5TH CLABIO
LATIN AMERICAN BIOIMPEDANCE
FLORIANOPOLIS – BRAZIL - 2024

DNA Biosensors based on Bioimpedance

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scientific instruments

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Current Challenge

It`s necessary to search for new technology and **Molecular Biomarkers** detection methods at low cost and with easy access at labs.

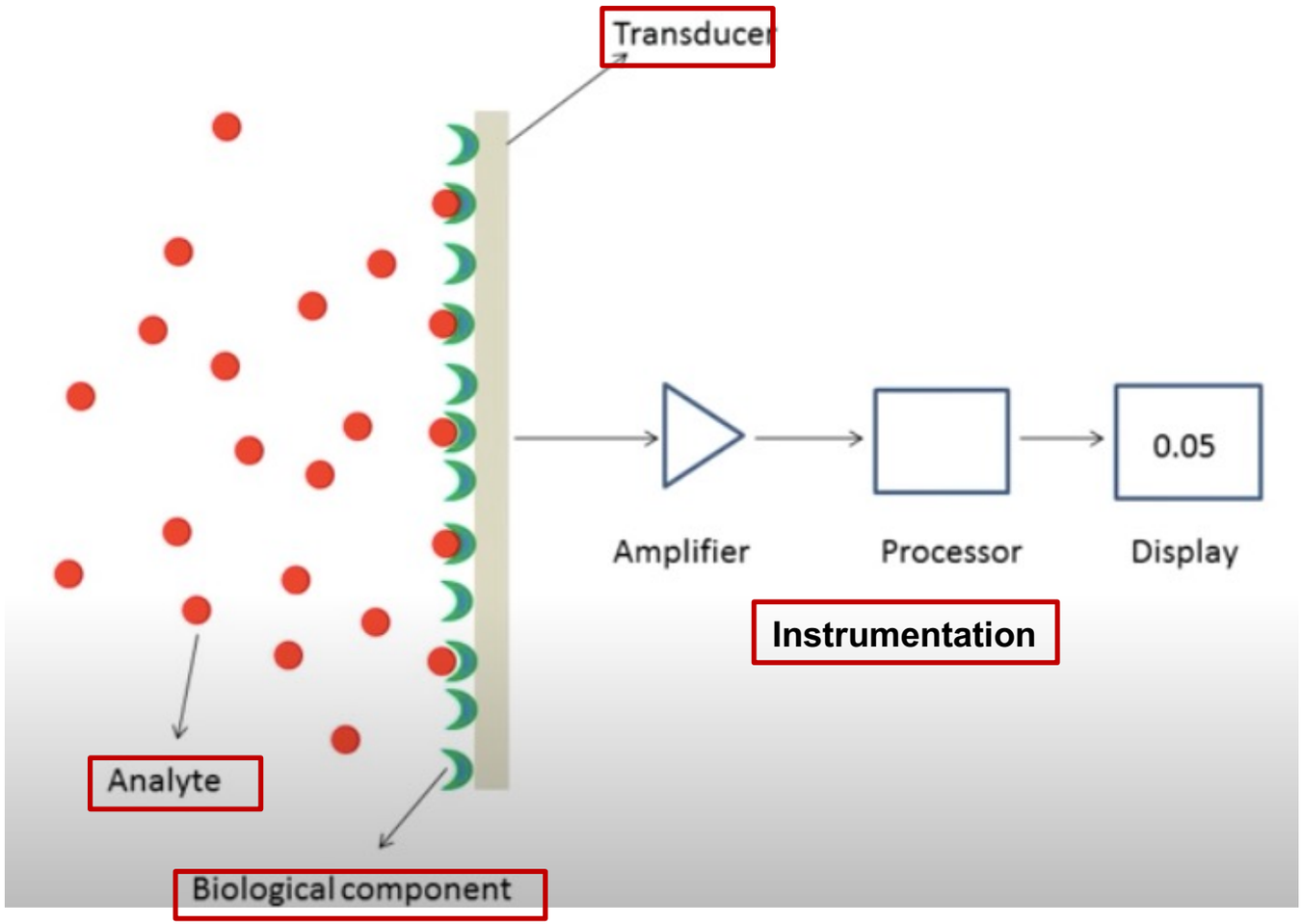
Outline:

- Intro
- Short review
- Technological Proposal
- The future

Biosensor:

- Device to detect the presence of biological analyte.
- A biological material (such as enzyme, antibody, whole cells, nucleic acid, etc) is used to interact with the analyte.
- This interaction produces a physical or chemical change detected by a transducer and produce a electrical signal
- This signal is interpreted and converted in concentration of the analyte (instrumentation).

Biosensor: Diagrammatic representation



Adapted from: https://www.youtube.com/watch?v=k5ZBUNqx2yI (visited October **2021**)

Sensors of floating/flowing bioparticles:

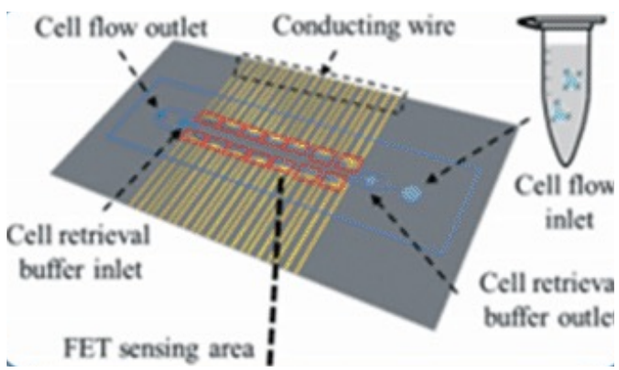
- Floating bioparticles in narrow micrometer range channel.
- Capturing of particles to electrodes is not requested.
- Fast flow of fluids containing particles is needed.

Affinity biosensors:

- Selectively detect bound (immobilized) bioparticles.
- At least one electrode is covered by selectively acting layer.

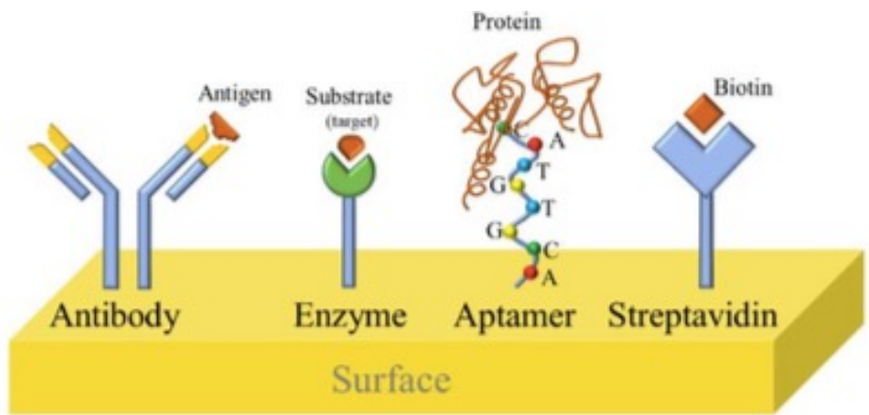
M. Min, T. Parve, and U. Pliquett,, Encyclopedia of Microfluidics and Nanofluidics, 2015.

