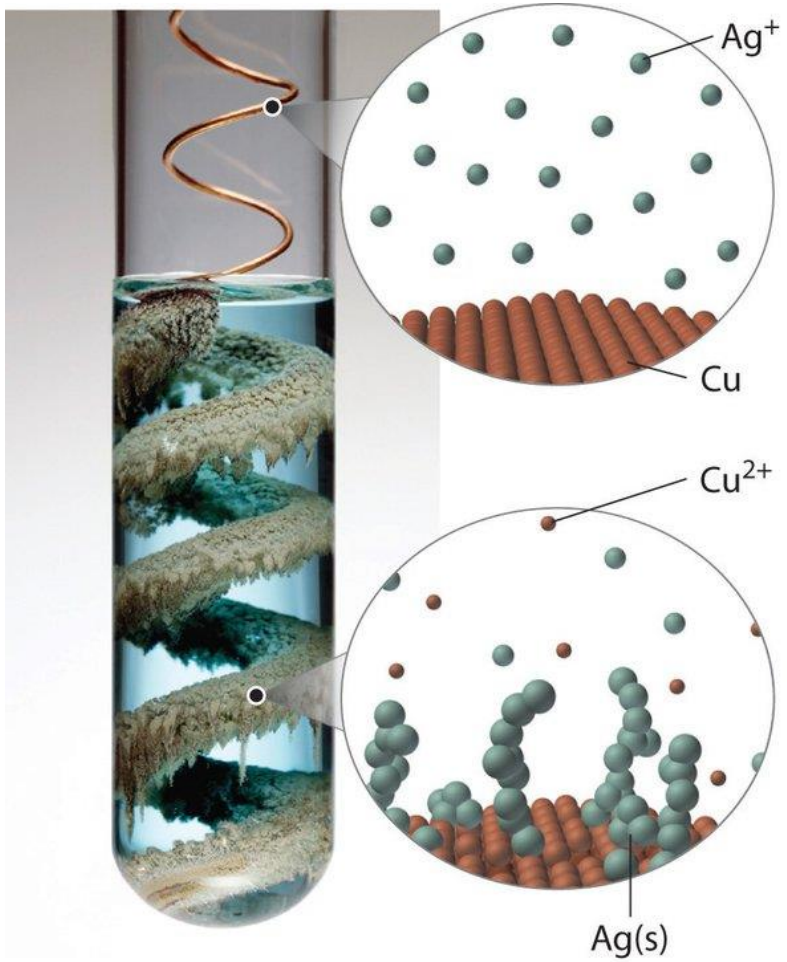
WHAT IS A REDOX REACTION?

Application of Electrochemical-based sensing strategies

WHAT IS A REDOX REACTION?

Cu wire + Silver nitrate solution



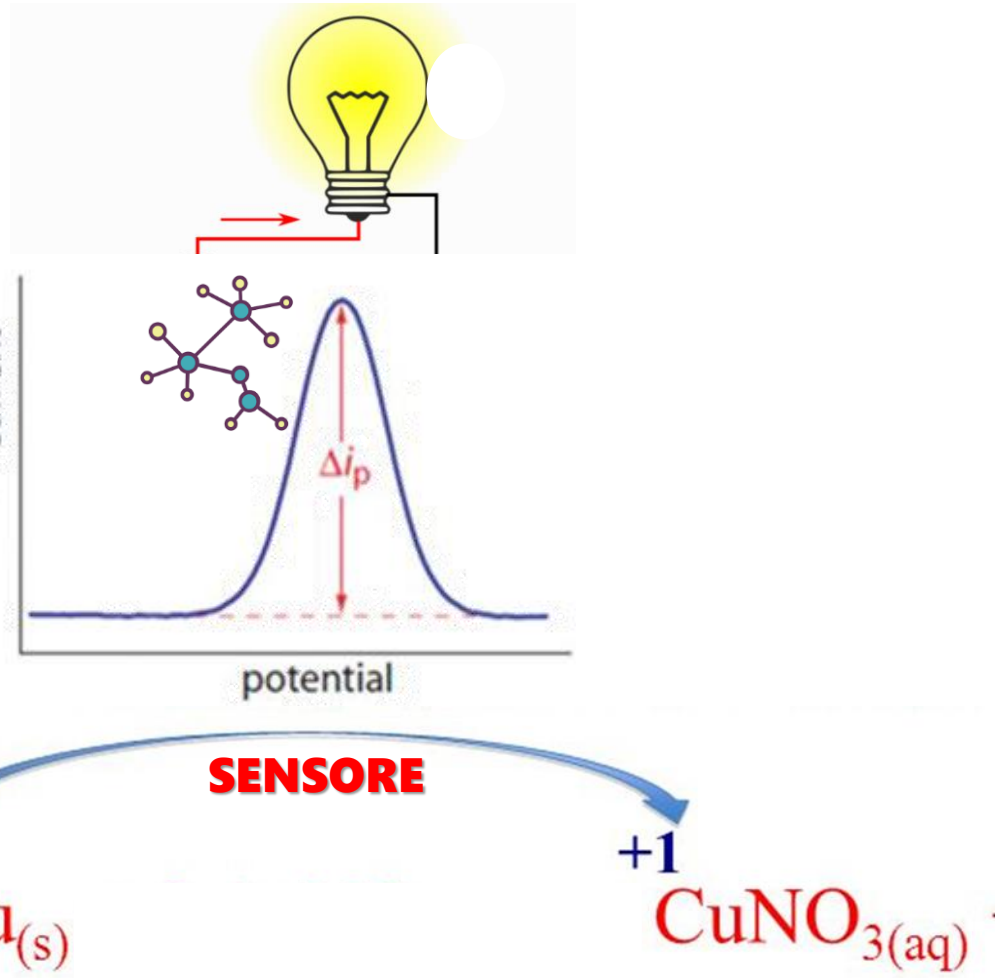
Oxidizing agent becomes reduced and the reducing agent becomes oxidized.

$$\overset{0}{Cu_{(s)}} + 2\,AgNO_{3(aq)} \rightarrow \overset{+1}{CuNO_{3(aq)}} + 2\,\overset{0}{Ag_{(s)}}$$

$Cu_{(s)}$: 0 → +1 (oxidized)

$AgNO_{3(aq)}$: +1 → 0 (reduced)

WHAT IS A REDOX REACTION?

