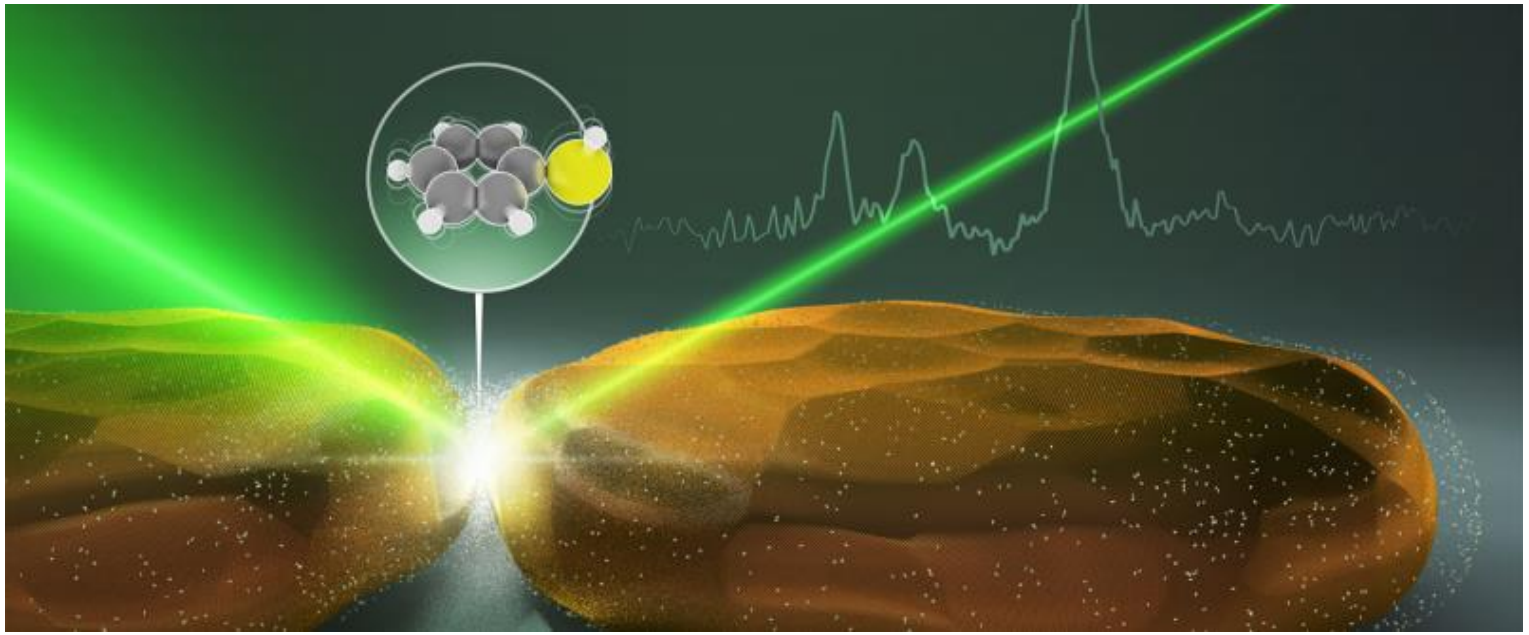


Nano-biosensors for medical research and services

Chatdanai Lumdee (Tua)

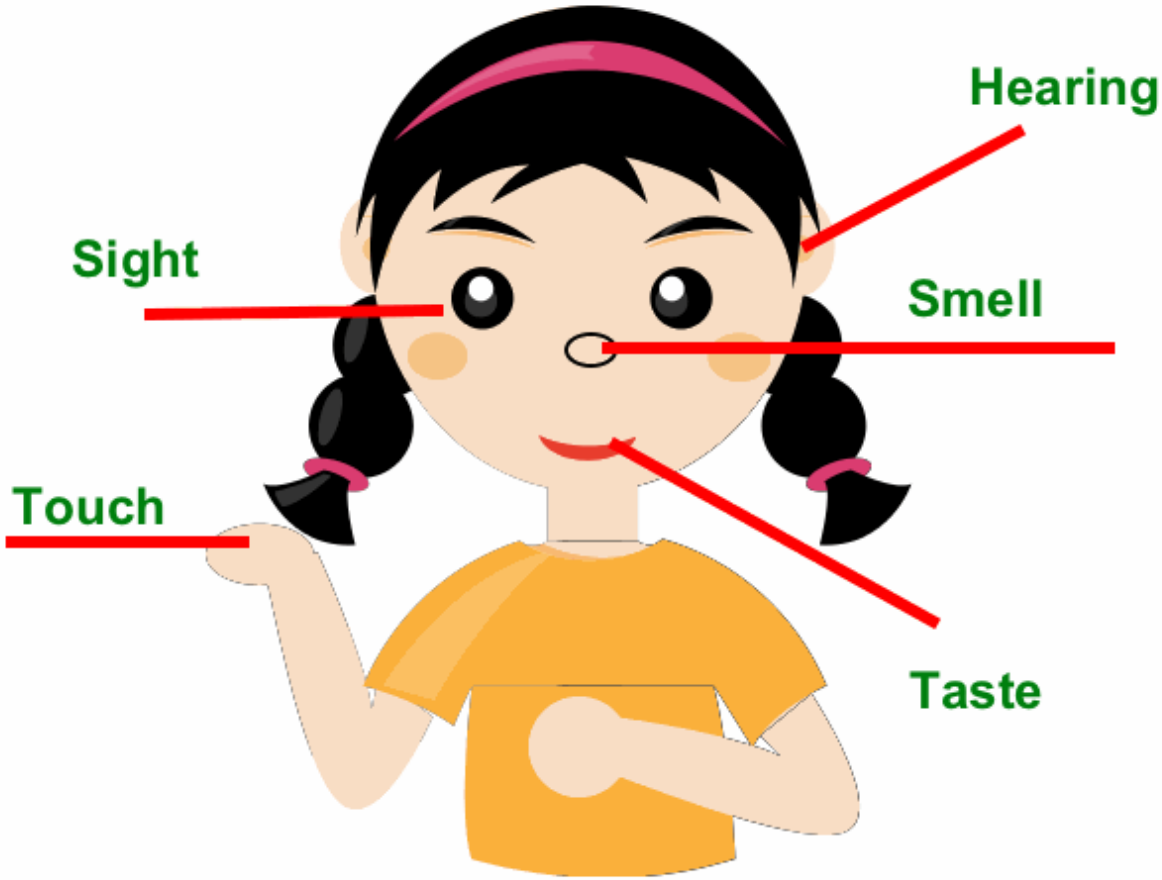
UNIVERSITY OF GOTHENBURG

KBTG
KASIKORN
BUSINESS-TECHNOLOGY GROUP

Nanosensors

Nanosensors

My Five Senses



By: Roberta L.

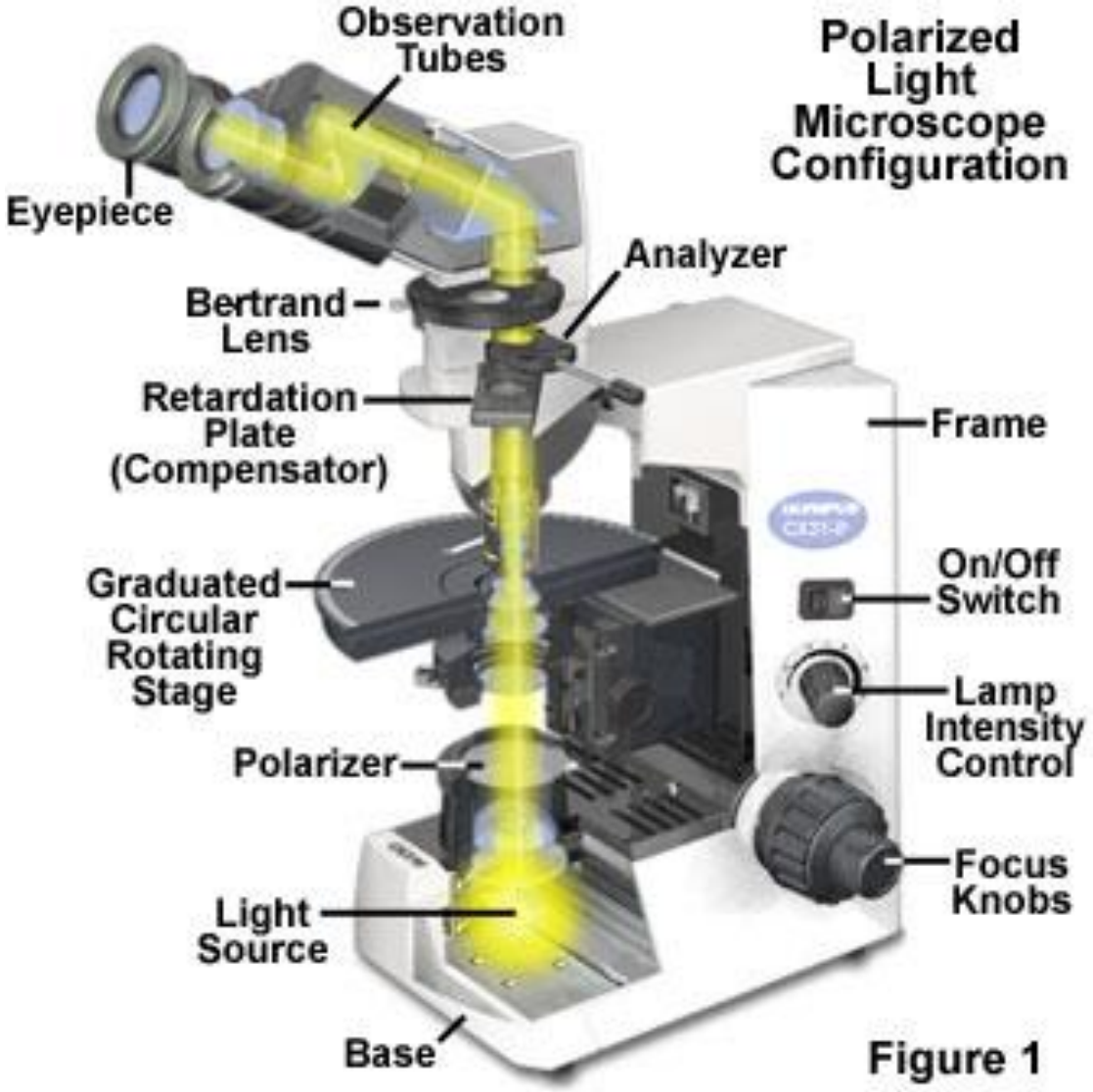
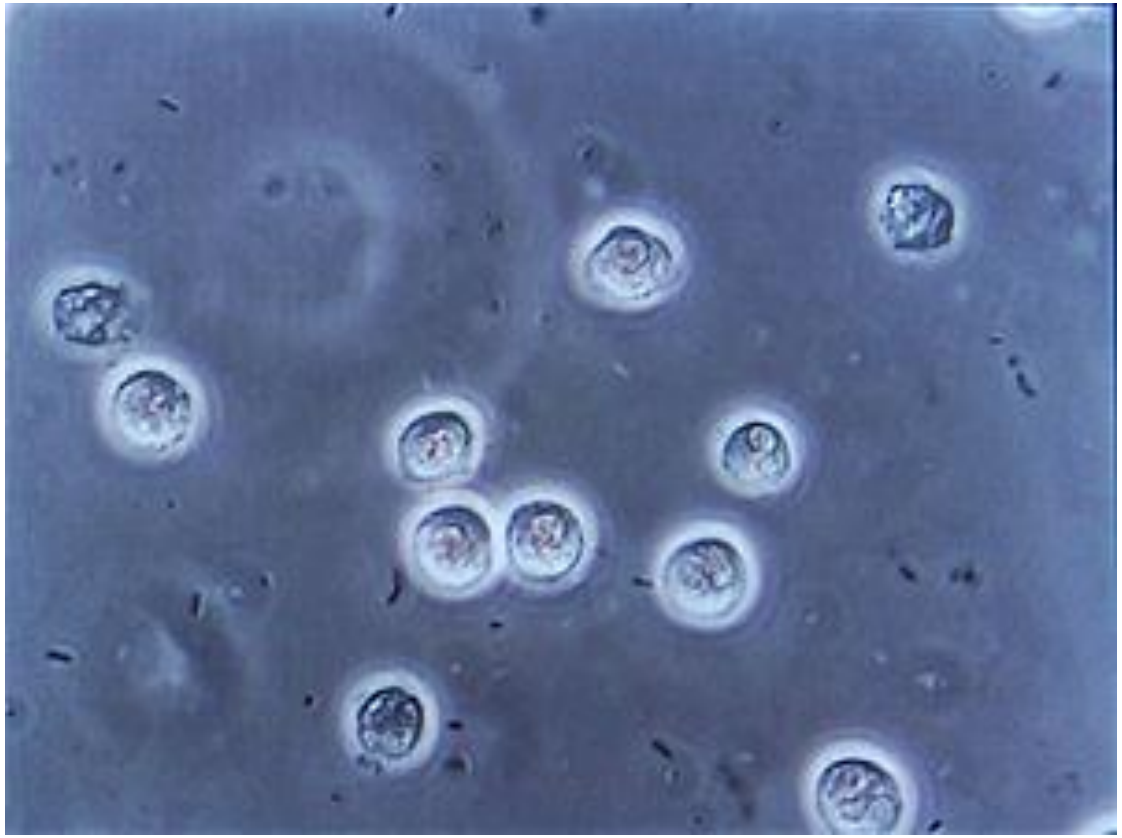


