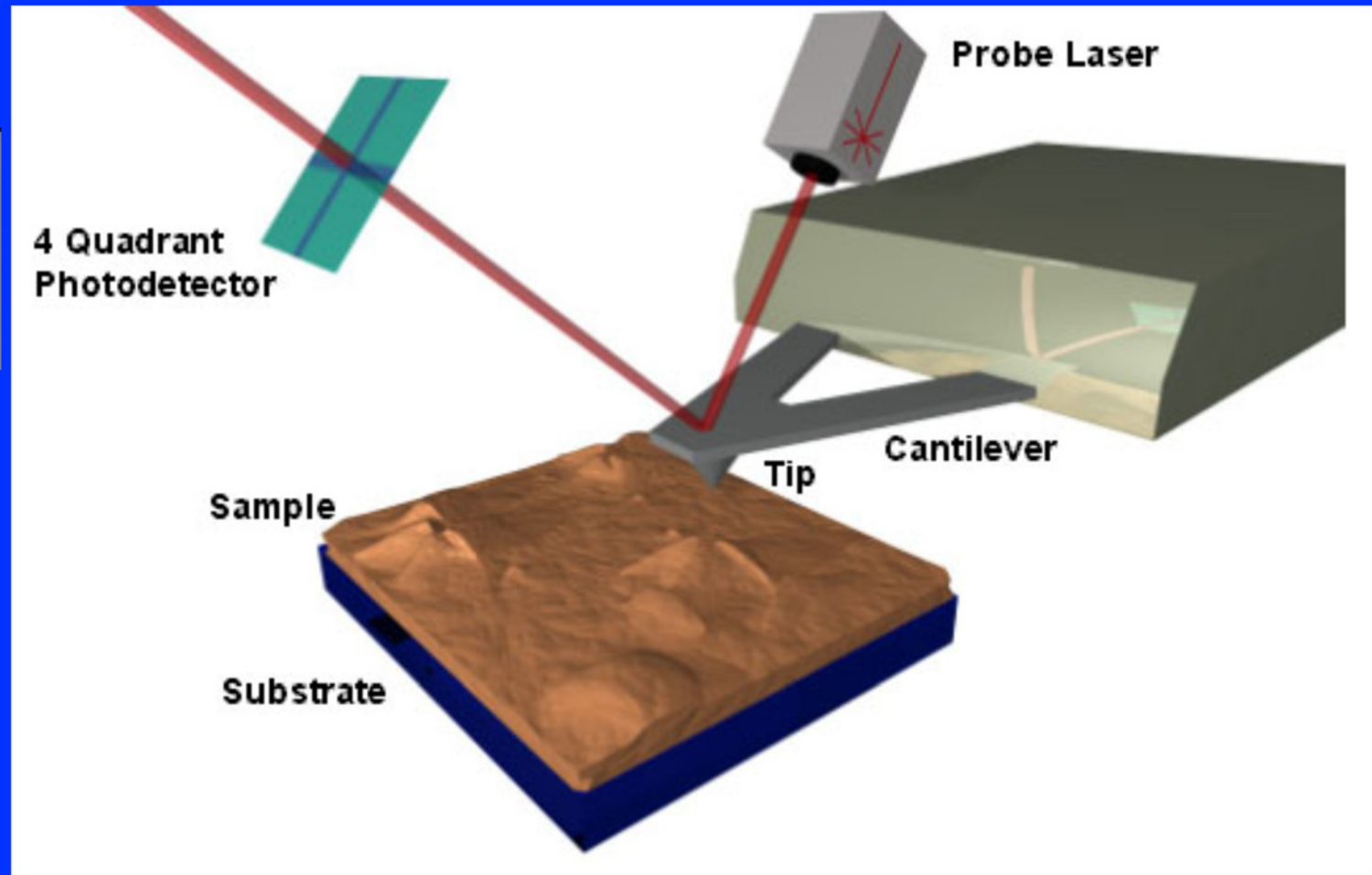
Principio di funzionamento delle microscopie a sonda

Usare il tatto per “vedere” una superficie (non vedente)



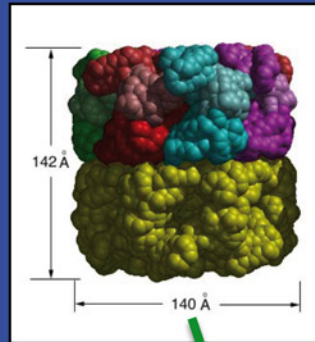
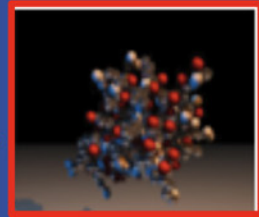
Il microscopio a forza atomica

