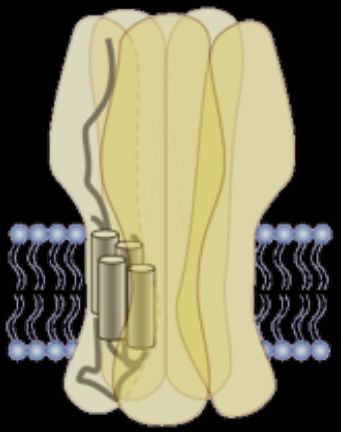
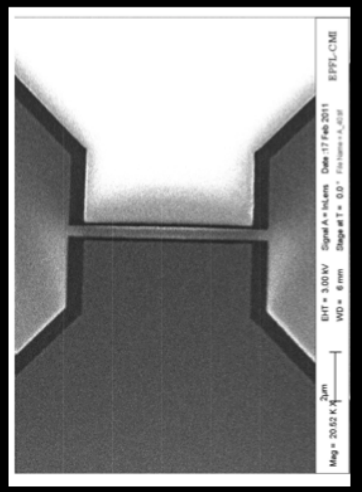
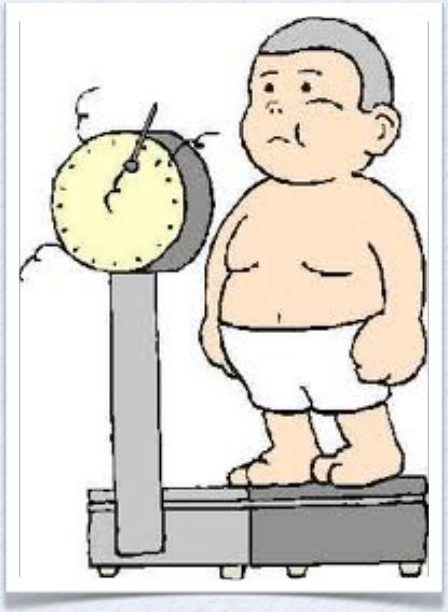
From biology to NEMS: the importance of new sensor developments