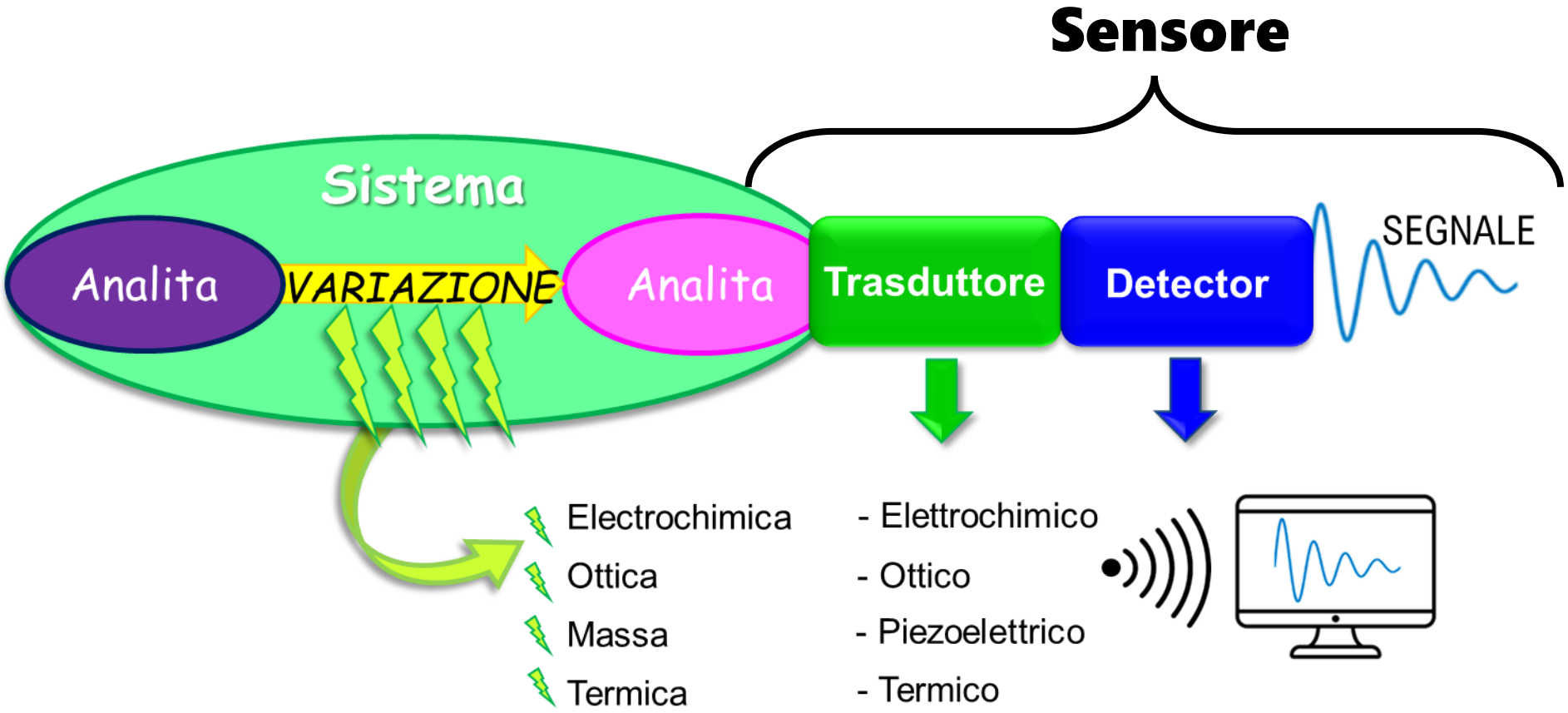


L'elettrochimica studia processi che coinvolgono il trasferimento di elettroni a carico di specie redox attive.

Le specie redox attive sono specie chimiche in grado di ridursi o ossidarsi ad una particolare differenza di potenziale applicata.

Quando una specie può essere forzata a cedere o acquistare elettroni tramite l'applicazione di una differenza di potenziale è possibile sfruttare la misura della corrente prodotta per misurare la concentrazione della specie stessa (ELETTROANALITICA).