(Binnig, Gerber, Quate 1985)
Premio Nobel

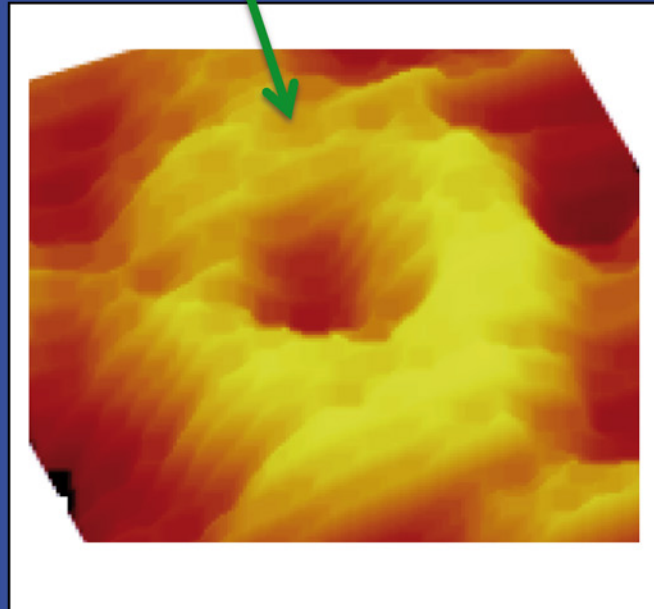


Biomolecule

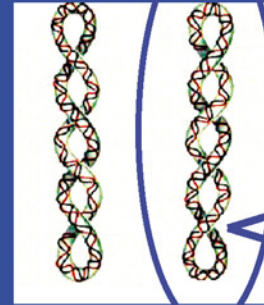
Tripsina su CNT



Chaperonina
GroEL

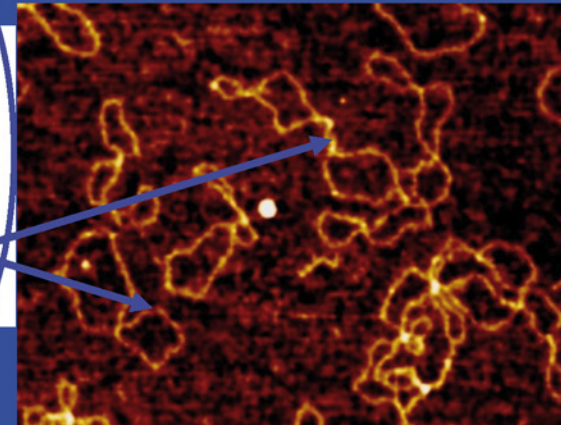


left

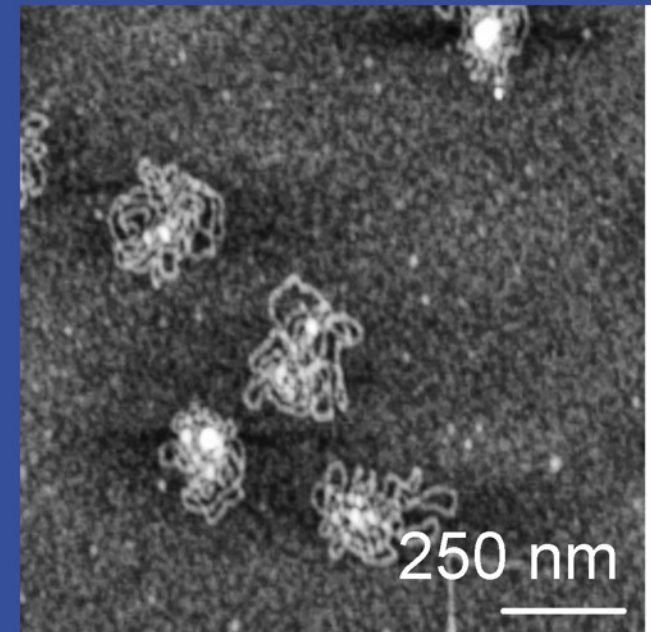


right
handed

DNA

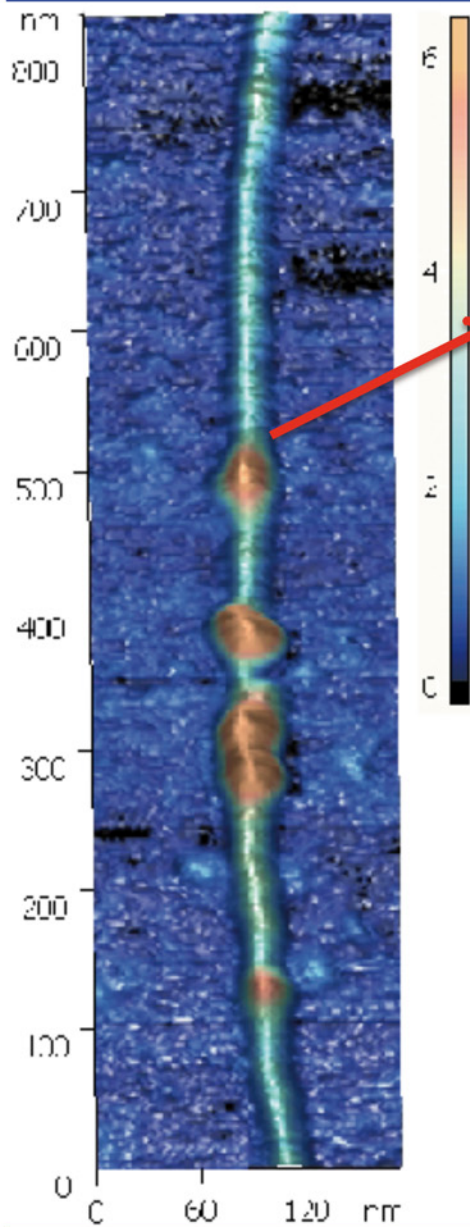


A. Calò



F. Valle

F. Valle

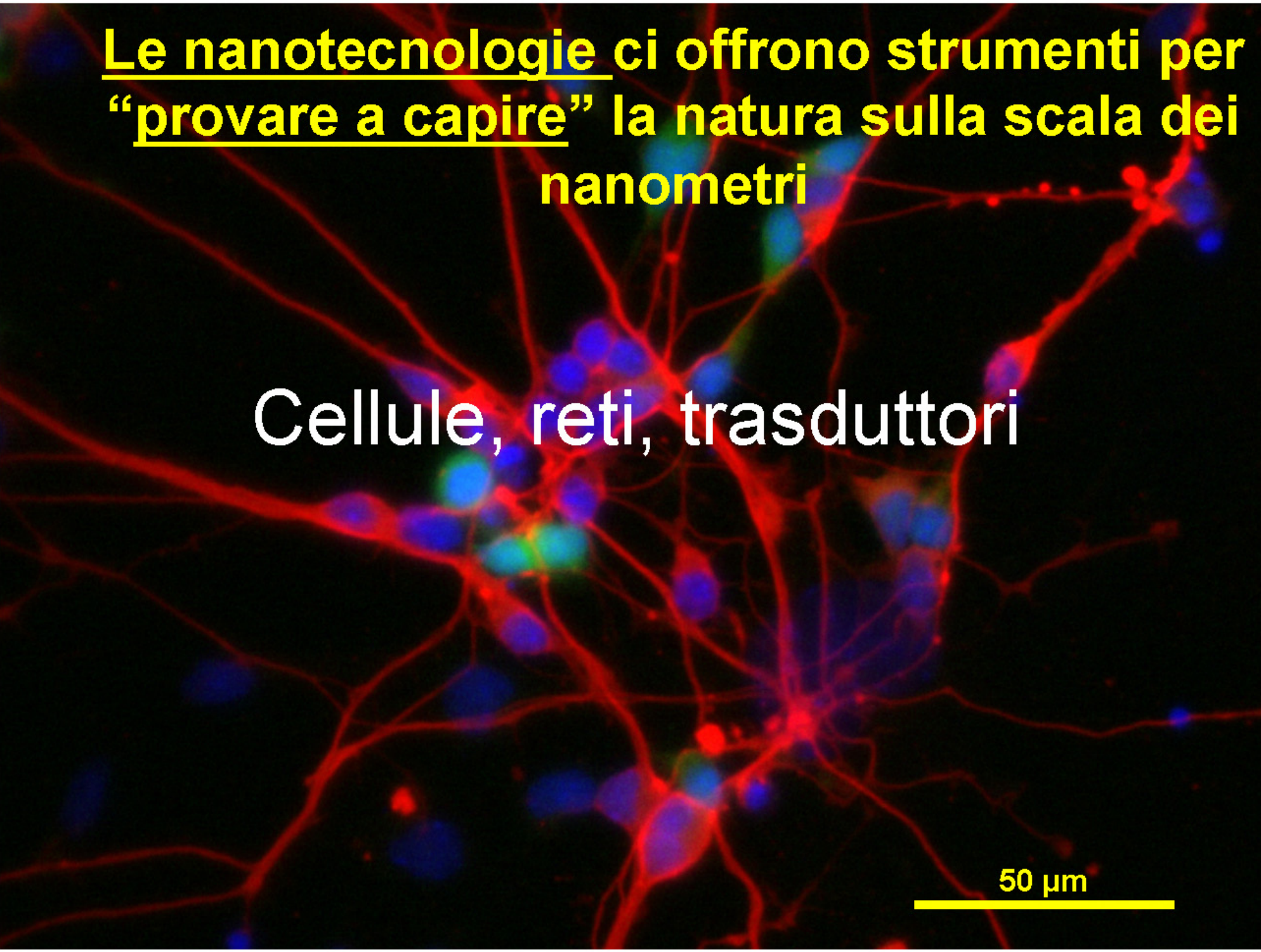


E. Bystrenova

Le nanotecnologie ci offrono strumenti per
“provare a capire” la natura sulla scala dei
nanometri

Cellule, reti, trasduttori

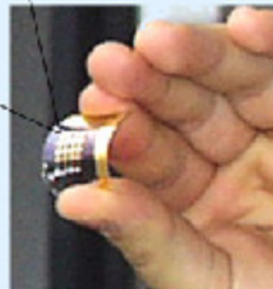
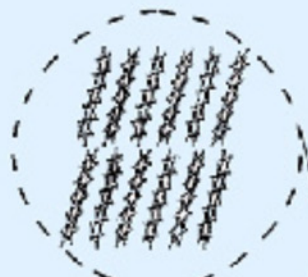
50 μm

A fluorescence micrograph showing a dense network of neurons. The cell bodies (soma) are stained blue, while the extensive branching processes (dendrites and axons) are stained red. The network is highly interconnected, with many fine processes extending across the field of view. A yellow scale bar in the bottom right corner indicates a length of 50 micrometers.