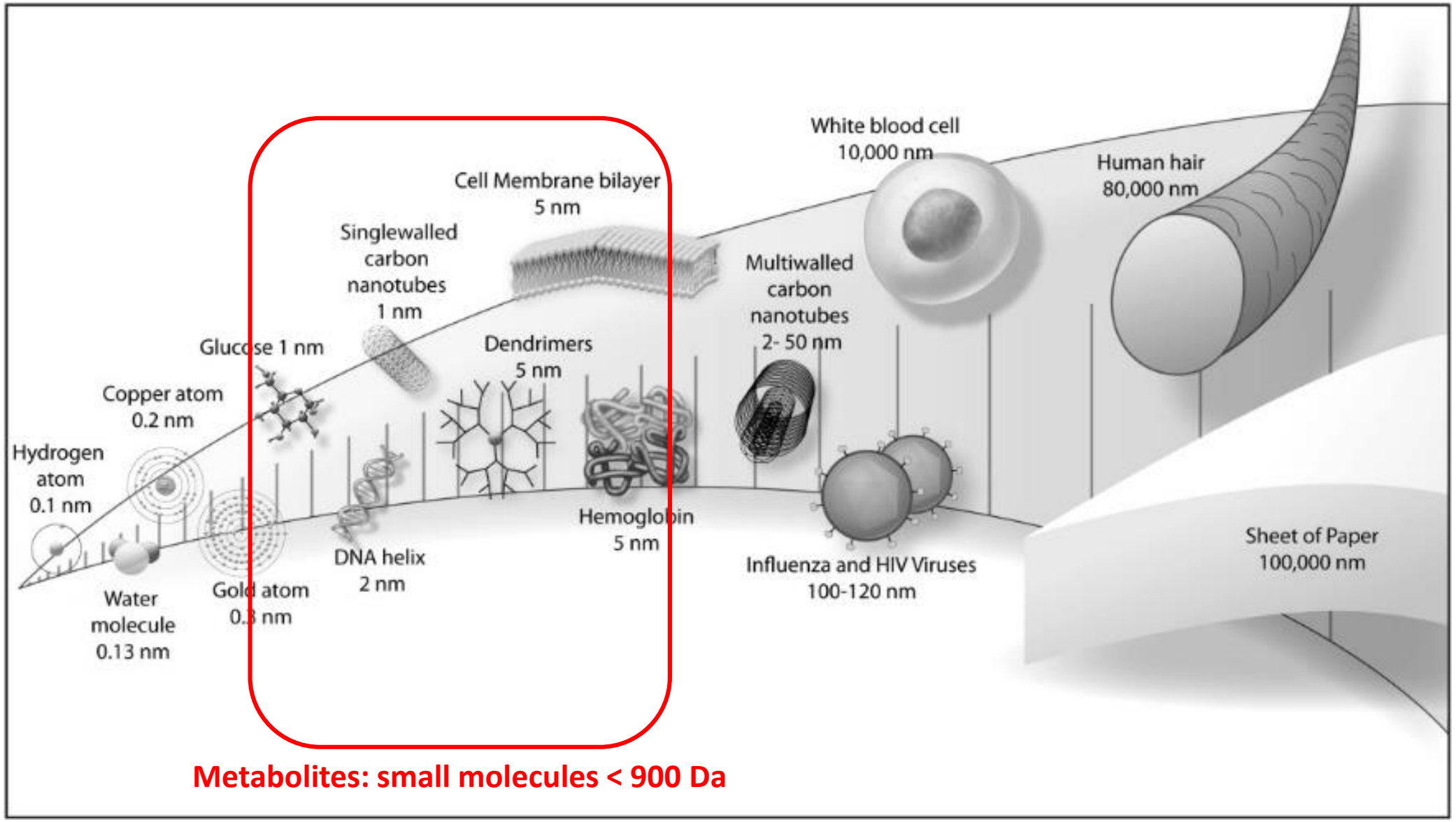
Figure 1

Most bacterial cells range in size from **0.2 to 10 microns**



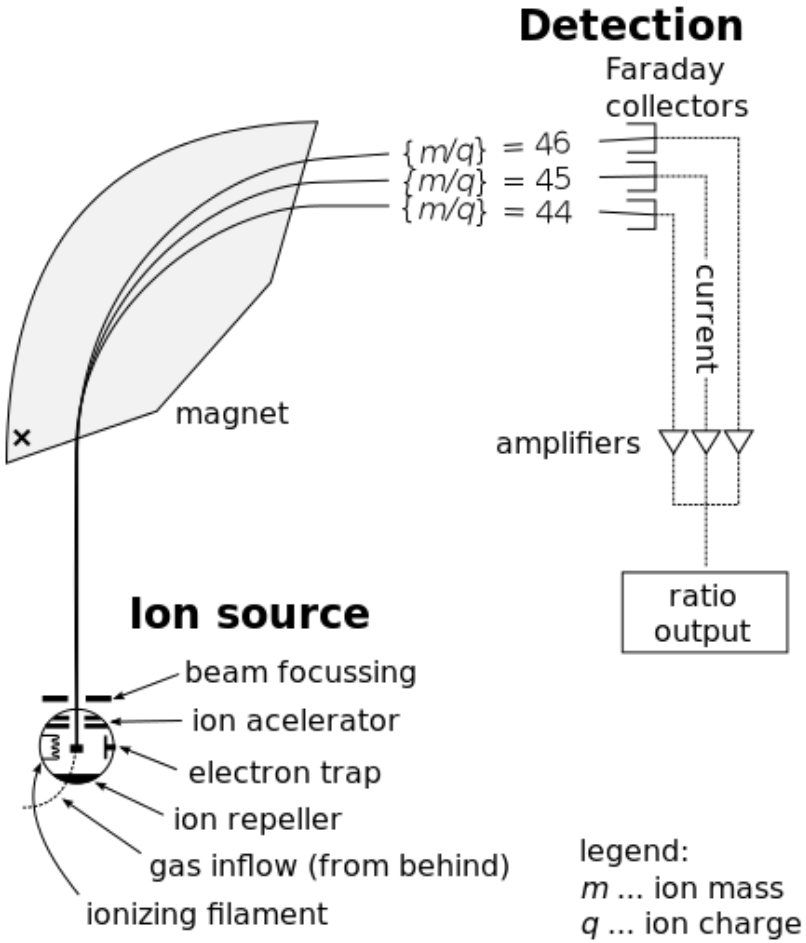
Multiple rod-shaped bacteria shown between the larger white blood cells at urinary microscopy

White blood cells ~10-15 um

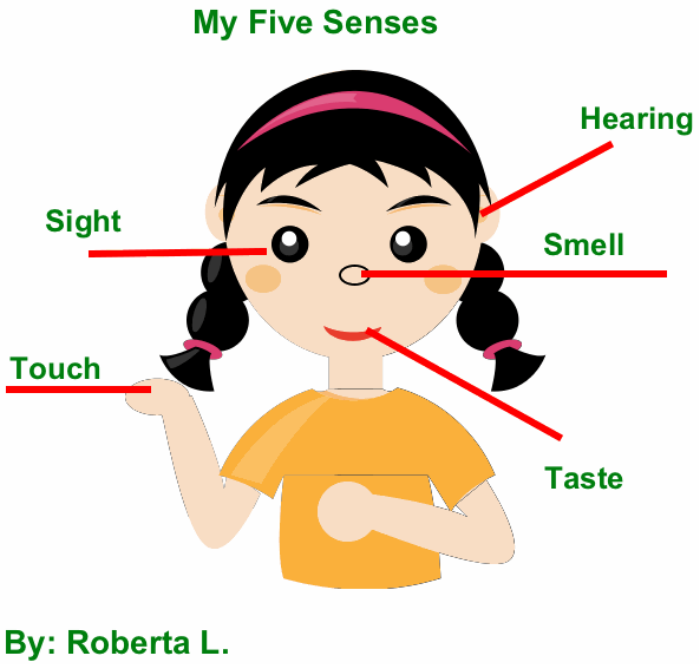


Metabolites: small molecules < 900 Da

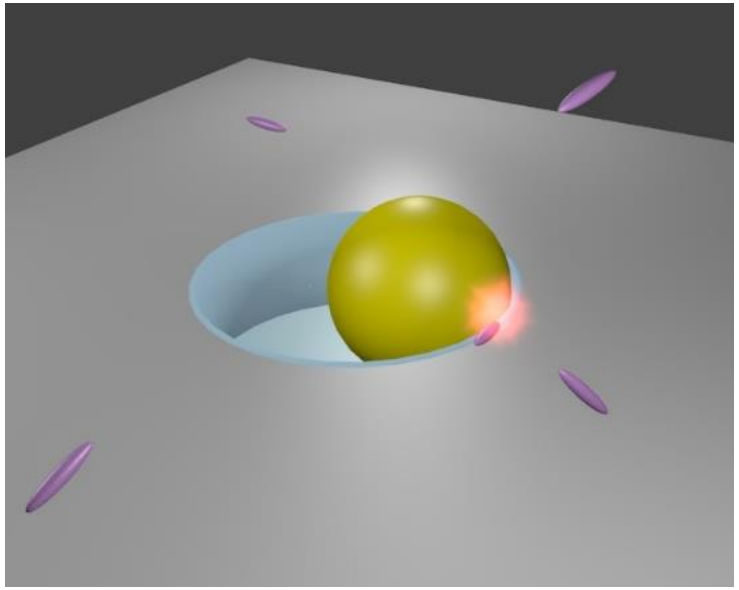

3654


Detection
Faraday collectors
{m/q} = 46
{m/q} = 45
{m/q} = 44
current
magnet
amplifiers
ratio output
Ion source
beam focussing
ion acelerator
electron trap
ion repeller
gas inflow (from behind)
ionizing filament
legend:
m ... ion mass
q ... ion charge