ELECTROCHEMICAL SENSOR



ELECTROCHEMICAL MEASUREMENT SET-UP

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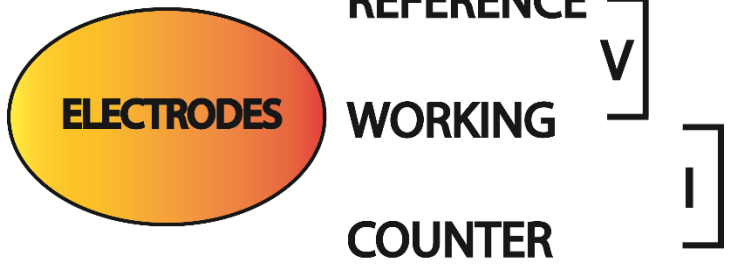
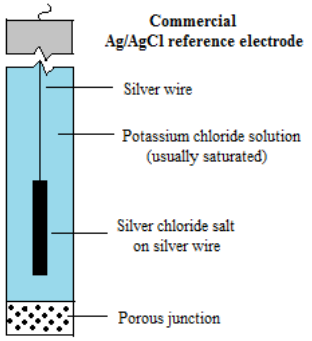
Overview: electrochemistry. Classical set-up

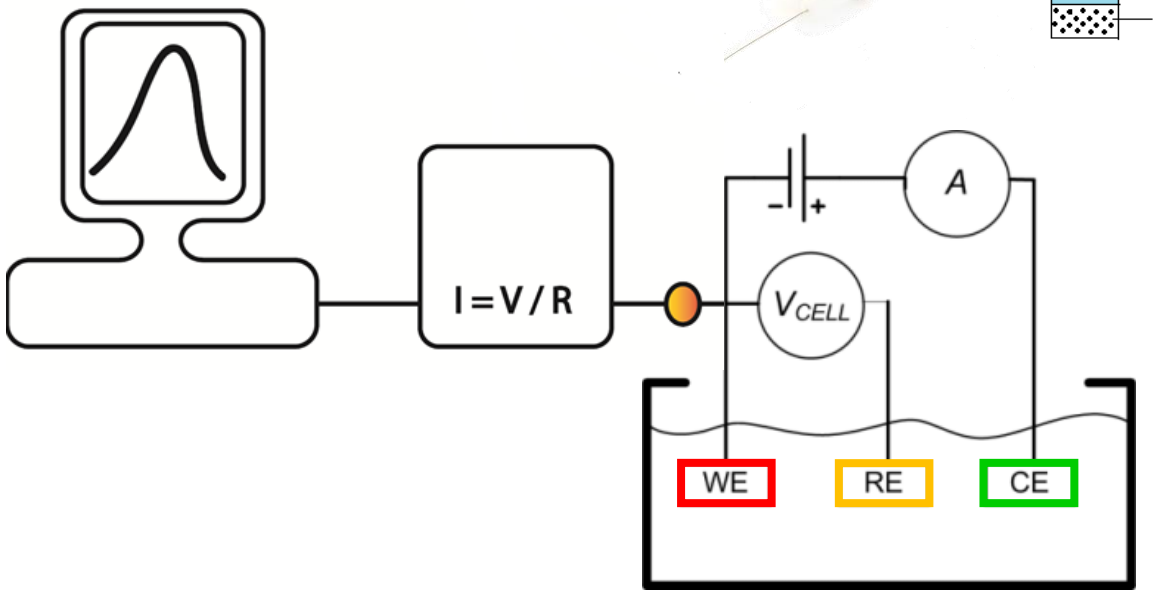


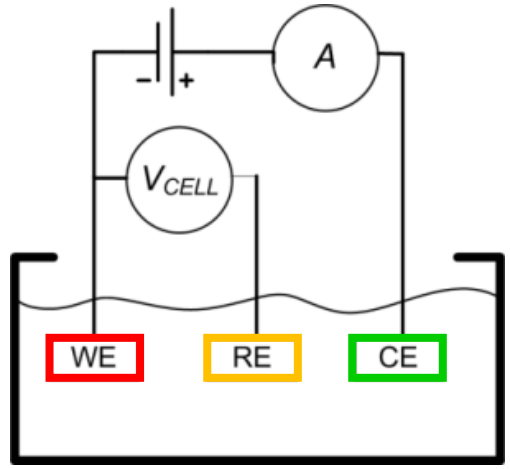
WE: Graphite, silver, gold

CE: Pt wire

RE: Ag/AgAgCl







WE - elettrodo di lavoro **(sensore)**, RE - elettrodo di riferimento, CE - elettrodo ausiliario.

[V= R ⋅ i]

ELECTROCHEMICAL MEASUREMENT SET-UP

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Overview: electrochemistry. Classical set-up

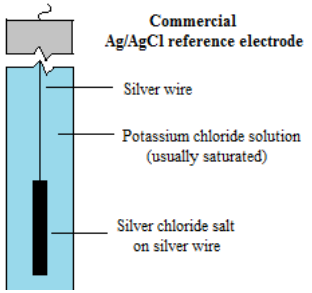
ELECTRODES

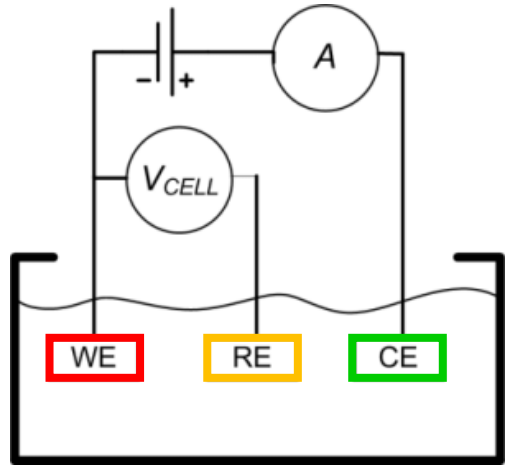
- REFERENCE — V
- WORKING — I
- COUNTER

WE: Graphite, silver, gold

CE: Pt wire

RE: Ag/AgAgCl



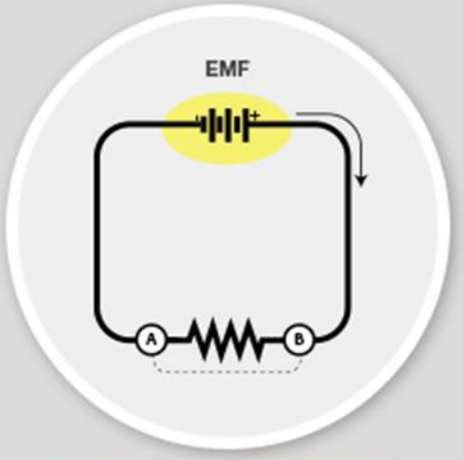


WE - elettrodo di lavoro **(sensore)**, RE - elettrodo di riferimento, CE - elettrodo ausiliario.