Organic Electronics



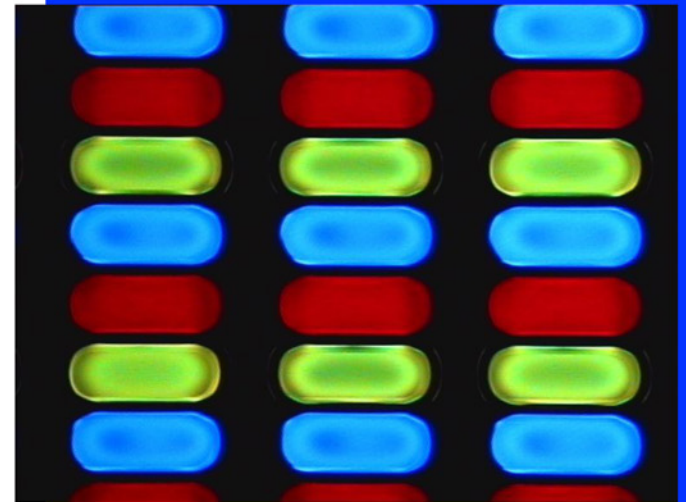
pentacene structure



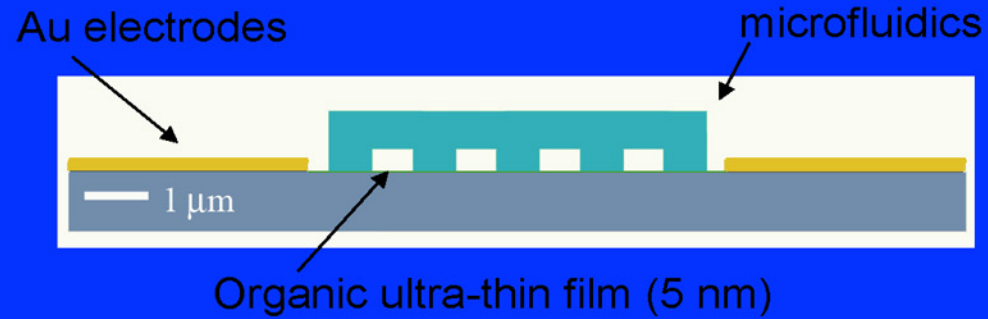
Flexible organic transistors



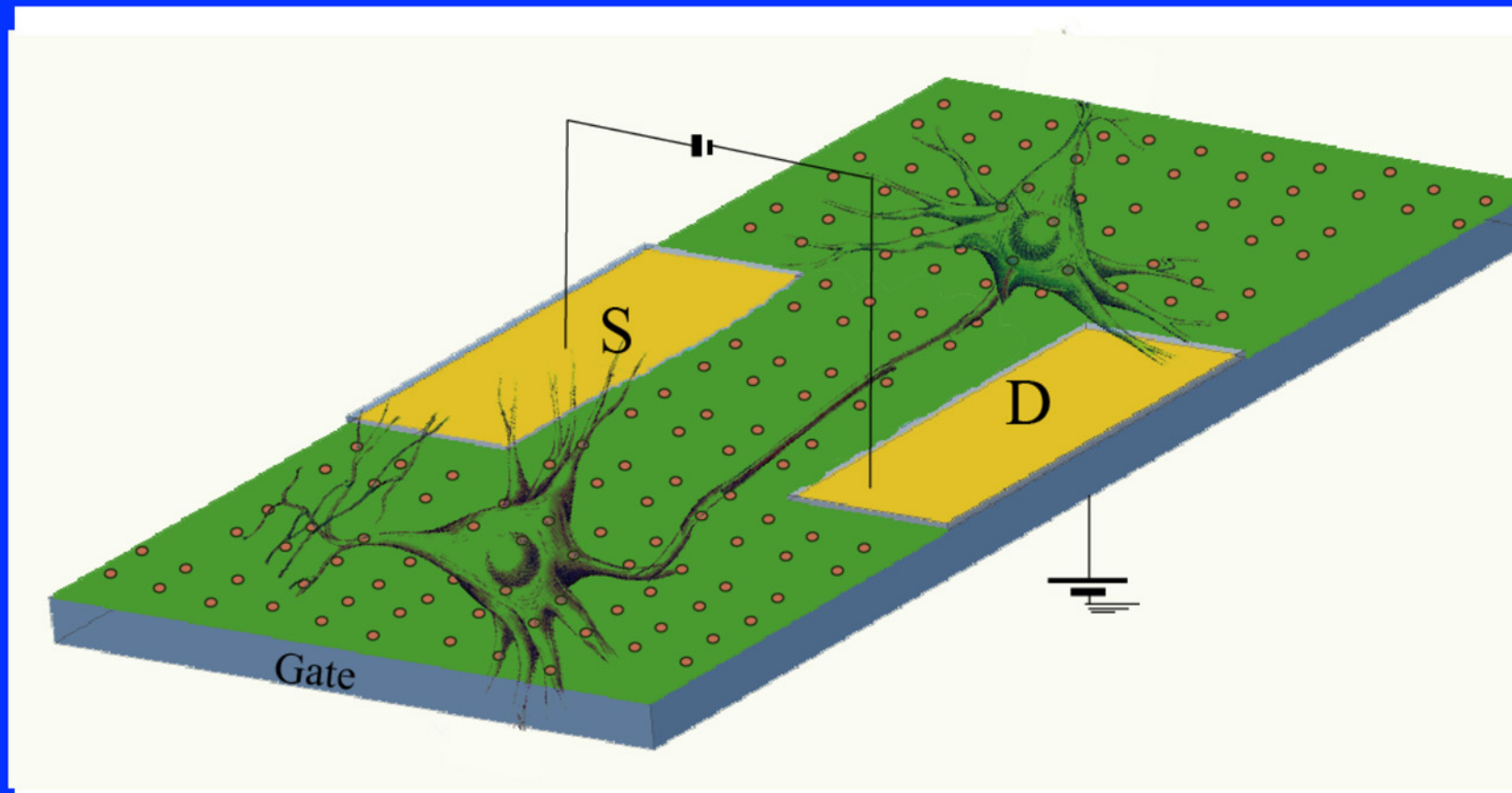
Flexible e-paper



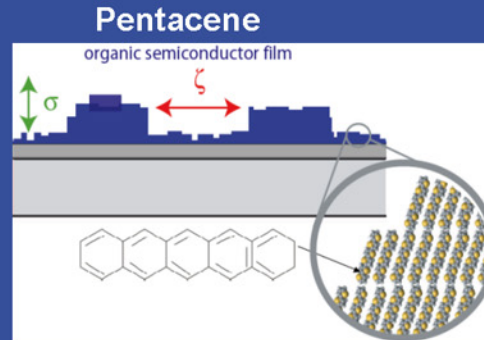