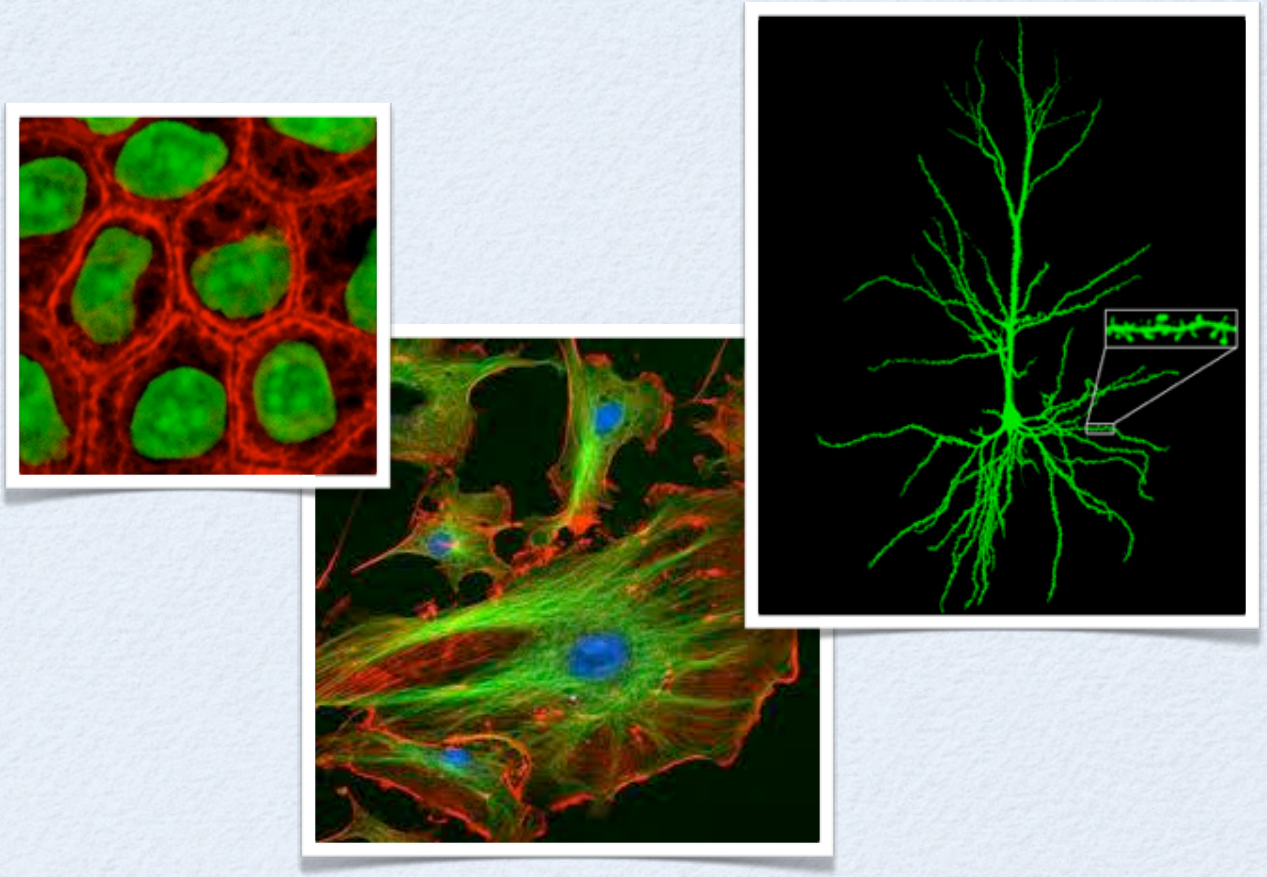


D. Bertrand
HiQScreen Sàrl

The human body

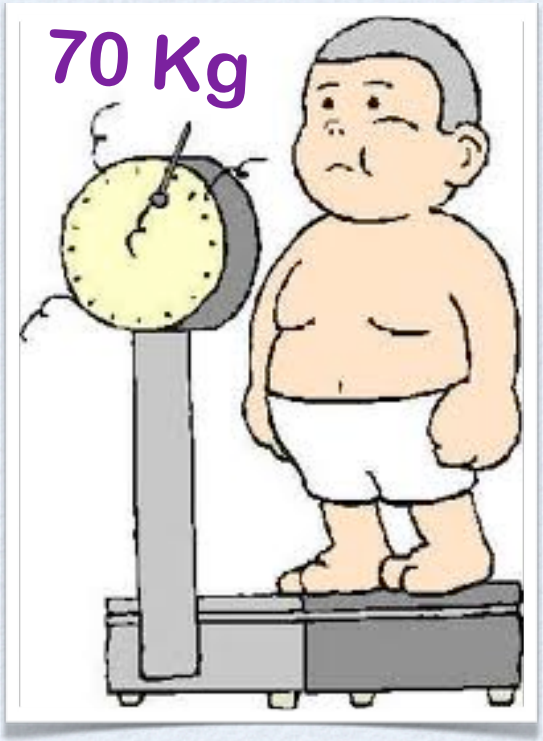


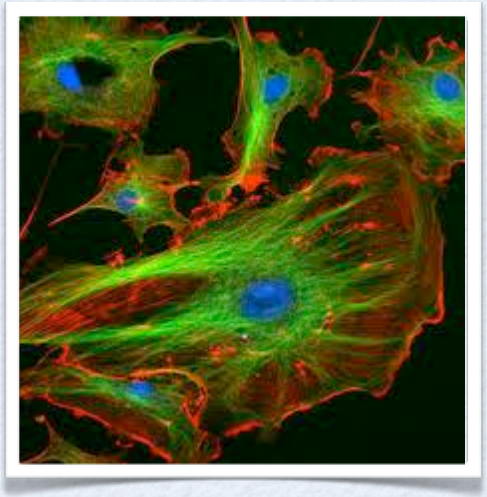
70 Kg



is composed of about 10^{14} cells with different shapes and functions

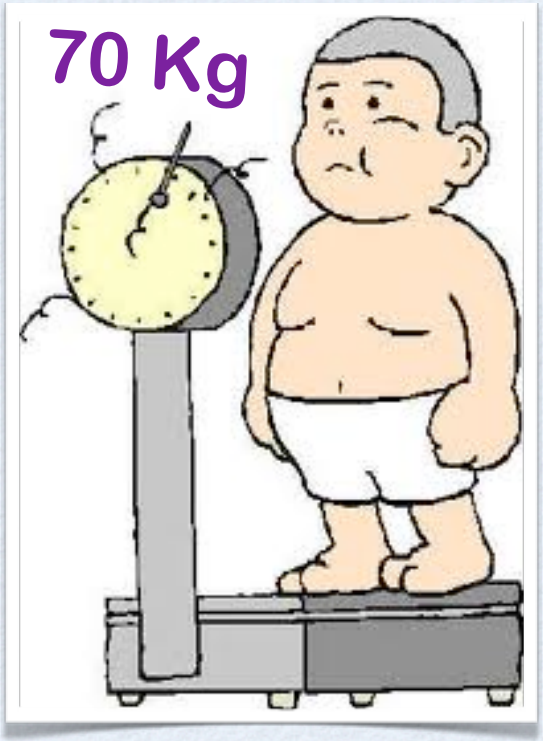
Importance of scale

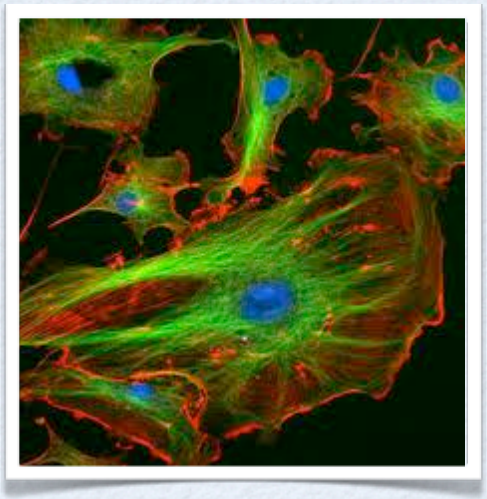




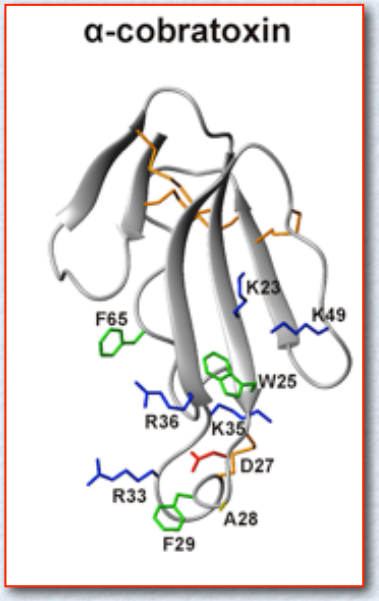
10^{-9}g

Importance of scale

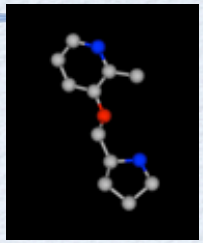




10^{-9}g



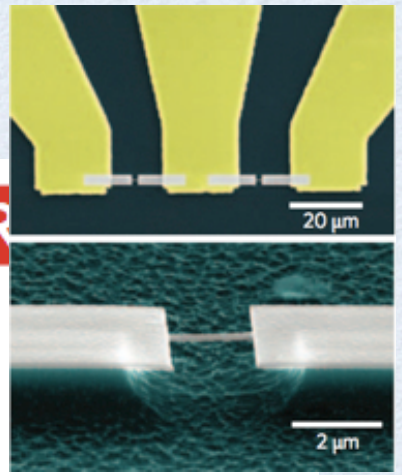
8 KDa
$1.3\ 10^{-17}$ g



10^{-21} g
zeptog

A proof of feasibility

Measurements in vacuum



NATURE NANOTECHNOLOGY DOI: 10.1038/NNANO.2009.152

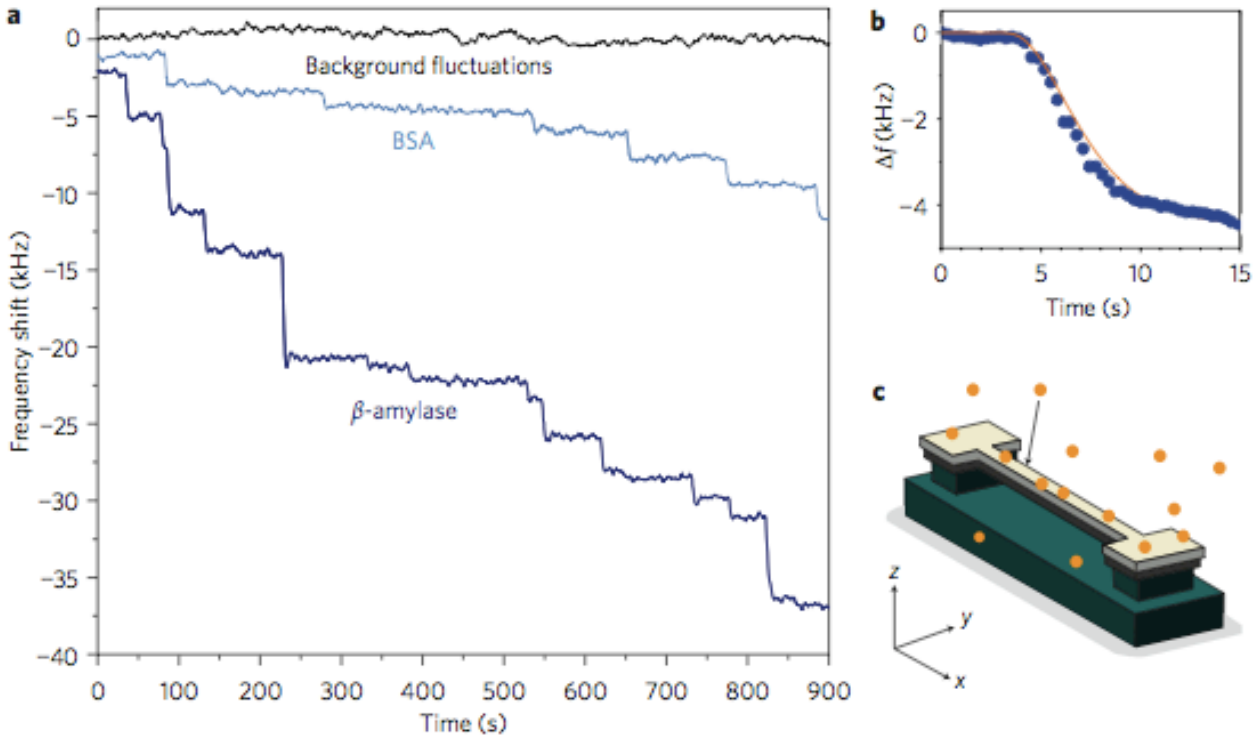
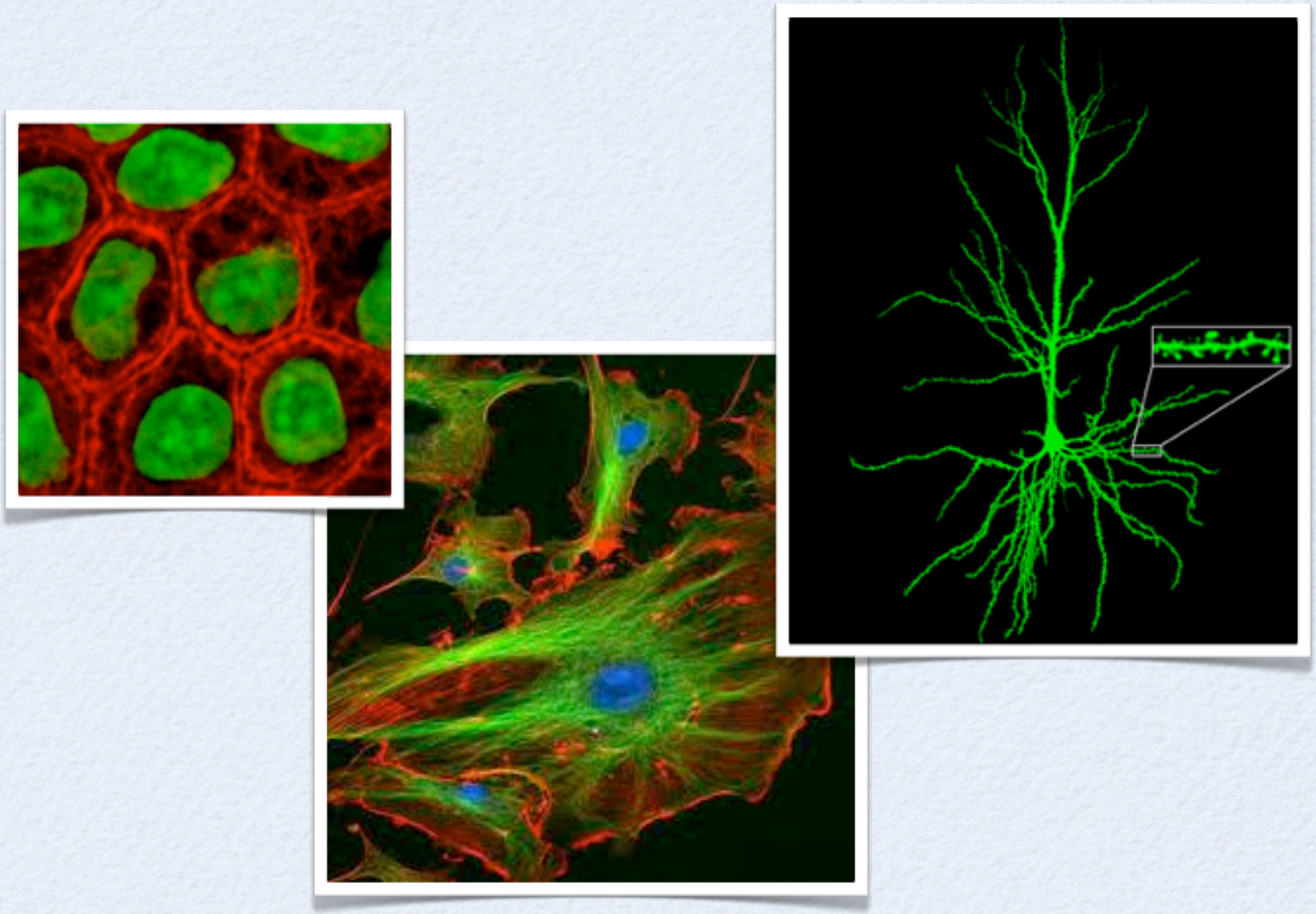


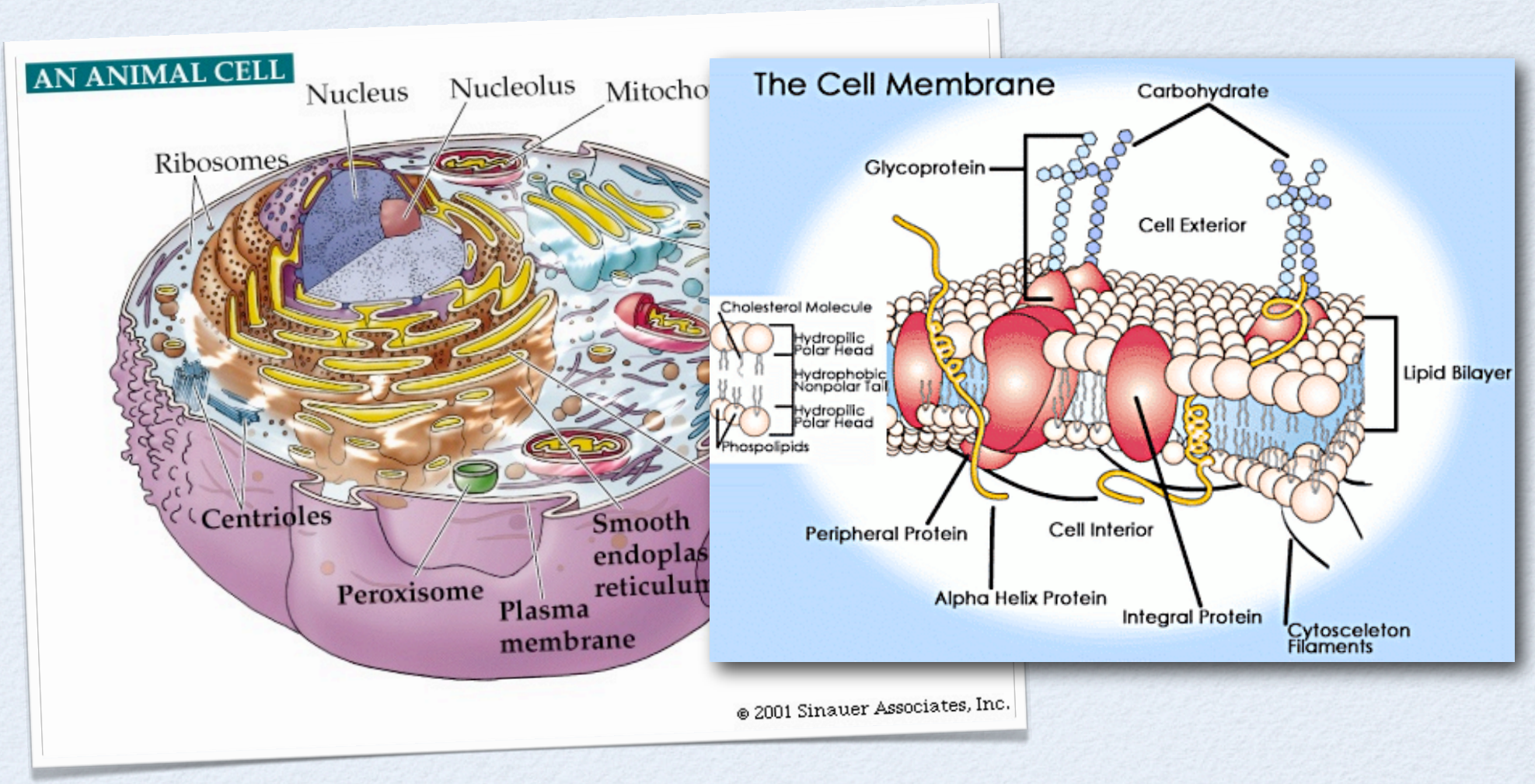
Figure 2 | Real-time records of single-molecule adsorption events on a NEMS mass sensor. a, These raw experimental data show the distinctly different,