Flowing



Gu, W.; ZhaoYi, Y. Expe Rev Med Devi 2010

Affinity



N.T. Kemp: **2021**. IEEE Sensors Journal

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Short Review

2024

Technological Proposal

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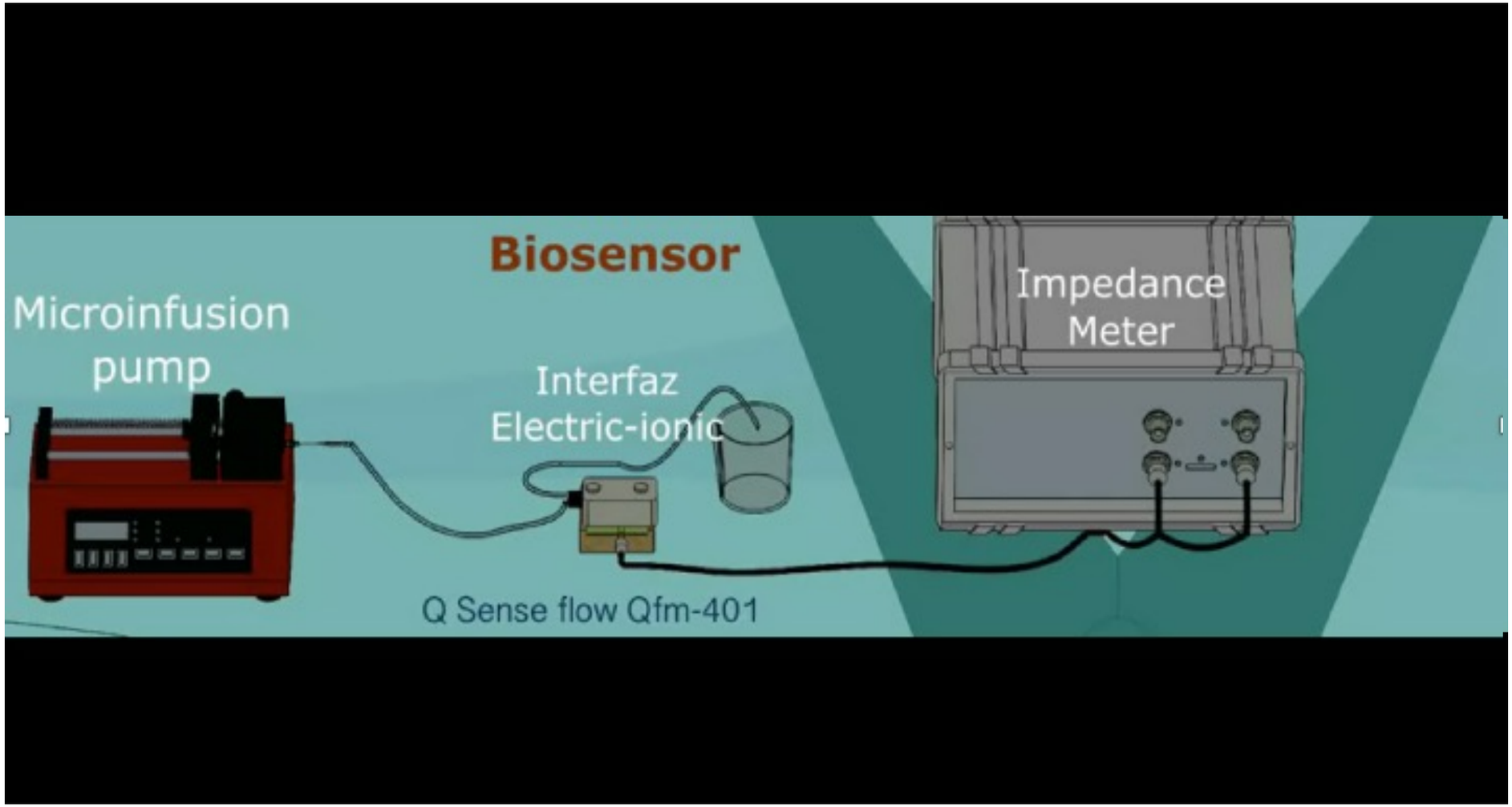

DNA Detection

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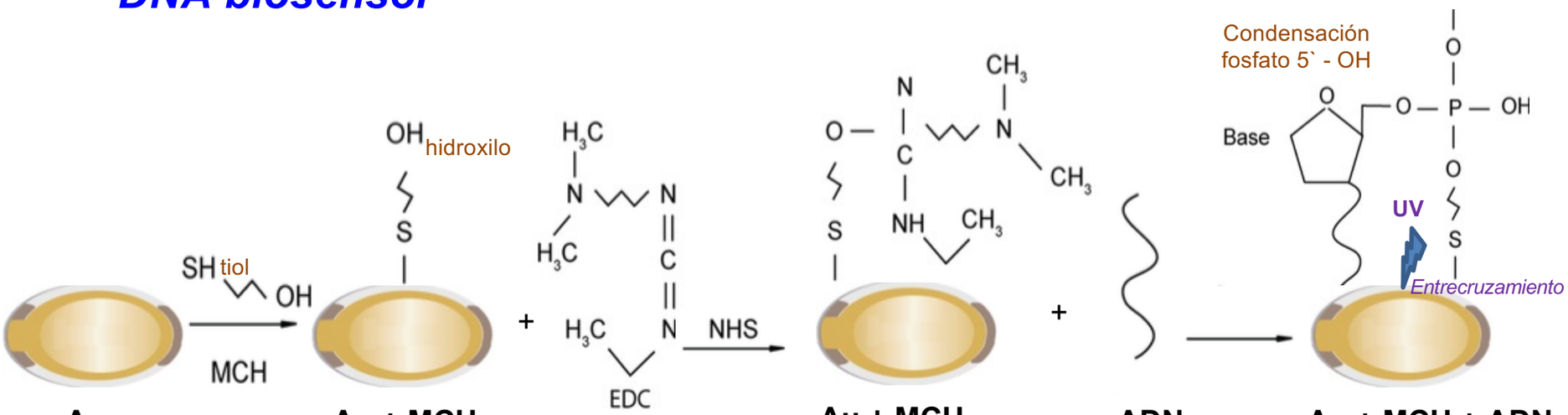
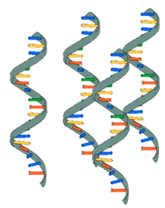
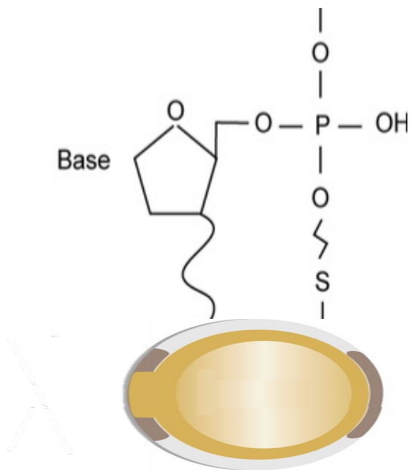
DNA biosensor

