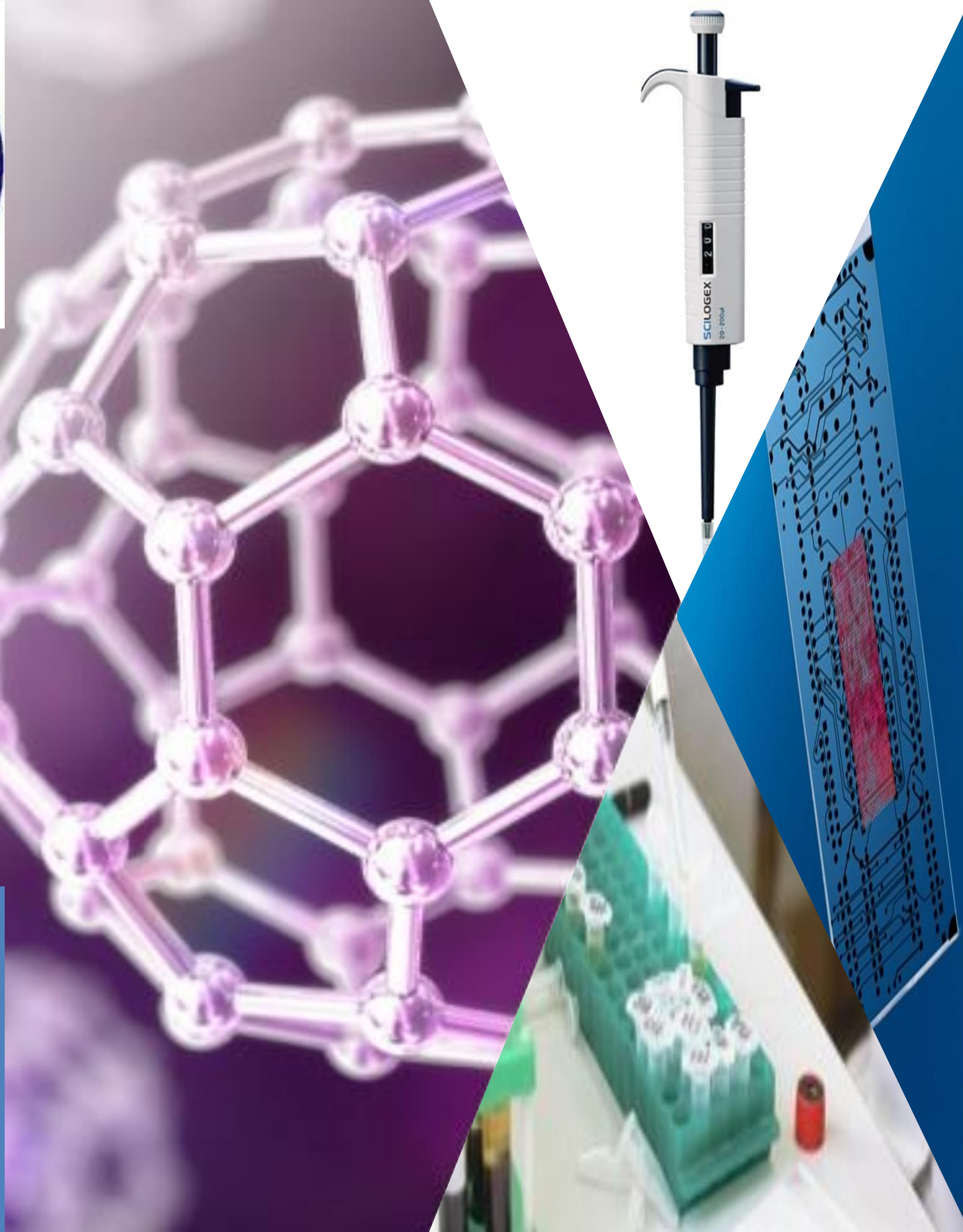


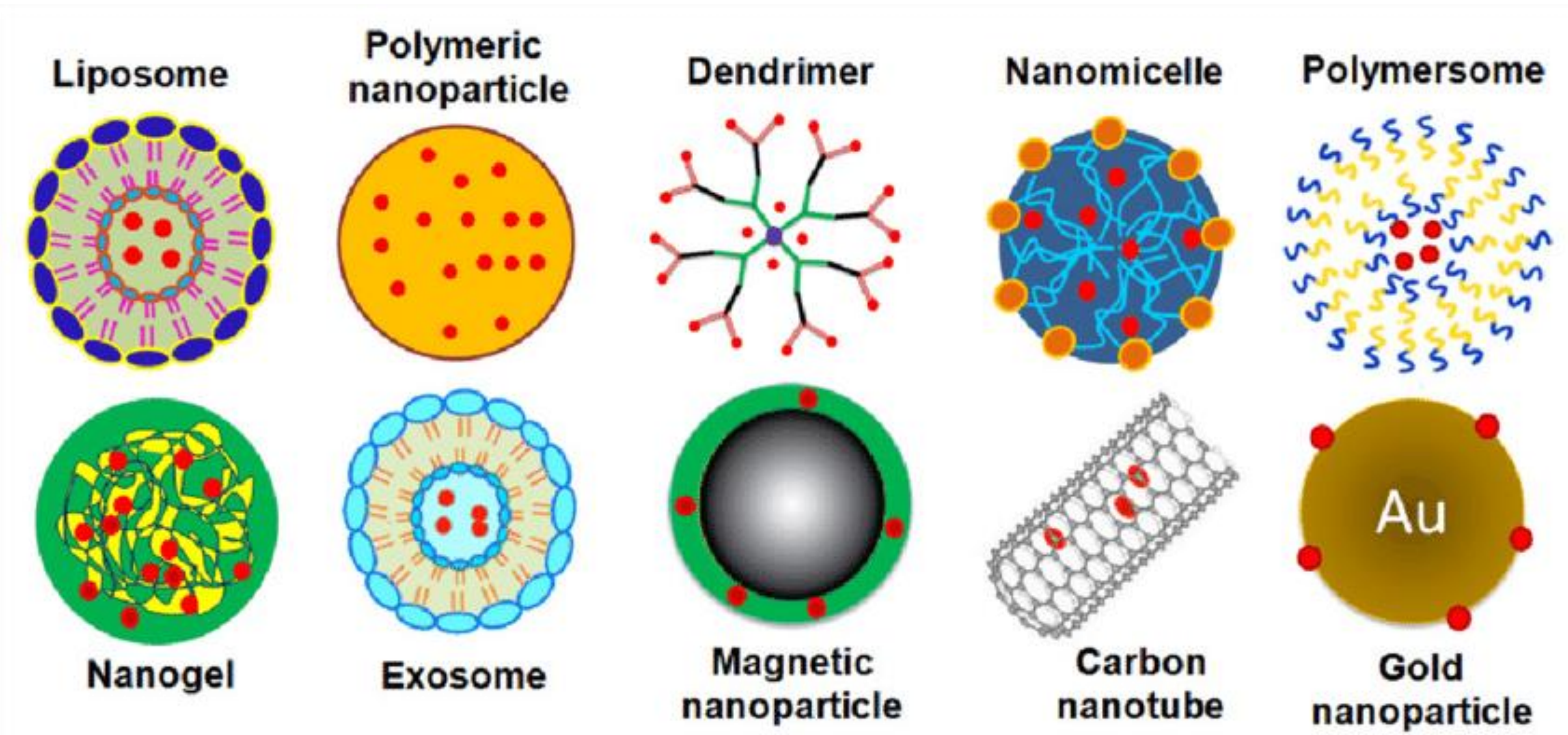
APPLICATIONS OF NANOBIOTECHNOLOGY APPROACHES

Dr. Hisham F. Mohammad

PhD. Applied Bionanotechnology

HD and MSc Genetic engineering

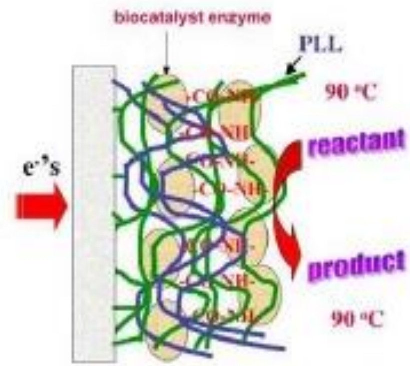
Nanoparticles



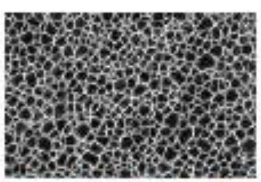
Bionanomaterials

<u>Bionanomaterials</u>

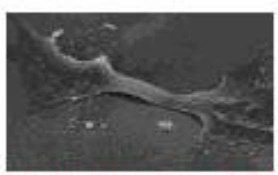
1) **Biological materials utilized in nanotechnology**
   - Proteins, enzymes, DNA, RNA, peptides
2) **Synthetic nanomaterials utilized in biomedical applications**
   - Polymers, porous silicon, carbon nanotubes



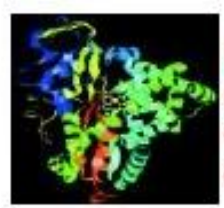
Cross-linked enzymes used as catalyst – *Univ. of Connecticut, Storrs , 2007*



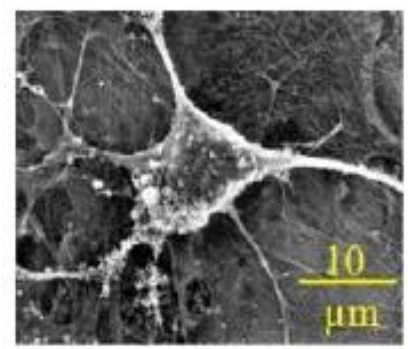
Porous silicon (PSi)