Cell biology

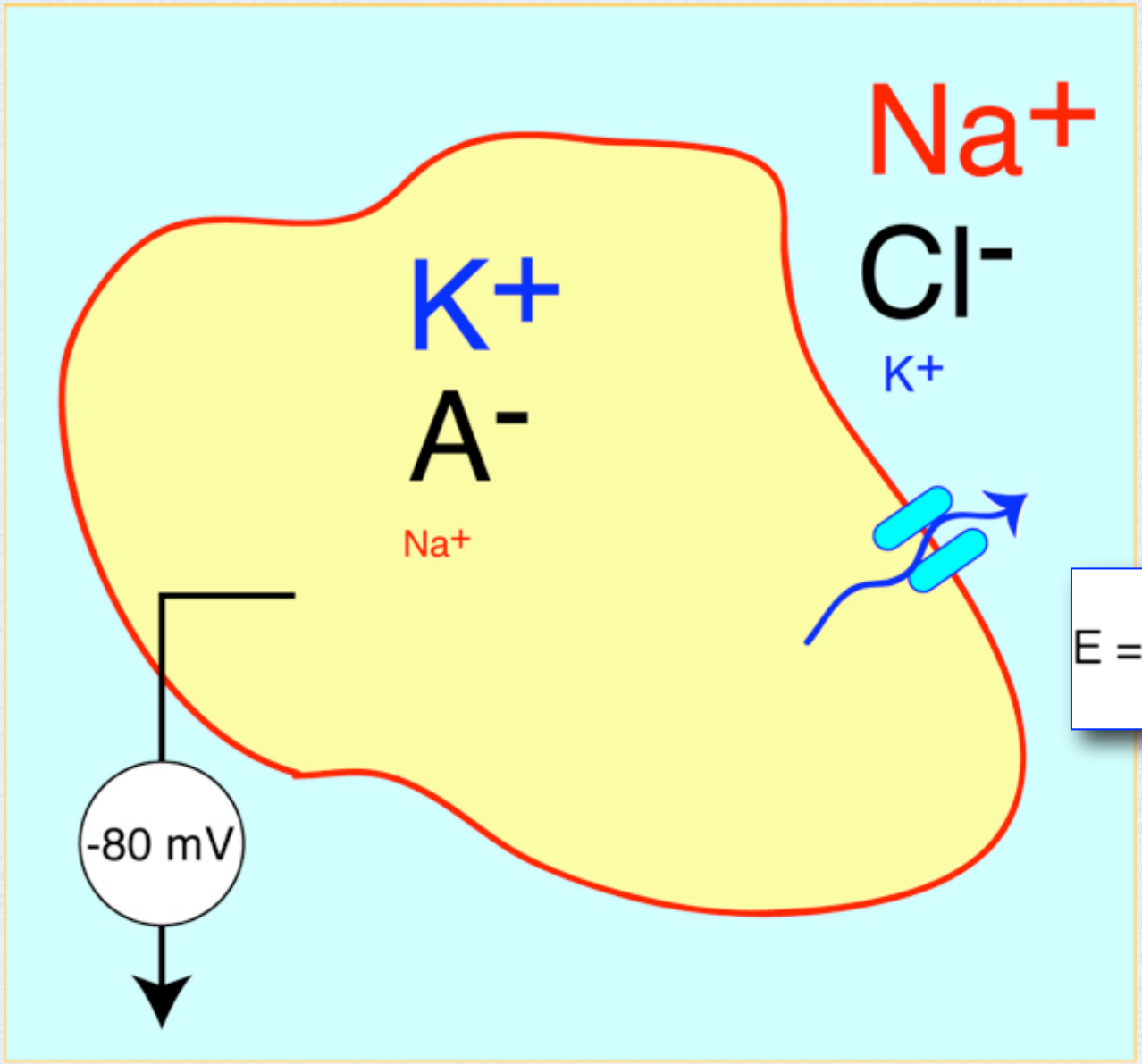


Cells are composed of at least 60 % water

The cell properties

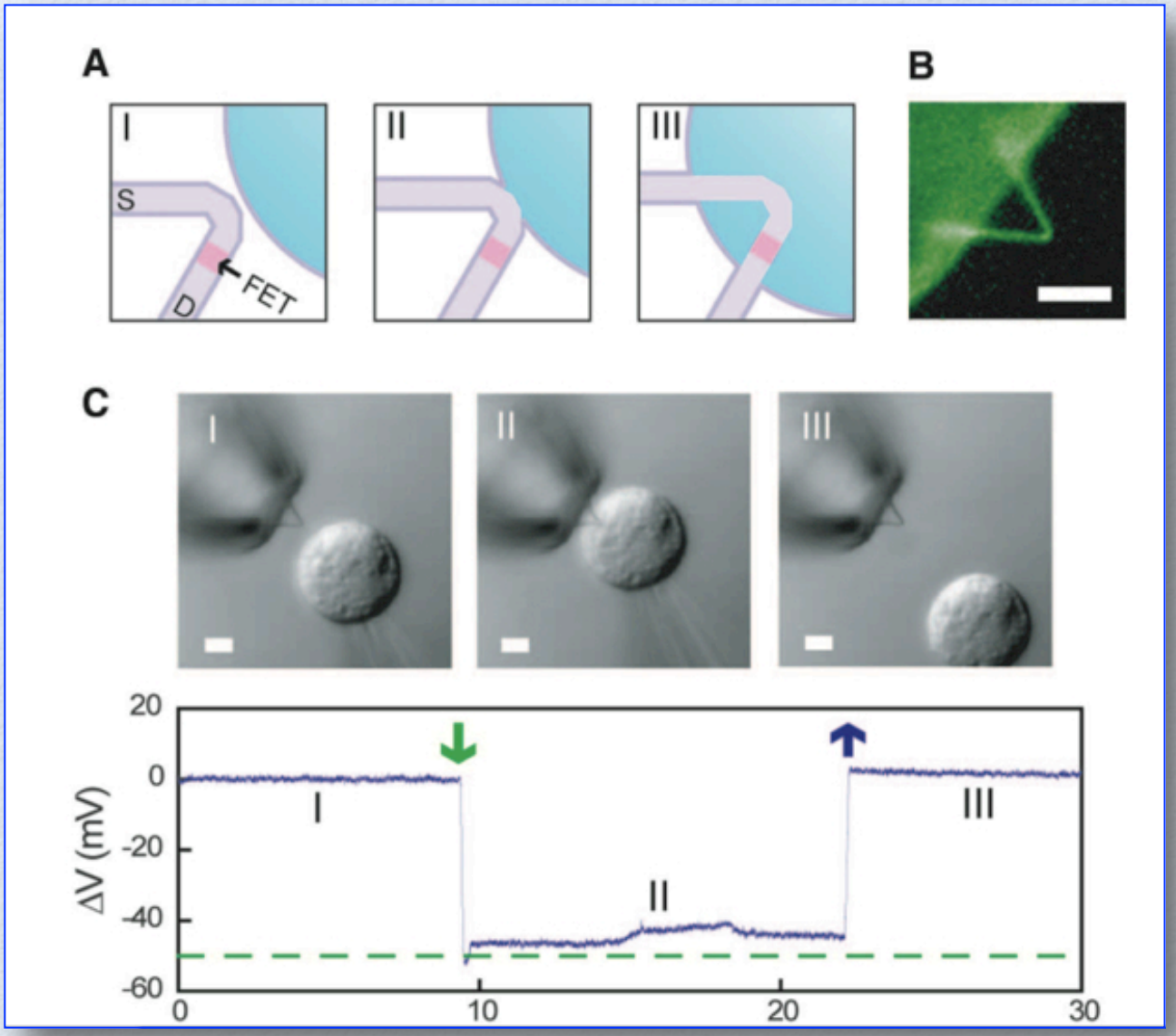


Physiological Properties of a Cell



$$E = \frac{RT}{ZF} \log \frac{[Ke]}{[Ki]}$$

Nano Scale Field Effect Transistor



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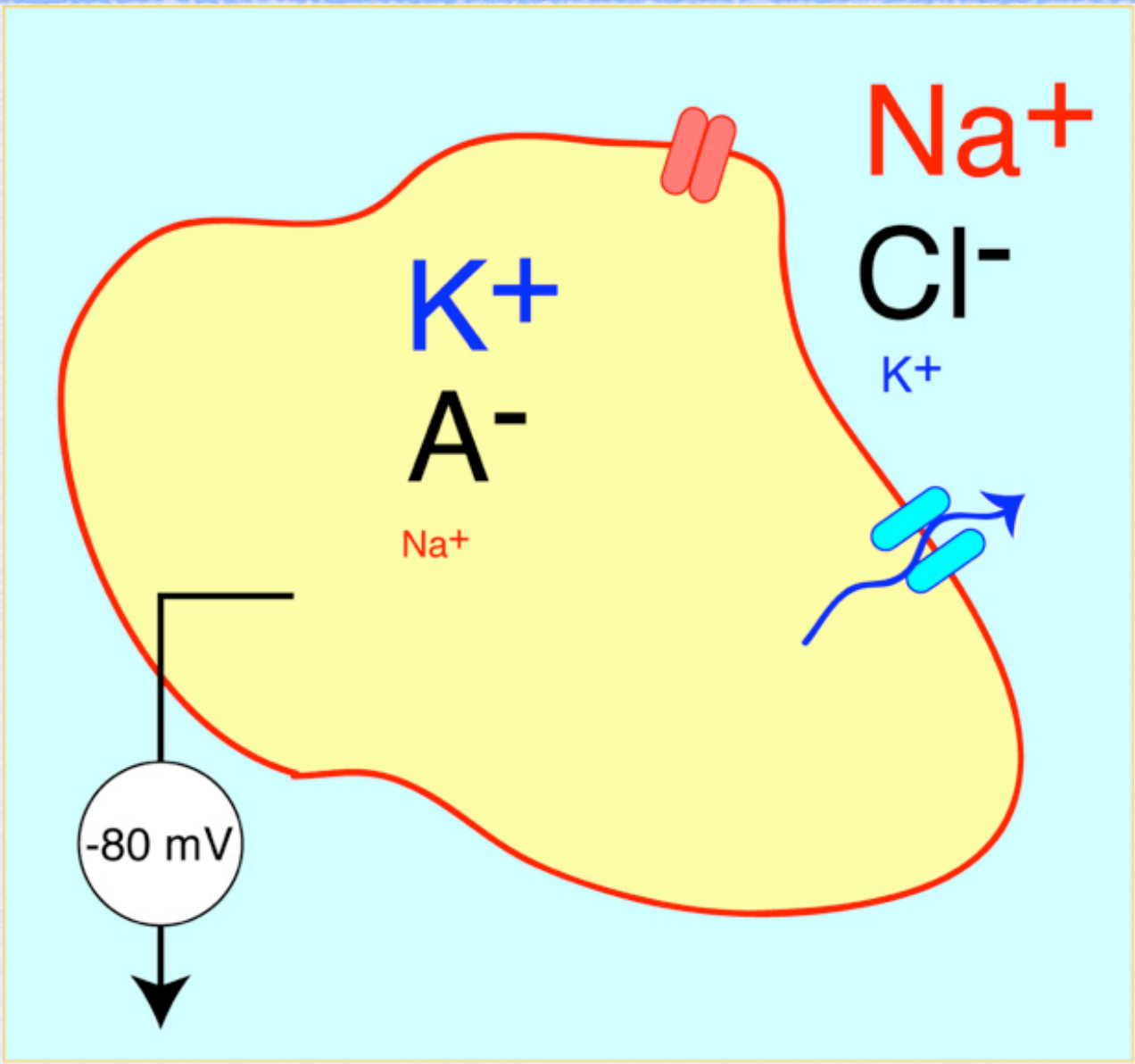
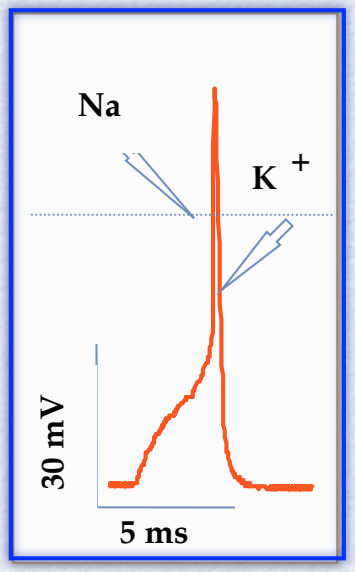
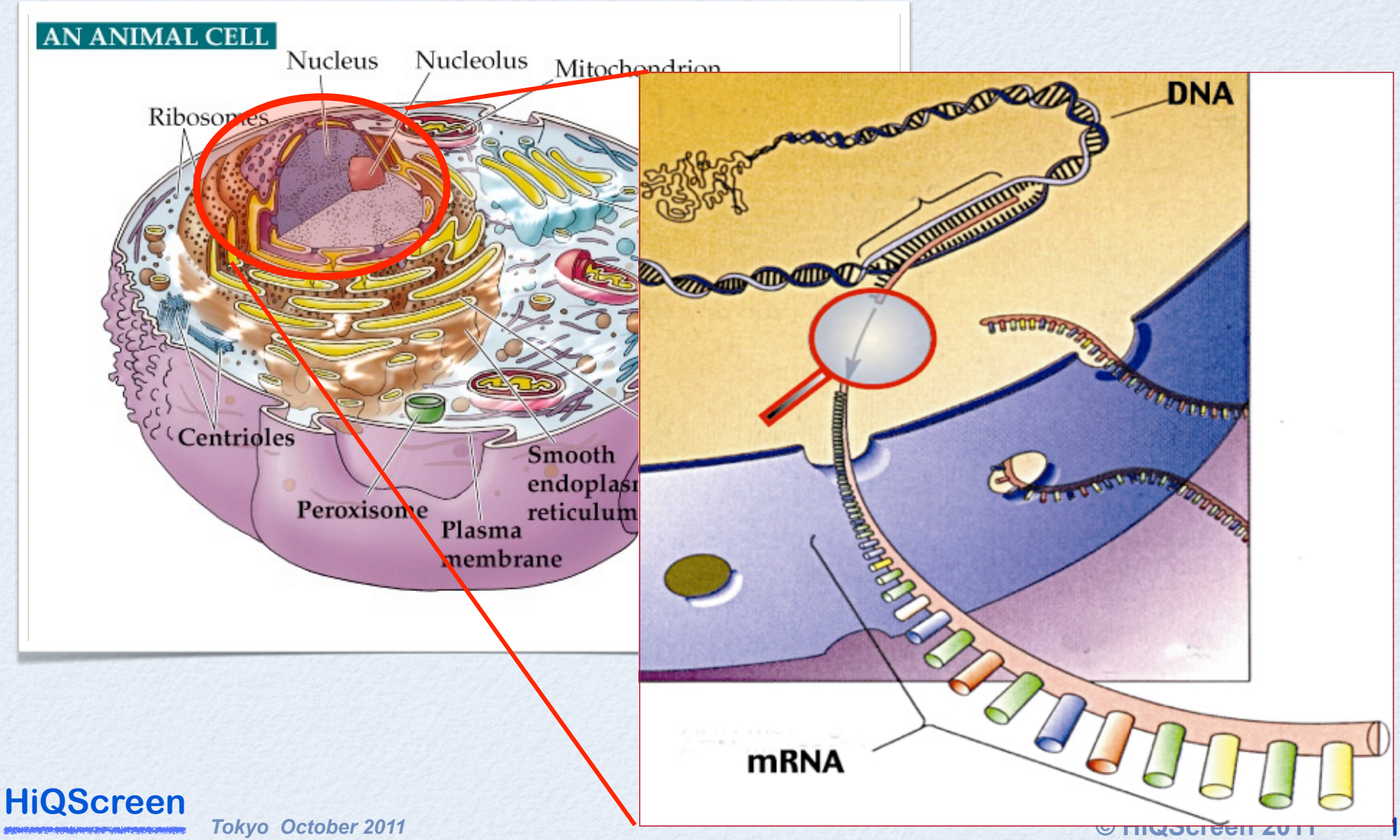
The electrical activity of a cell