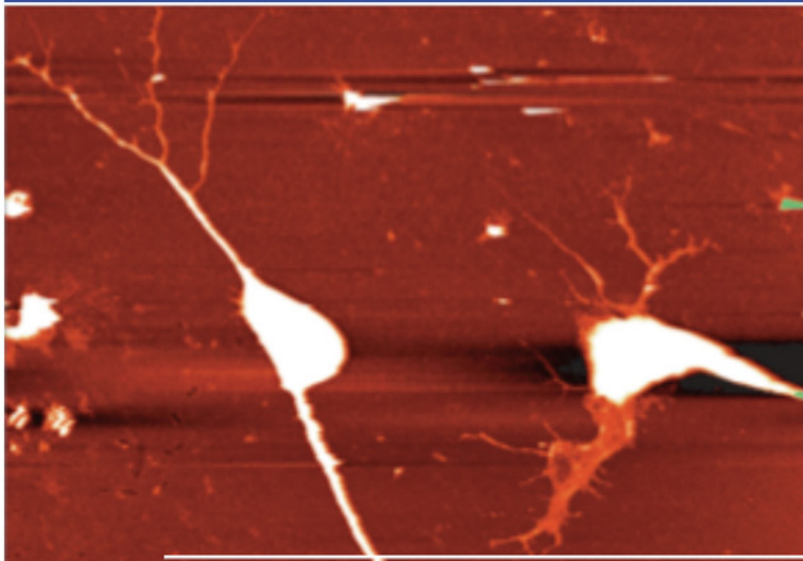
Trasduzione (label free) di segnali cellulari



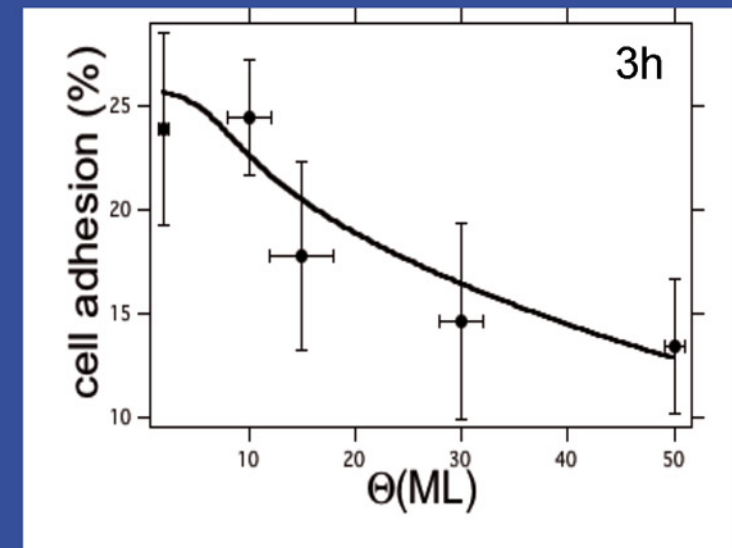
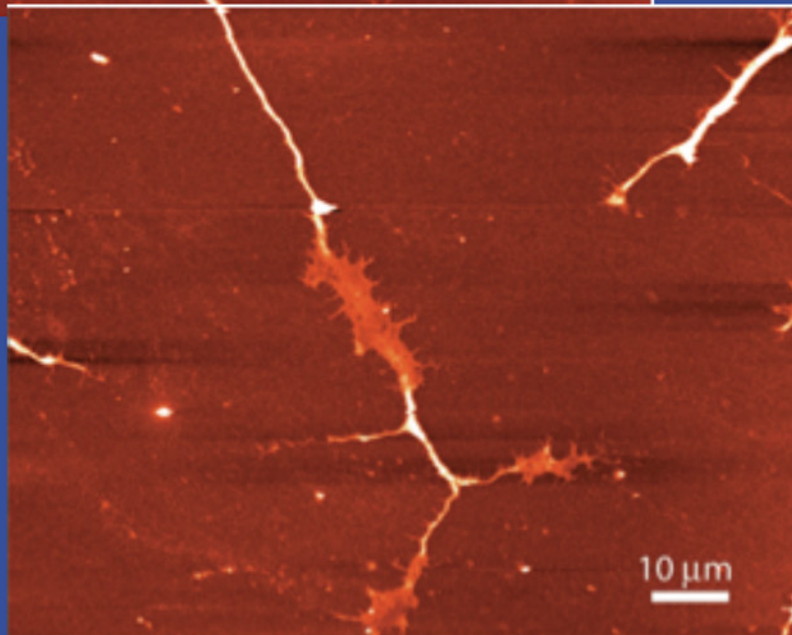
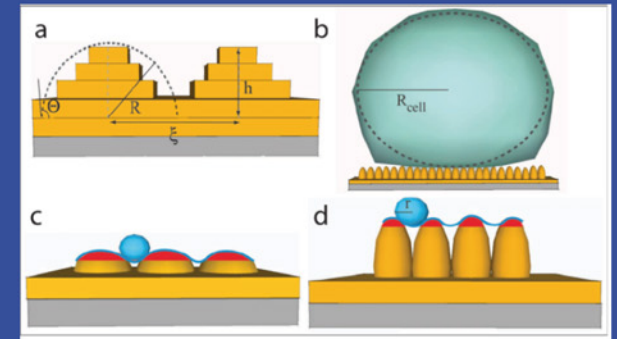
Transistor organico