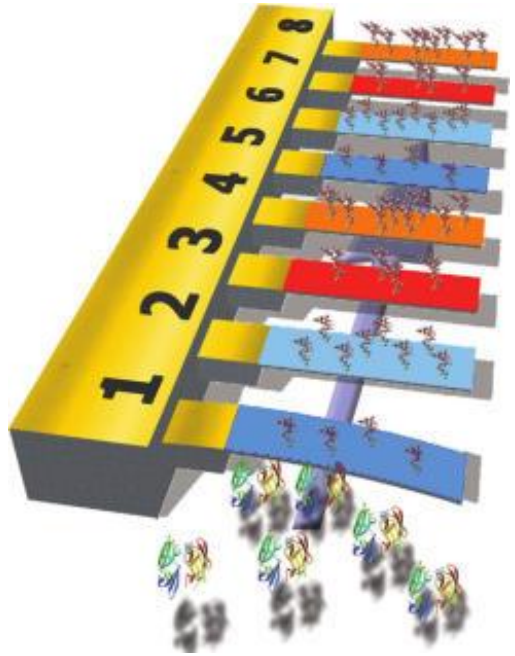
Nanosensors



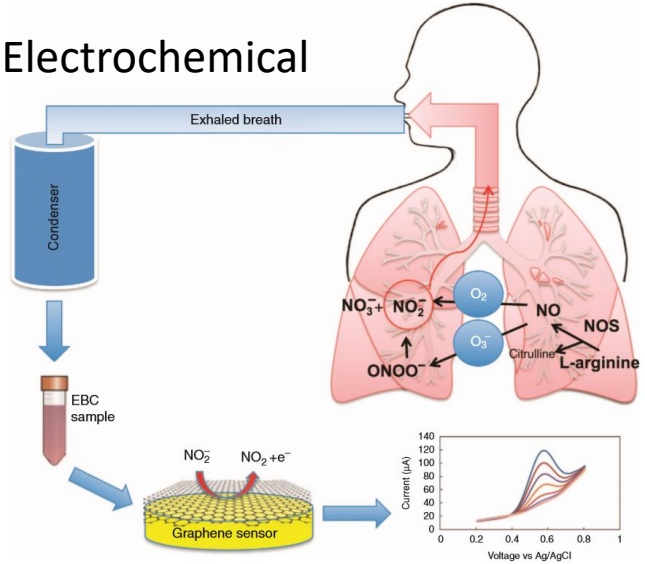
Optical



Mechanical

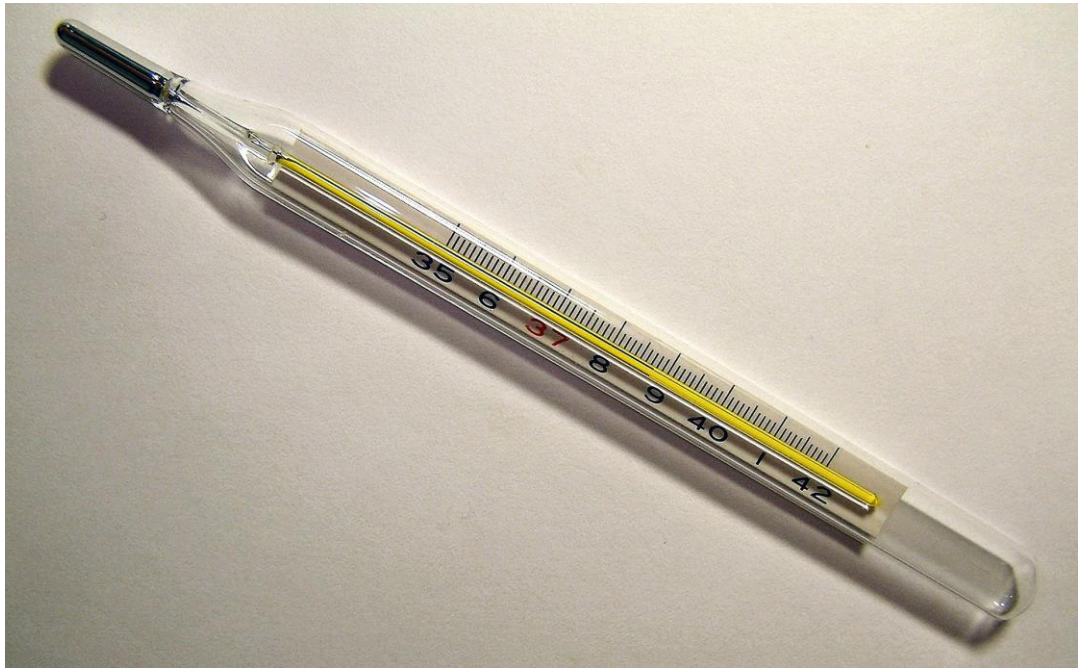


Electrochemical



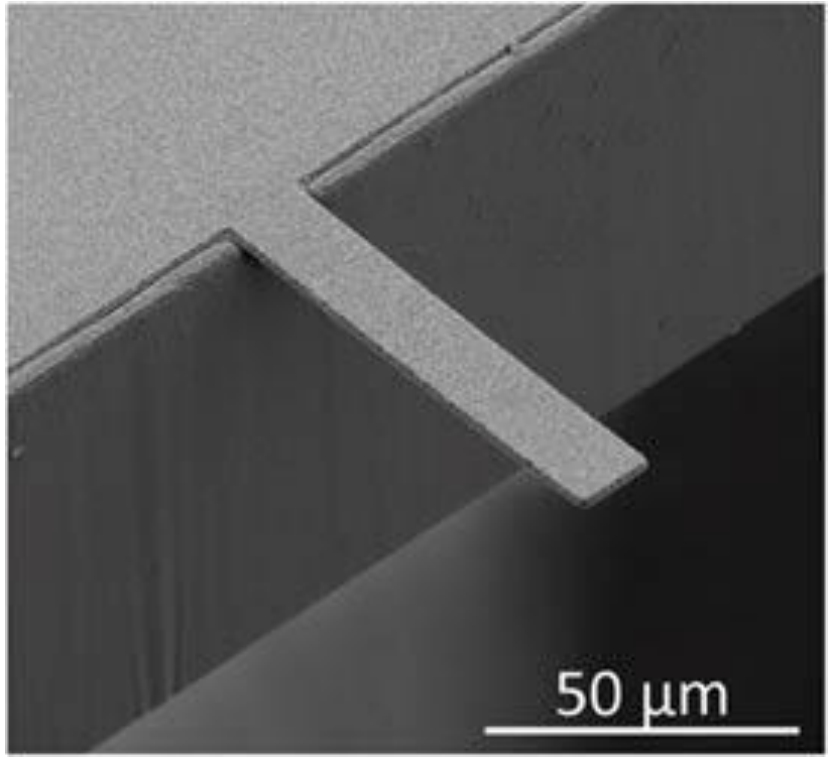
Mechanical sensors

Body weight scale



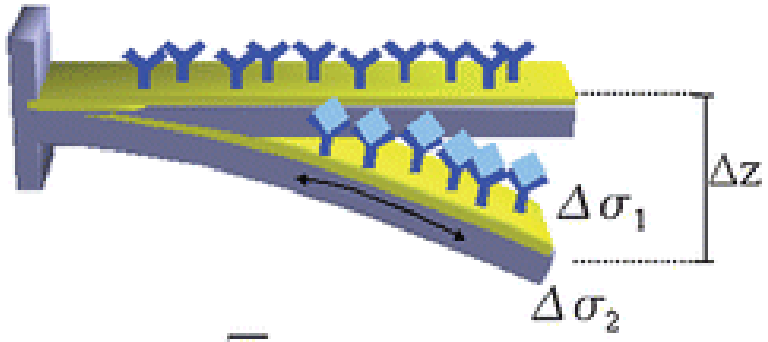
A medical/clinical thermometer

Mechanical sensors

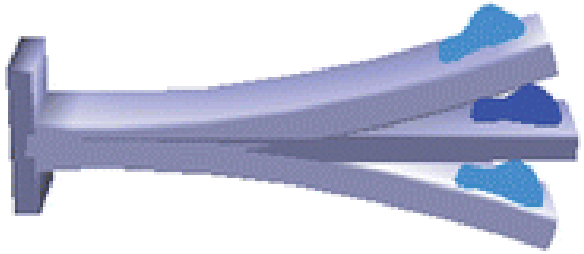


http://www.microchem.com/Appl-MEMs-Cantilevers.htm

a) $(\Delta\sigma_1 - \Delta\sigma_2) = \frac{Et^2}{3(1-\nu)L^2}\Delta z$