[$V = R \cdot i$]

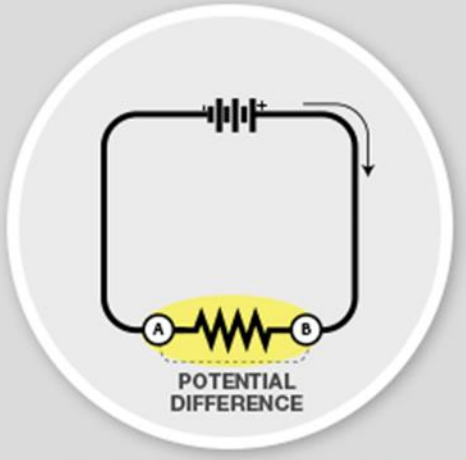
REMINDER

DIFFERENCE BETWEEN EMF AND VOLTAGE



EMF

THE ELECTROMOTIVE FORCE IS THE TYPE OF ENERGY WHICH FORCES A UNIT POSITIVE CHARGE TO MOVE FROM THE POSITIVE TO THE NEGATIVE TERMINAL OF THE SOURCE. IT SEPARATES THE TWO CHARGES FROM EACH OTHER.



VOLTAGE

VOLTAGE IS THE DIFFERENCE IN ELECTRIC POTENTIAL BETWEEN TWO POINTS. THE VOLTAGE BETWEEN TWO POINTS IS EQUAL TO THE WORK DONE PER UNIT OF CHARGE AGAINST A STATIC ELECTRIC FIELD TO MOVE A TEST CHARGE BETWEEN TWO POINTS.

ELECTROCHEMICAL MEASUREMENT SET-UP

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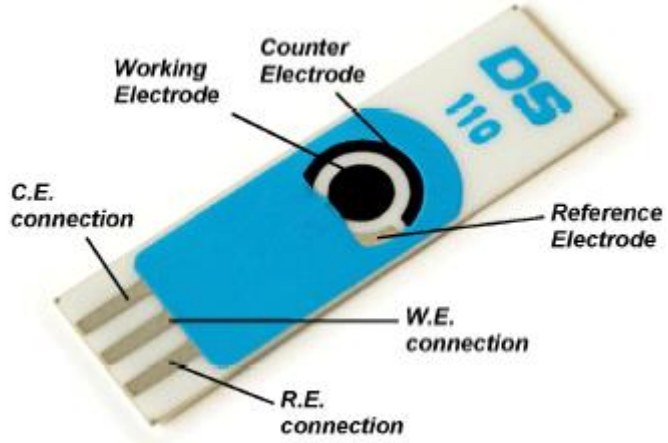
Overview Voltametric measurement

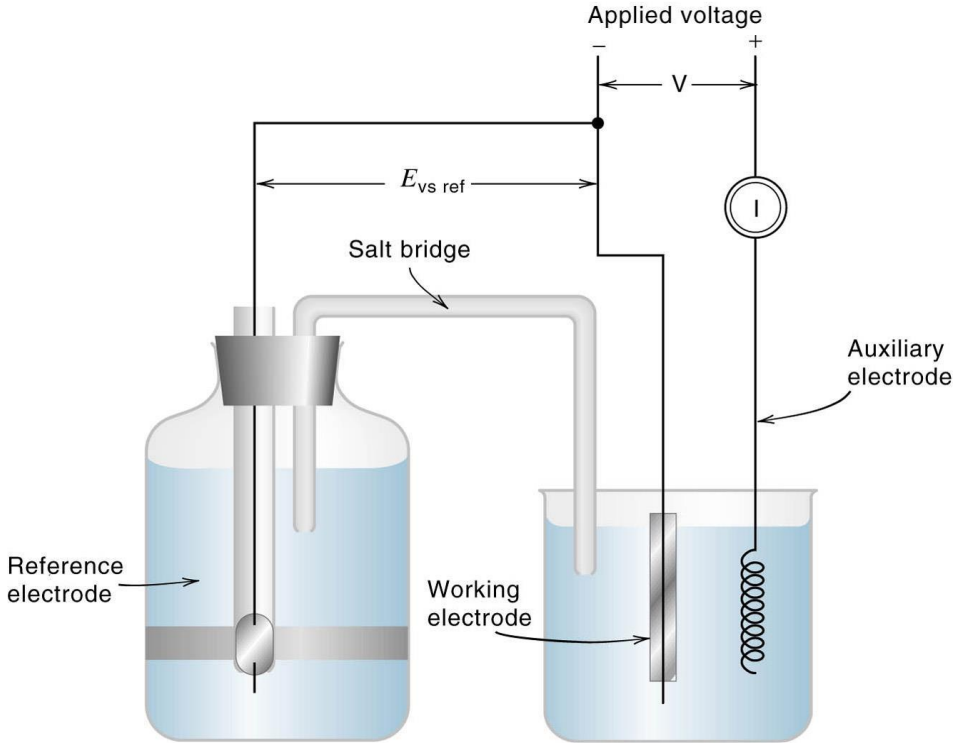
- In voltammetry, 3 electrodes (reference, work and counter electrode) and a potentiostat are used.