Human cell on PSi

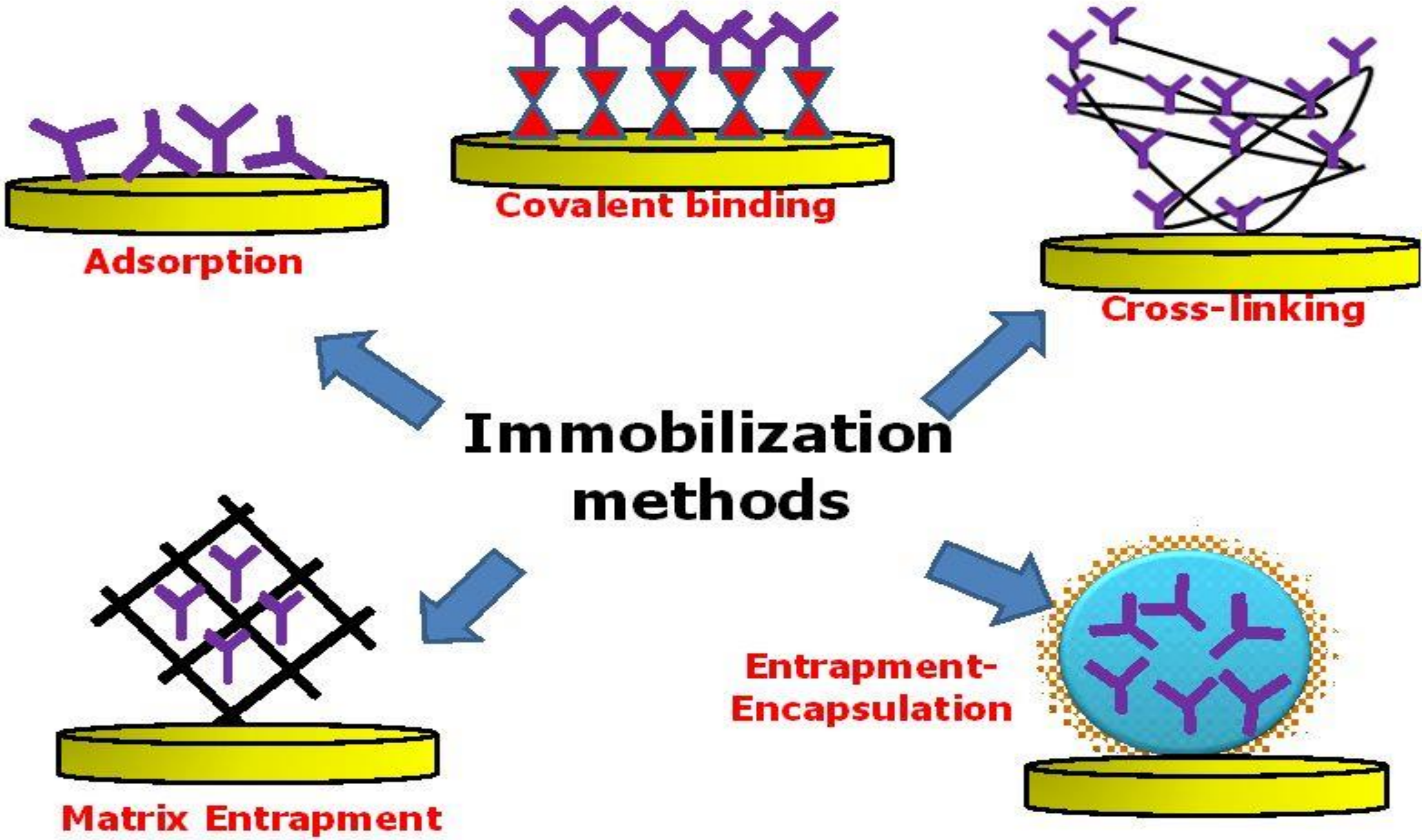


Enzymes are used as oxidation catalysts

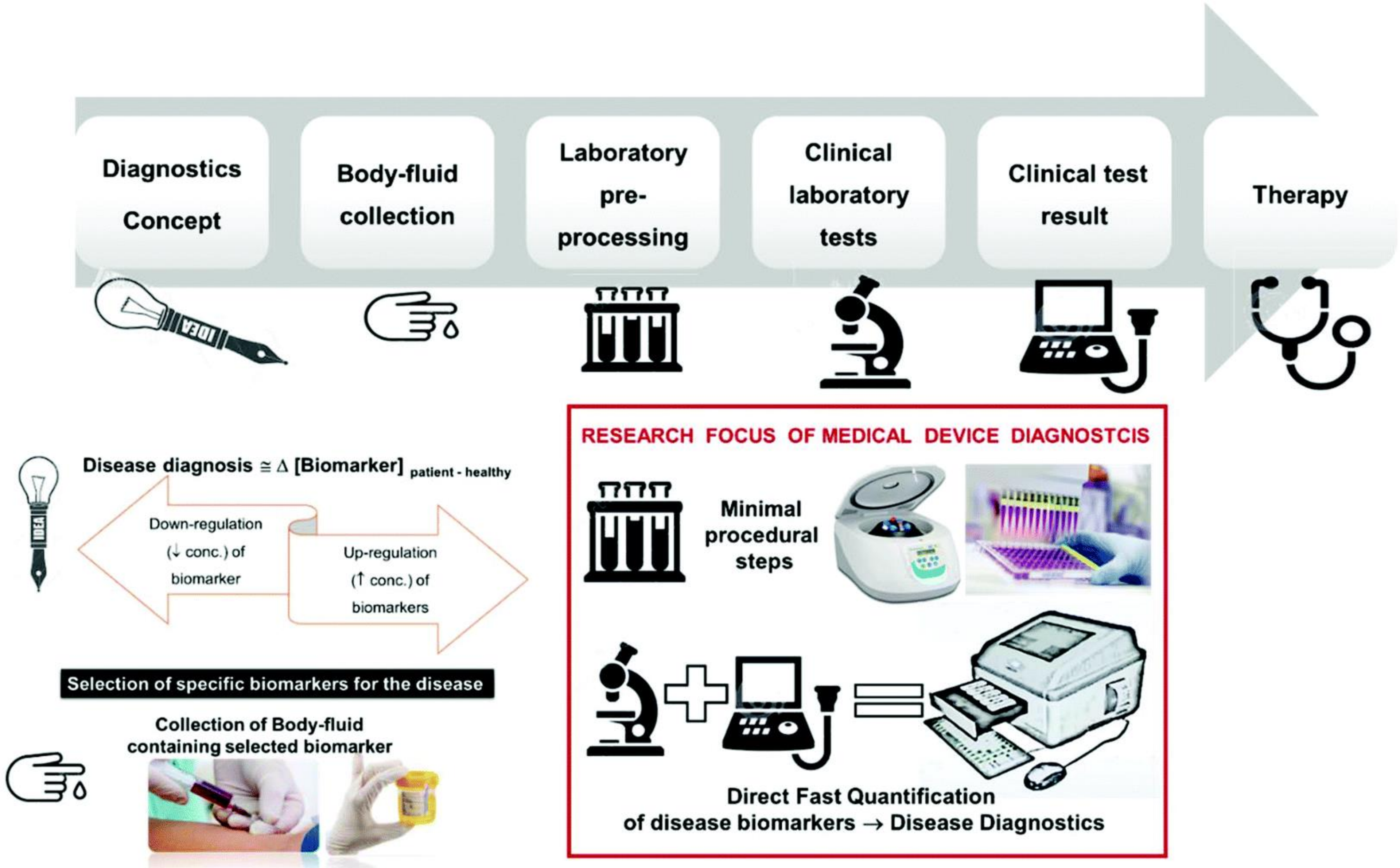


Bone cell on porous silicon – *Univ. of Rochester, 2007*

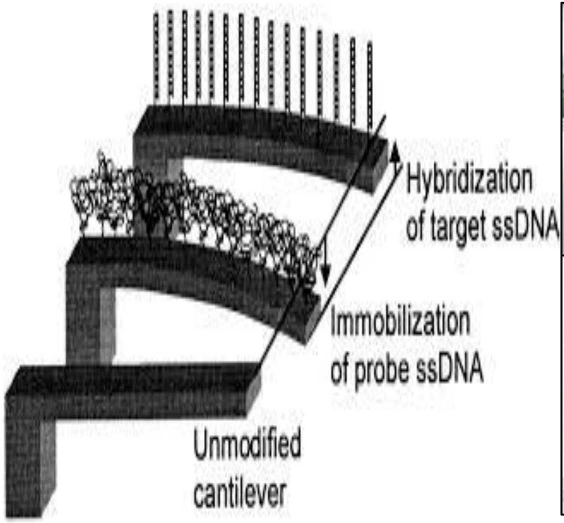
Immobilization Protocol

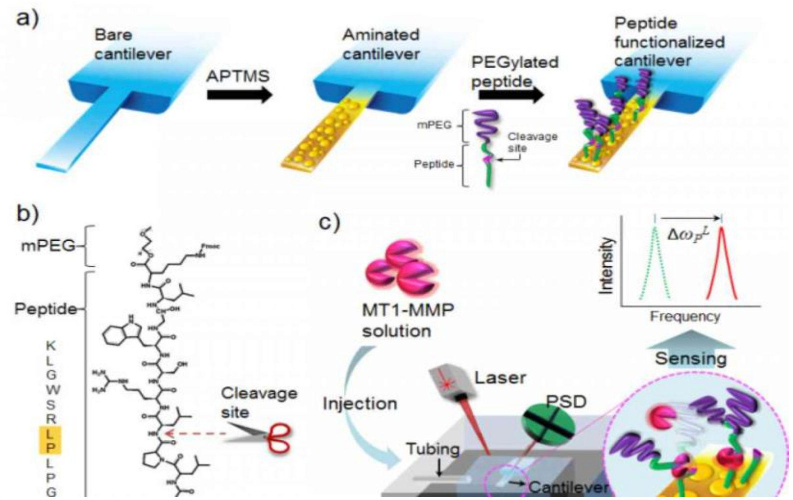


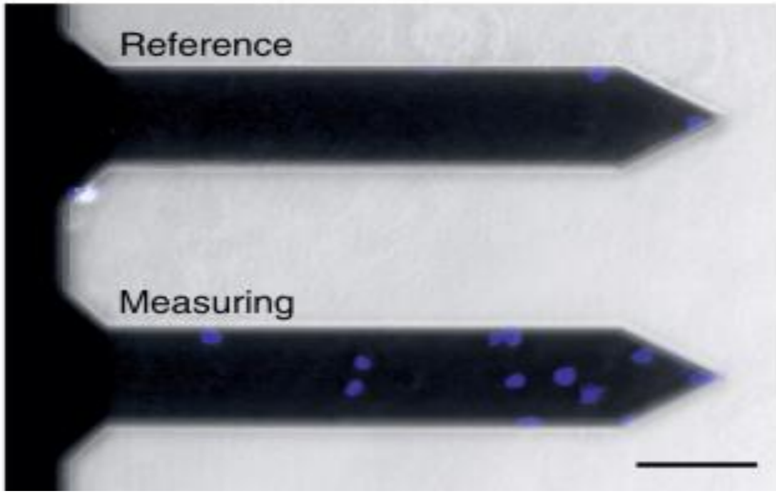
Applications

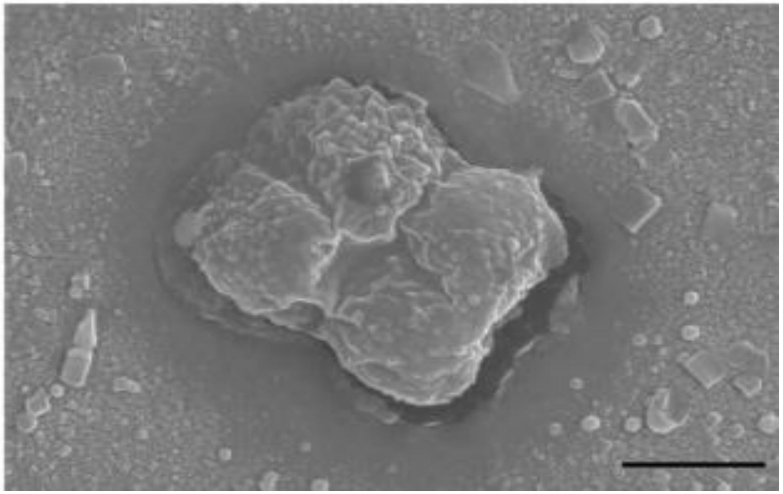


Nanocantilevers

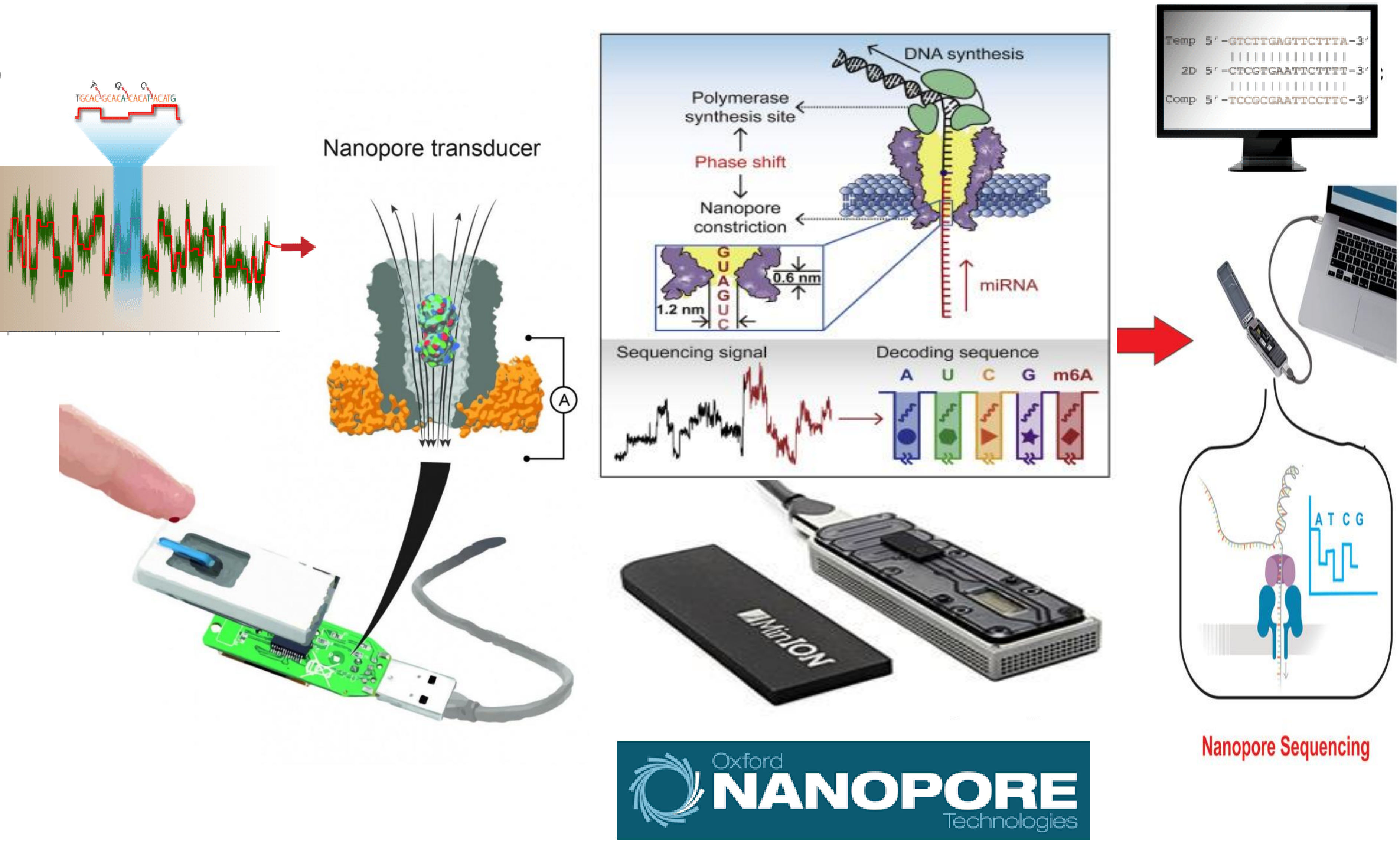