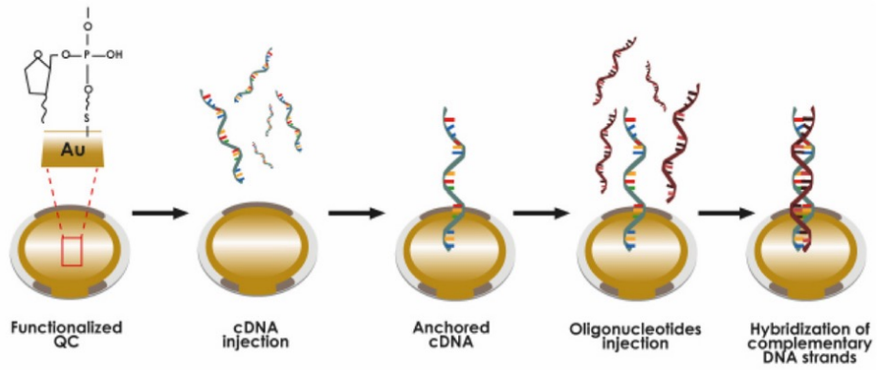


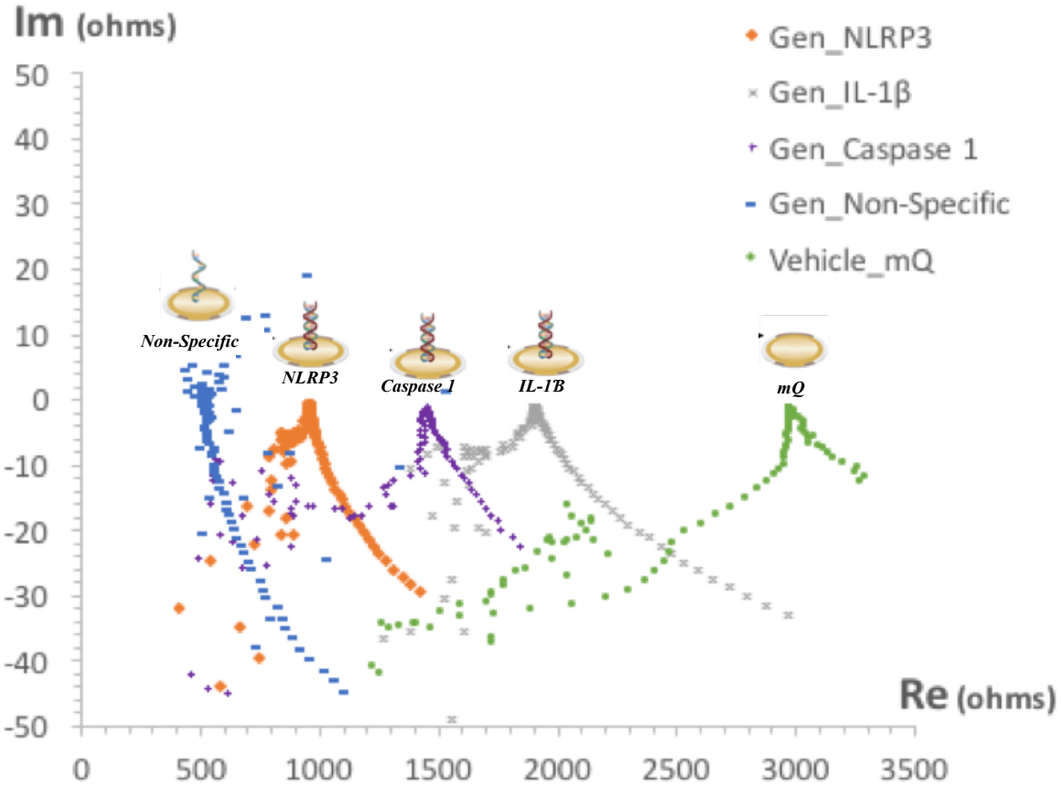




cDNA affinity to gold surface

Perez N, **González CA**, et al. J Electr Bioimp, (2020)