- In fact, since E = i R, to accurately control E during scanning it is necessary to make the redox reactions (passage of current) take place between the working electrode and a counter electrode.

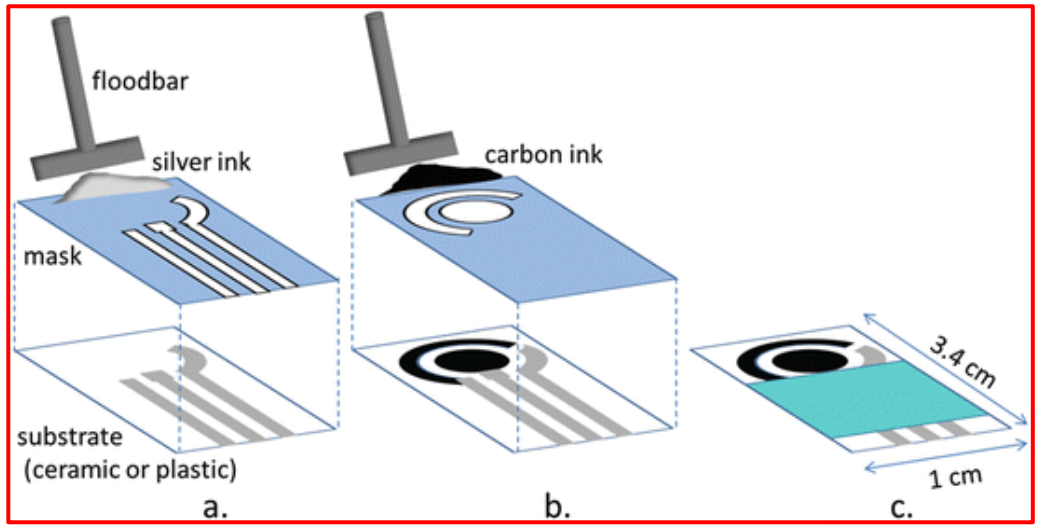
The current passes between the counter electrode (auxiliary) and the working electrode

The applied potential is between the reference electrode and the working electrode