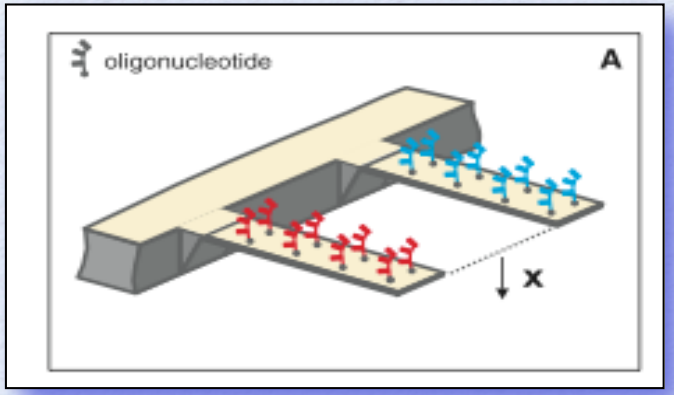
the action potential

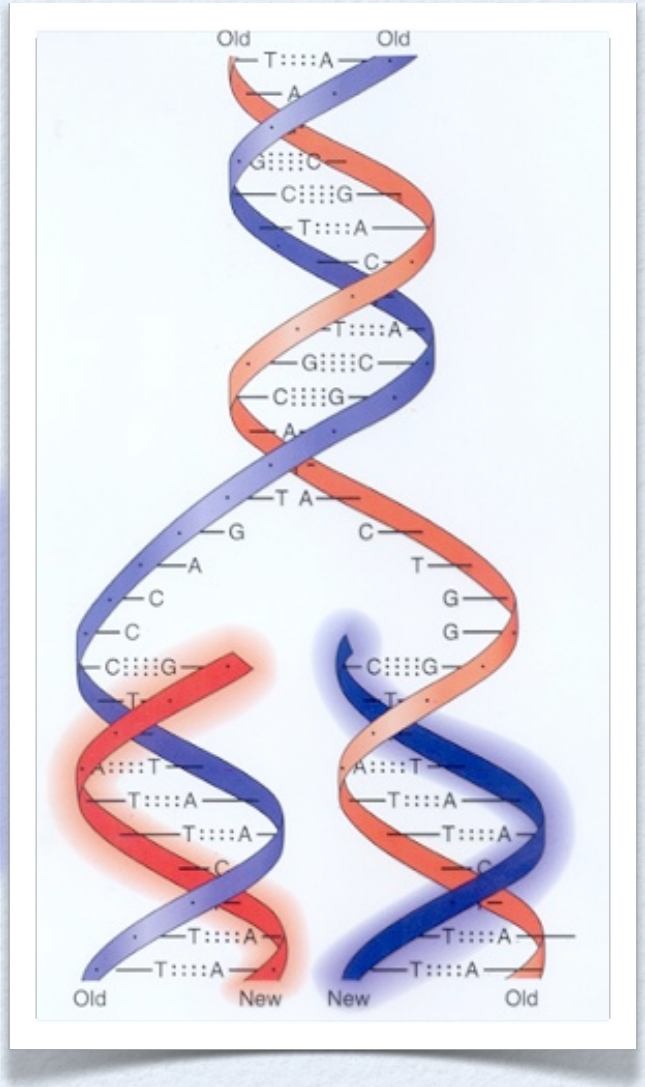
The cell properties

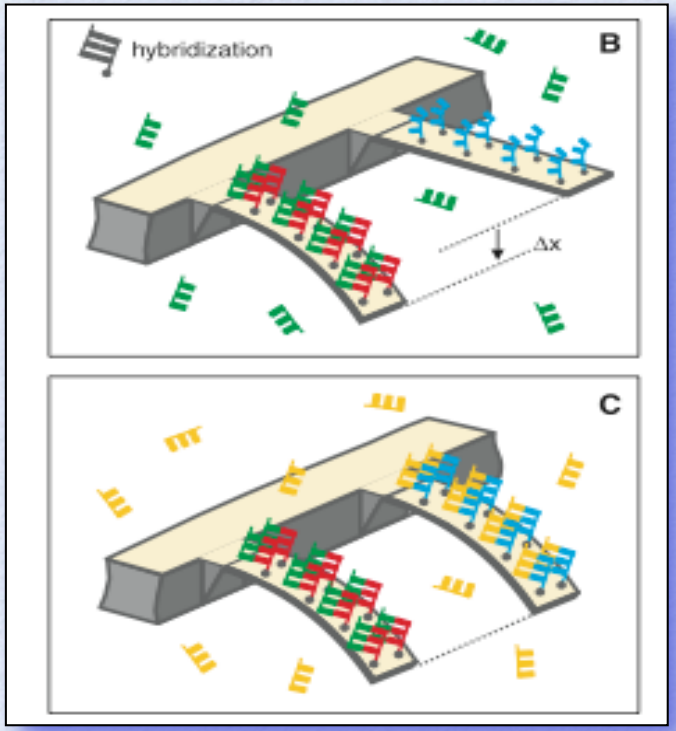


DNA detection

Static measurements in vacuum







DNA detection

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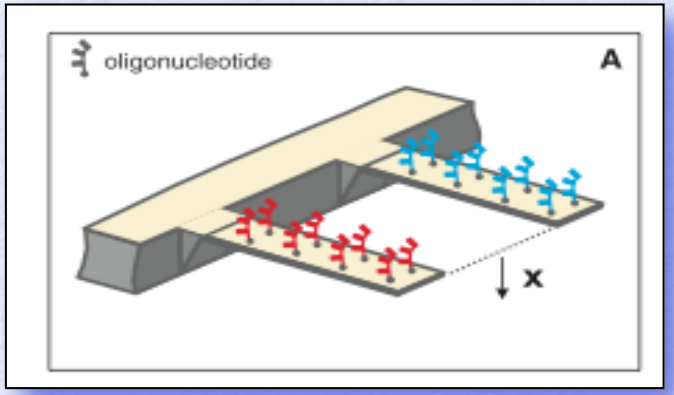
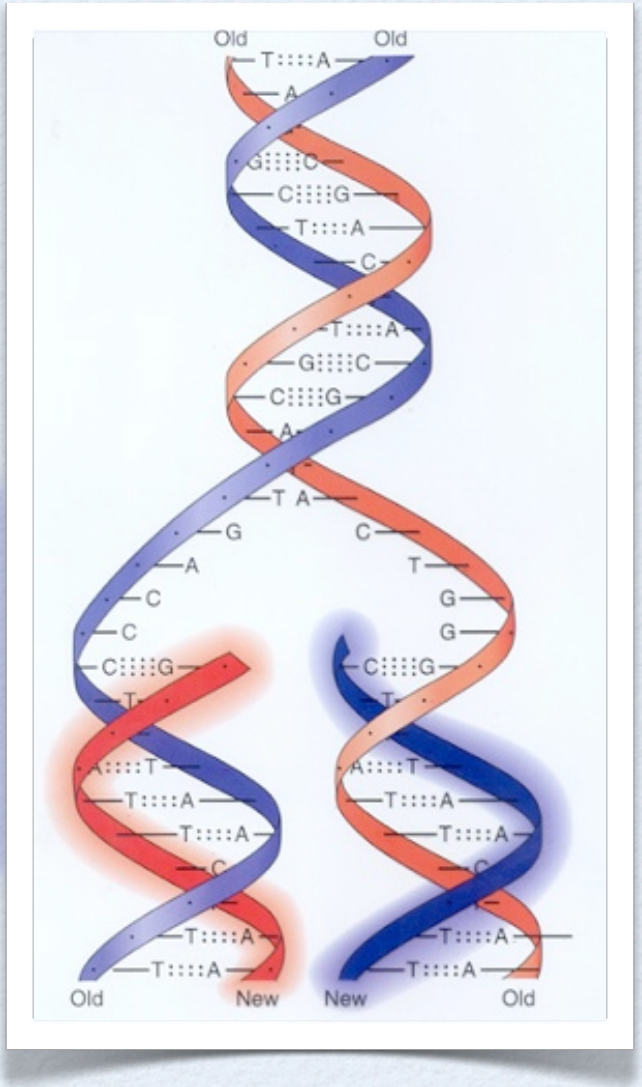
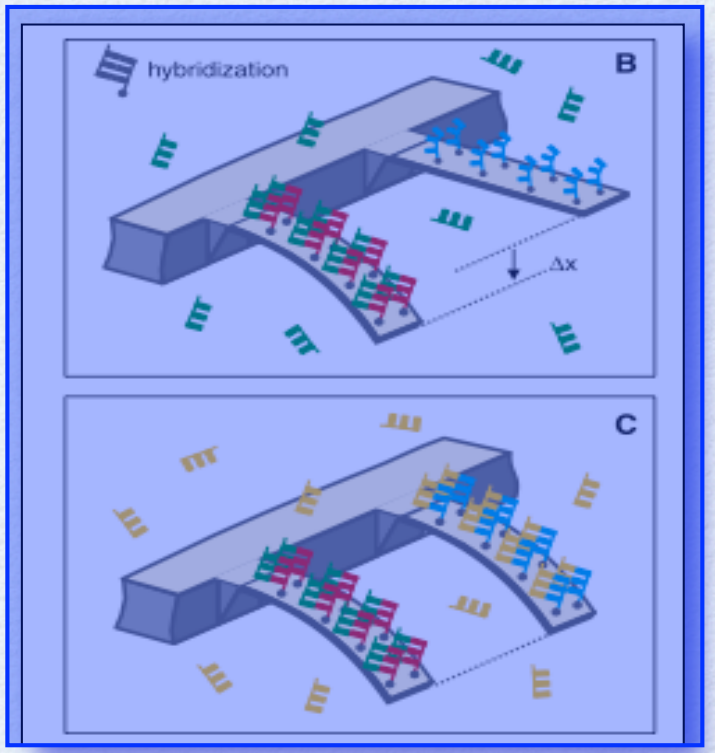