Neuroni su film ultrasottili di semiconduttore organico



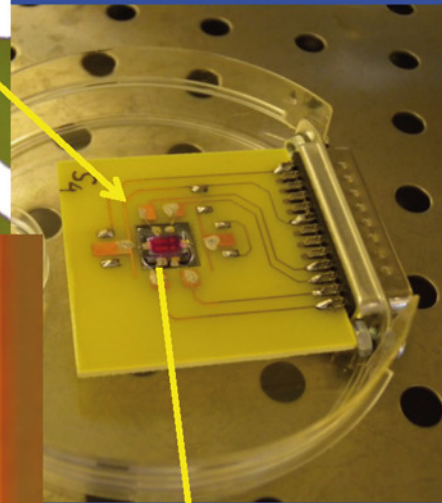
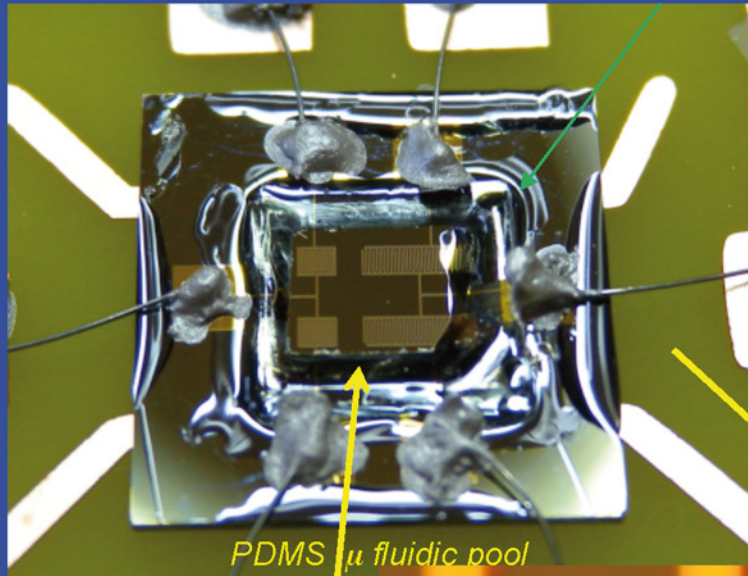
Film Thickness (θ)
(expressed in ML)



I. Tonazzini et al. Biophys. J. 2010

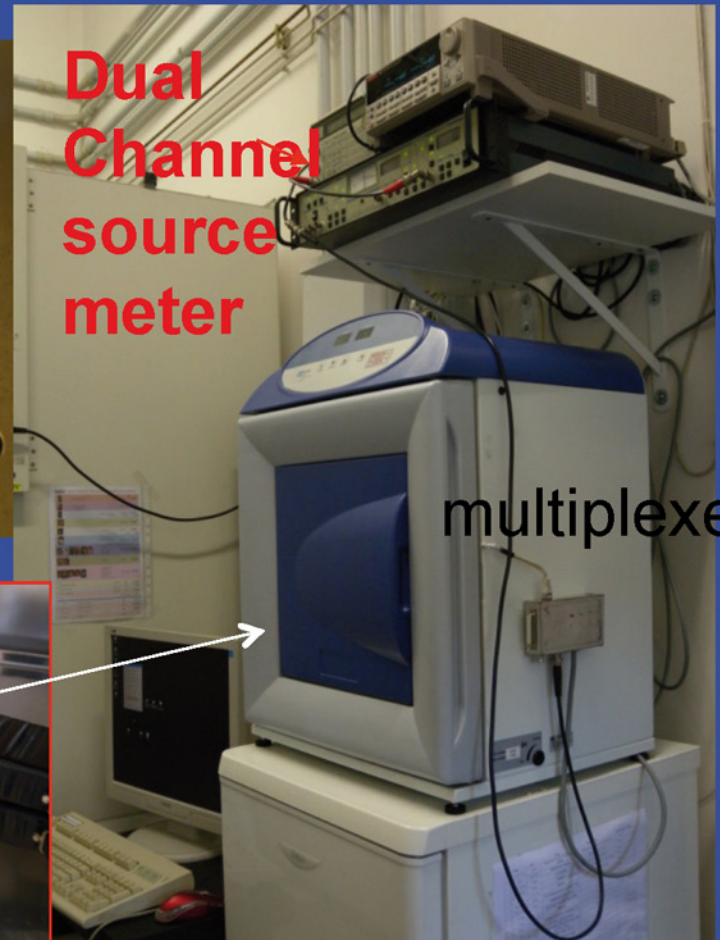
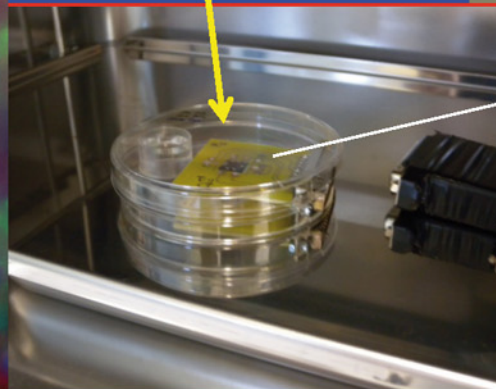
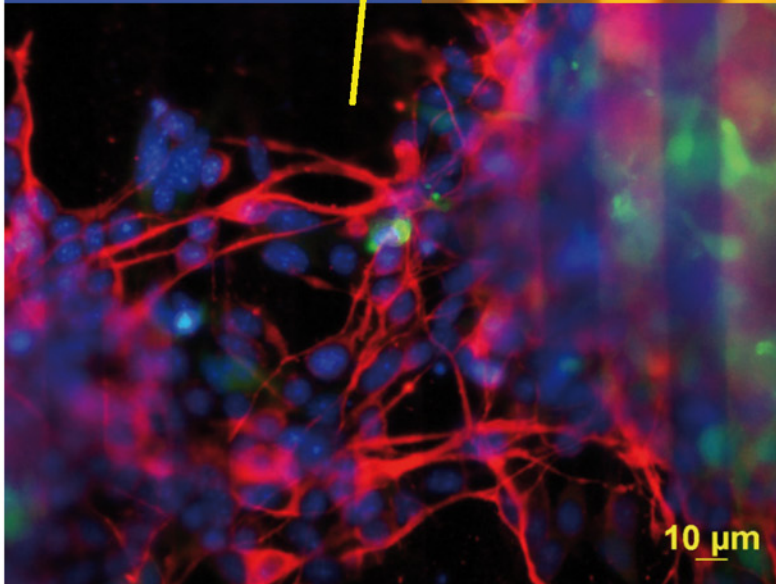
Misura dei segnali da cellule staminali differenziate