DNA biosensor

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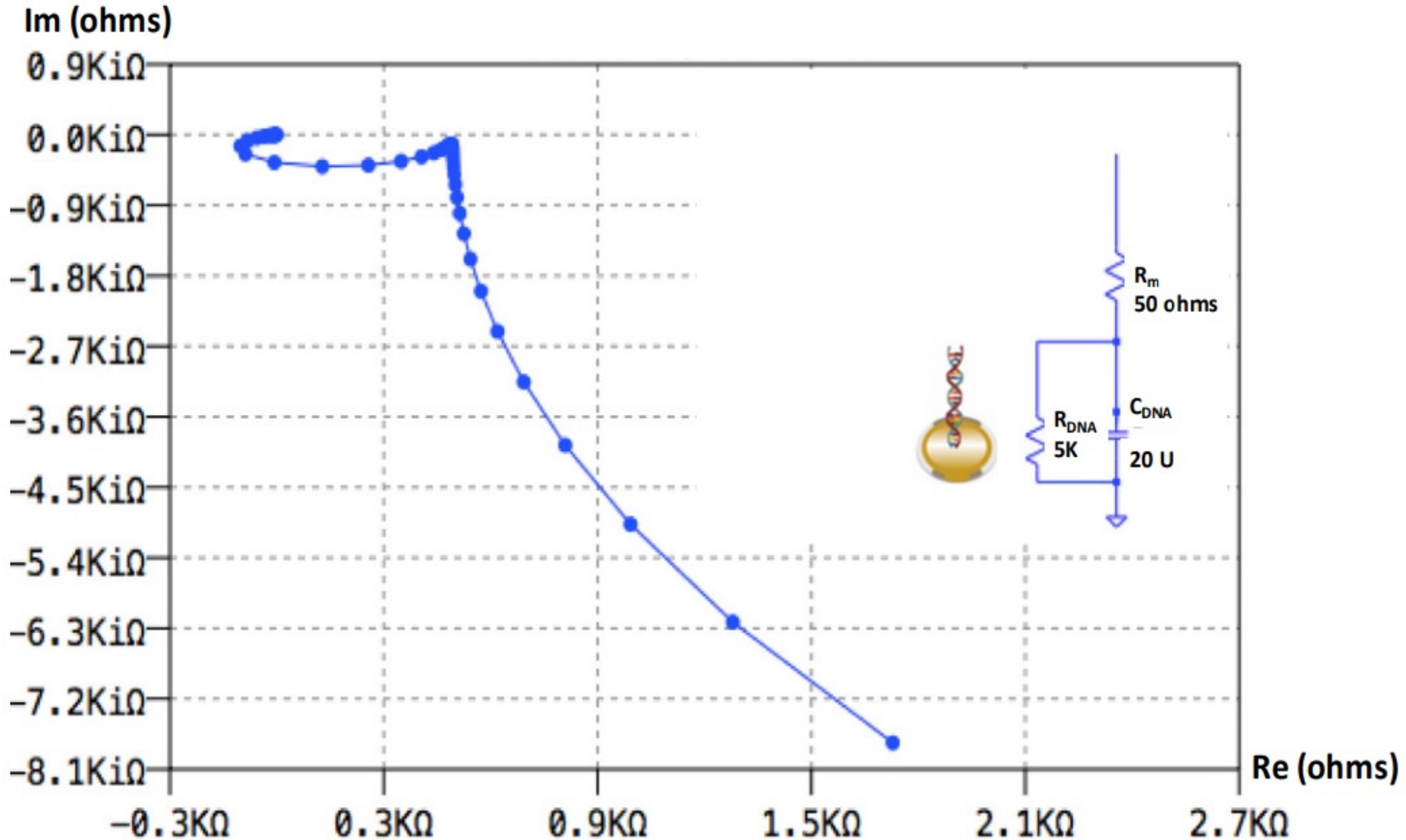
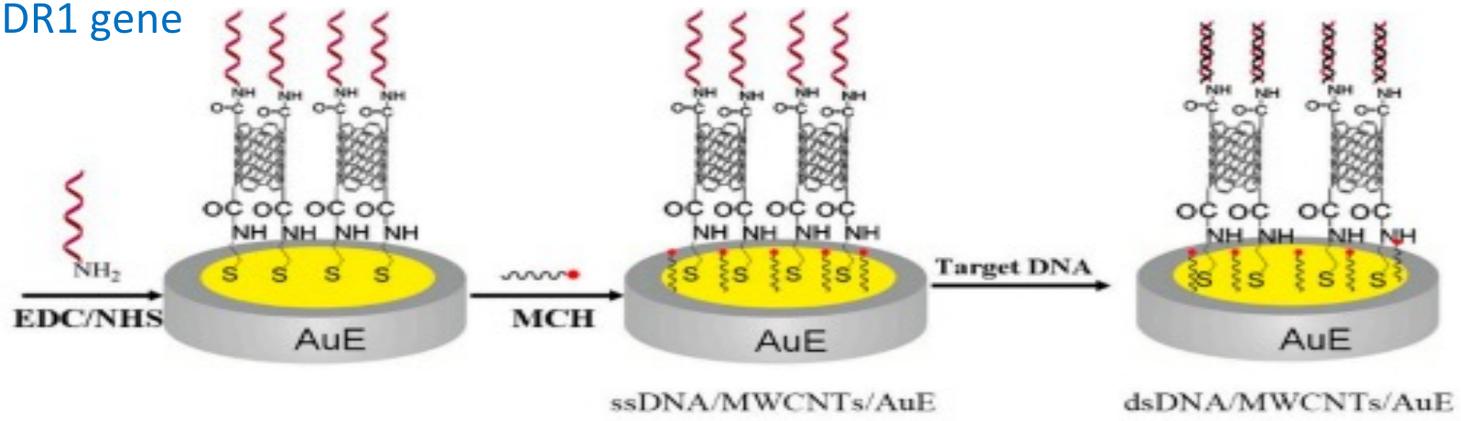
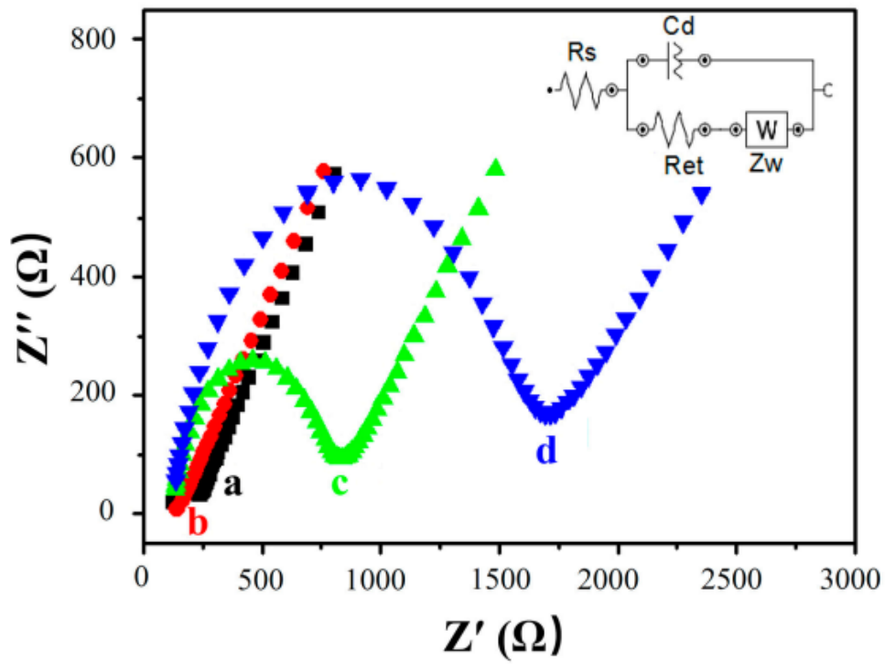


Perez N, González CA, et al. J Electr Bioimp, (2020)

MDR1 gene



a. Au Electrode
b. Au/MWCNTs Electrode
c. Au/MWCNTs/DNAss Electrode
d. Au/MWCNTs/DNAds Electrode