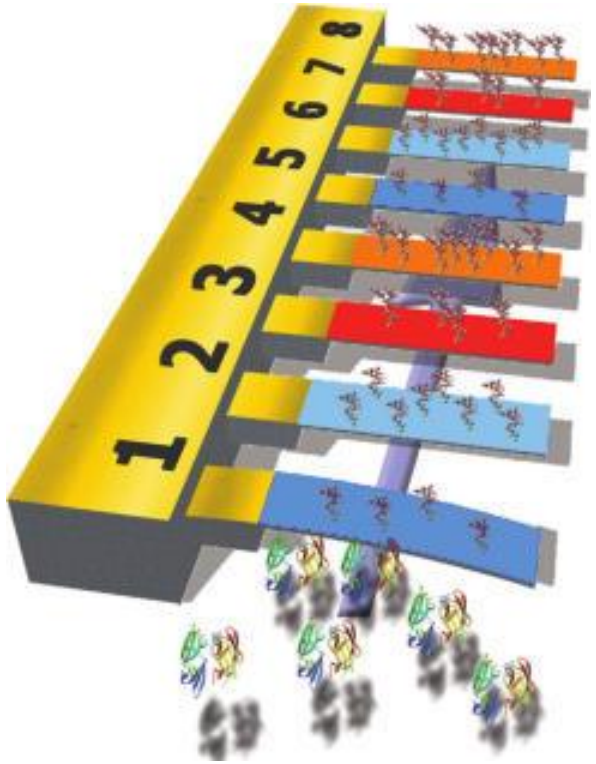


b) $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$



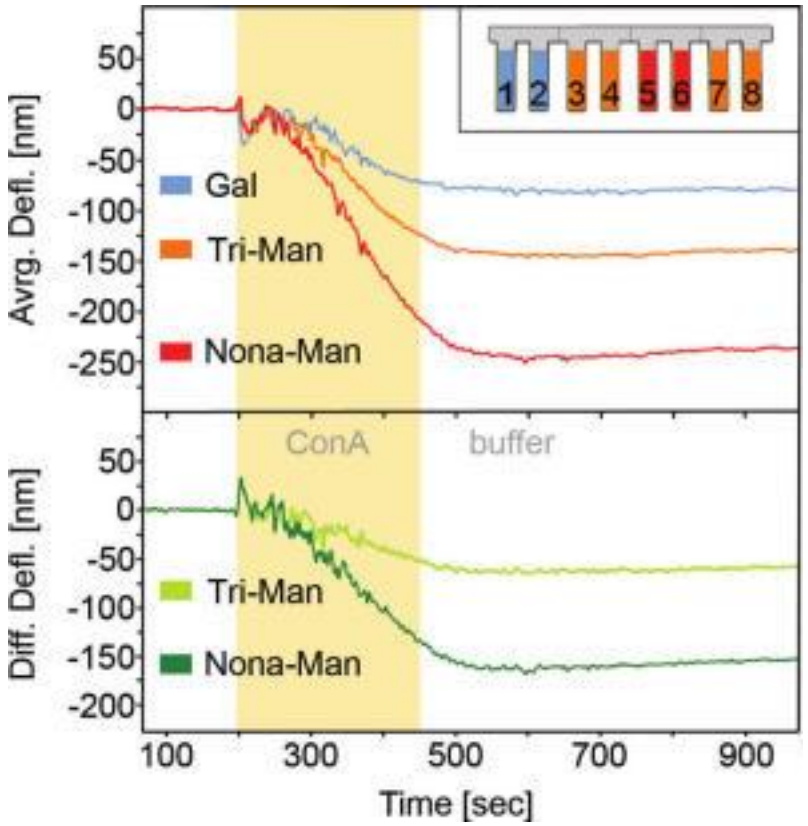
Analyst (2010), 135, 827

Mechanical sensors



ACS Nano (2011), 5, 3670

Cantilever Array Sensors Detect Specific Carbohydrate-Protein Interactions with Picomolar Sensitivity



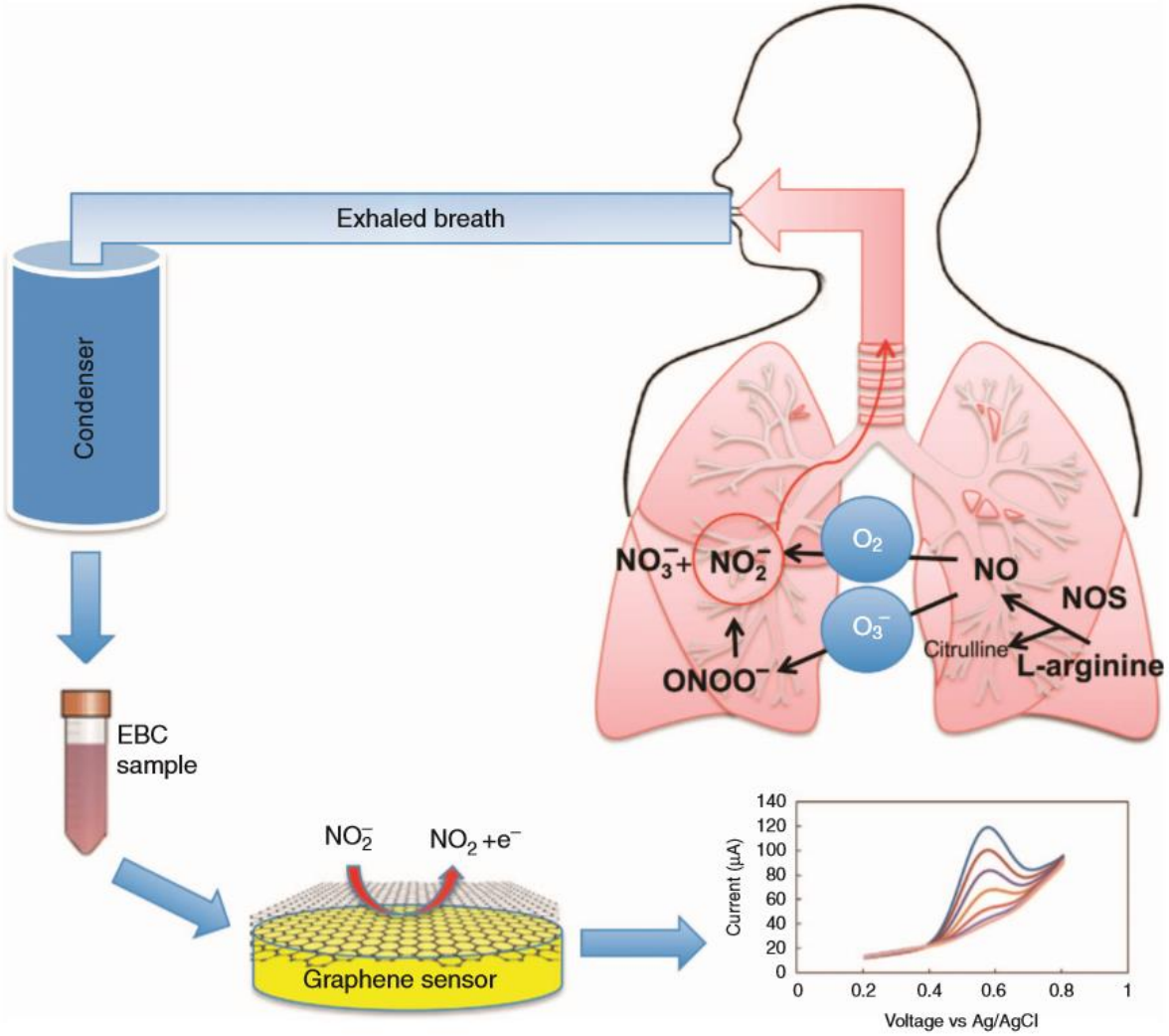
Cyanovirin-N (CV-N) is a protein produced by the cyanobacterium *Nostoc ellipsosporum* that displays virucidal activity against several viruses, including human immunodeficiency virus (HIV)