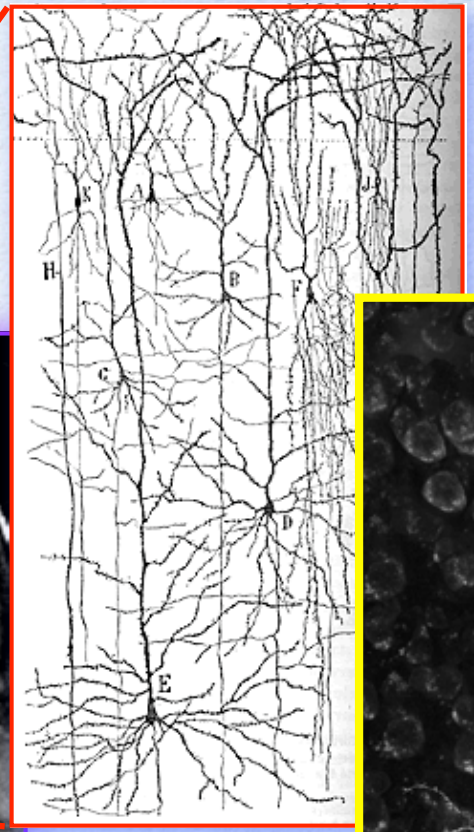
Dynamic measurements in liquid



The neurobiology of the brain

Brain

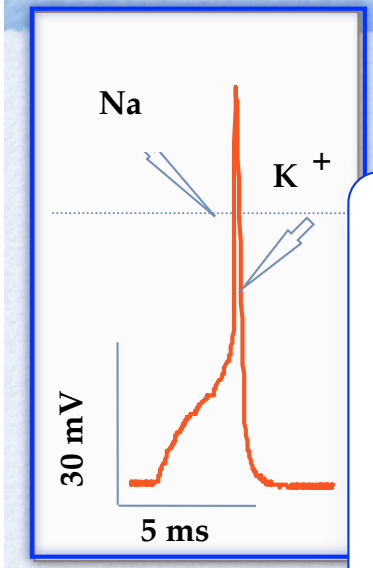
cortex and white matter



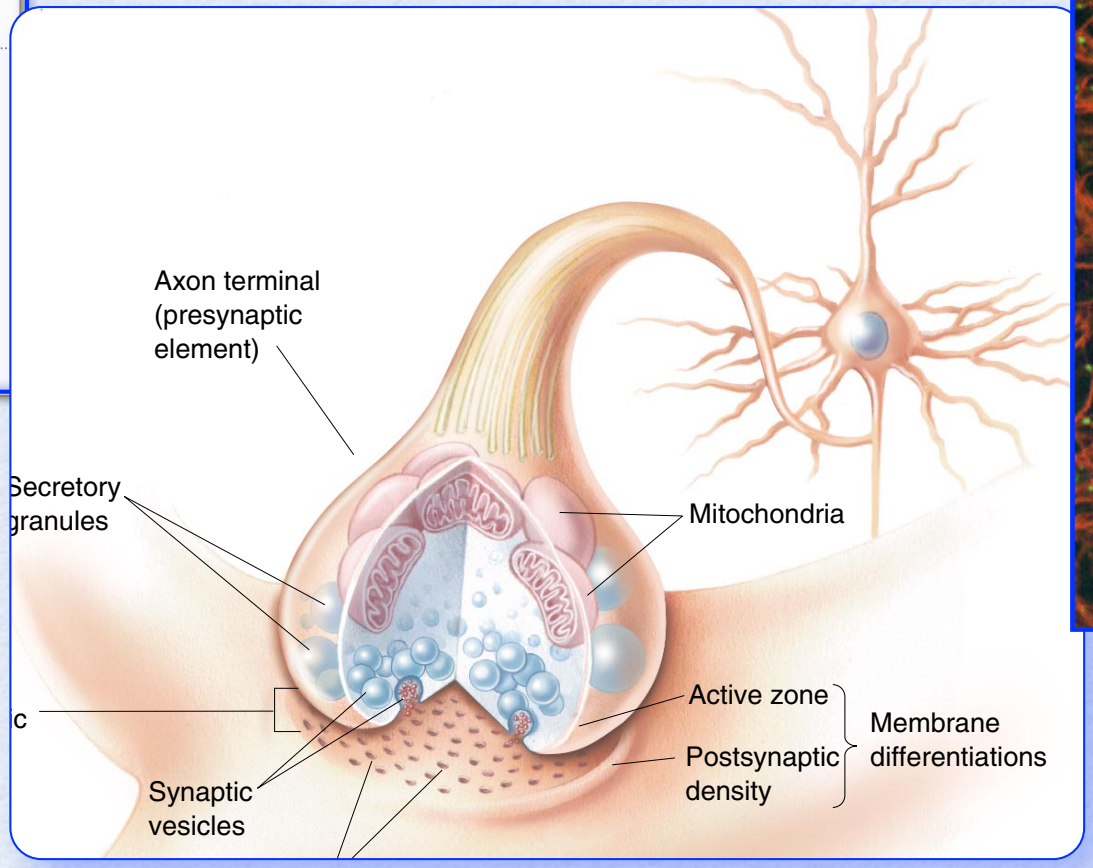
Cajal drawing

single neuron

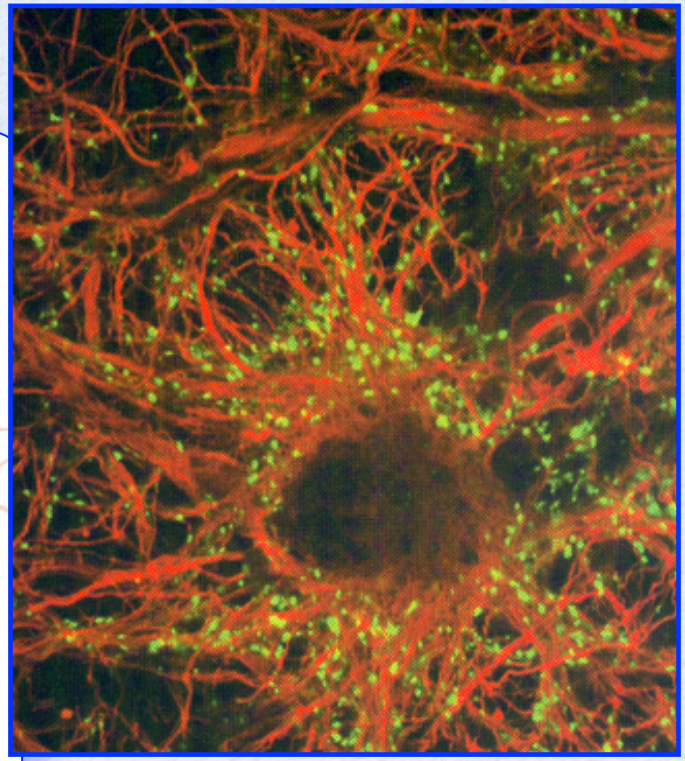
How neurons communicate



the action potential



the chemical synapse occurring in ms or less

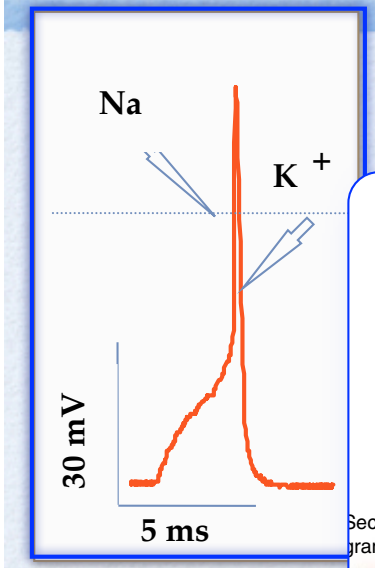


a single neuron: 100 ’000 synaptic connections

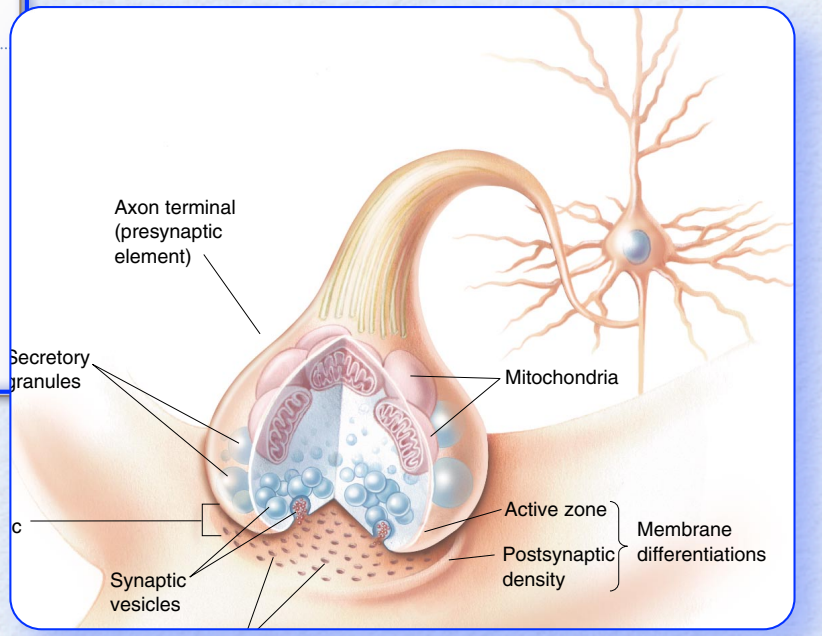
10^{11} neurons
10^{16} connections
20 W consumption

The importance of neurotransmitters and receptors

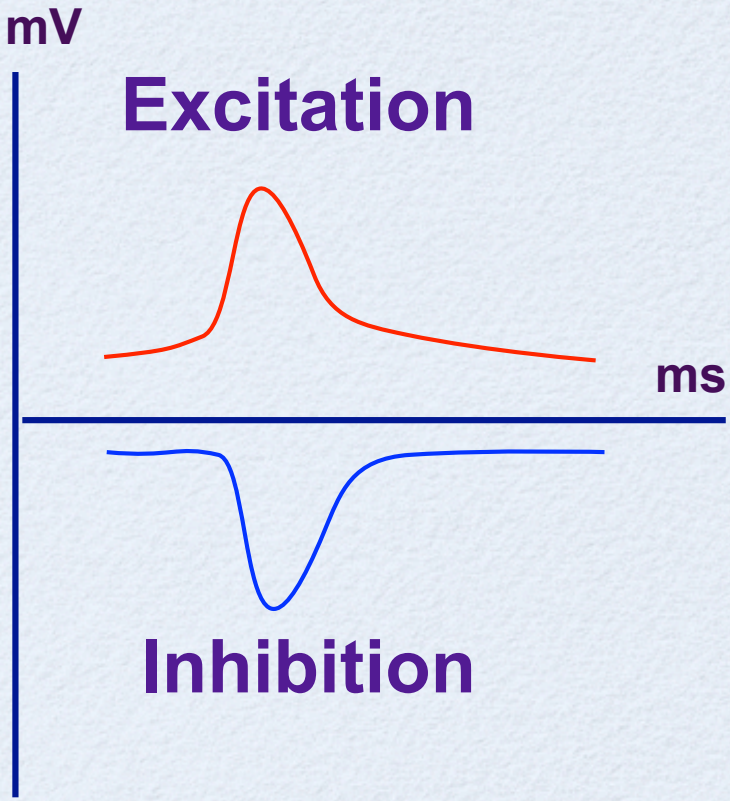
How neurons communicate



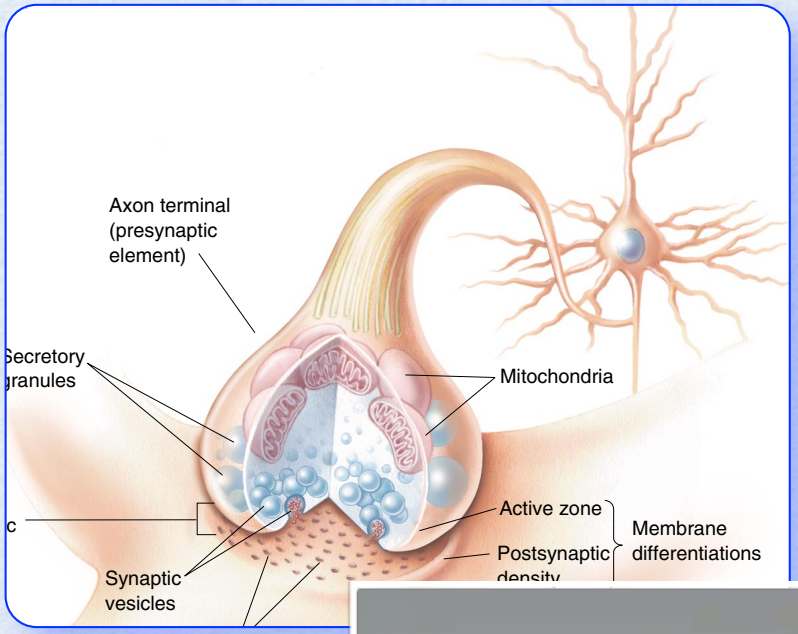
Electrical activity



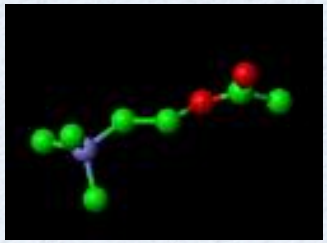
the chemical synapse occurring in ms or less