- controlled humidity
- controlled temperature
- controlled CO₂
- in situ el. measurement



Dual
Channel
source
meter

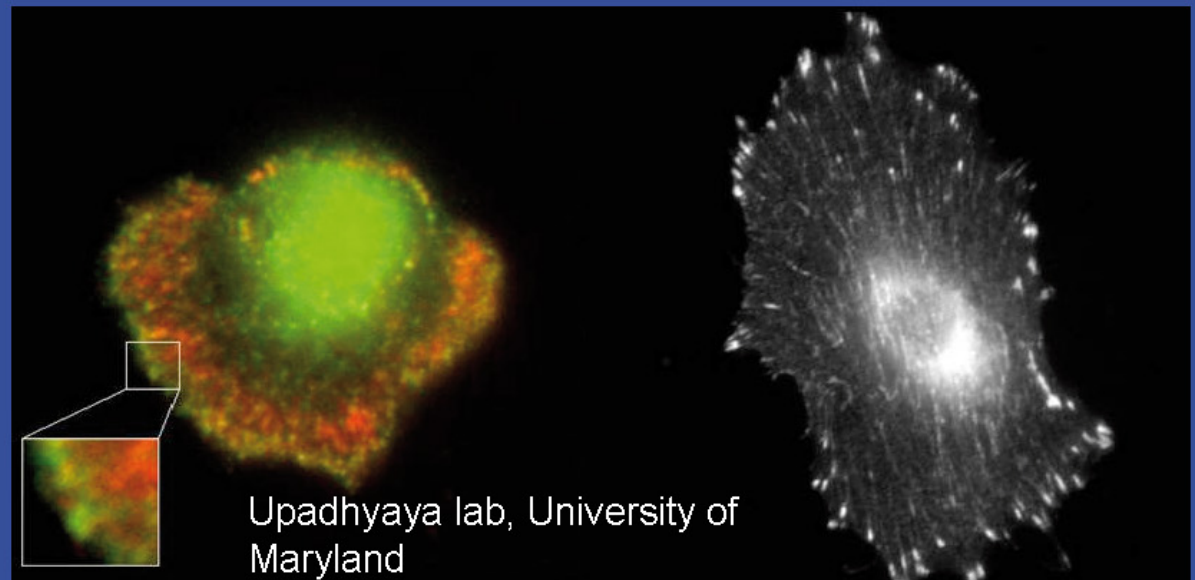
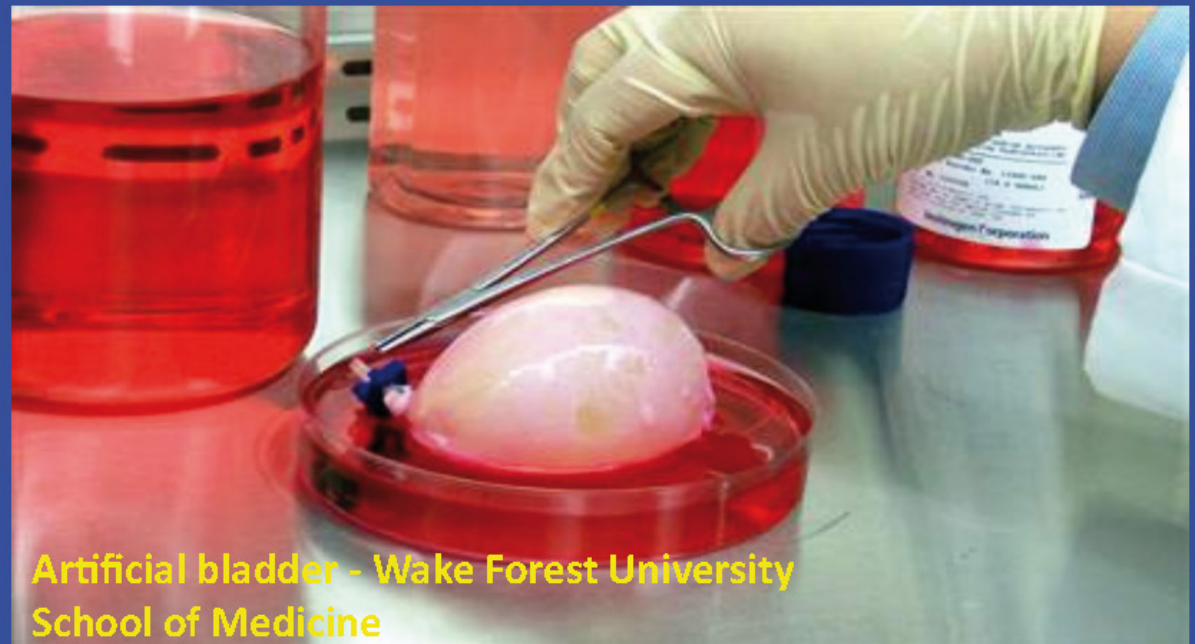
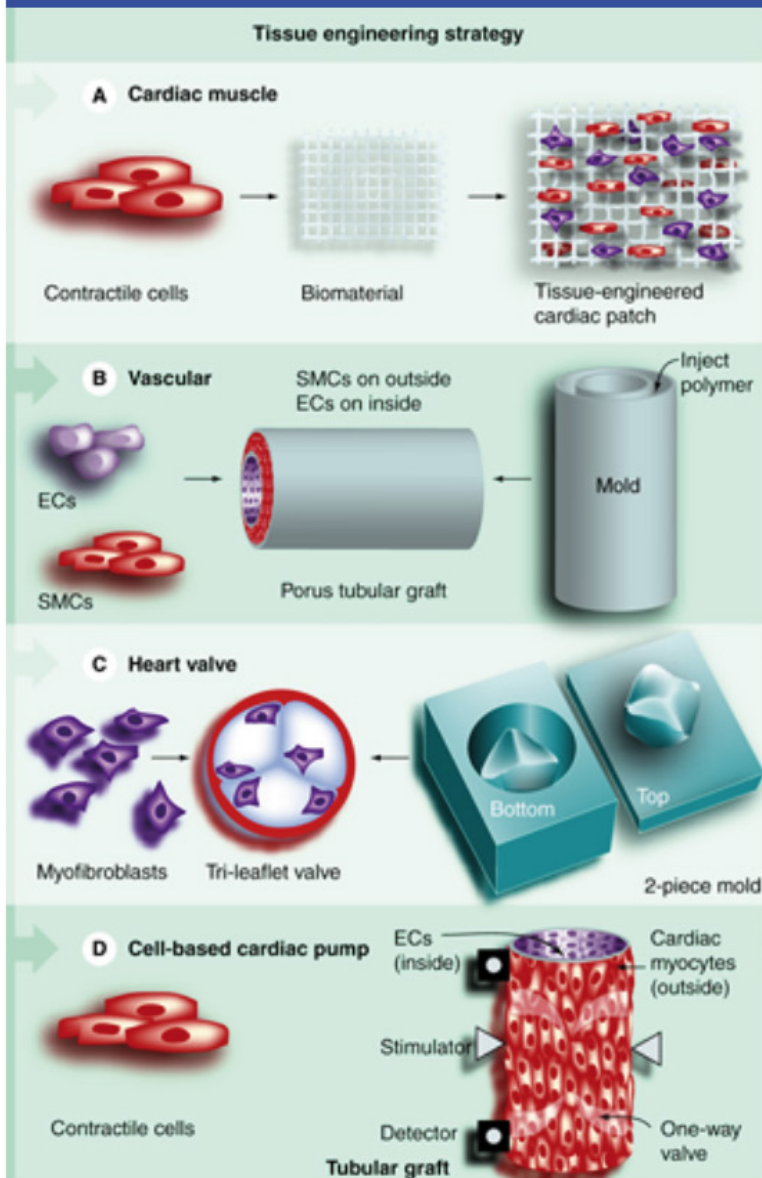
multiplexer