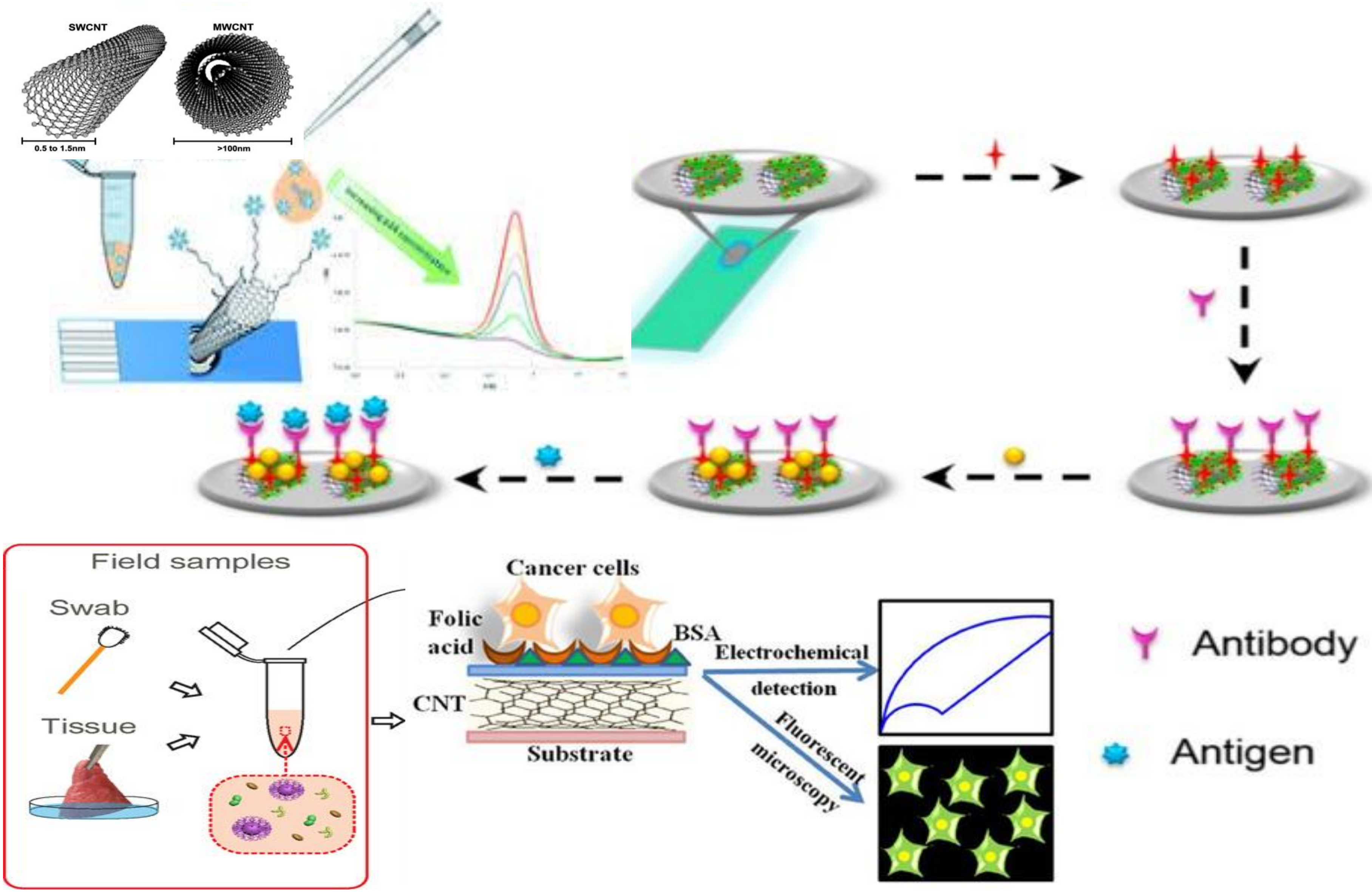




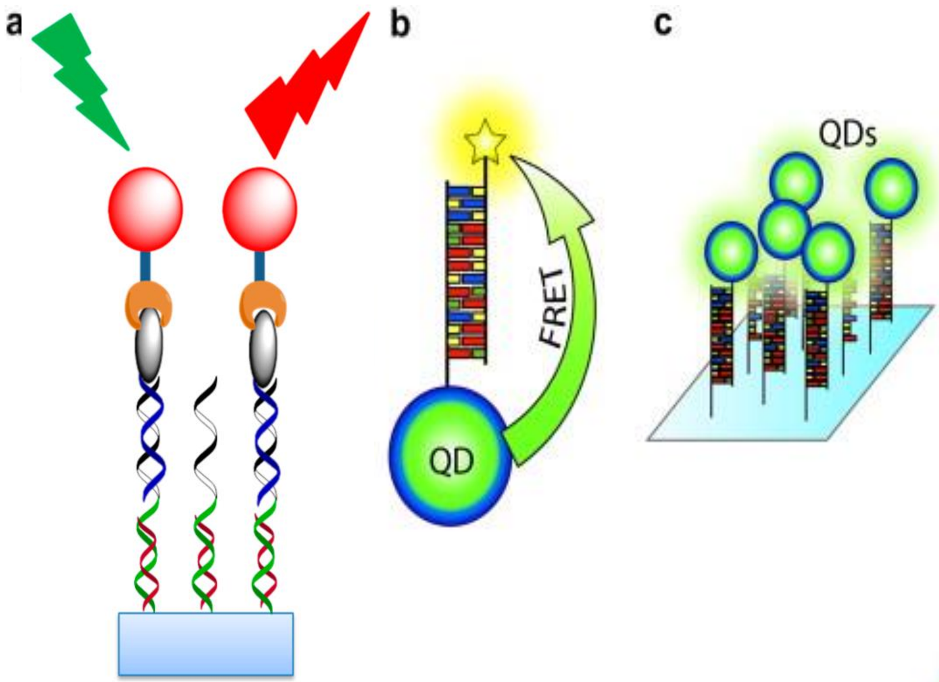
Nanopores

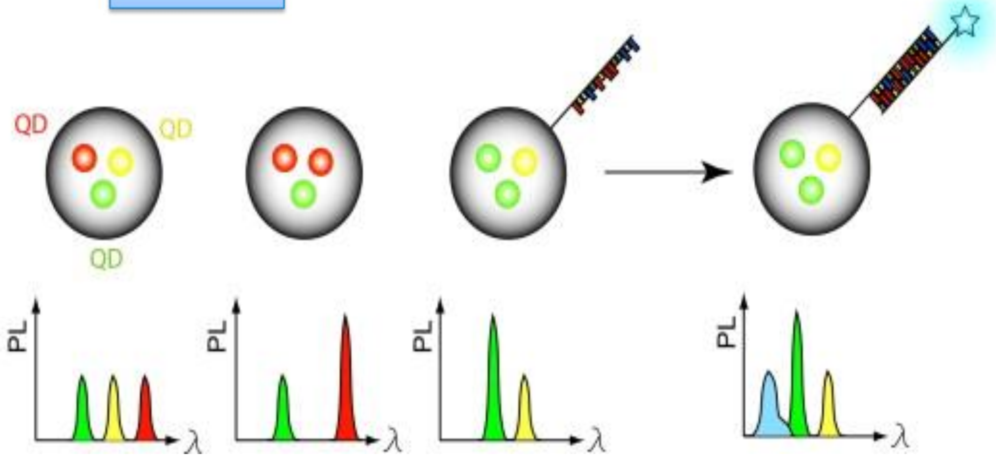

Nanopore transducer
DNA synthesis
Polymerase synthesis site
Phase shift
Nanopore constriction
0.6 nm
1.2 nm
miRNA
Sequencing signal
Decoding sequence
A
U
C
G
m6A
Temp 5'-GTCTTGAGTTCTTTA-3'
2D 5'-CTCGTGAATTCTTTT-3'
Comp 5'-TCCGCGAATTCCTTC-3'
A T C G
MinION
Nanopore Sequencing
Oxford NANOPORE Technologies