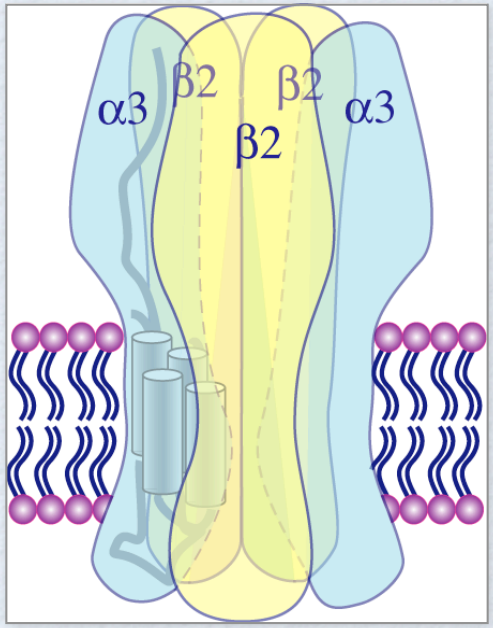


An example of neurotransmission



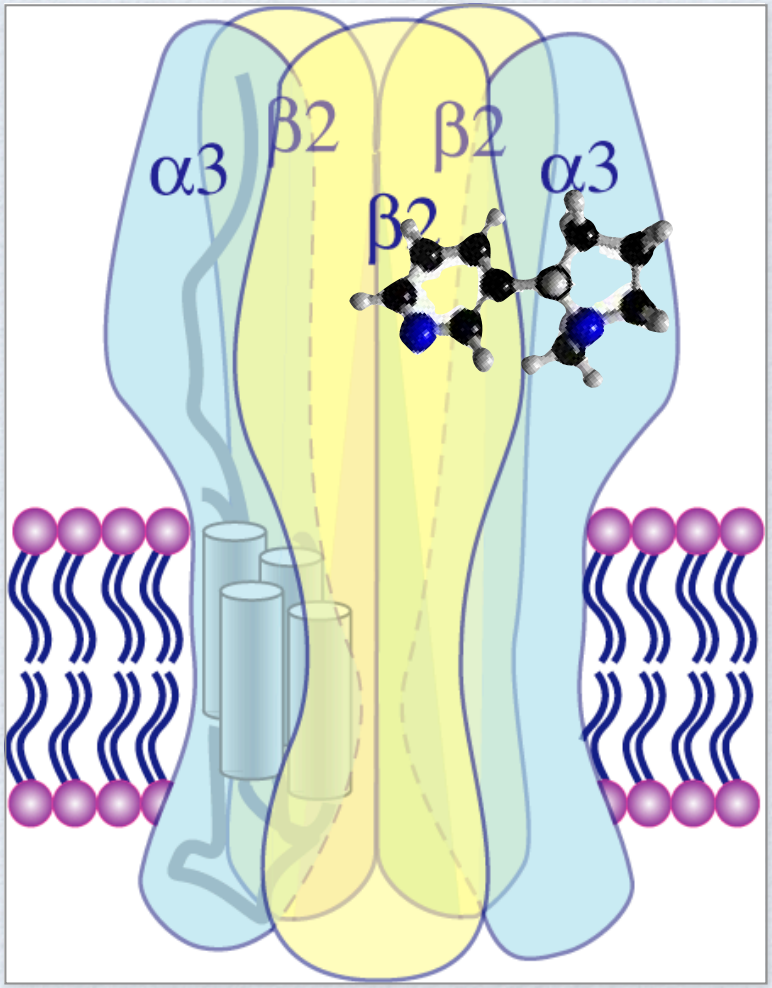
Acetylcholine





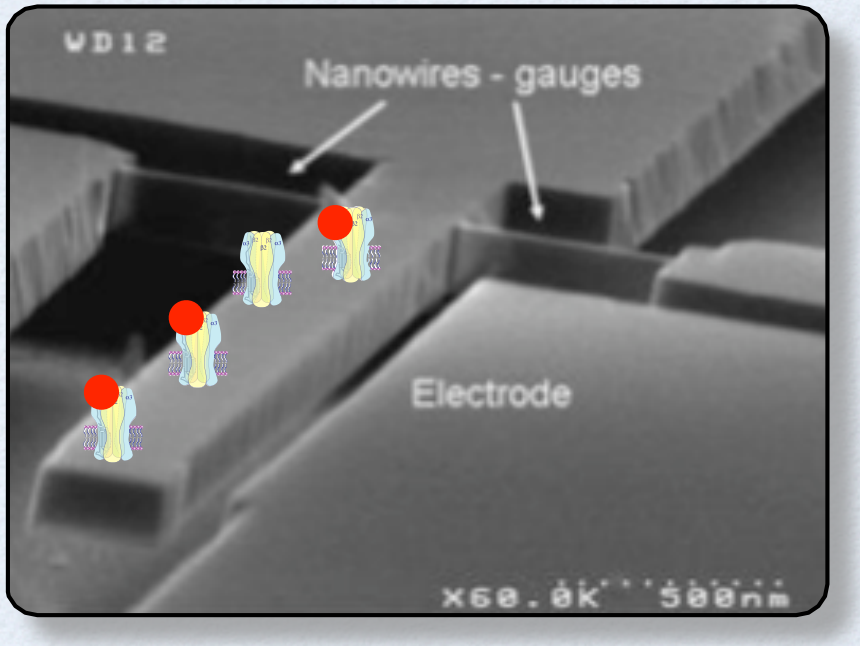
Nicotine

Pharmaceutical applications for NEMS

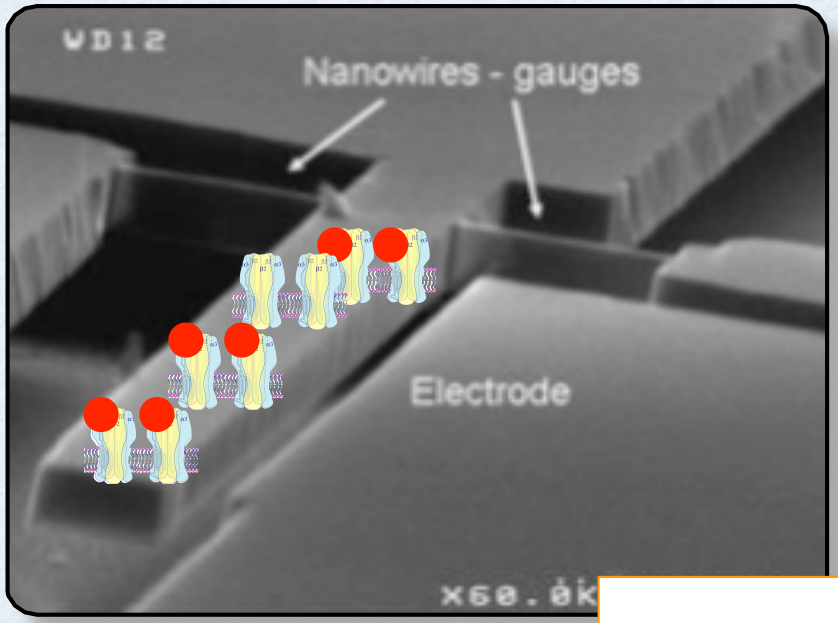


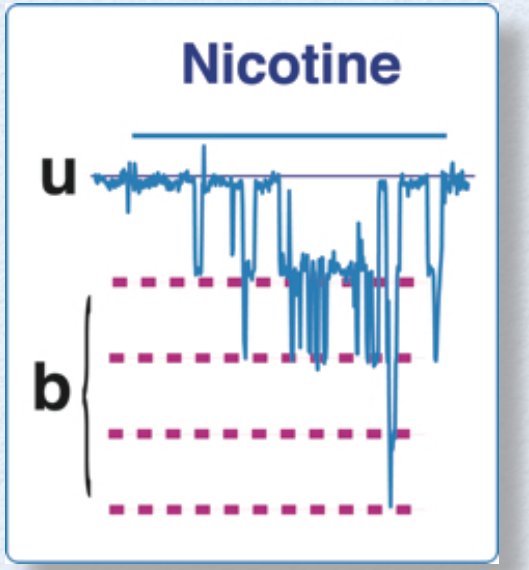
+Nicotine

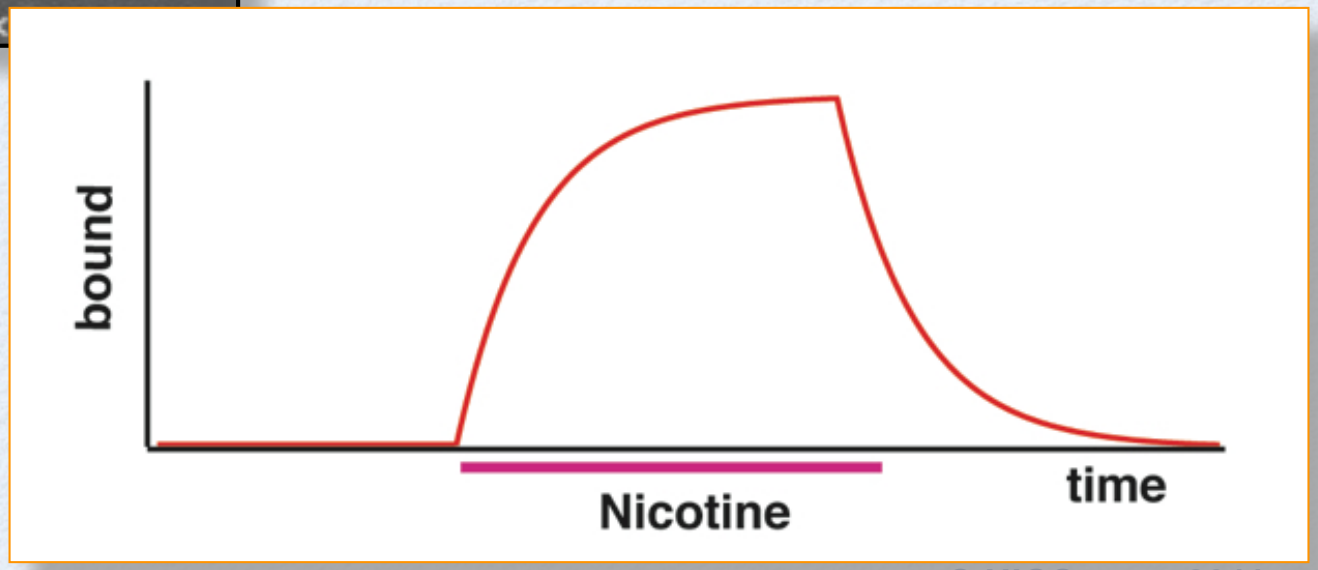
Δ weight



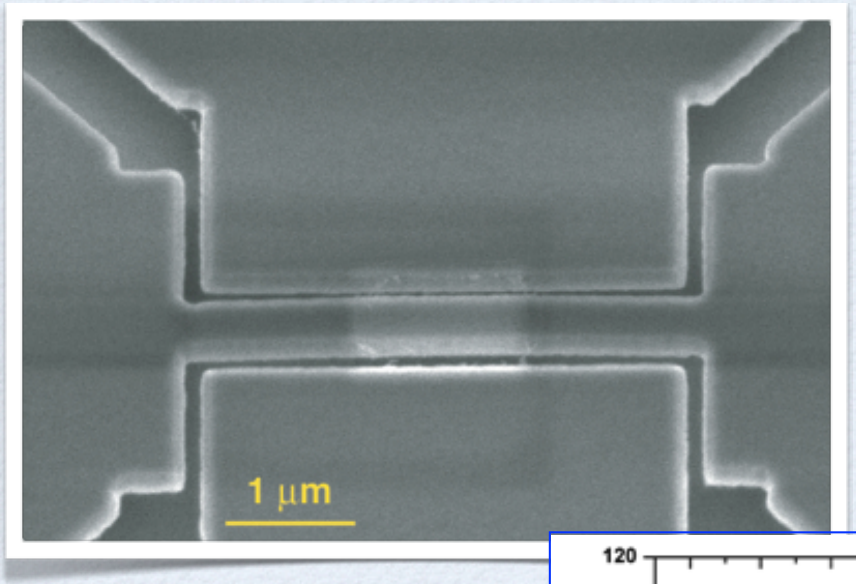
Pharmaceutical applications for NEMS

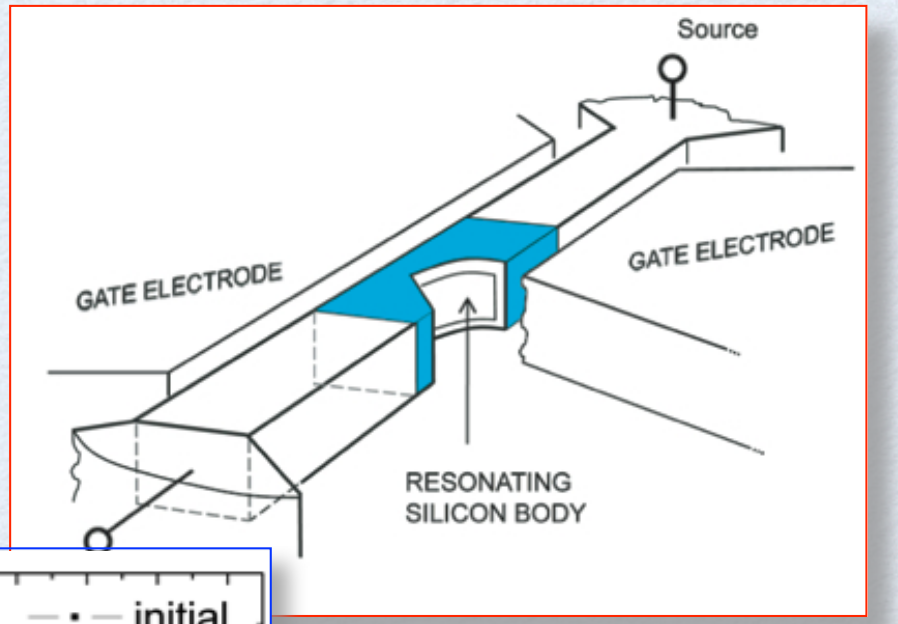


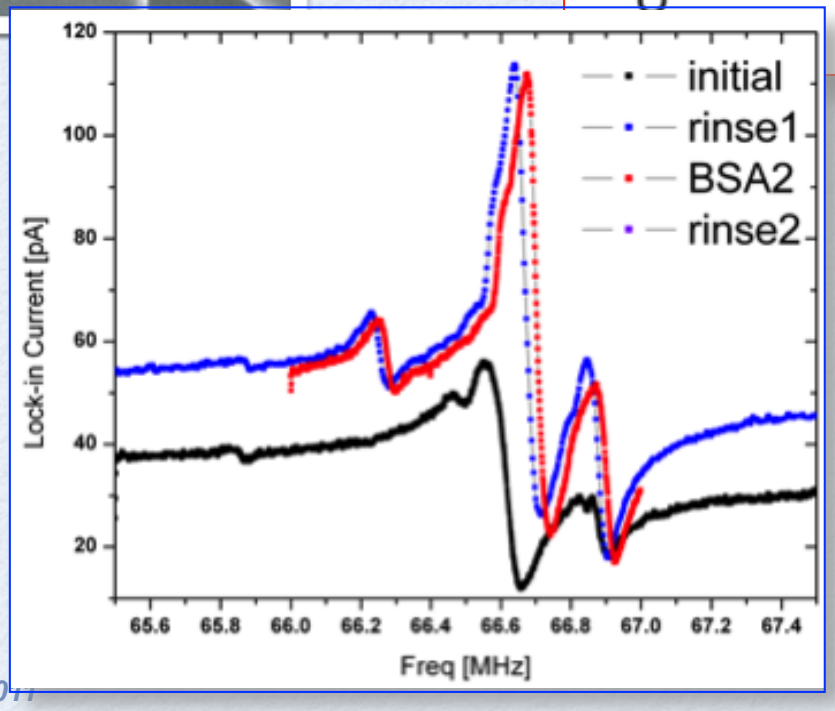




Resonating body FET

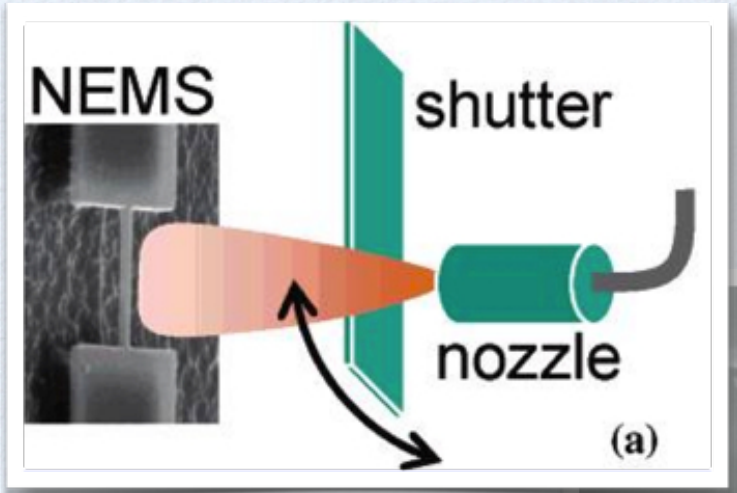


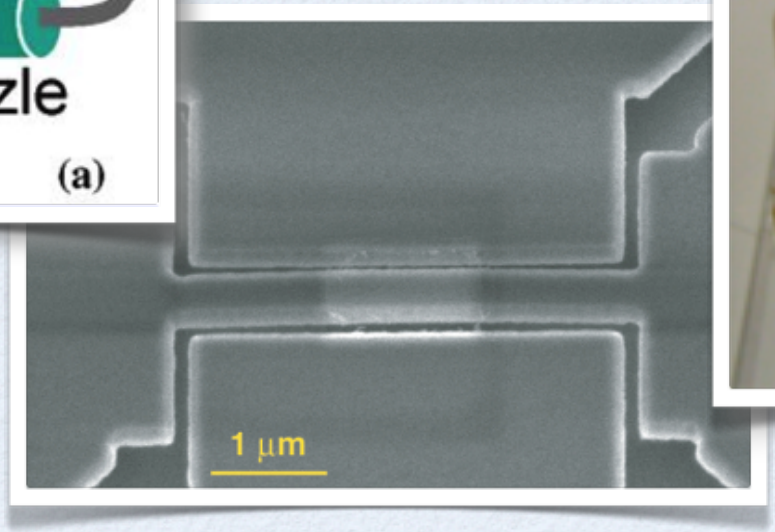


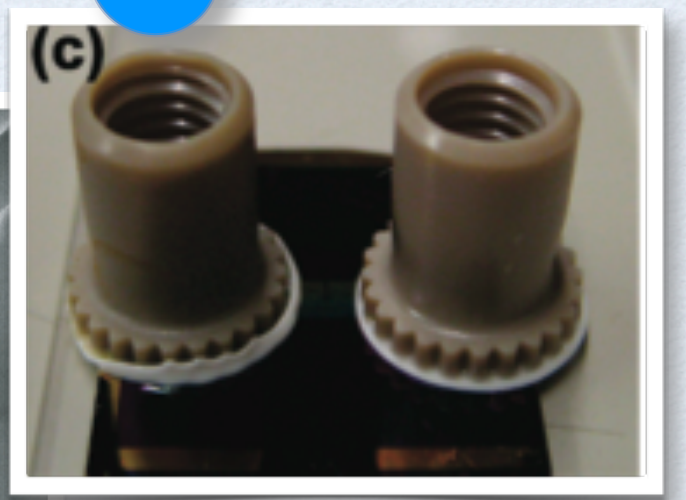


Measurements in vacuum carried out at EPFL with A. Ionescu & S. Bartsch