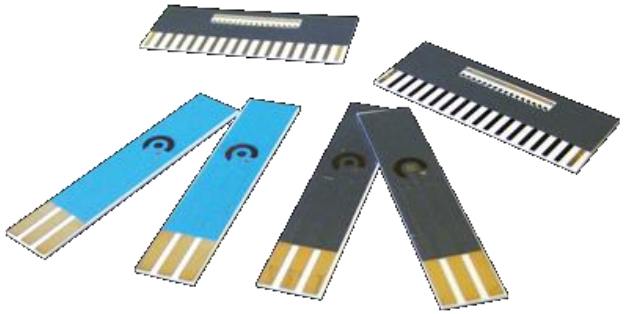


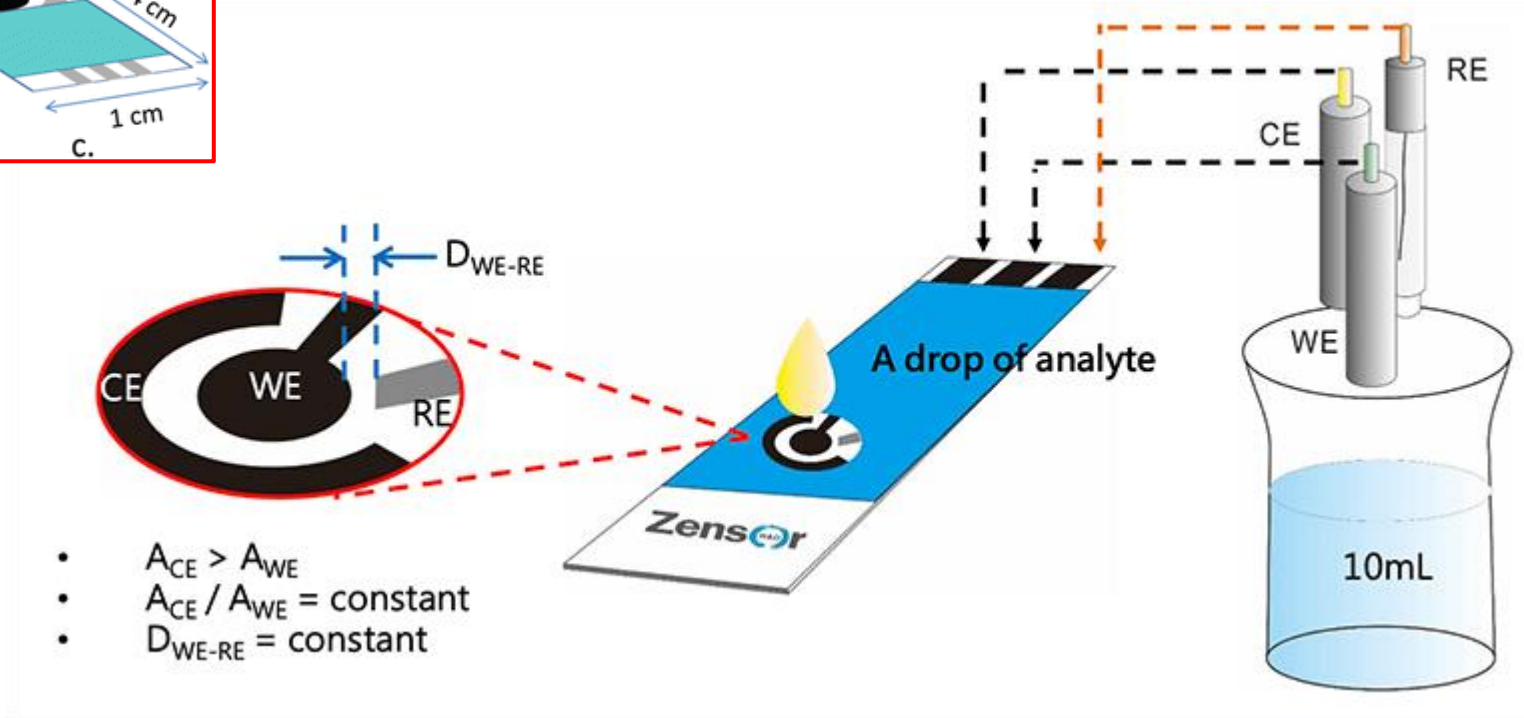


ELECTROCHEMICAL MEASUREMENT SET-UP



Screen printed electrode (disposable)

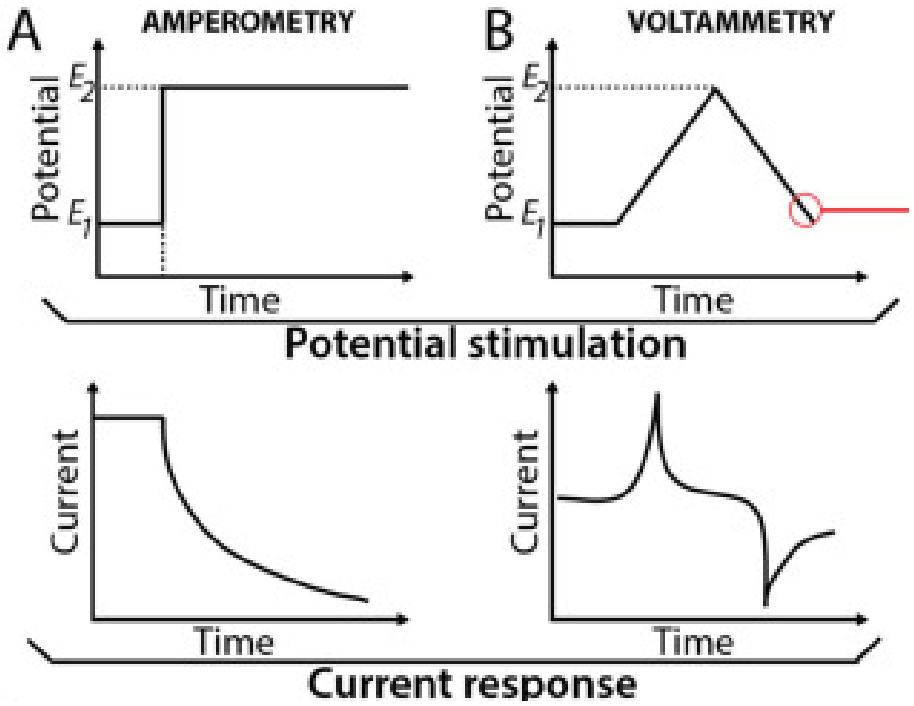




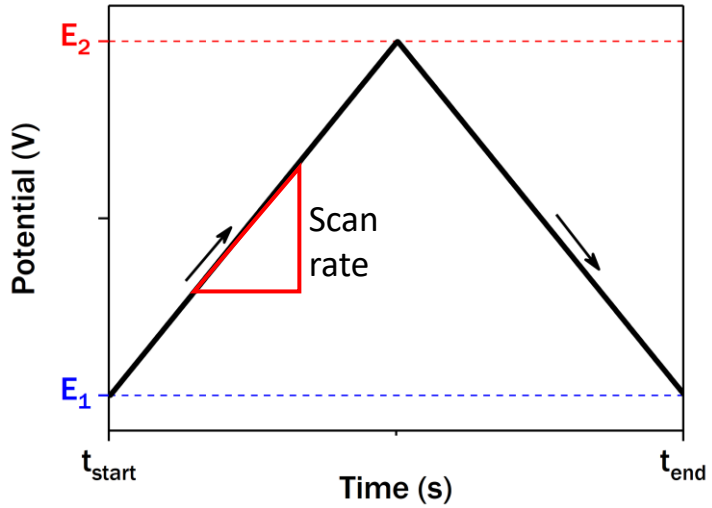
ELECTROCHEMICAL STRATEGIES

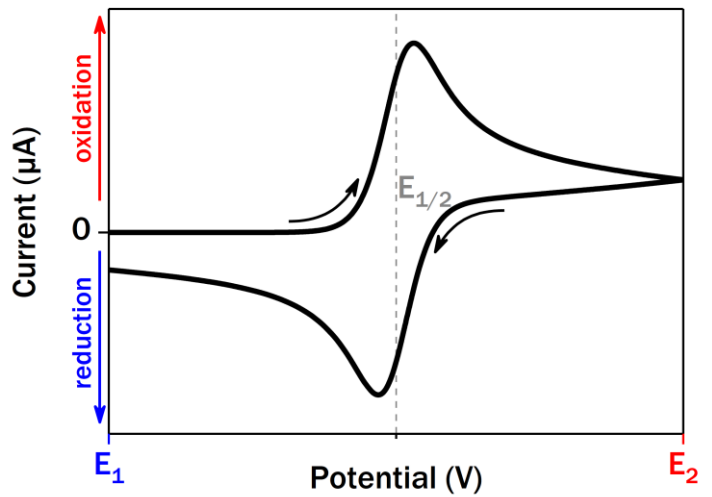
Amperometria: Tecniche basate sulla misura della corrente a **potenziale controllato costante**.