Electrochemical sensors

NIOX VERO Medical device for measurement of exhaled nitric oxide

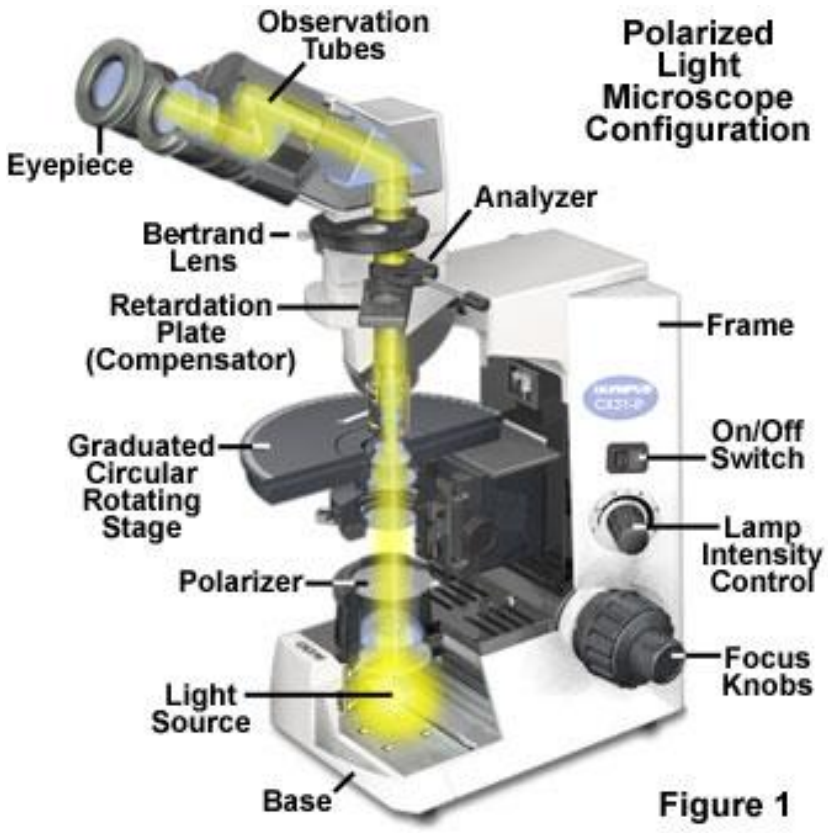
Blood glucose monitoring device

Electrochemical sensors



Microsystems & Nanoengineering (2017), 3, 17022

Optical sensors



Optical microscope

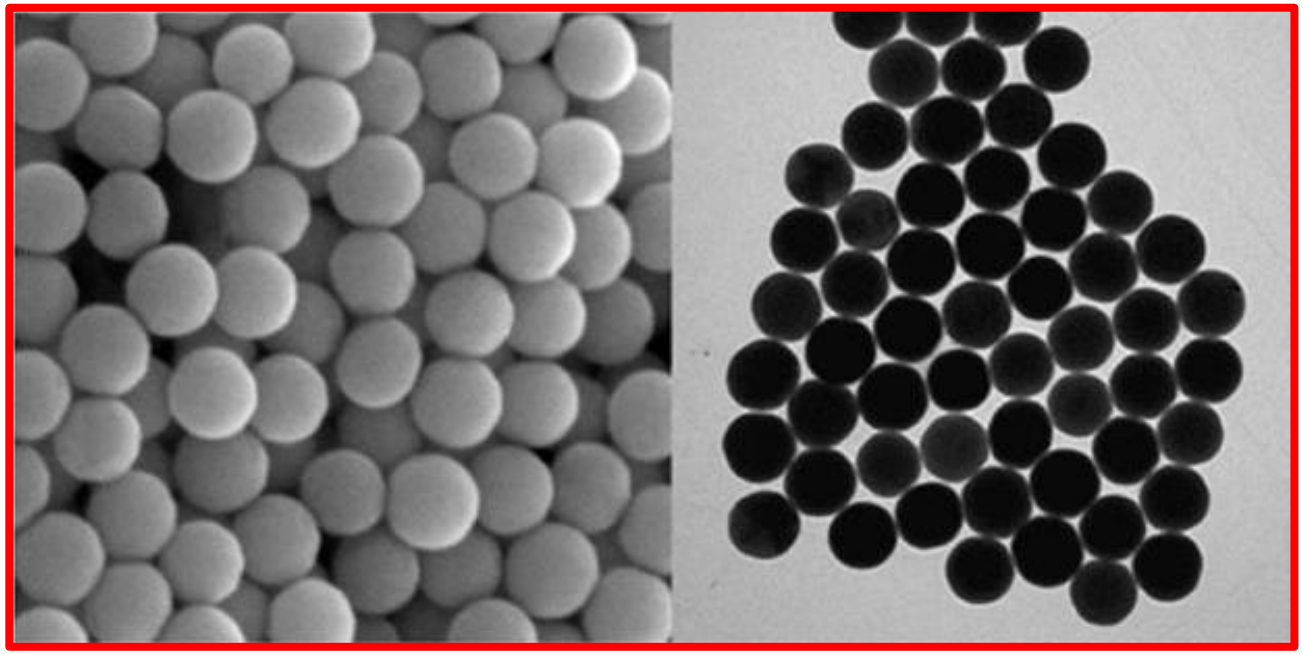
X-ray scan

Examples → absorption, scattering, fluorescence

Optical **nano**sensors

How nanostructures can help?

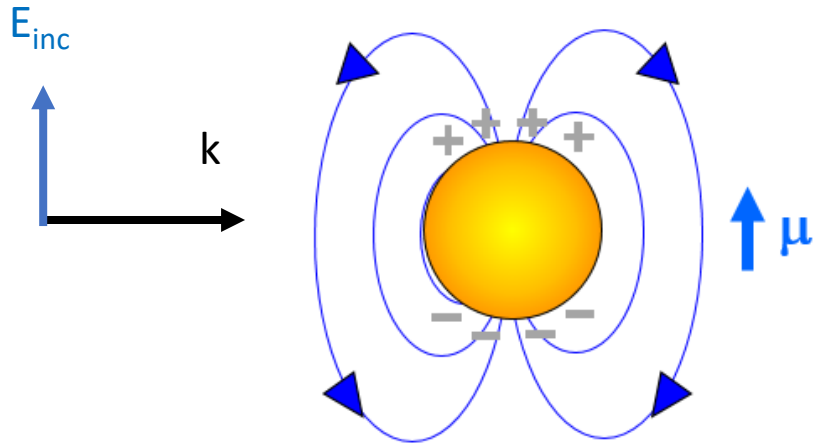
Simplest form → nanosphere



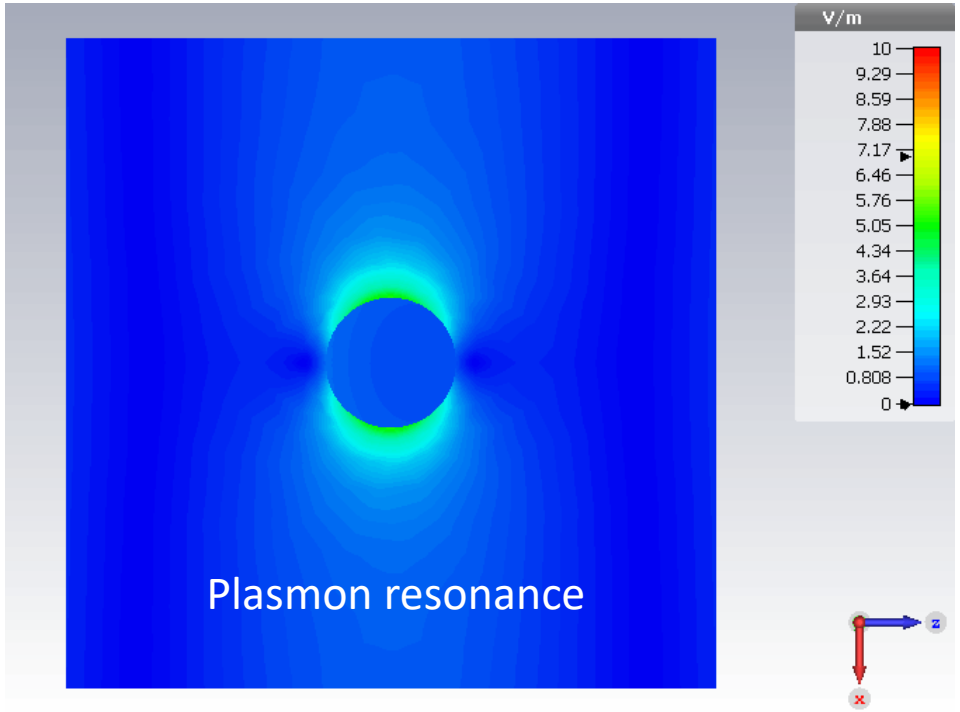
ACS Nano 7, 11064 (2013)

Optical **nano**sensors

Single NP in free space



50 nm diameter Au NP nm diameter in water

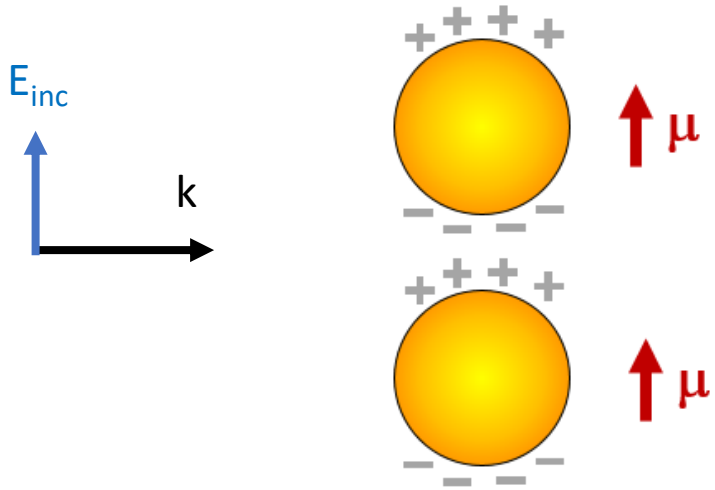


Frequency domain finite-element simulation

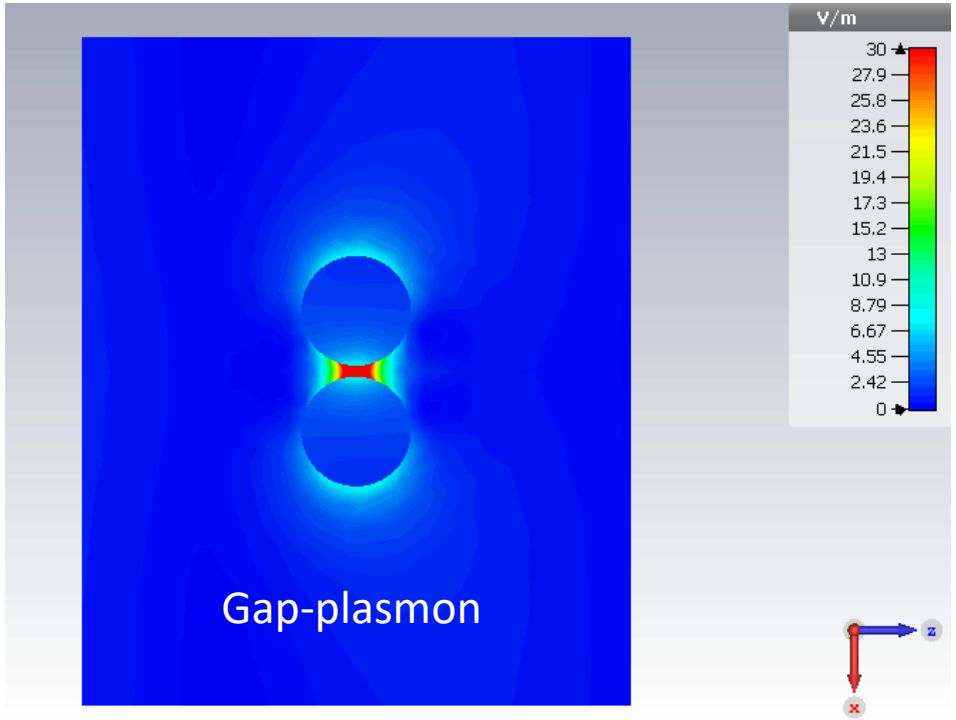
Active optical volume *almost* in the same order as a metabolite

Optical **nano**sensors

NP dimer in free space



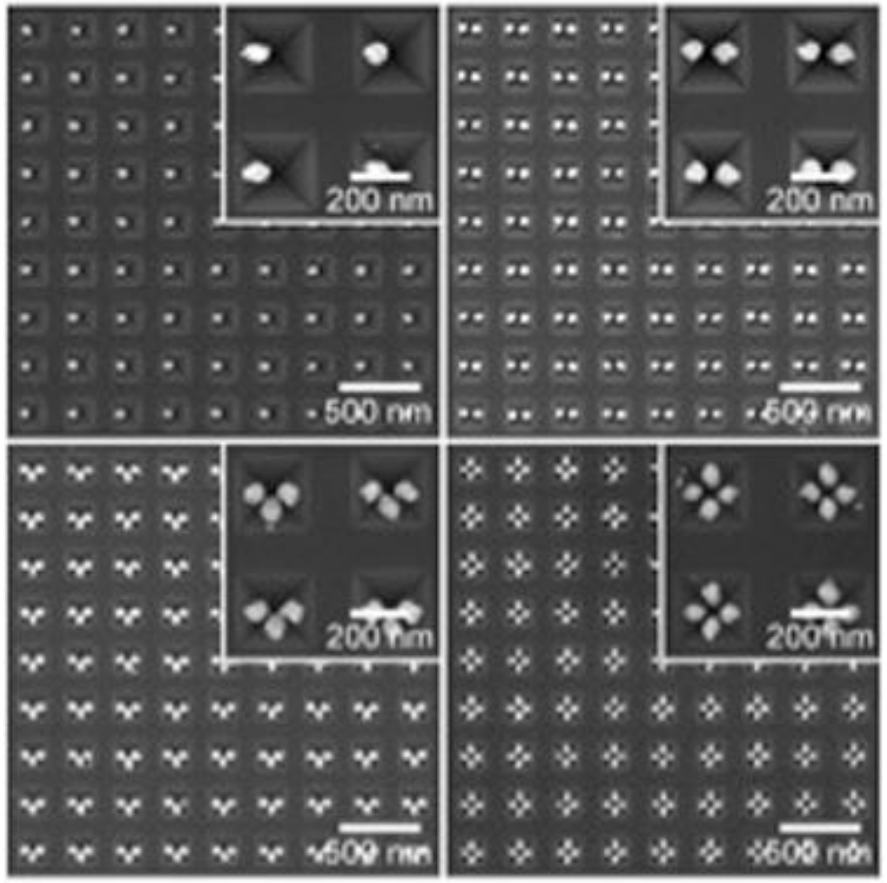
50 nm diameter Au NP dimer (5 nm gap) in water