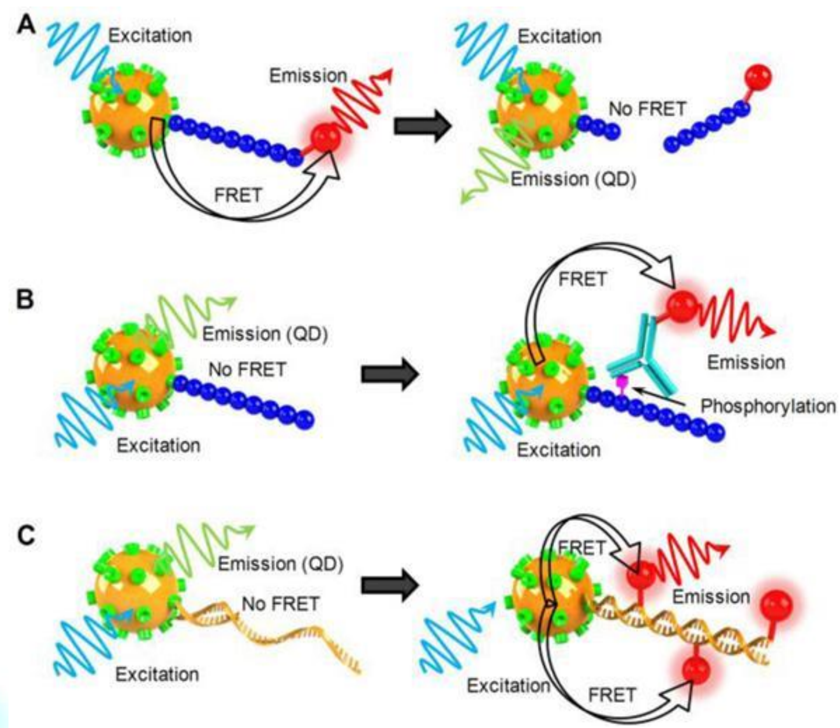
CarbonNanoTubes

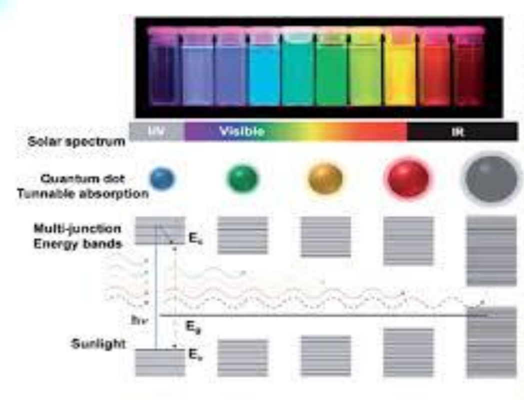


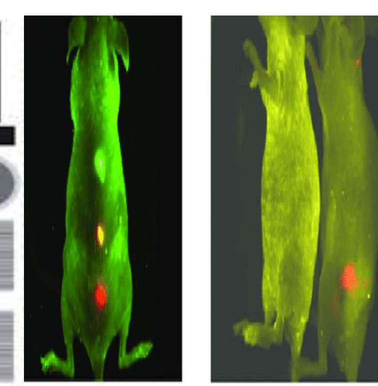
Quantum NanoDots



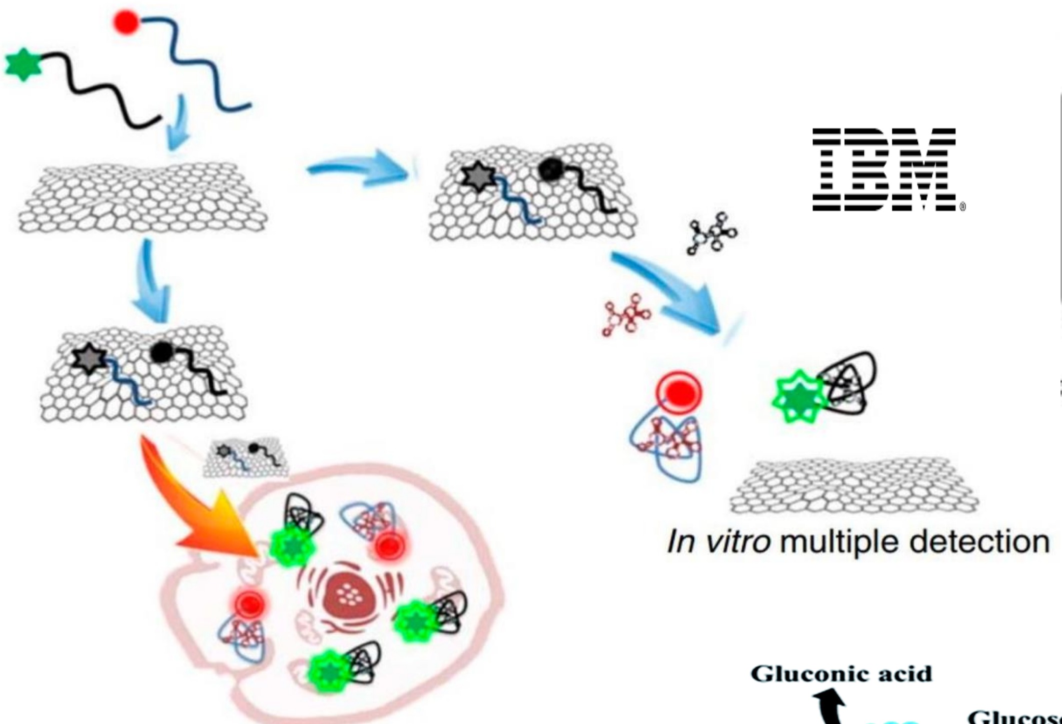


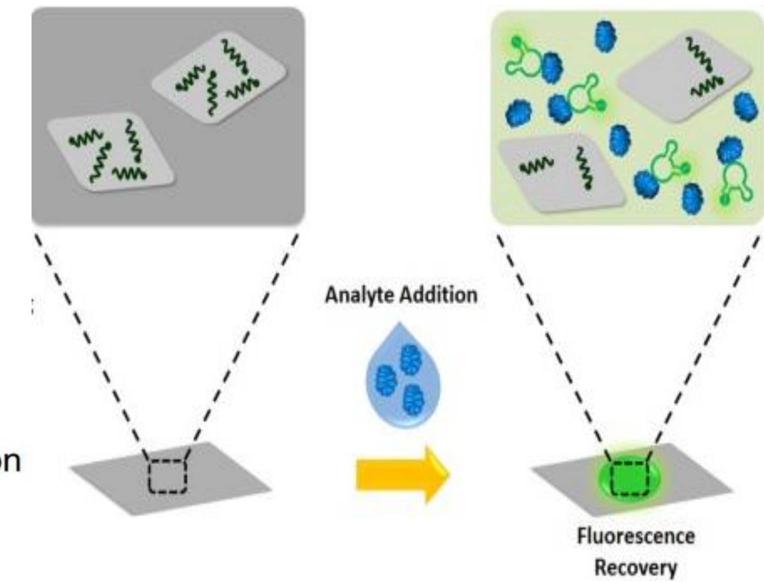


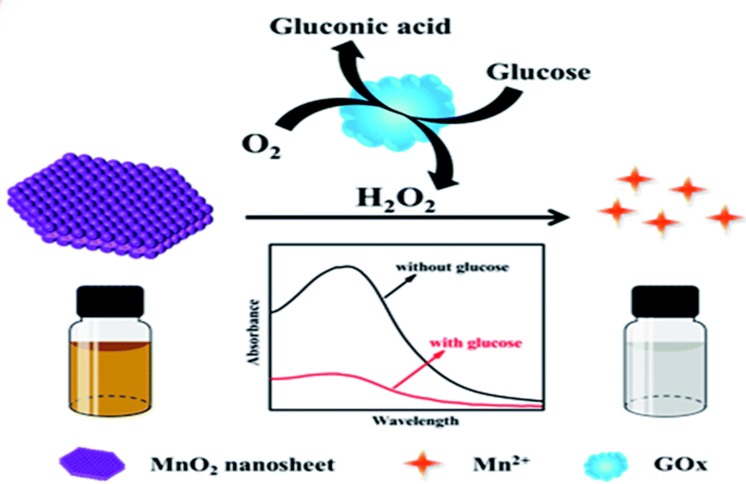


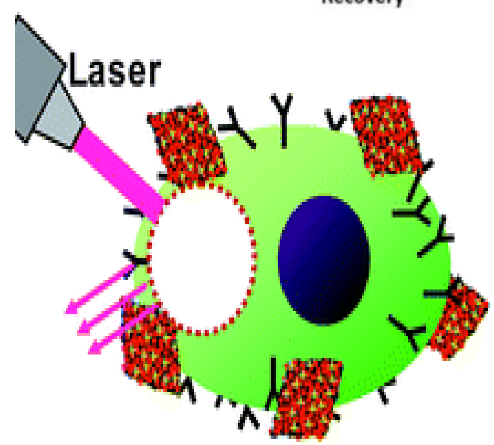


Nanosheets

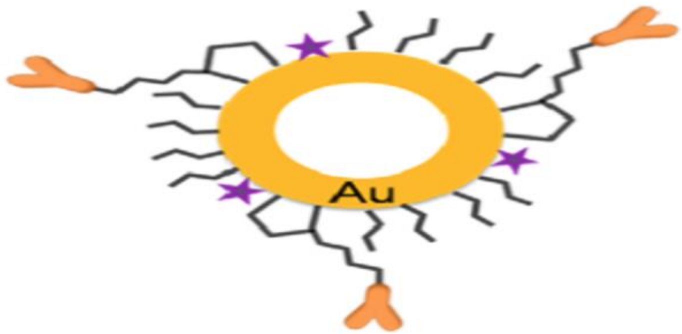

In vitro multiple detection

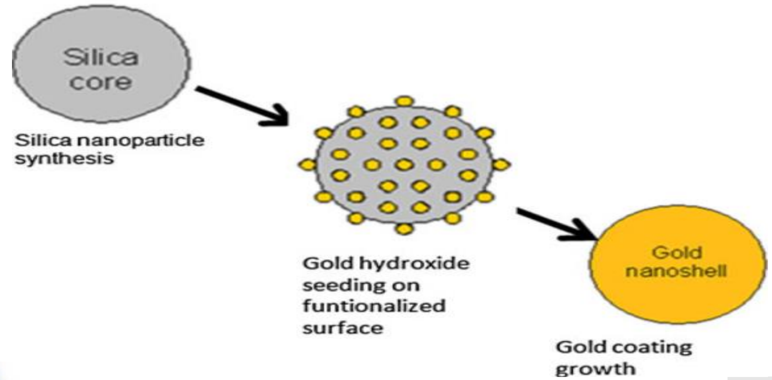

Analyte Addition
Fluorescence Recovery

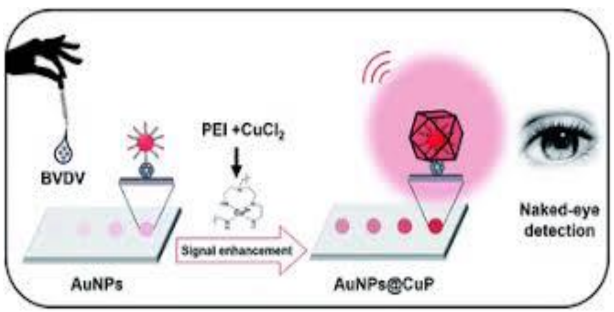

Gluconic acid
Glucose
O_2
H_2O_2
without glucose
with glucose
Absorbance
Wavelength
MnO_2 nanosheet
Mn^{2+}
GOx

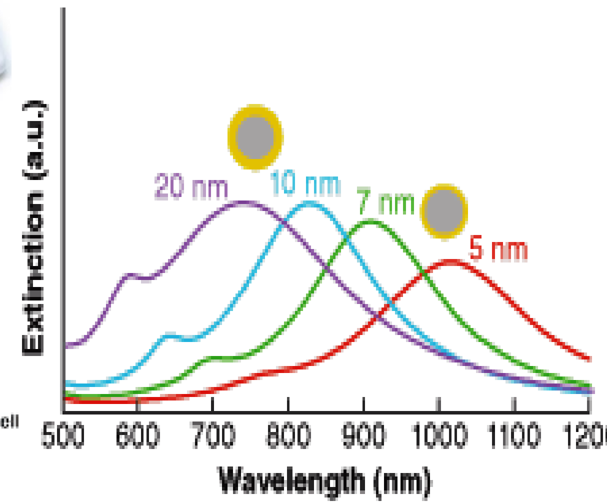

Laser

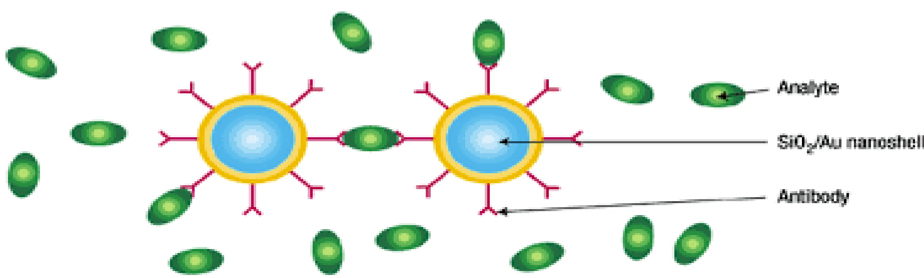
Nanoshells


Au

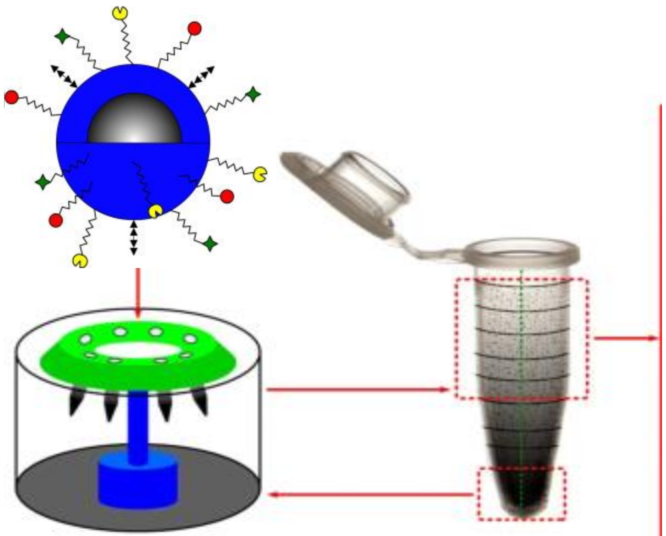

Silica core
Silica nanoparticle synthesis
Gold hydroxide seeding on funtionalized surface
Gold nanoshell
Gold coating growth