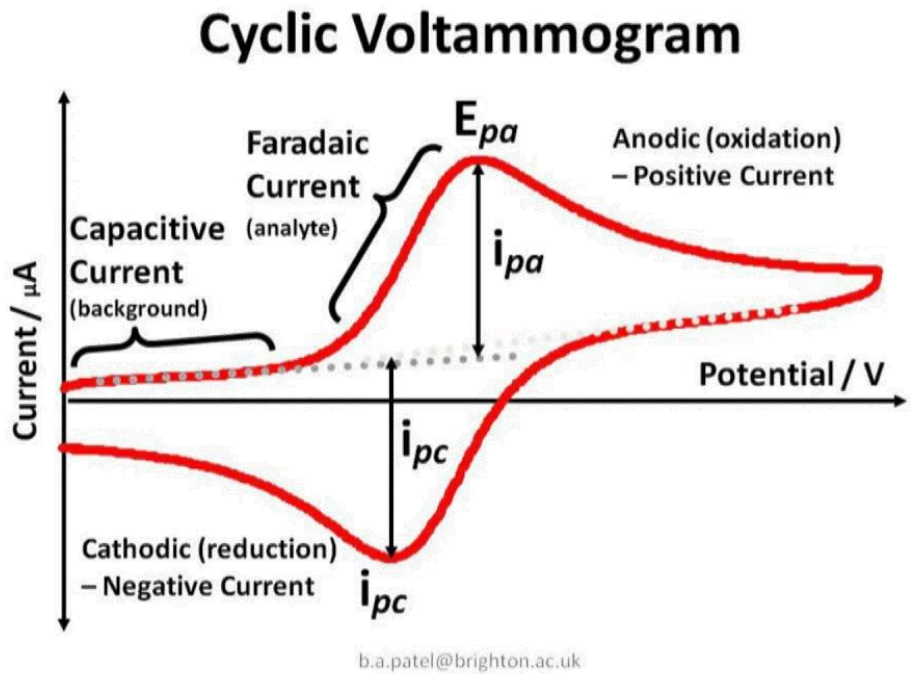
Voltammetria: Tecniche basate sulla misura della corrente a **potenziale che varia nel tempo**



ELECTROCHEMICAL STRATEGIES: Cyclic voltammetries







ELECTROCHEMICAL STRATEGIES: Cyclic voltammetries

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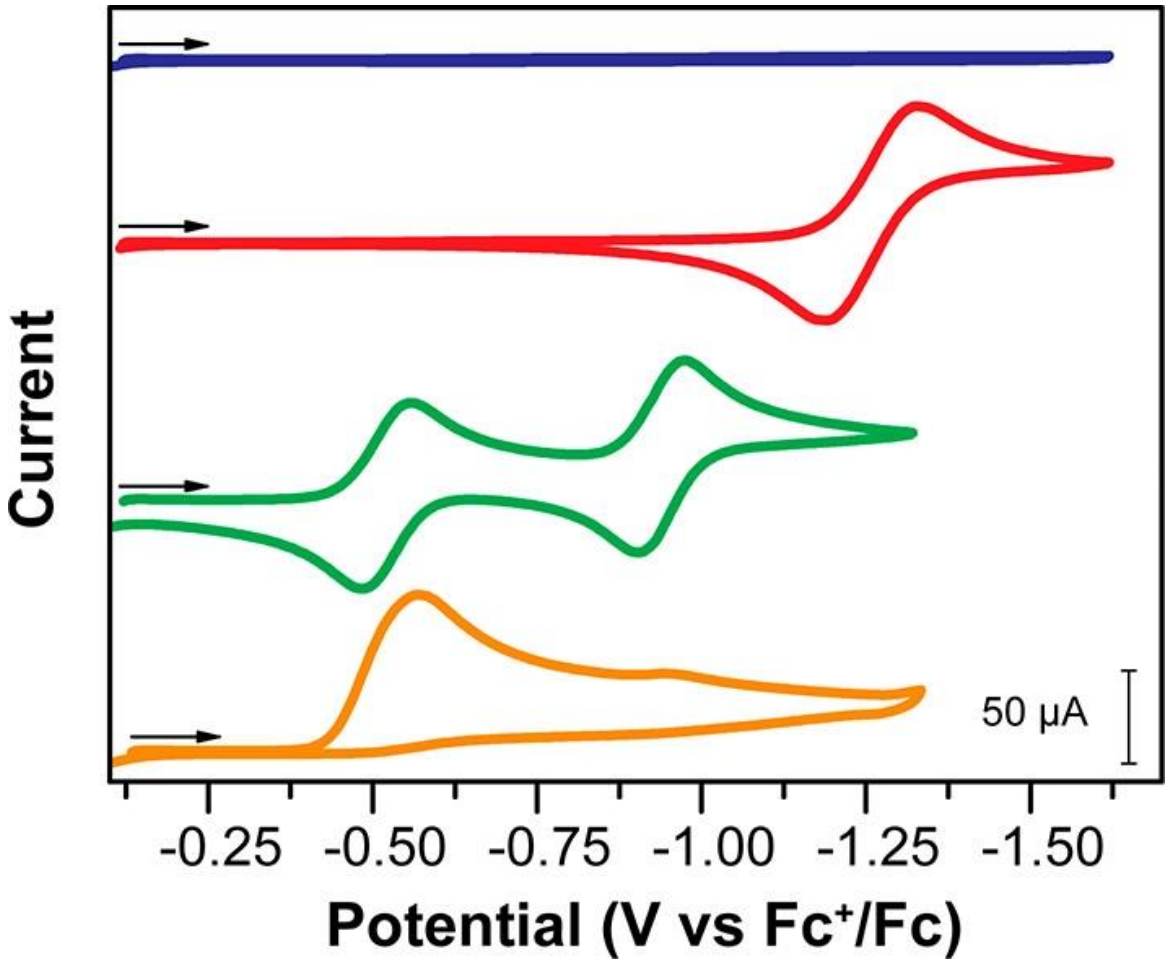
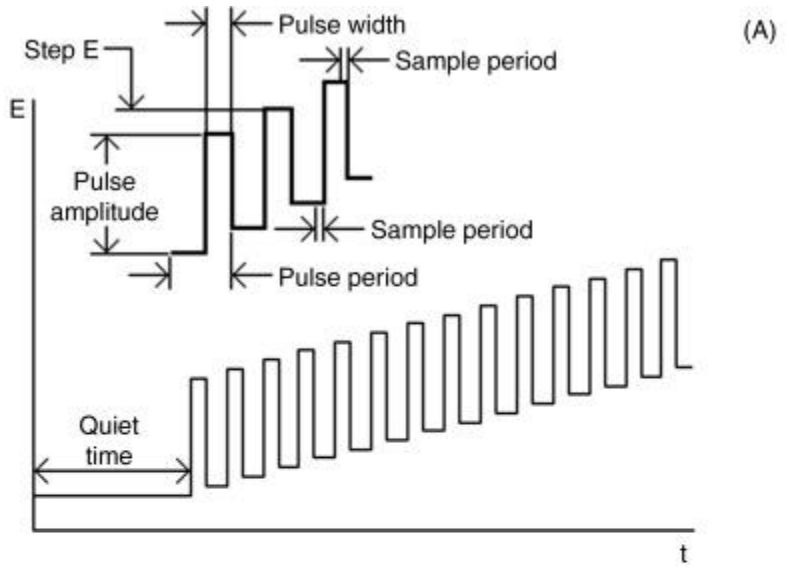
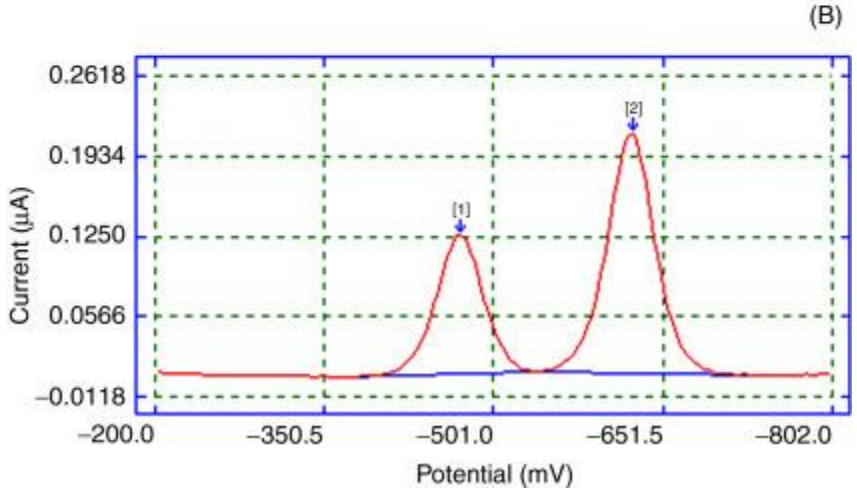
Which information can I obtain from a CV?