Chen R. biosensors 2023

Label-free DNA detection

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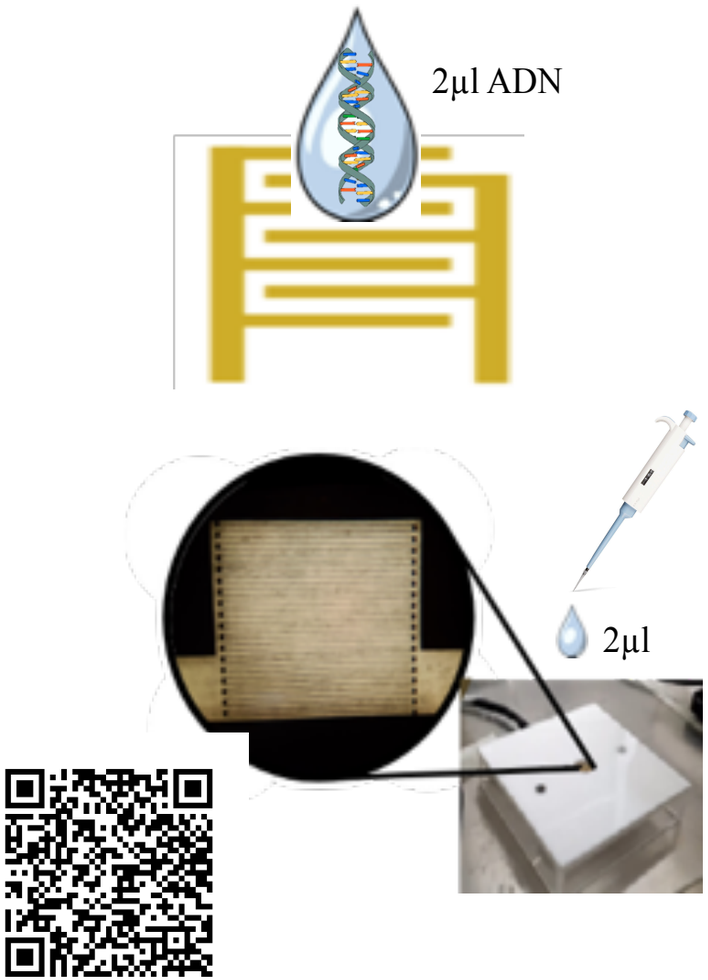
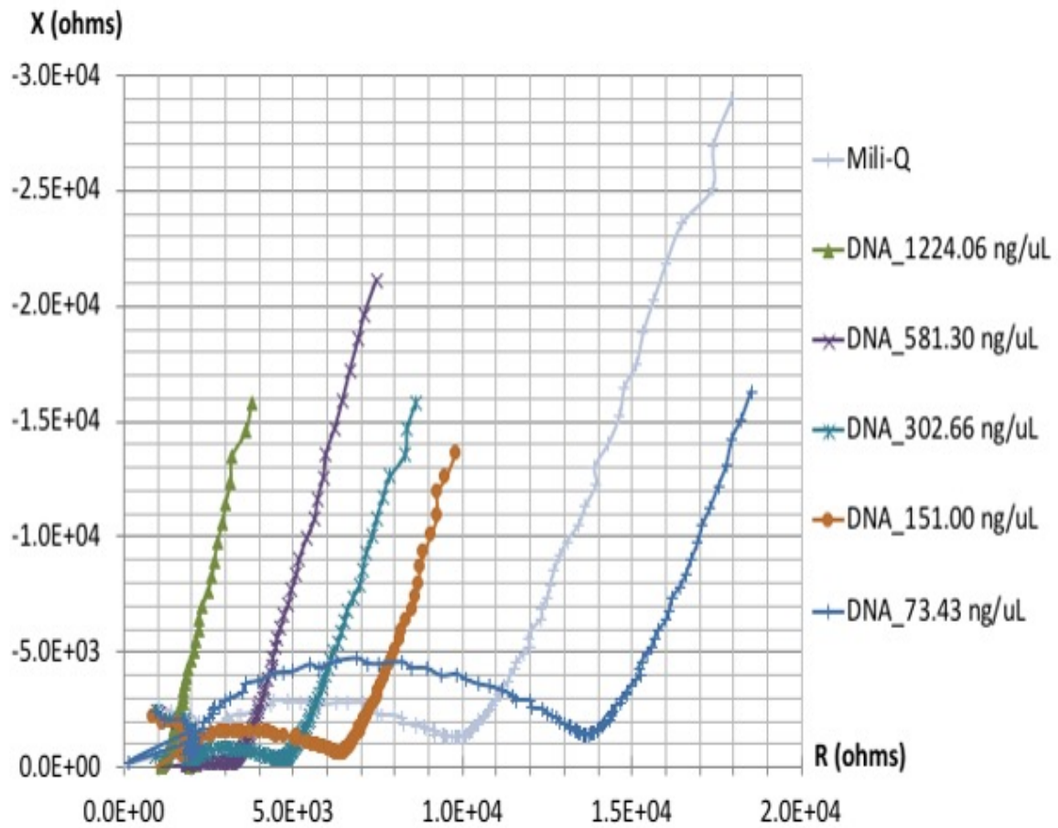
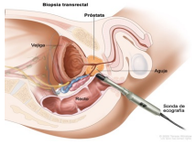
Multifrequency Bioimpedance Characterization of DNA Concentration.





Gomez N., Montoya C., ***González C.A.*** *et al. IFMBE Proceedings CNIB2023, Springer.* ***2023***

Association of endogenous PCR final product in VPH human samples with EBiS measurements.