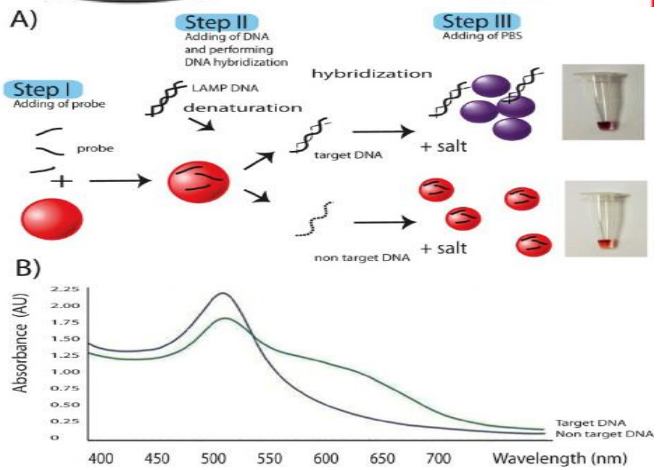

BVDV
PEI +CuCl$_2$
Signal enhancement
Naked-eye detection
AuNPs
AuNPs@CuP

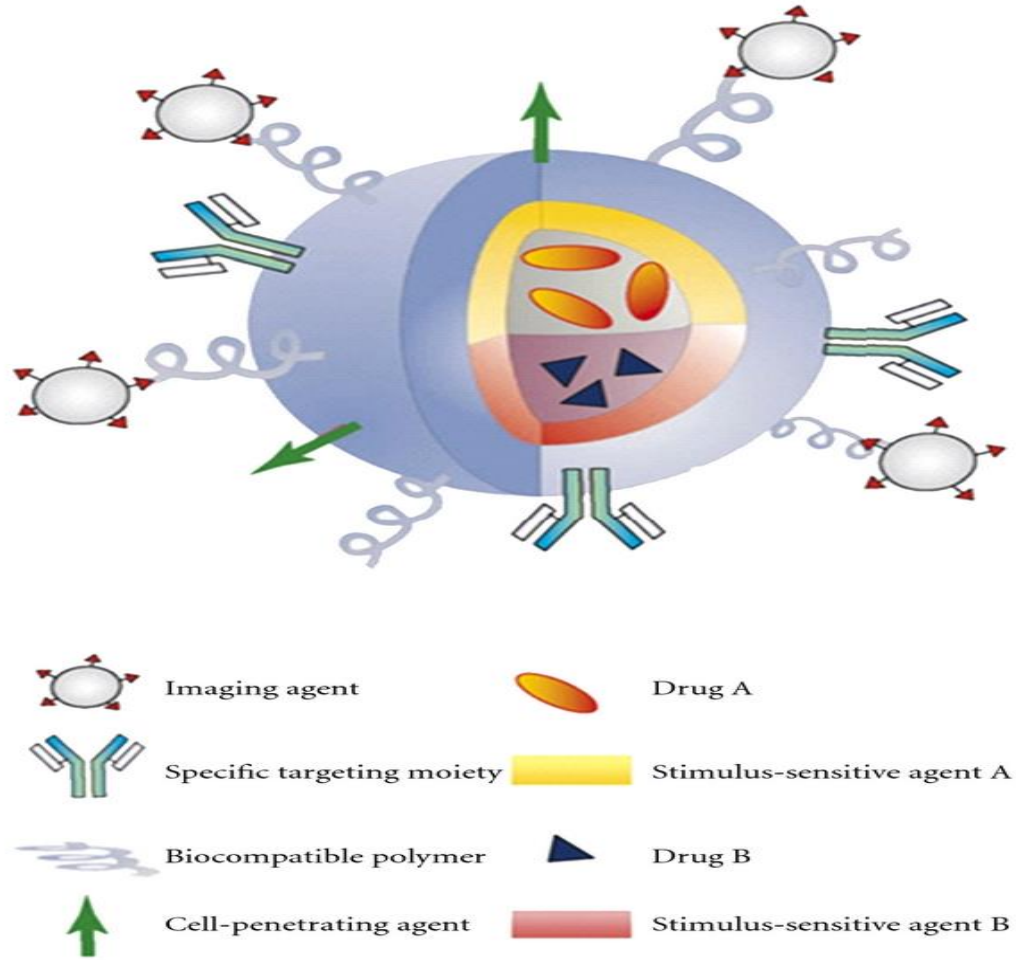

Extinction (a.u.)
20 nm
10 nm
7 nm
5 nm
500 600 700 800 900 1000 1100 1200
Wavelength (nm)


Analyte
SiO$_2$/Au nanoshell
Antibody

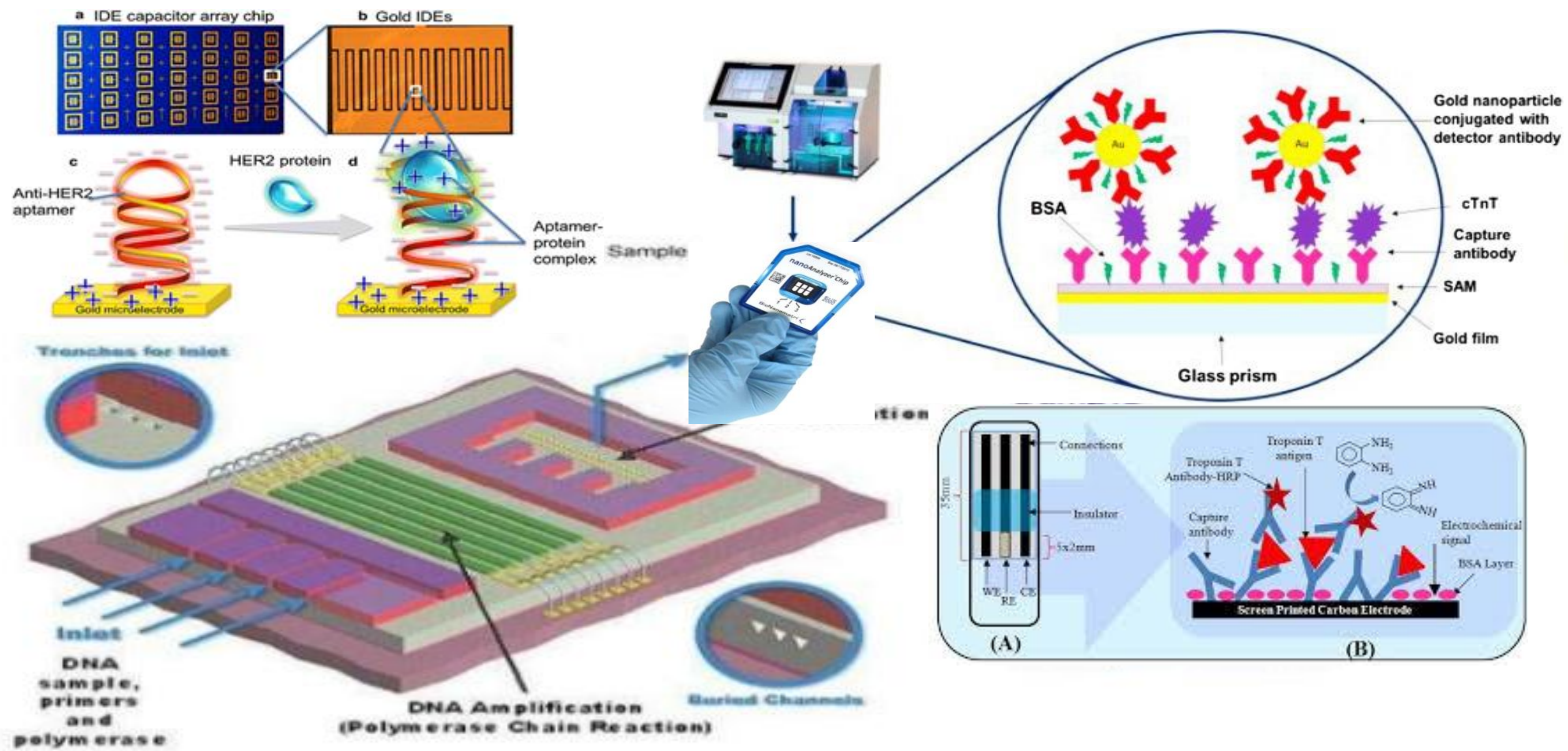
Magnetic Nanoparticles



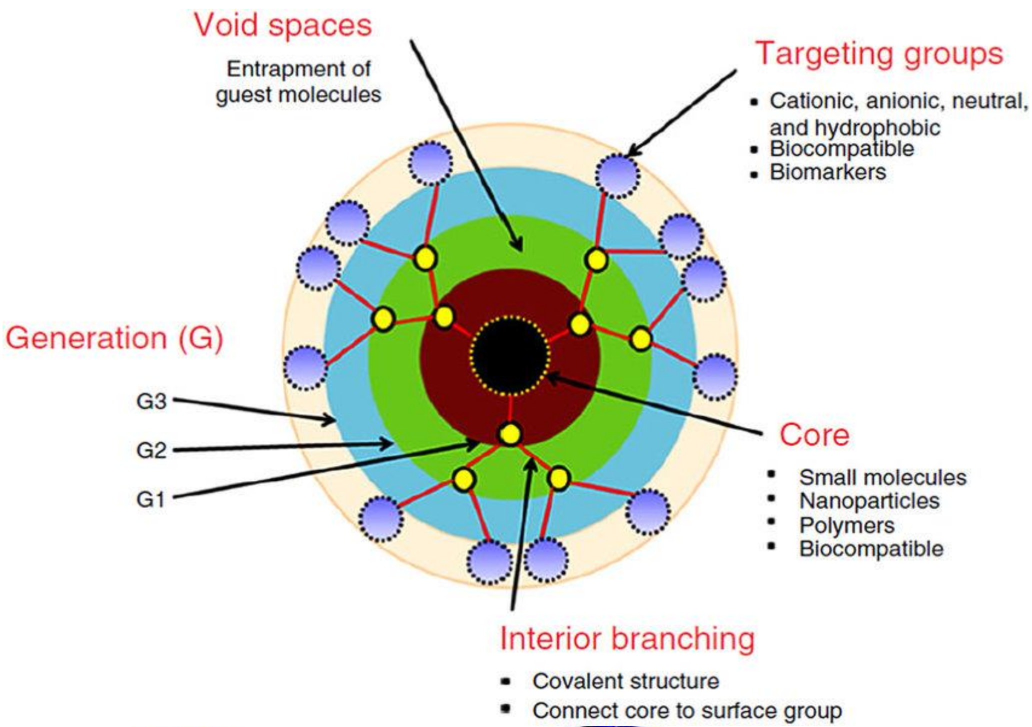




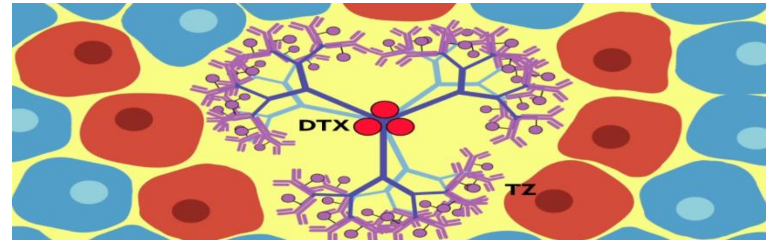
Bio-NanoChip



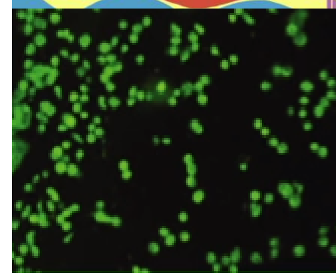
Dendrimers

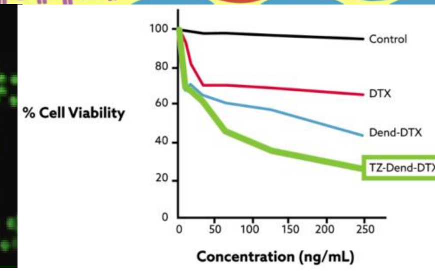


Void spaces
Entrapment of guest molecules
Targeting groups
• Cationic, anionic, neutral, and hydrophobic
• Biocompatible
• Biomarkers
Generation (G)
G3
G2
G1
Core
• Small molecules
• Nanoparticles
• Polymers
• Biocompatible
Interior branching
• Covalent structure
• Connect core to surface group

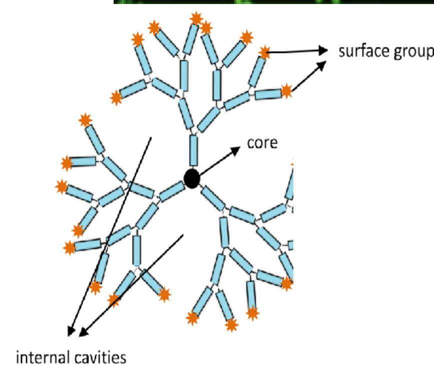


DTX
TZ

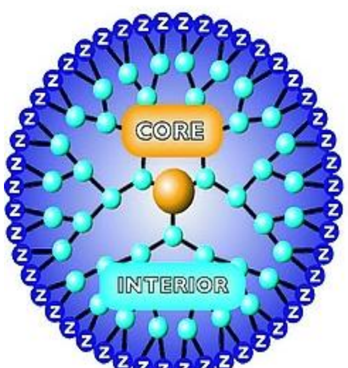




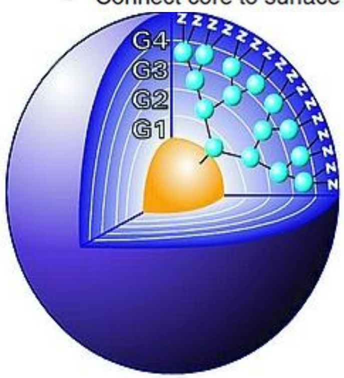
% Cell Viability
Control
DTX
Dend-DTX
TZ-Dend-DTX
Concentration (ng/mL)