From present to future

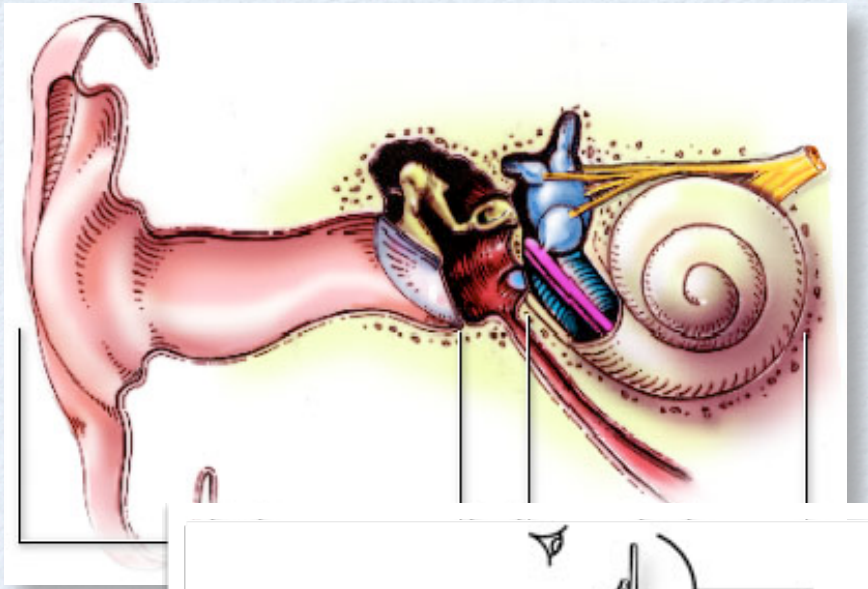


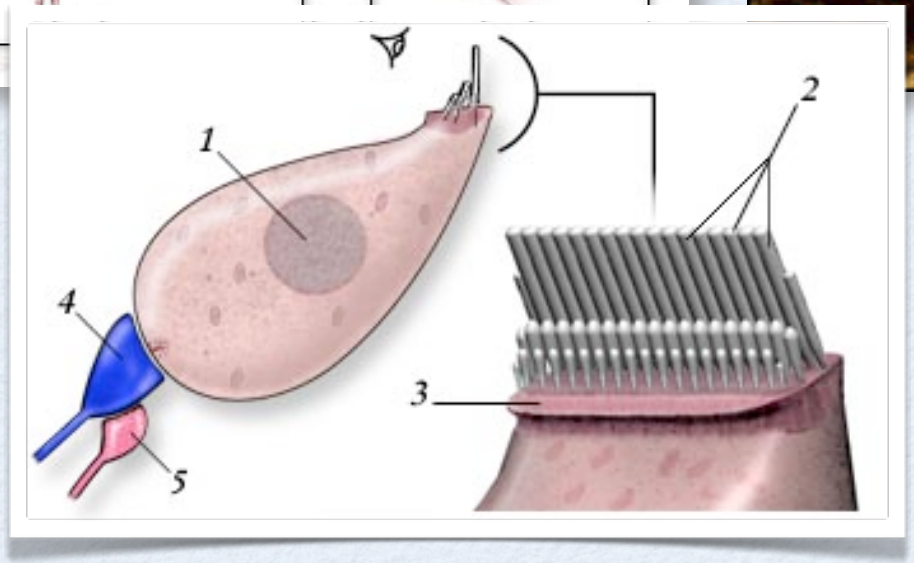


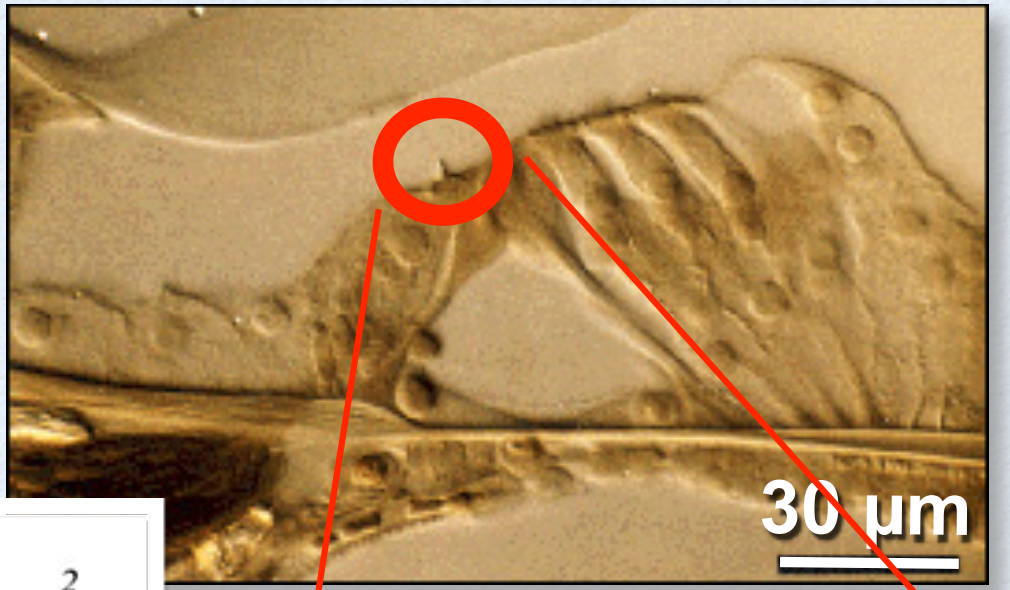


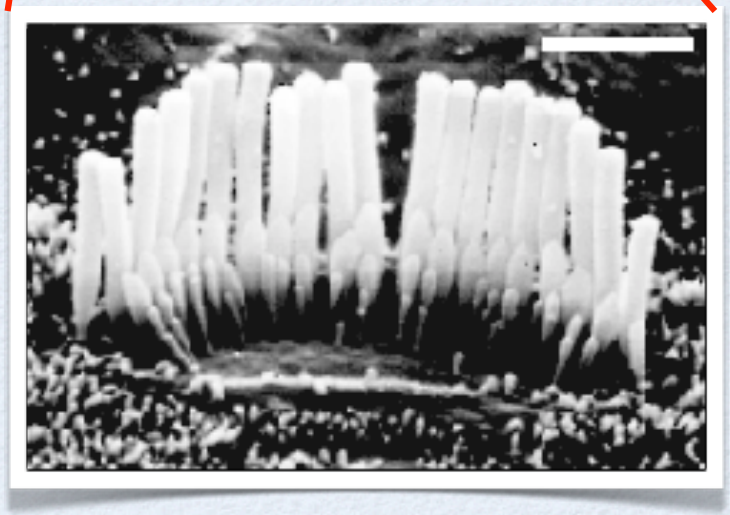
From Vacuum to Liquid

The inner ear: a biological example of NEMS



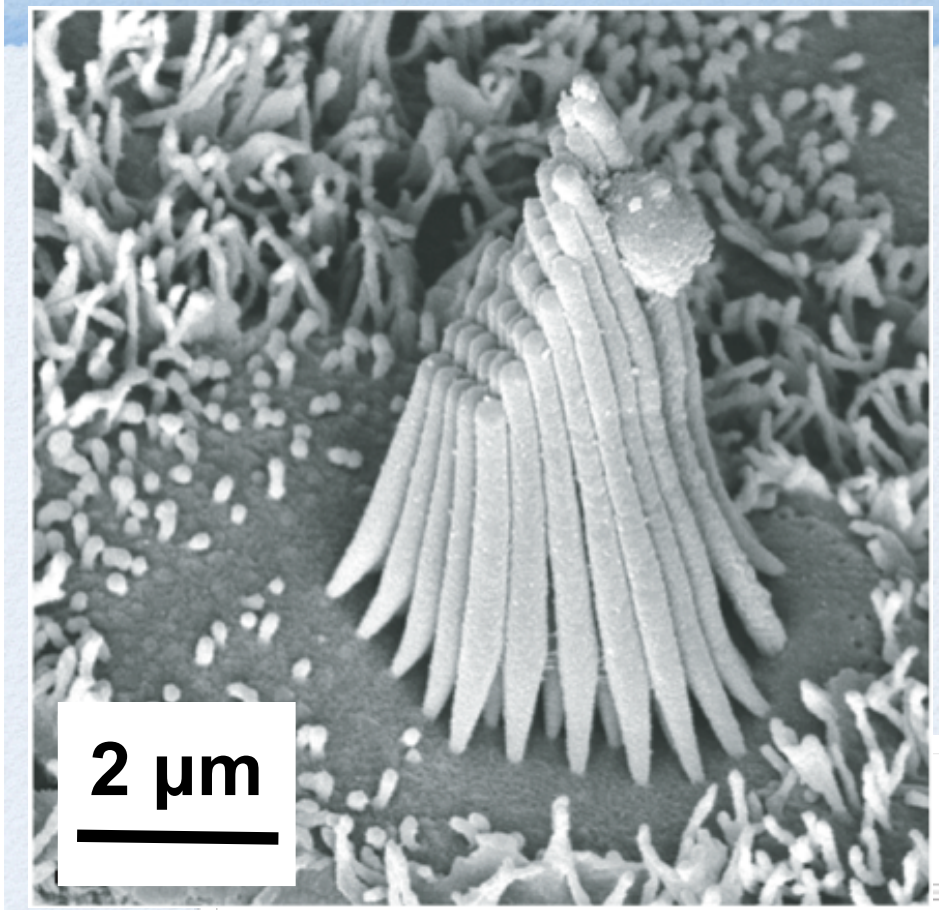


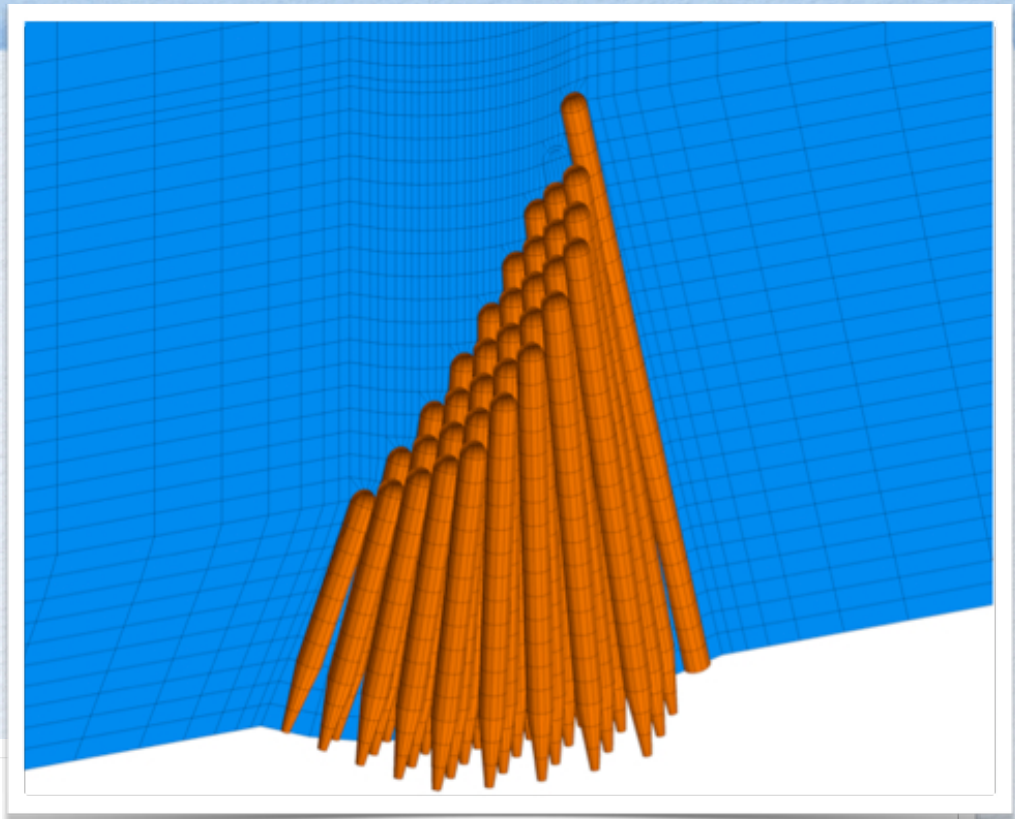




Subnanometer displacement

The physics of stereocilia





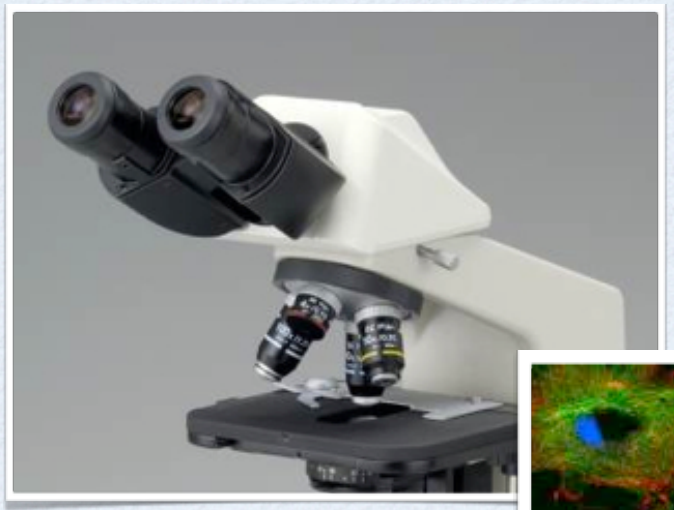
doi:10.1038/nature10073

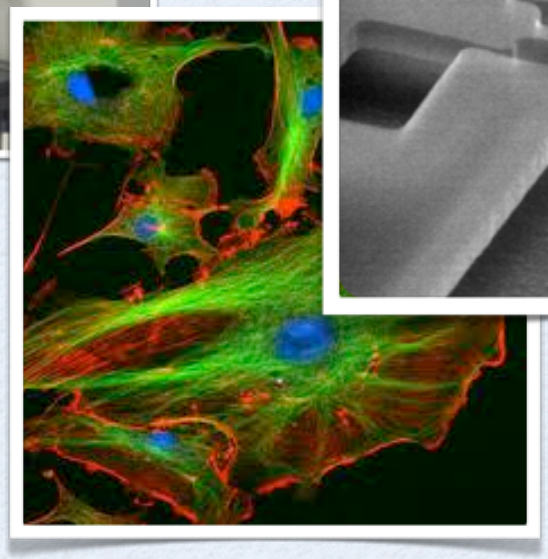
Forces between clustered stereocilia minimize friction in the ear on a subnanometre scale

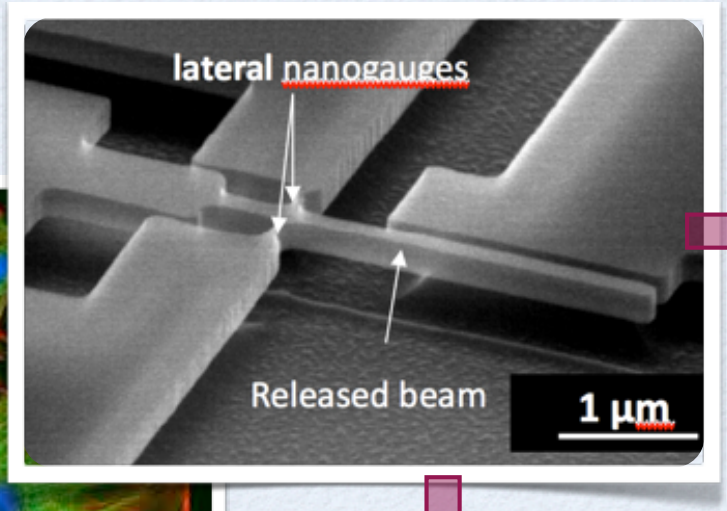
Andrei S. Kozlov[1], Johannes Baumgart[2], Thomas Risler[3,4,5], Corstiaen P. C. Versteegh[1,6] & A. J. Hudspeth[1]