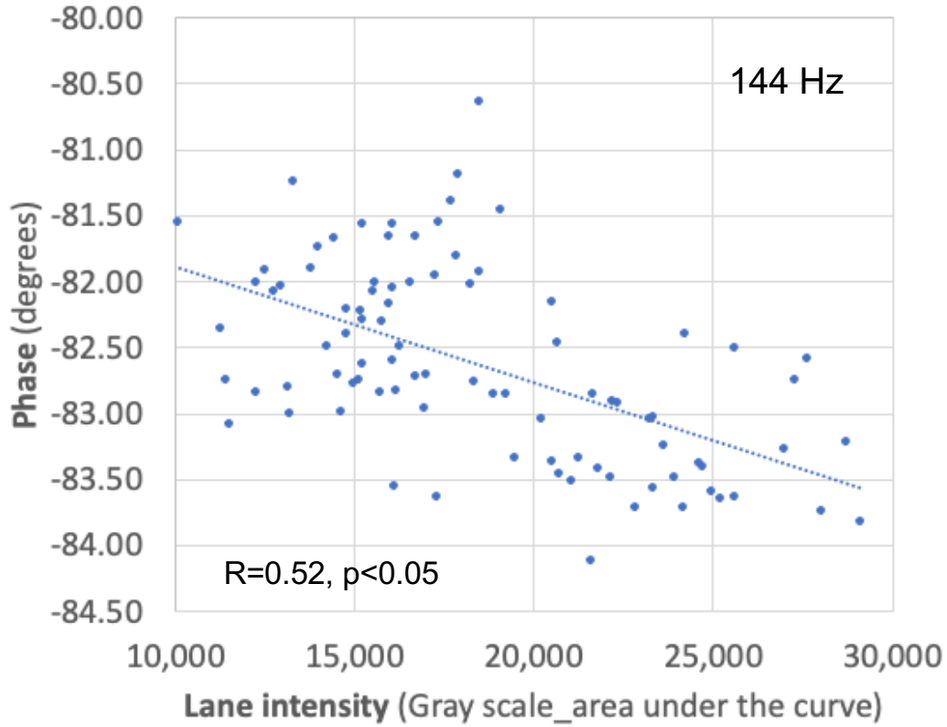


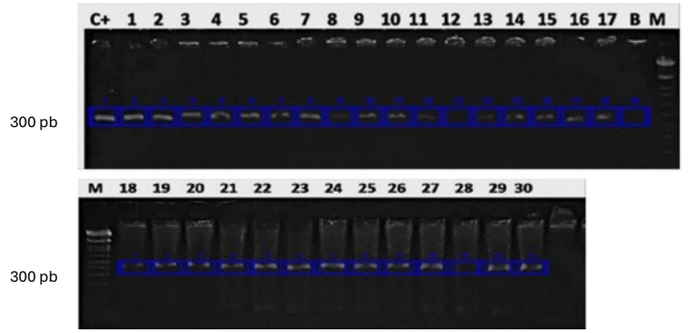
[50 ng/µl]

Extracción ADN

PCR

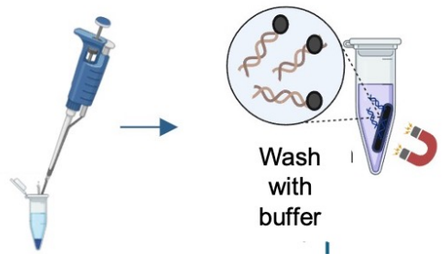
Secuencias de **OGG1** (Primers) + *Master_Mix* *(Taq* DNA Polymerase, dNTPs)

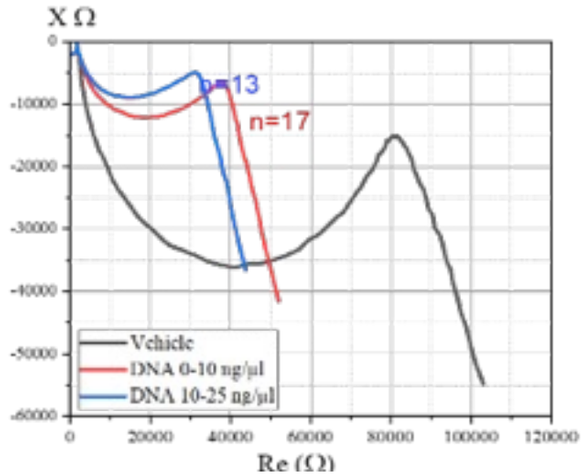


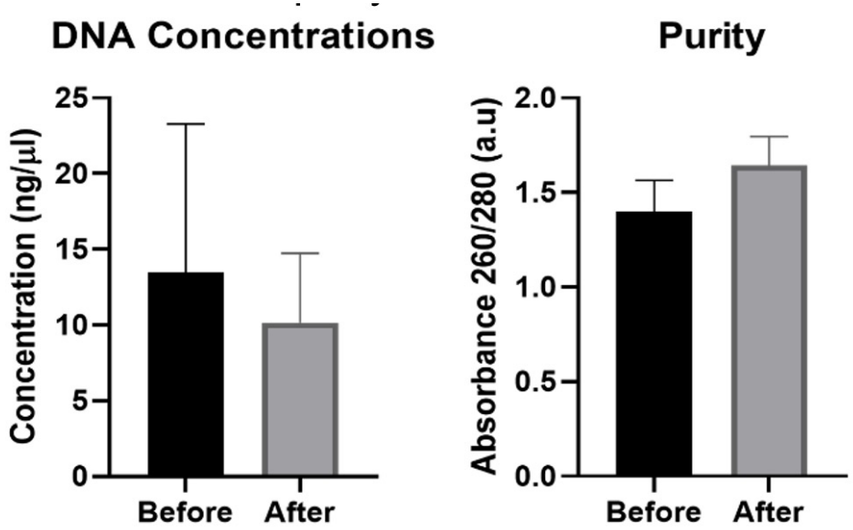


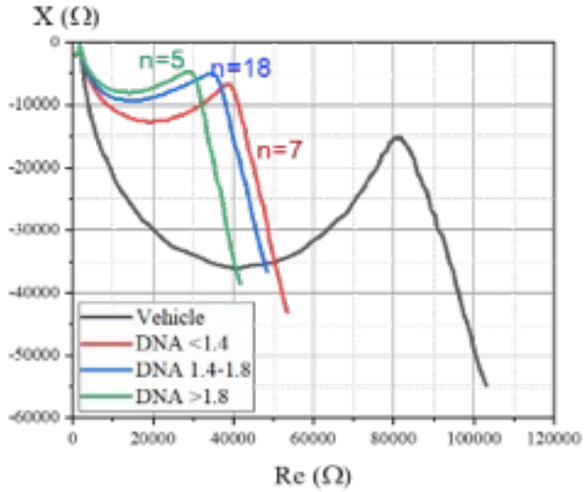
*Corzo-Cruz A., **González C.A.** et al. CyS, CNIBi2024 proceedings, in review*

DNA characterization through nanotechnology-assisted bioimpedance and feature extraction for Artificial Intelligence.









*Alcantara-Jacobo MY., **González C.A.** et al. CyS, CLABIO2024 proceedings, in review*

Label-free & Non-contact DNA detection

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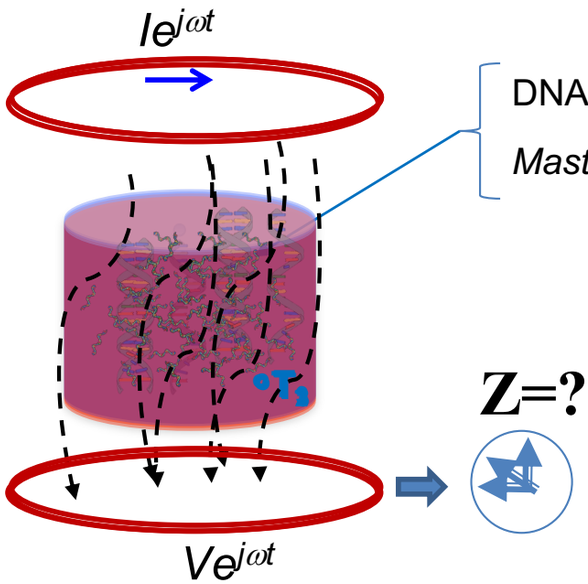
$$\Delta \times E = -\partial B / \partial t$$

$$J = \sigma E$$

Label-free & Non-contact DNA detection

Label-free & Non-contact
DNA detection by Magnetic Induction Spectroscopy



$DNA_{sequence}$ + Primers +

Master_Mix (*Taq* DNA Polymerase, dNTPs)

Z=?