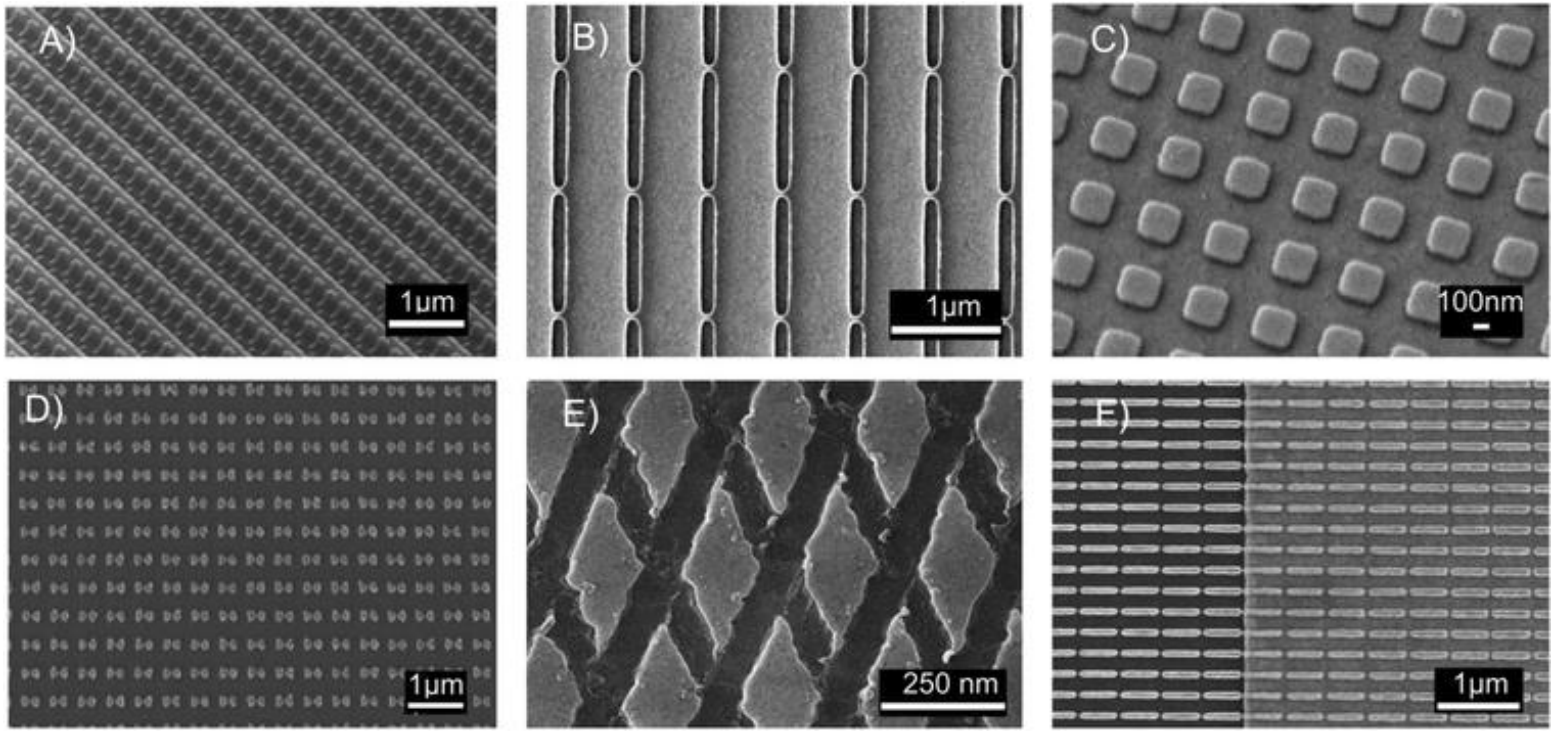
Frequency domain finite-element simulation

Active optical volume in the same order as a metabolite

Optical **nano**sensors



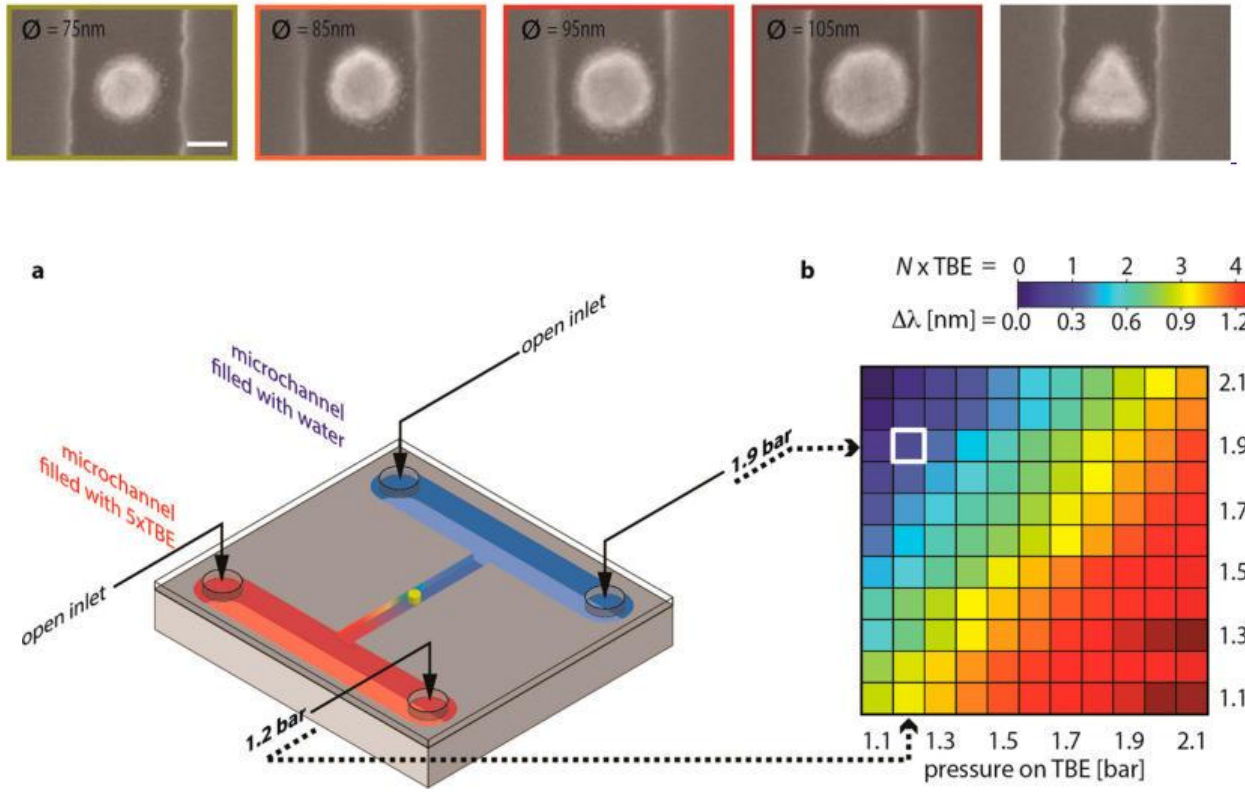
ACS Nano (2014), 8, 7639



(Review) Analyst (2016), 141, 756

Optical **nano**sensors

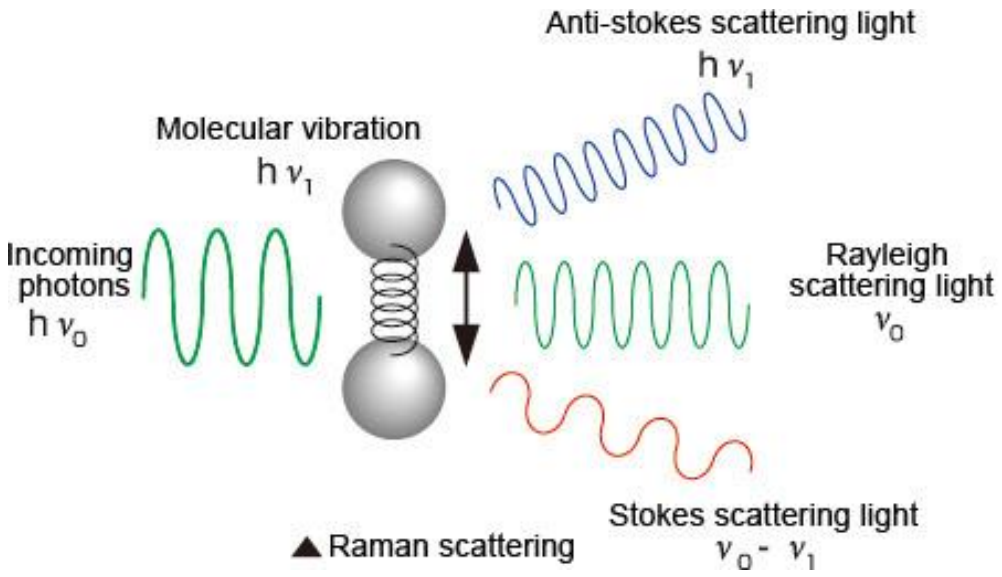
Single Particle Nanoplasmonic Sensing in Individual Nanofluidic Channels



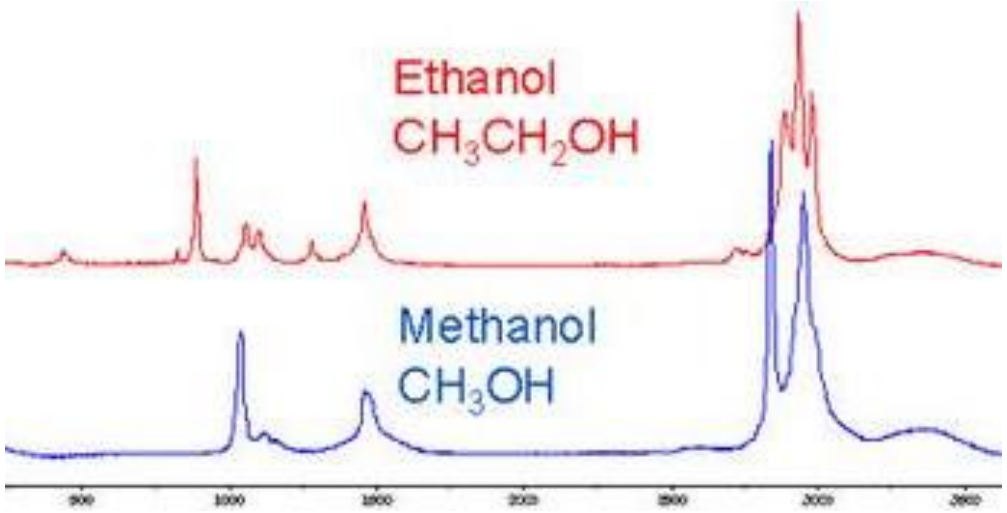
Nano Lett. (2016), 16, 7857

Is labeling necessary?