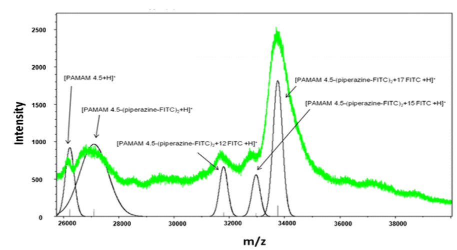
surface groups
core
internal cavities



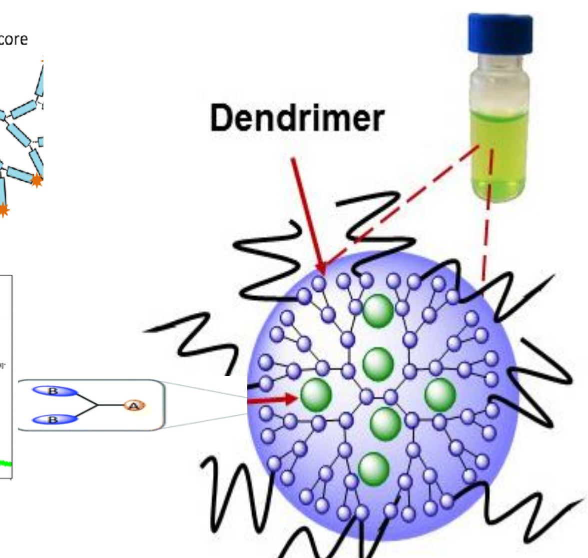
CORE
INTERIOR



G4
G3
G2
G1

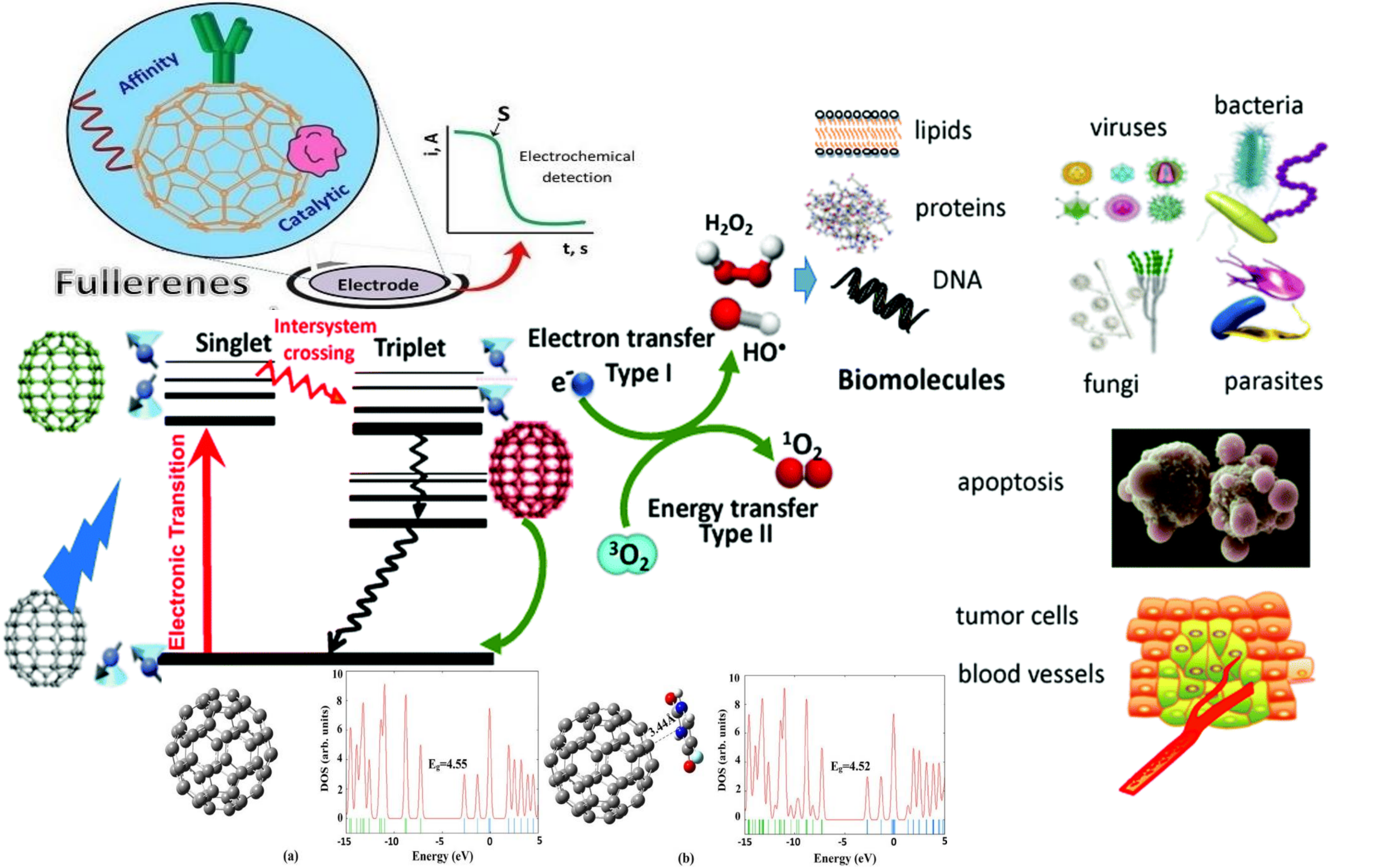


Intensity
m/z



Dendrimer

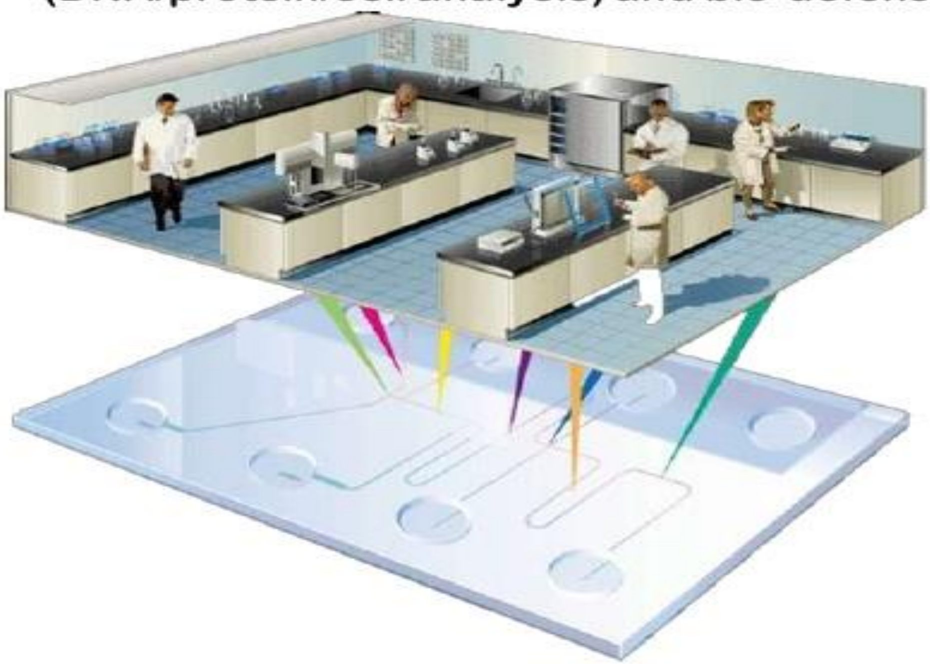
Fullerenes C60

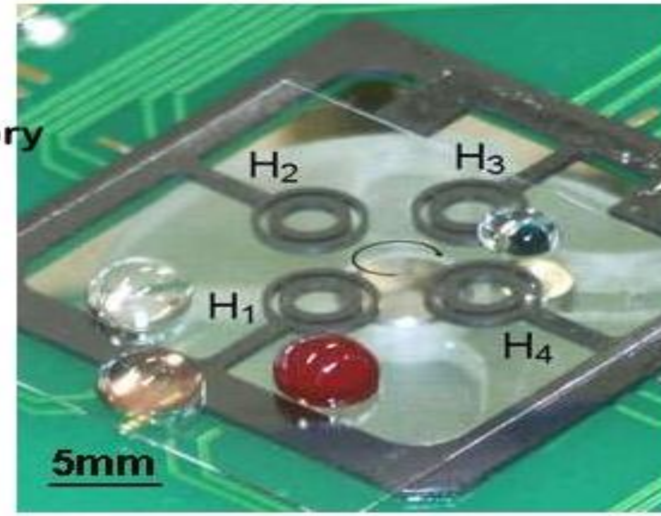


Lab on Chip

Lab on Chip

- A lab on chip integrates one or more laboratory operation on a single chip
- Provides fast result and easy operation
- Applications: Biochemical analysis (DNA/protein/cell analysis) and bio-defense

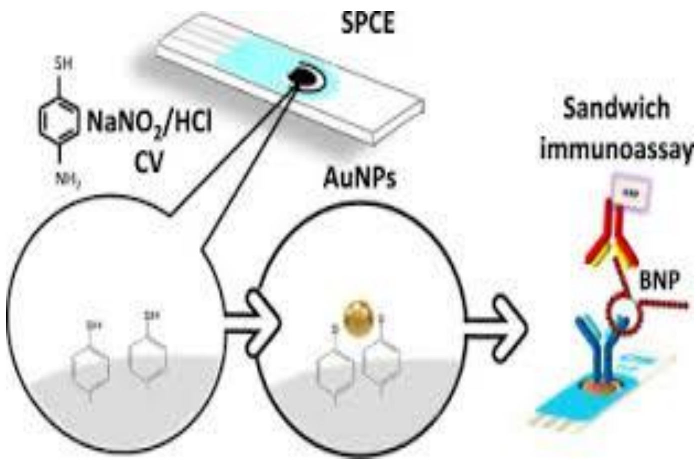


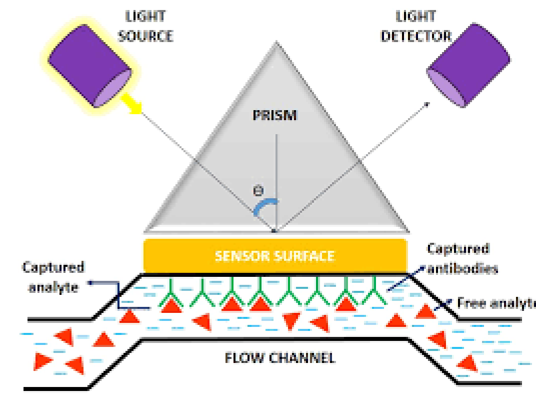


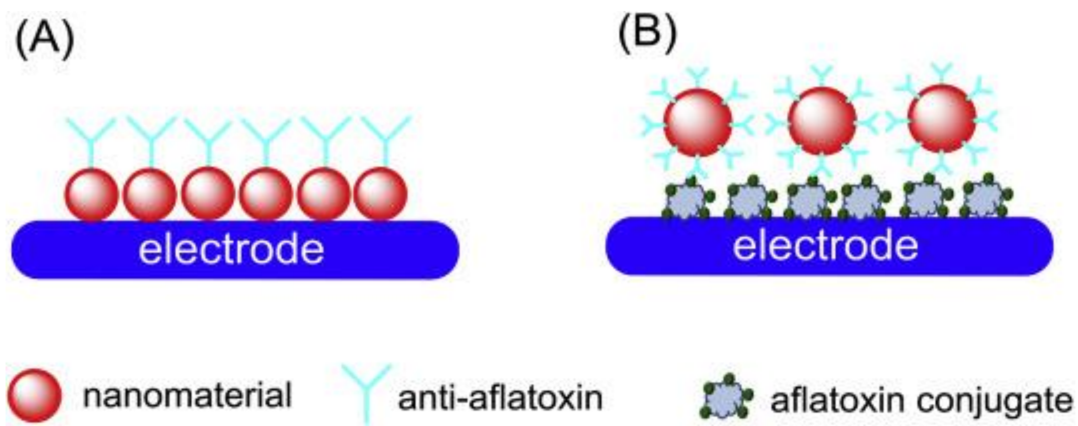
Fabrication of Gene chip

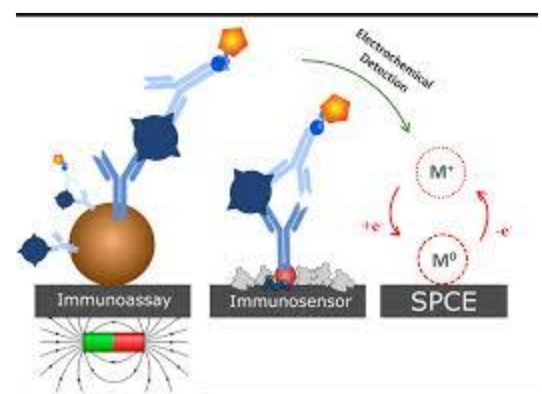
Potential applications:
(1) Lab-on-a-chip applications
(2) Early cancer detection
(3) Infectious disease detection
(4) Environmental monitoring
(5) Pathogen detection

Real Time Immune Sensor









LSPR/TIRE bio-sensing platform for detection of low molecular weight toxins

Publisher: IEEE

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Ali Al-Rubaye ; Alexei Nabok ; Hisham Abu-Ali ; Andras Szekacs ; Ester Takacs All Authors

LSPR/TIRE bio-sensing platform for detection of low molecular weight toxins

Ali Al-Rubaye, Alexei Nabok, Hisham Abu-Ali
Materials and Engineering Research Institute, Sheffield Hallam University, UK
Andras Szekacs, Ester Takacs
Agro-Environmental Research Institute, NARIC, Budapest, Hungary

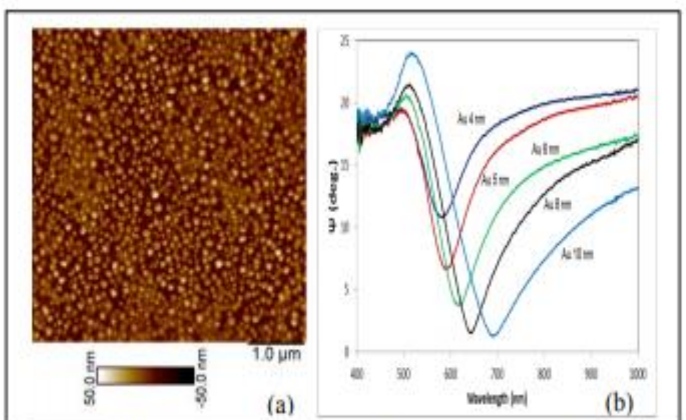


Fig.1. (a) AFM image of 5nm thick film after annealing at 550C°; (b) ellipsometry Ψ spectra of nano-structured Au films of different thickness.