Le nanotecnologie ci offrono strumenti per
“controllare” la natura su molte scale



Controllo dell'adesione cellulare è importante in medicina rigenerativa

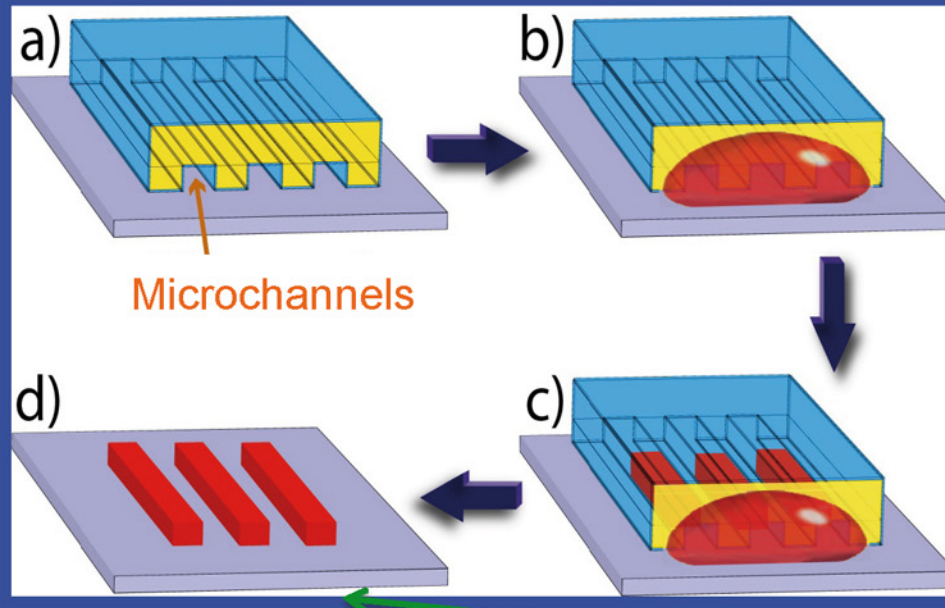


Patterning di materiali per controllare il destino delle cellule

Proprietà generale	Topografia	Meccanica	Chimica
Segnale fornito	Morfologia superficiale, rugosità	Durezza, elasticità	Proteine di adesione e fattori di crescita
Strategia	Superfici micro e nano strutturate 	Modulazione della elasticità locale 	Patterning con “soft lithography” 

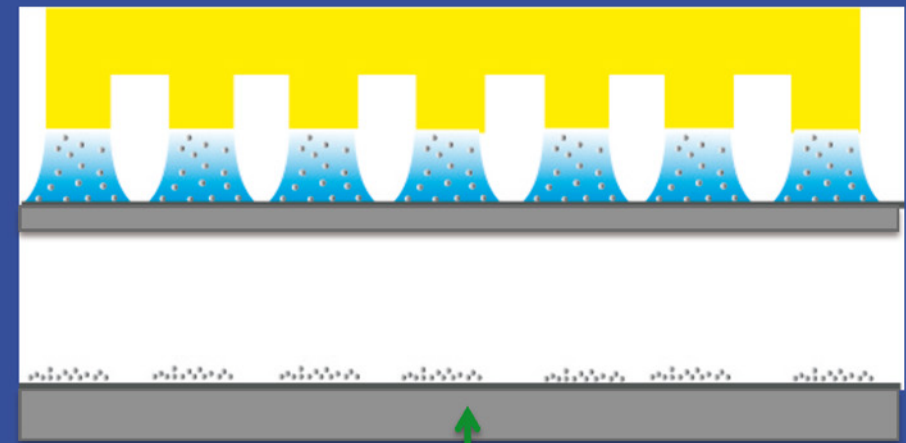
Soft-lithography per il patterning di proteine e stimoli chimici/topografici

MIMIC: Micro Molding in Capillaries



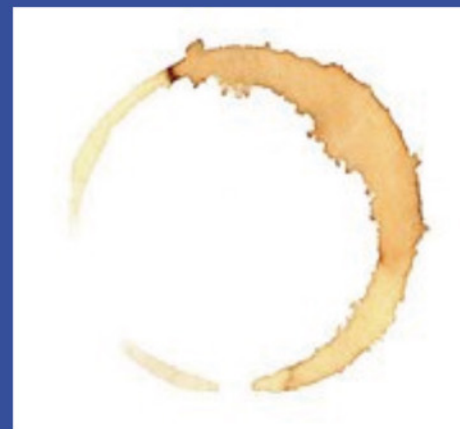
Y. N. Xia & G. Whitesides, Angew. Chemie 1998