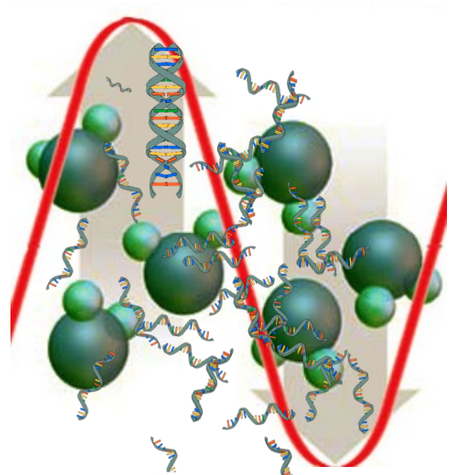
$$\mathbf{J} = (nze\mathbf{v})+ + (nze\mathbf{v})- = \sigma\mathbf{E}$$

$$\sigma = Fc\gamma(\mu+ + \mu-)$$

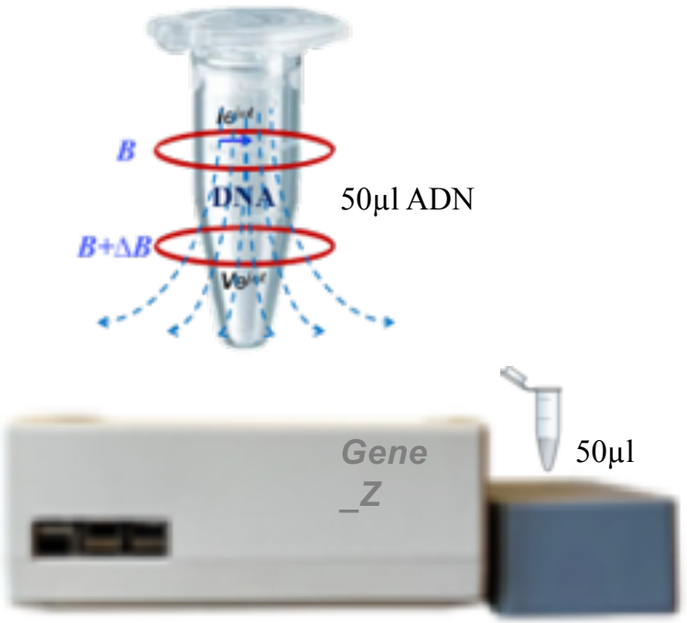
Friedrich Georg Kohlrausch

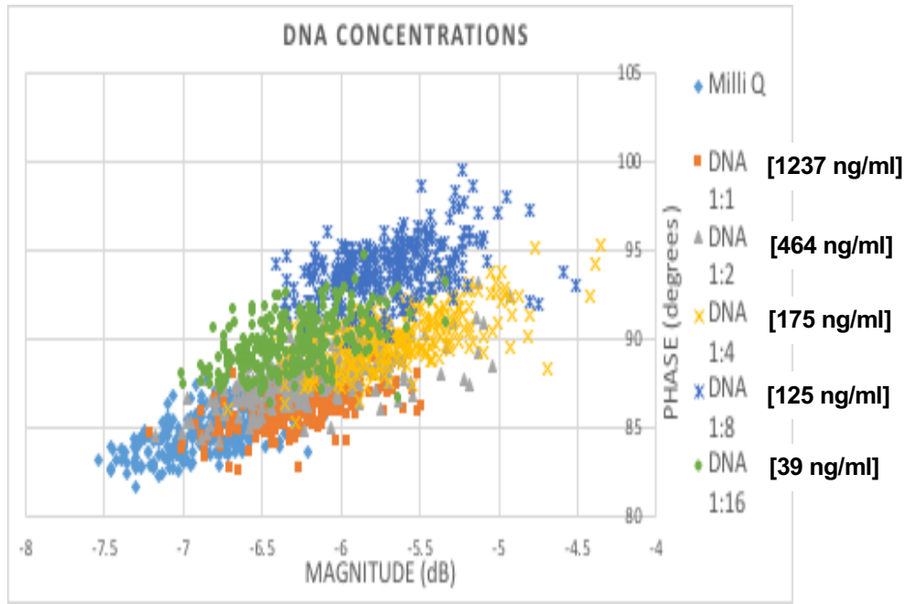
$$\mathbf{f} = 6\pi\eta a\mathbf{v}$$

High freq.