Nature 2011

NEMS in Biology







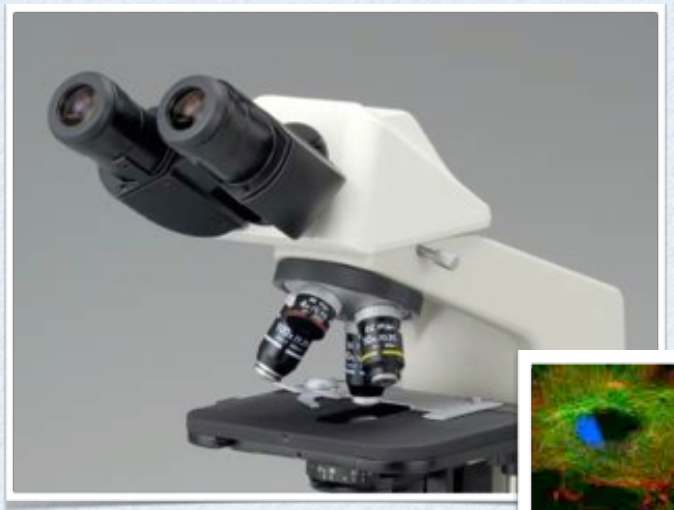
biochemical reactions

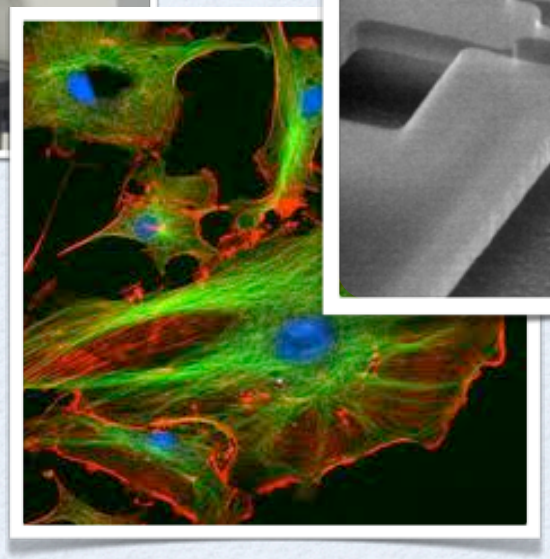
pharmacology

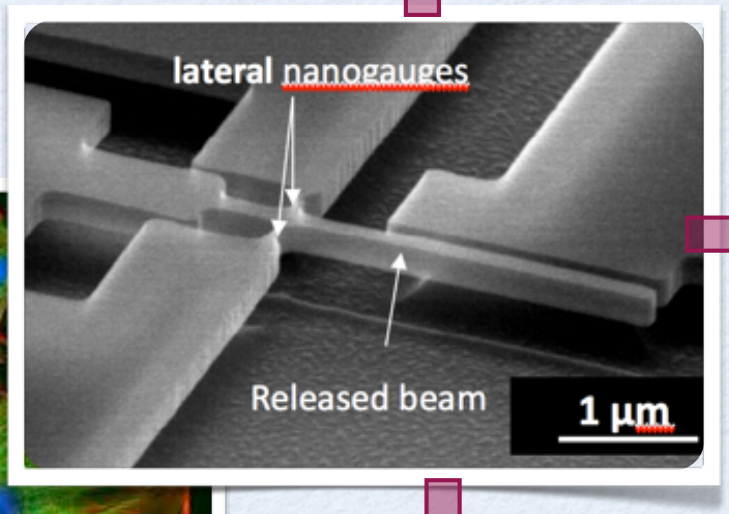
Microscope brought us the possibility to discover cells

NEMS brings the possibility to weigh biological reactions

NEMS in Biology







compound detection
DNA sequencing

biochemical
reactions

pharmacology

Microscope brought us the possibility to discover cells

NEMS brings the possibility to weigh biological reactions

Work Done in Collaboration

HiQScreen

Ryoko Krause

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HiQSCREEN

High Quality Screening for Drug Discovery

CEA-LETI

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& many others...