LCW: Lithographically Controlled Wetting



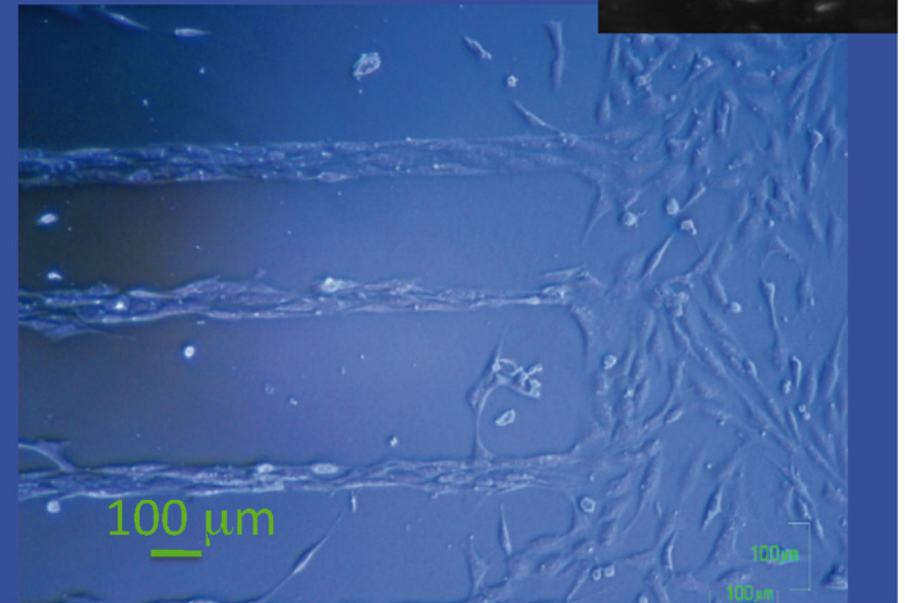
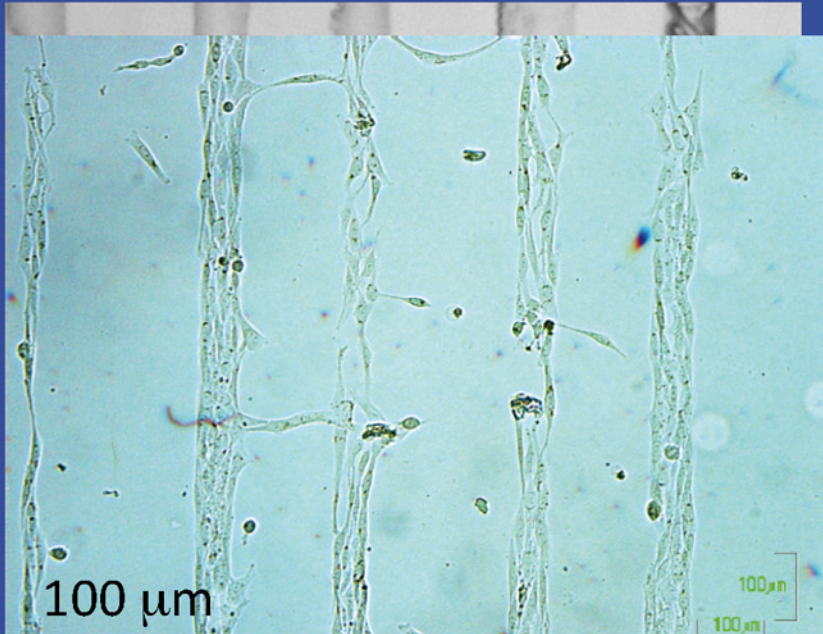
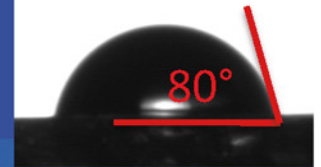
Patterned solute

M. Cavallini & F. Biscarini, Nano Letters 2003

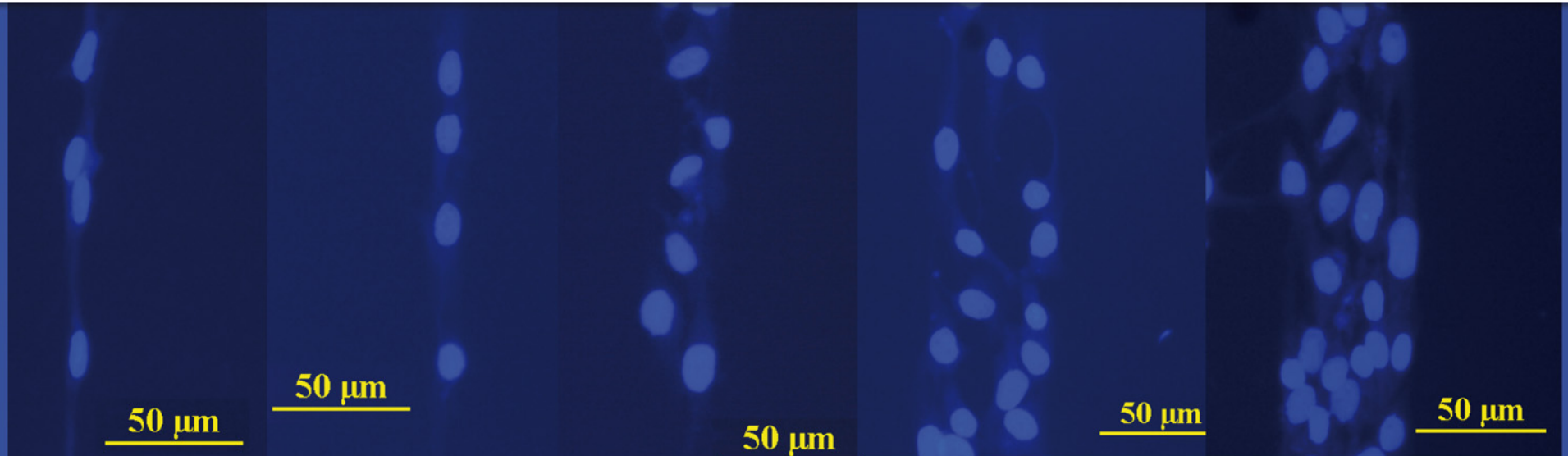


Glial cells grown on patterned polystyrene well

Cell growth after 6 days



Il numero di cellule dipende dalla larghezza delle strisce



Immuno staining images: nuclei marker Hoechst 33342



Nanotecnologie dei Materiali Multifunzionali @ CNR