Toward non-labeled detection: Raman scattering

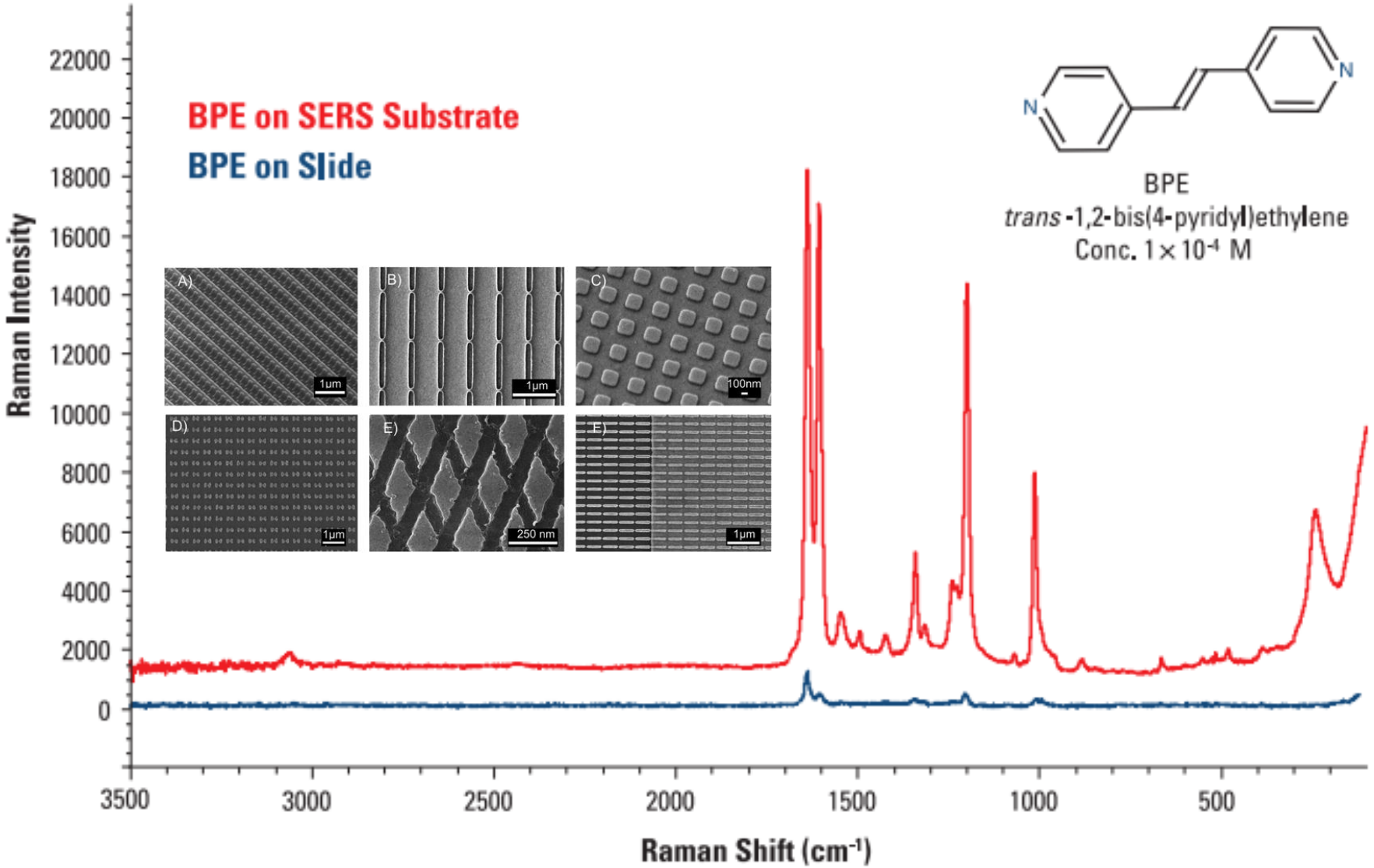


http://www.hamamatsu.com/eu/en/technology/lifephotonics/environment/SuperiorDetectionOfDiverseChemicals/index.html



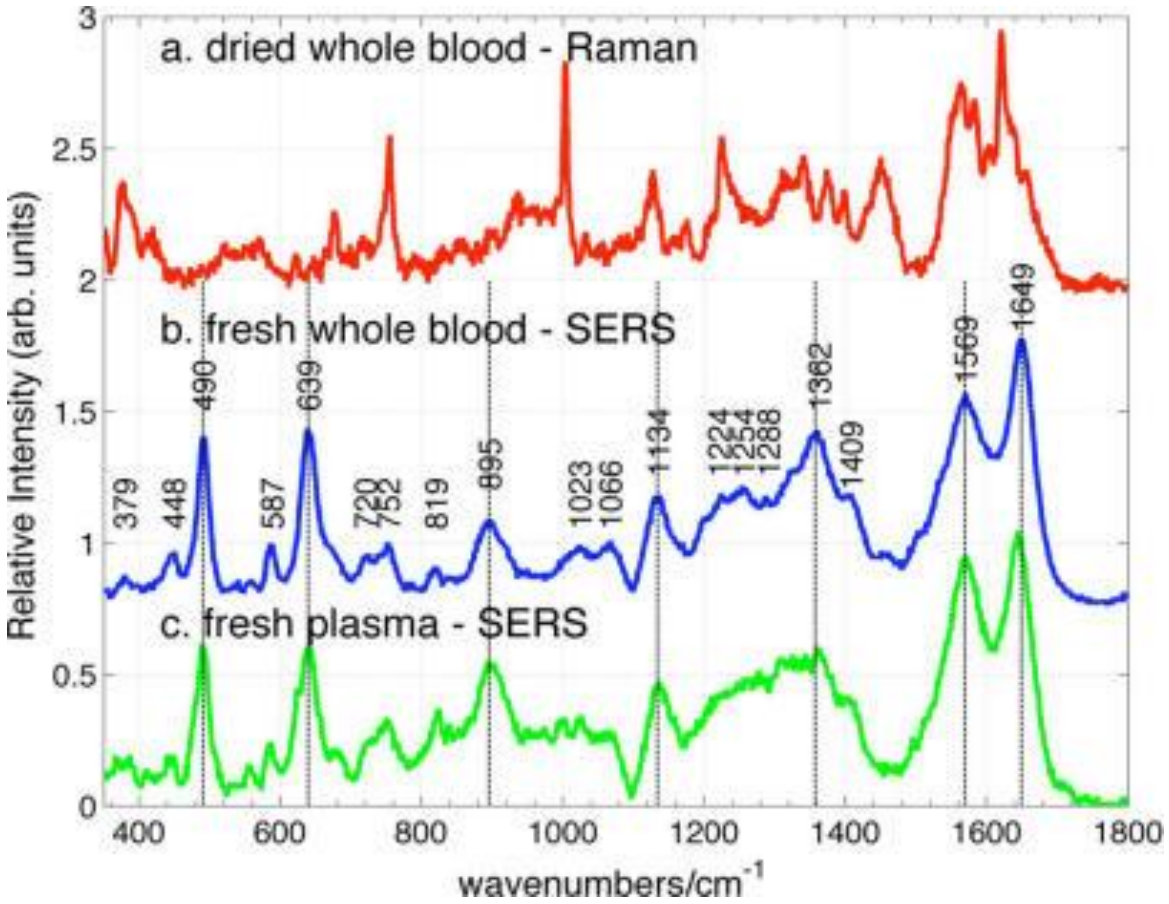
http://www.horiba.com/us/en/scientific/products/raman-spectroscopy/raman-academy/raman-faqs/what-information-does-raman-spectroscopy-give/

Technical Note: 51874, Thermo Fisher Scientific Inc.



Comparison of Raman spectrum of a BPE solution on a plain surface (bottom, blue line) and on a commercial SERS substrate (top, red line) measured at the same conditions

Biofluids/bodily fluids contain several metabolites



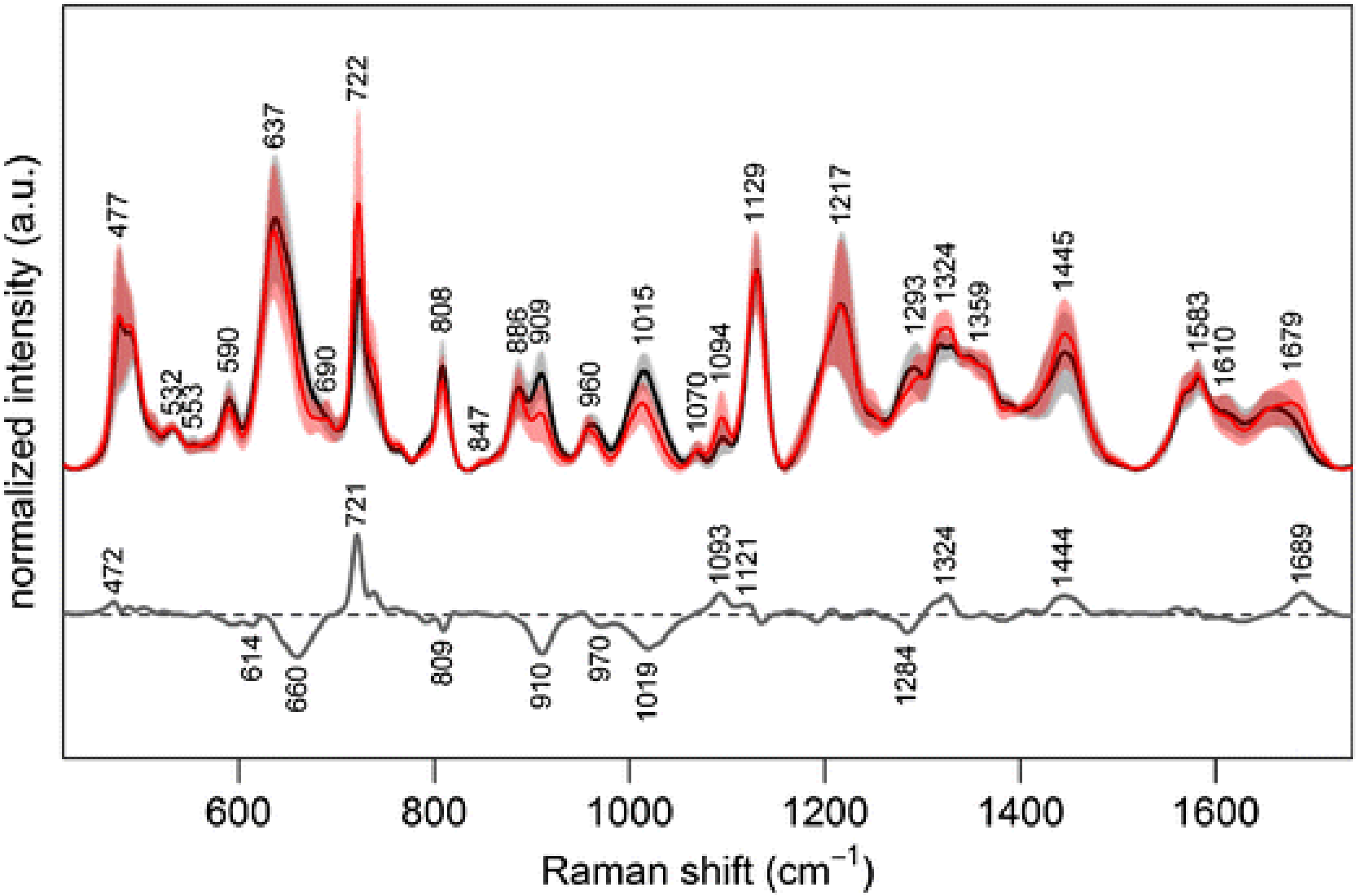
The 785 nm excited (b) SERS spectrum of fresh whole blood compared to (a) normal Raman spectrum of dried whole blood and (c) SERS spectrum of fresh plasma. The peak positions of the bands in the SERS spectrum of fresh whole blood are given in (b).