Magnetic Induction Spectroscopy for DNA Quantification

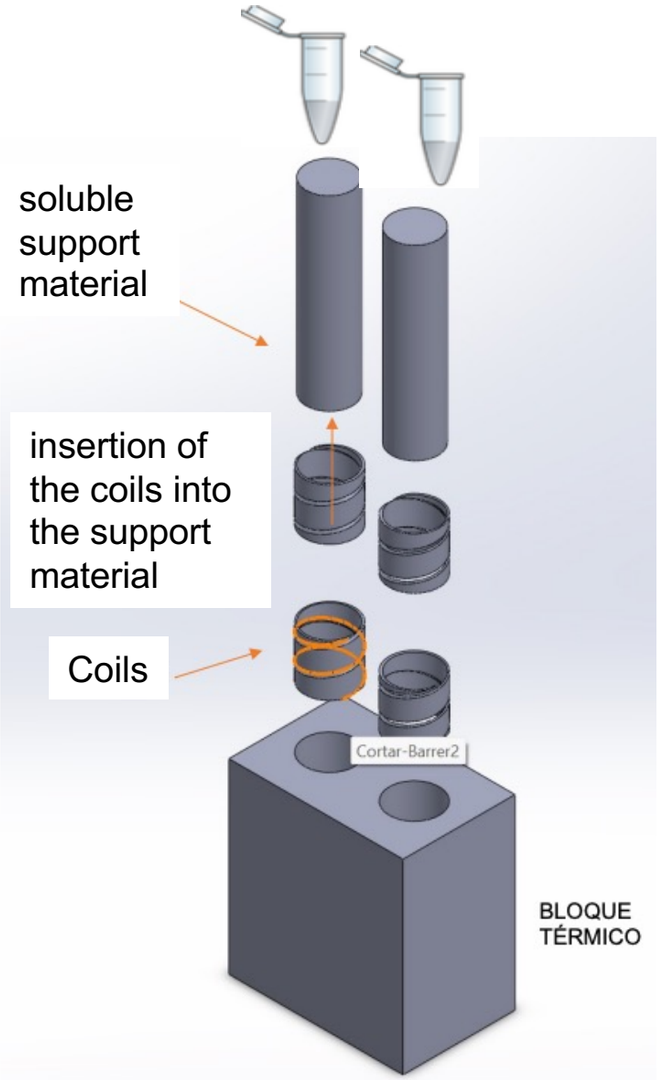




Desarrollo Experimental

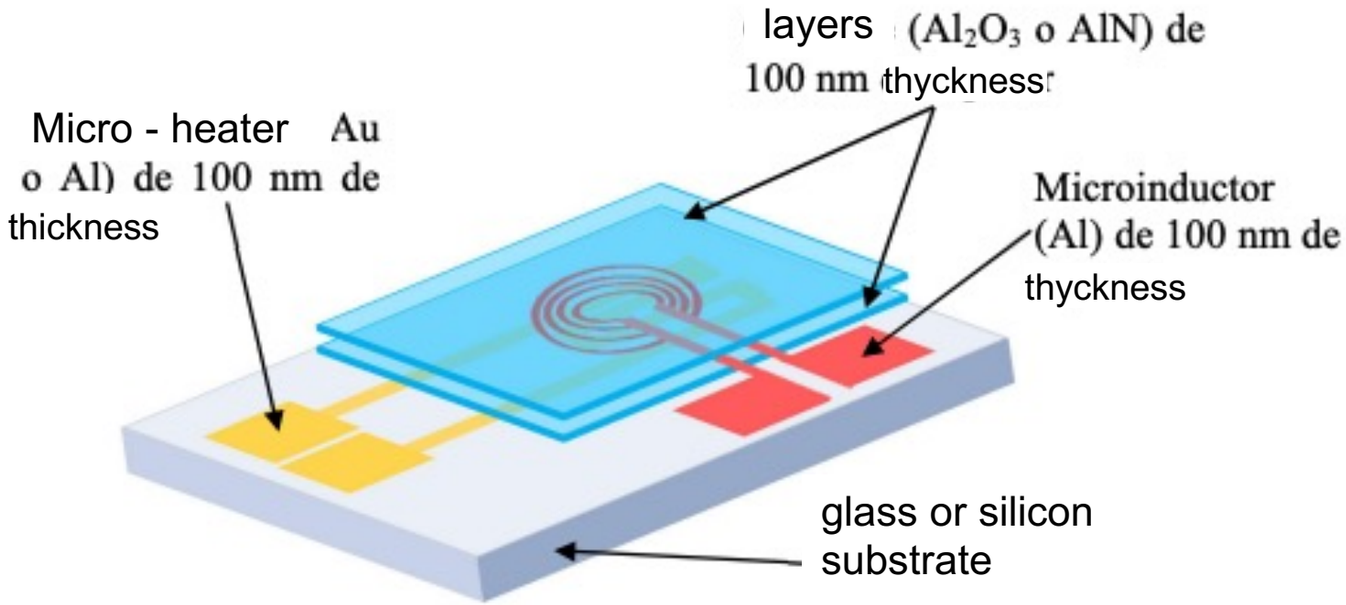
López J. Becerra L., ***González C.A.*** *et al. IFMBE Proceedings CNIB2023, Springer.* ***2023***

Future works



- Alumina Resin 4N (purity del 99.99%)
- Thermal Conductivity 32 W/m·K y
- Electrical resistivity greater than $1x10^{14}$ Ω·m
- Ideal for heat conduction and electrical insulation simultaneously.

Future works *Gene-Z*

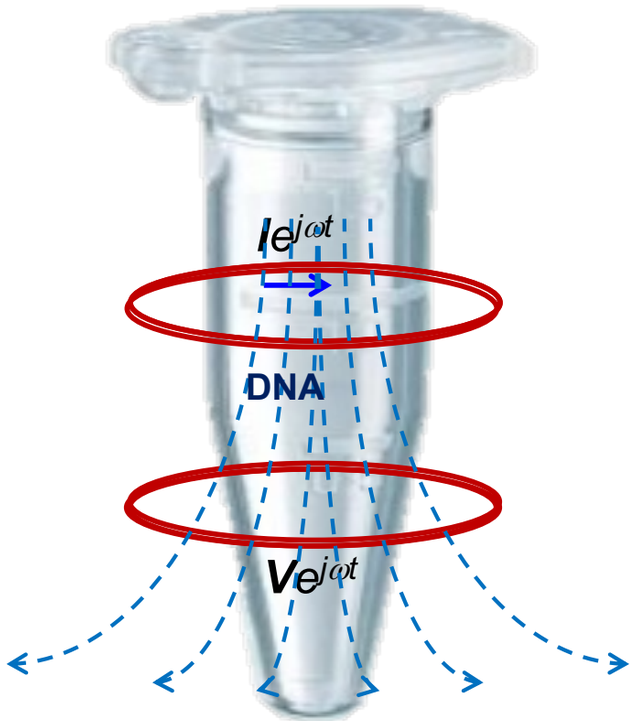


óxido de aluminio (Al_2O_3) o bien nitruro de aluminio (AlN).

Material	Resistividad eléctrica	Conductividad térmica
Aluminio	2.7×10^{-6} Ω-cm	210 W/m K
Al_2O_3 (99.5 % pureza)	1×10^{14} Ω-cm	30-35 W/m K
AlN	1×10^{10} Ω-cm	180 W/m K

Future works

Gene-Z



- Optimization instrumentation magnetic induction.
- Clinical sensitivity and specificity studies
- Graphical User Interface assisted AI
- Eficiencia Tx Calor

The future challenges

- The problems of precision and sensitivity are a major challenge.
- Bioimpedance is affected by multiple factors; is necessary new models, equations, and methods to improve specificity. i.e. (AI)
- Bioimpedance Lab-on-Chip based technology for PoC and NoC devices opens new perspectives, i.e. Genomic Medicine.
- Sample preparation imposes important portability restrictions.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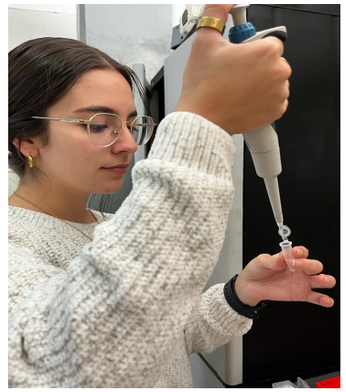

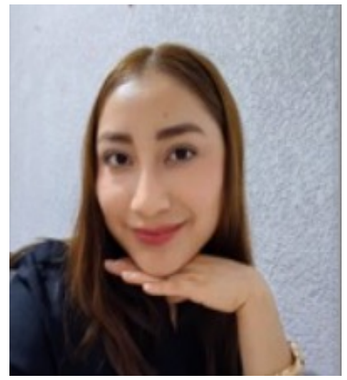







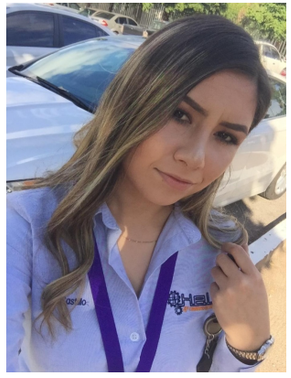

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