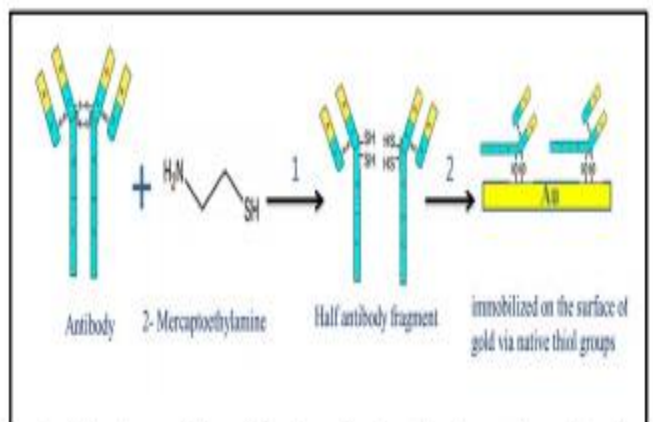


Fig. 3. The scheme of immobilization of split antibodies on the gold surface.

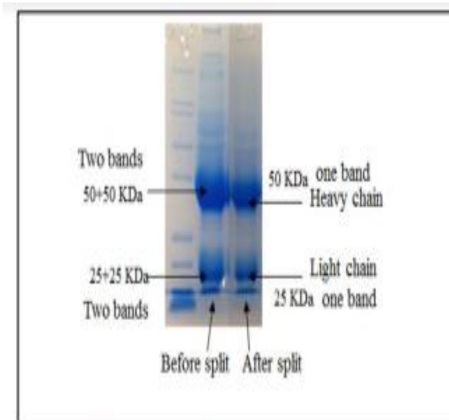


Fig. 4. SDS – PAG electrophoresis of antibodies before and after splitting

Analytical and Bioanalytical Chemistry
https://doi.org/10.1007/s00216-019-02033-4

RESEARCH PAPER

Highly sensitive label-free in vitro detection of aflatoxin B1 in an aptamer assay using optical planar waveguide operating as a polarization interferometer

Ali Al-Jawdah[1] · Alexei Nabok[1] · Hisham Abu-Ali[1] · Gaelle Catanante[2] · Jean-Louis Marty[2] · Andras Szekacs[3]

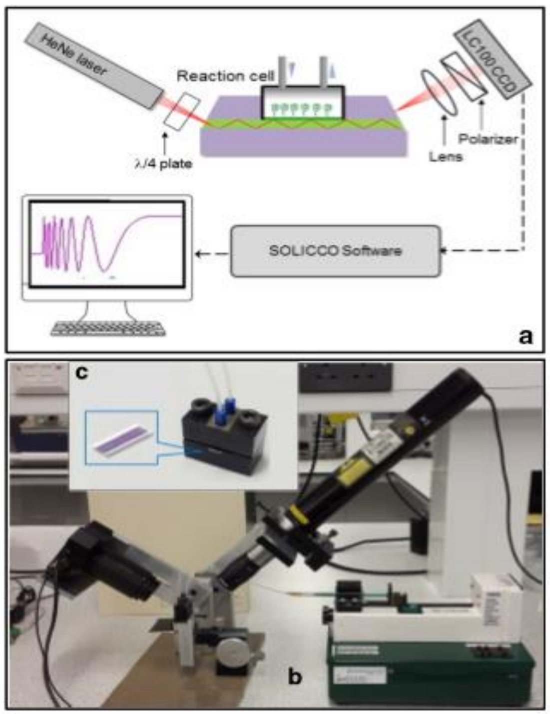


Fig. 1 Schematic diagram (**a**) and photograph (**b**) of the PI OPW experimental setup; the reaction cell with inserted OPW (**c**), the inset shows zoomed-in OPW chip

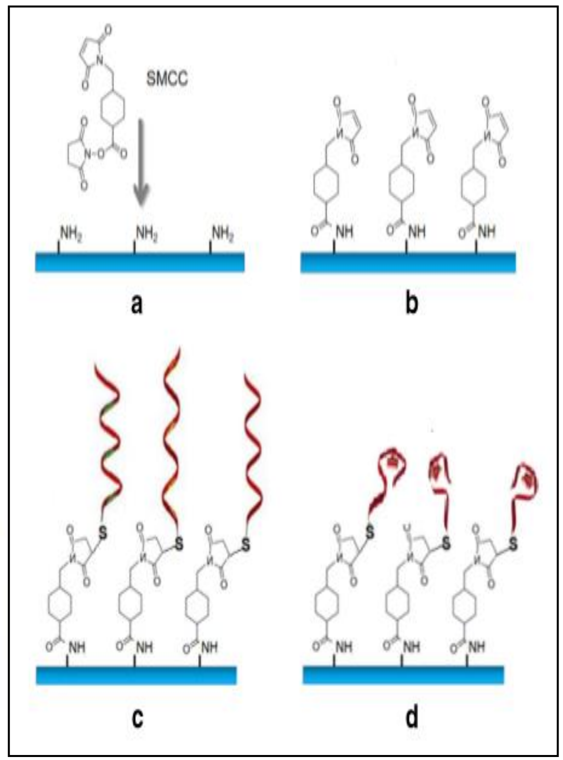


Fig. 3 Aptamer immobilization protocol: amine-functionalized surface of Si3N4 (a), SMCCactivated surface (b), aptamers immobilized (c), and aptamer binding target analyte molecules (d)

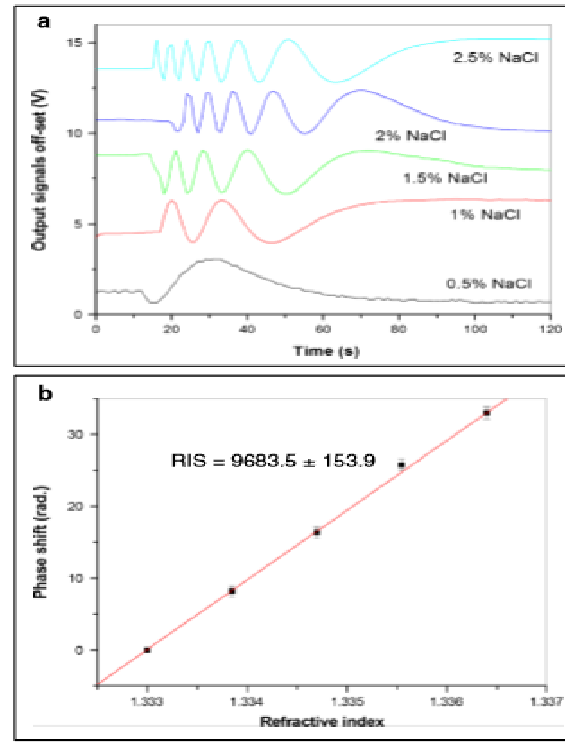
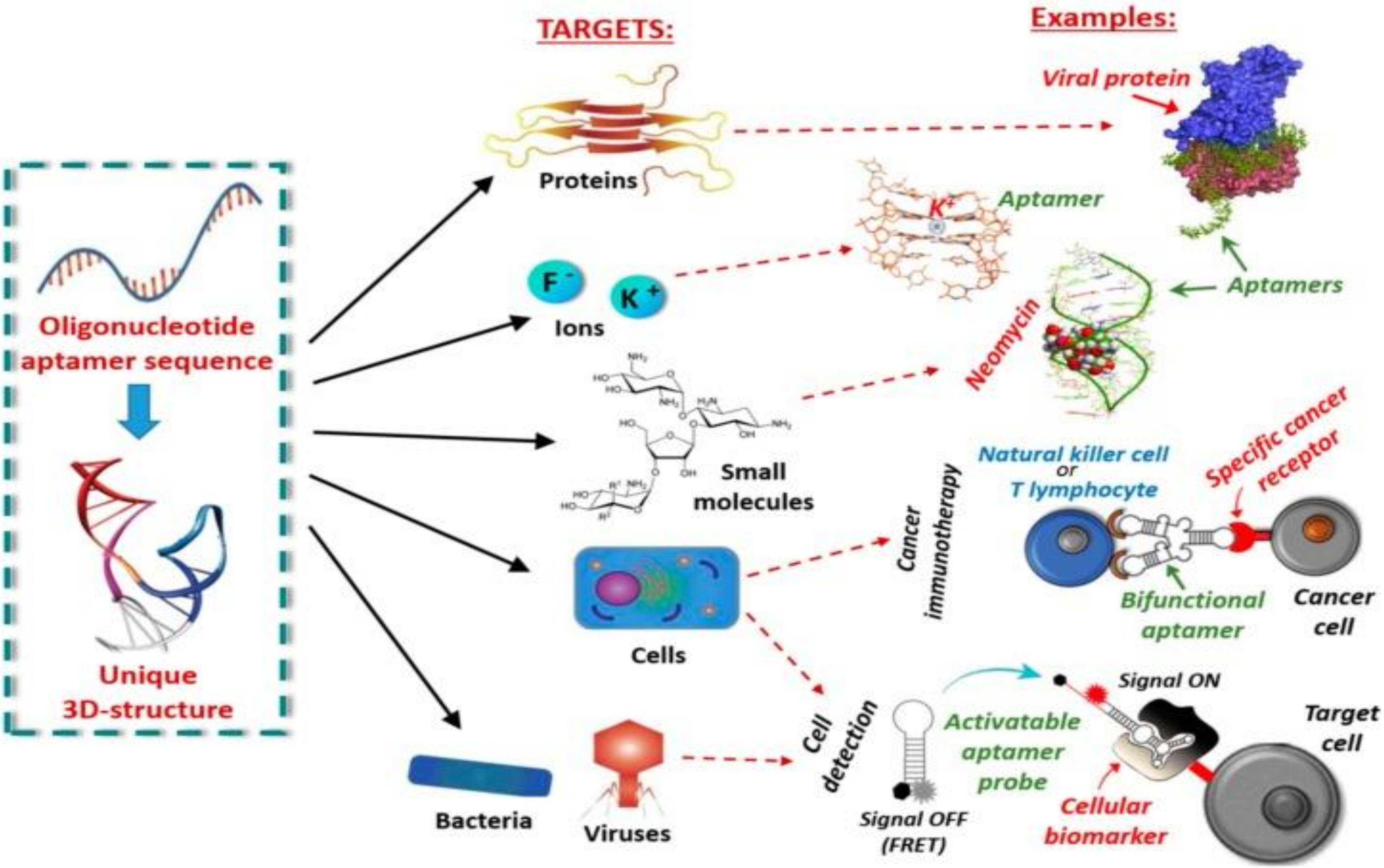


Fig. 2 Evaluation of the refractive index sensitivity (RIS): response signals to refractive index changes by injecting NaCl solutions of different concentrations (**a**), the dependence of phase shift against refractive index (**b**)