J. Phys. Chem. B (2012), 116, 9376

https://da-dk.mostphotos.com/365650/mess-of-cables

Machine learning (i.e. statistics)

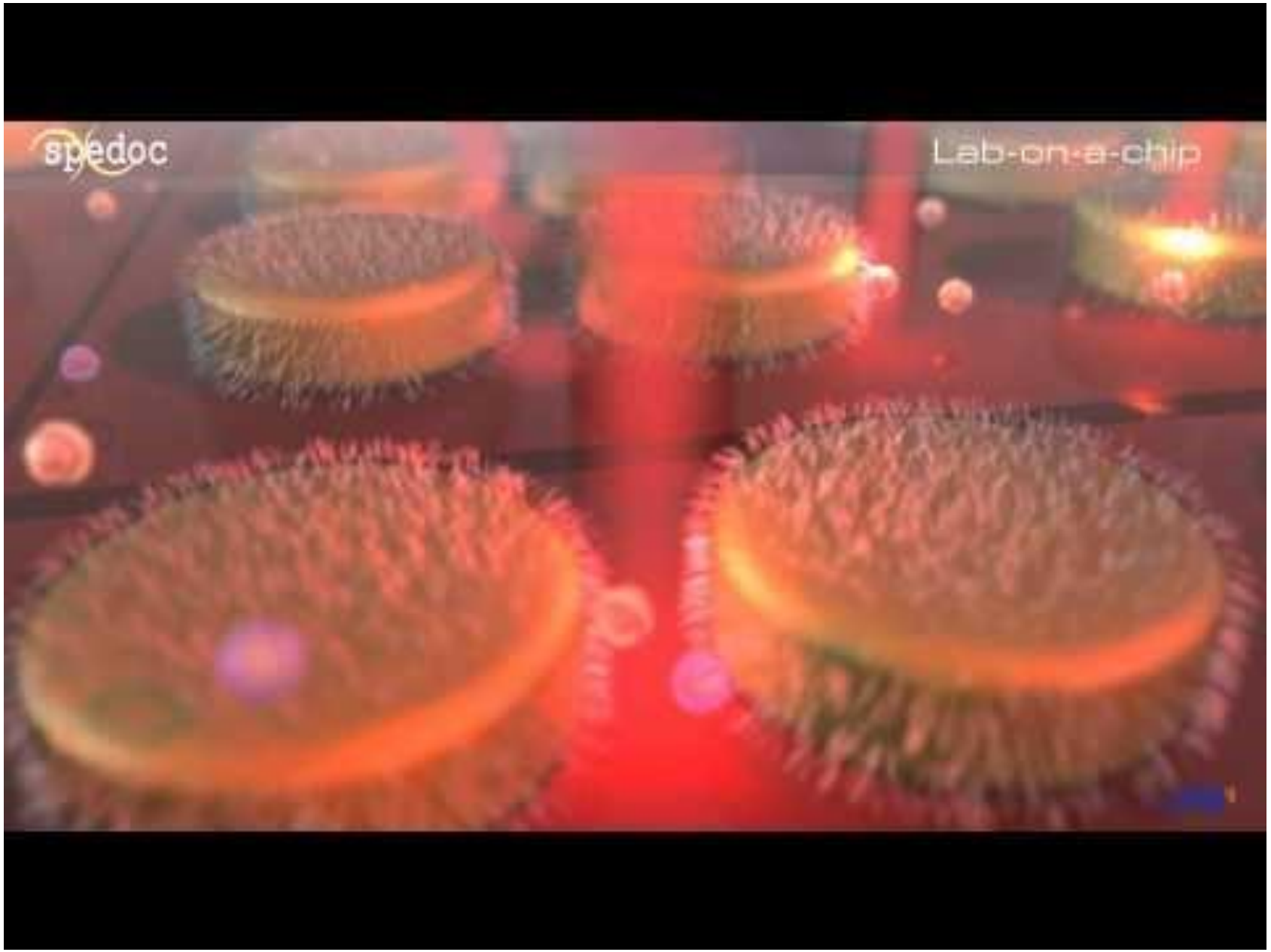
SERS + Machine learning → breast cancer detection



Analytical and Bioanalytical Chemistry (2015), 407, 7503

SERS + Machine learning is catching fire

Surface-enhanced Raman spectroscopy of urine for prostate cancer detection: a preliminary study	Anal Bioanal Chem (2015), 407, 3271
Optical diagnosis of malaria infection in human plasma using Raman spectroscopy	Journal of Biomedical Optics (2015), 20, 017002
Conductive silver paste smeared glass substrates for label-free Raman spectroscopic detection of HIV-1 and HIV-1 p24 antigen in blood plasma	Anal Bioanal Chem (2017) 409:3253–3259
Optical diagnosis of dengue virus infection in human blood serum using Raman spectroscopy	Laser Phys. Lett. (2013), 10, 035602
Label-free blood serum detection by using surface-enhanced Raman spectroscopy and support vector machine for the preoperative diagnosis of parotid gland tumors	BMC Cancer (2015), 15, 650


spedoc
Lab-on-a-chip

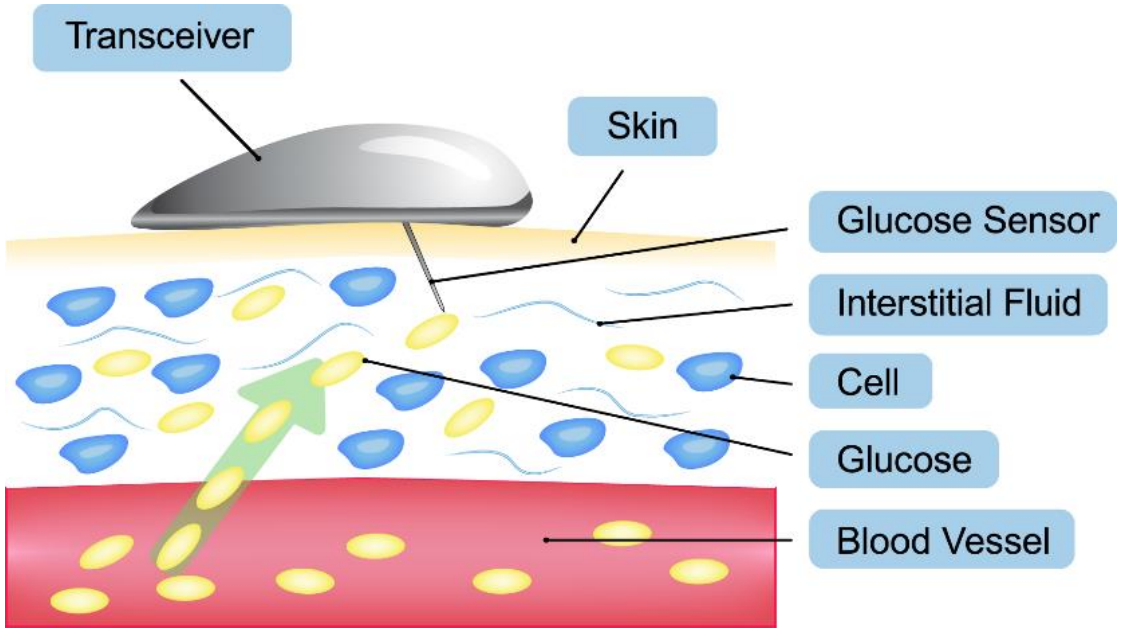

BIG DATA
&
INTERNET of THINGS

By **MARY BROPHY MARCUS** / **CBS NEWS** / *February 9, 2016, 11:42 AM*

Fitbit fitness tracker detects woman's pregnancy

A Fitbit tracks heart rate, steps, sleep, and calories, and apparently gives clues a woman may be pregnant, a man learned after thinking the fitness tracker was just faulty. His wife was wearing a Fitbit Surge. / **FITBIT**

Continuous Glucose Monitoring



Harvard Business Review

ANALYTICS

How Machine Learning Is Helping Us Predict Heart Disease and Diabetes

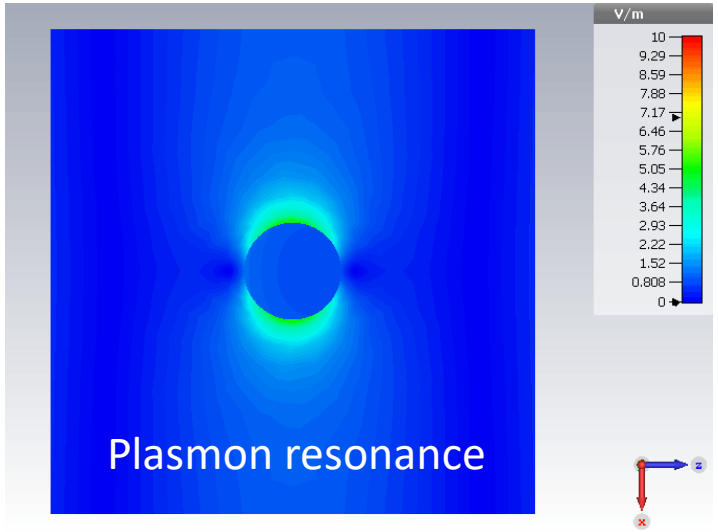
by Yannis Paschalidis

MAY 30, 2017

IBM Watson

Summary

Nanoscale phenomena



Big data and machine learning

Raman and surface enhanced Raman spectroscopy