Aptasensors



chemosensors

MDPI
Chemosensors

Q2 Analytical Chemistry best quartile

Article

Development of Novel and Highly Specific ssDNA-Aptamer-Based Electrochemical Biosensor for Rapid Detection of Mercury (II) and Lead (II) Ions in Water

Hisham Abu-Ali [1,2,*], Alexei Nabok [1] and Thomas J. Smith [3]

1 Material and Engineering Research Institute, Sheffield Hallam University, Sheffield S1 1WB, UK; a.nabok@shu.ac.uk
2 Faculty of Science, University of Basrah, Basrah 61004, Iraq
3 Biomolecular Research Centre, Sheffield Hallam University, Sheffield S1 1WB, UK; scitjs@exchange.shu.ac.uk
* Correspondence: b4039024@my.shu.ac.uk

Received: 21 March 2019; Accepted: 28 May 2019; Published: 4 June 2019

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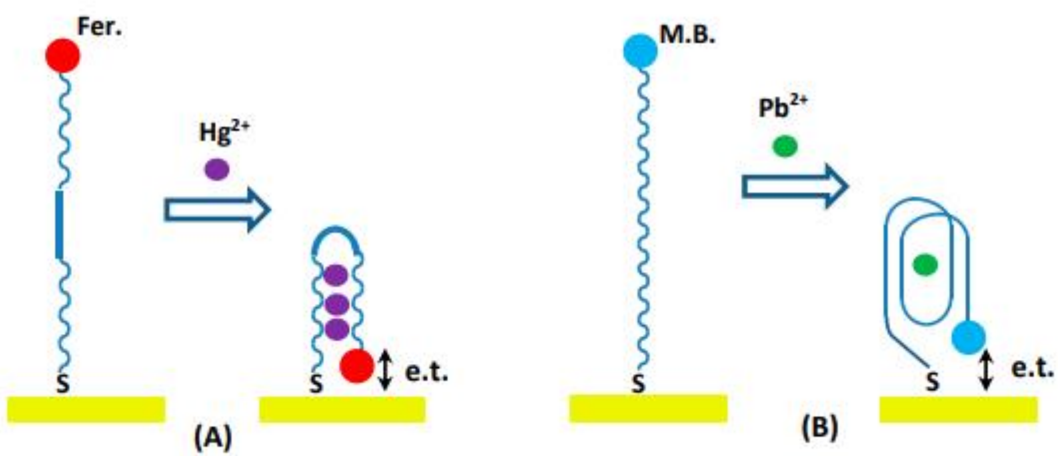

Figure 1. Schematic diagram of electrochemical detection of heavy metal ions Hg^{2+} (**A**) and Pb^{2+} (**B**) using redox-labelled aptamers.

chemosensors

MDPI

Chemosensors

Q2 Analytical Chemistry best quartile

Article

Electrochemical Aptasensor for Detection of Dopamine

Hisham Abu-Ali [1,3], Cansu Ozkaya [1,2], Frank Davis [1], Nik Walch [1] and Alexei Nabok [1,*]

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2 Department of Physics, Balikesir University, 10145 Cagis, Balıkesir, Turkey
3 College of Science, Biology Department, University of Basrah, Basrah IQ-61002, Iraq
* Correspondence: a.nabok@shu.ac.uk

Received: 27 February 2020; Accepted: 11 April 2020; Published: 15 April 2020

check for updates

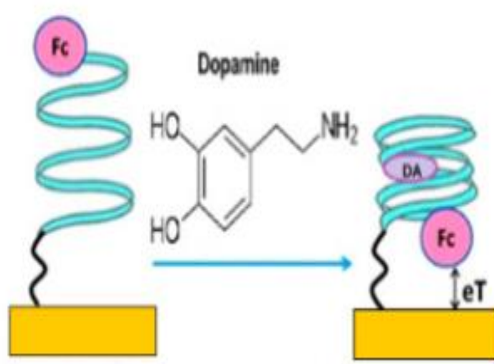


Figure 2. The scheme of electrochemical aptasensing of dopa

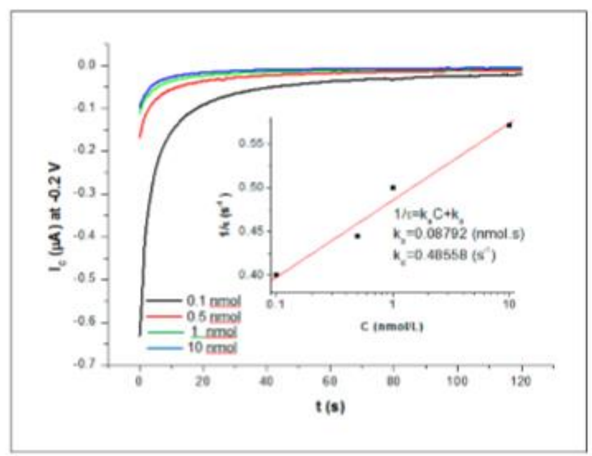
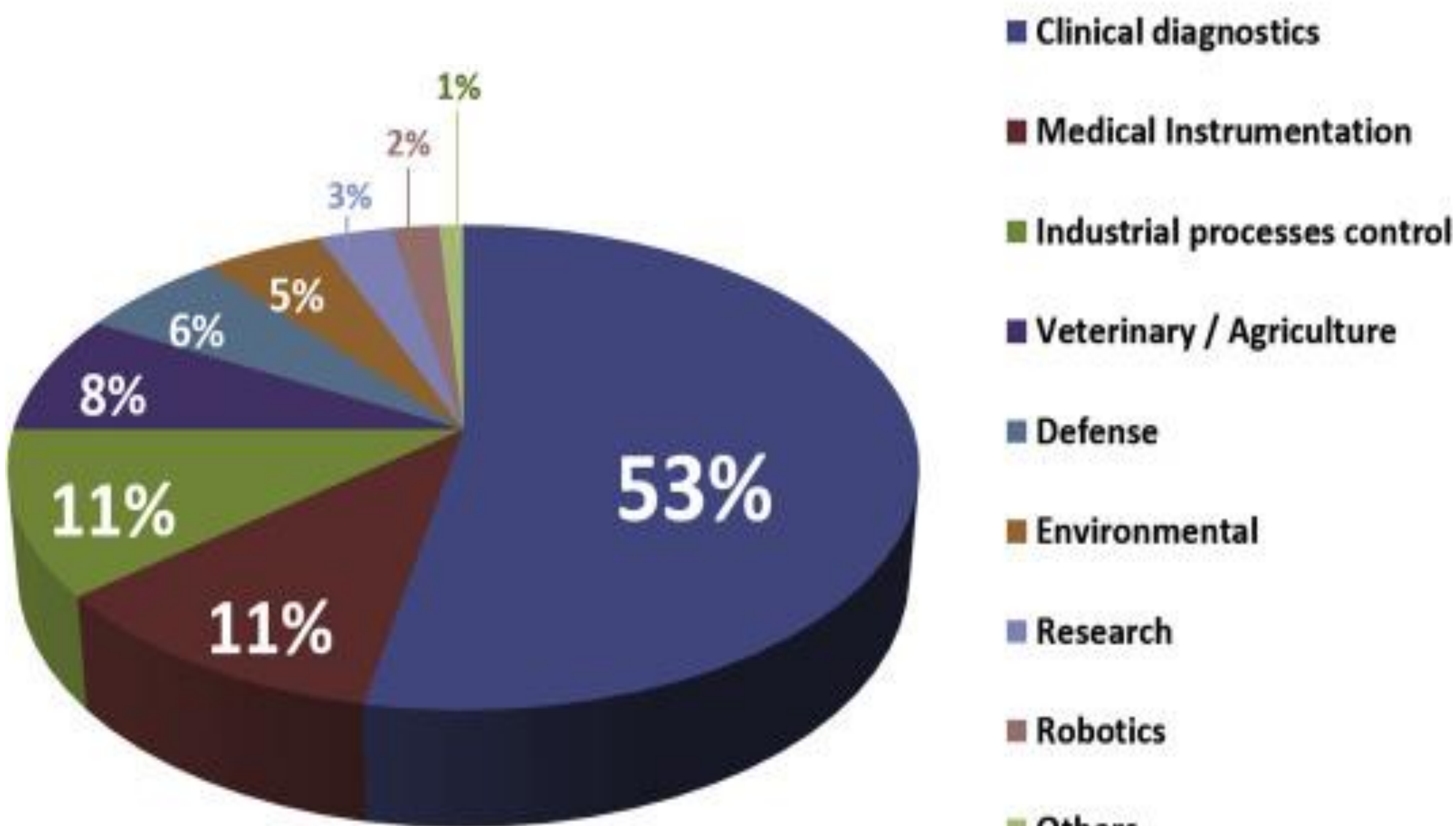
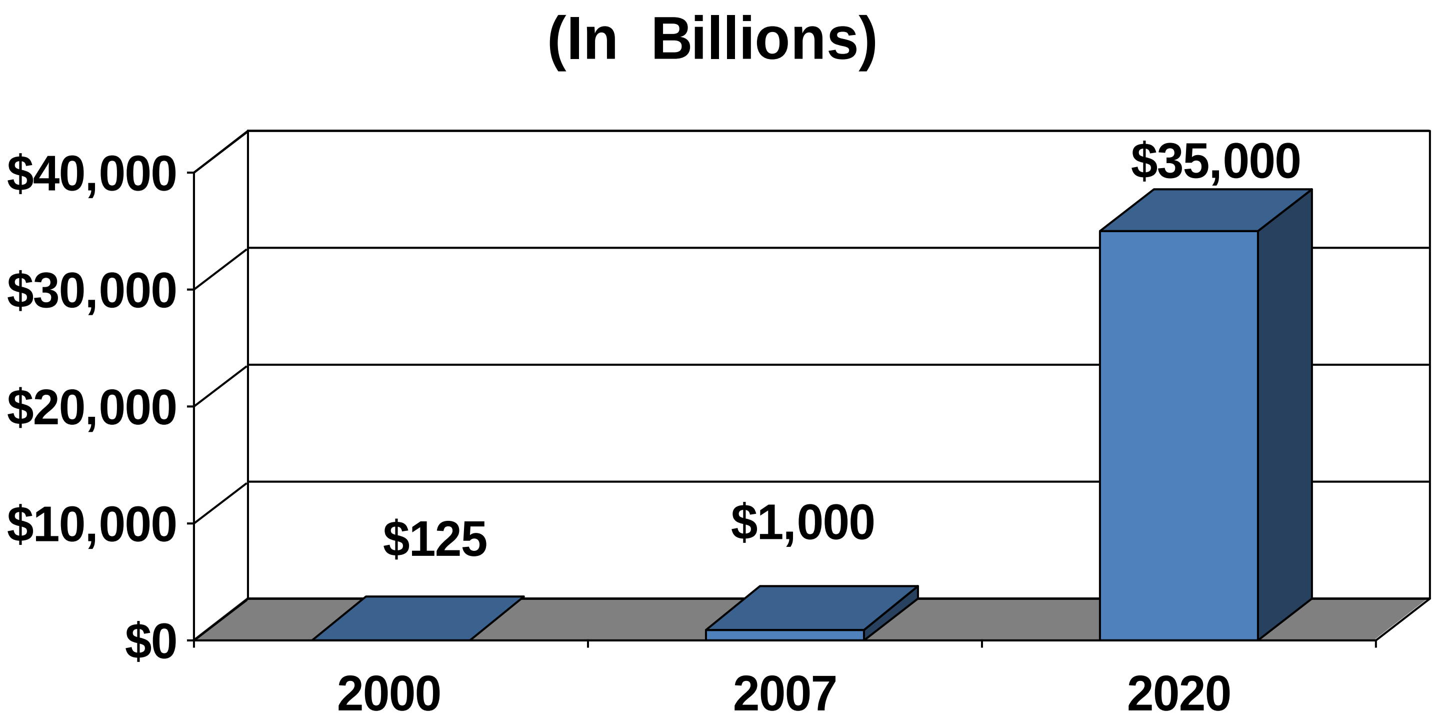


Figure 5. Time dependencies of Ic (at −0.2 V) at different concentrations of dopamine. Inset shows the linear dependence of $1/\tau$ vs., C and the values of k_a and k_d found.

Nanoproducts Marketing



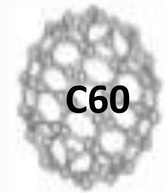


The US market for nanomaterials started with $125 million in 2000 and increased to $1 billion in 2007 and expected to reach $35 billion by the end of 2020.

NanoQuiz ???

12,756 Km

22 cm



0.7 nm

10^{16}

1.27 × 107 m

0.22 m

0.7 × 10-9 m

10 millions times smaller

1 billion times smaller

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THE END
BIG THANKS FOR YOUR ATTENTION