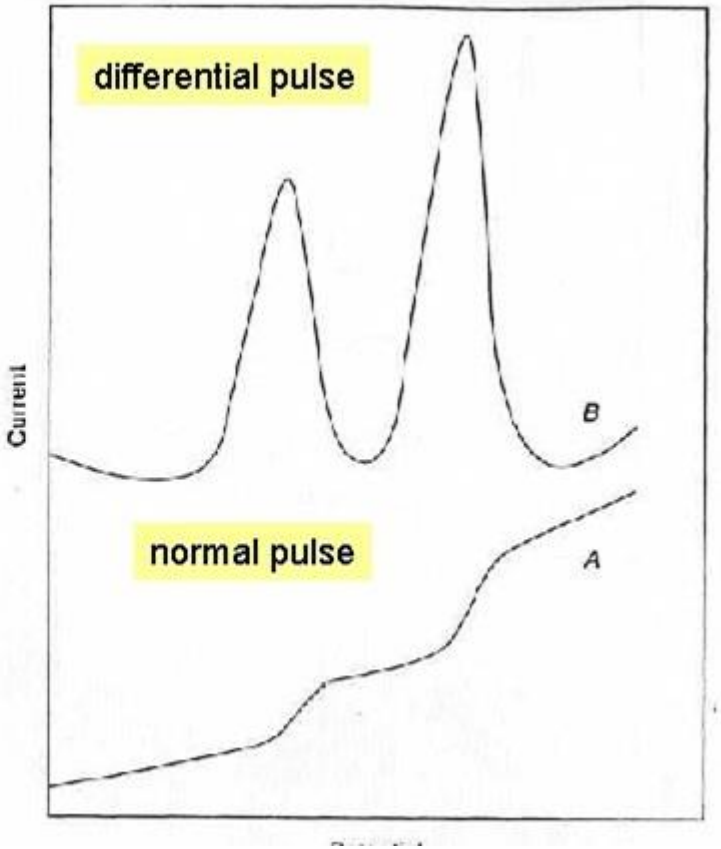


ELECTROCHEMICAL STRATEGIES: Differential Pulse Voltammetries





- allows measurement down to 10-8 M concentration
- improved resolution between the species with similar potential (down to 50 mV)



ELECTROCHEMICAL STRATEGIES: Differential Pulse Voltammetries

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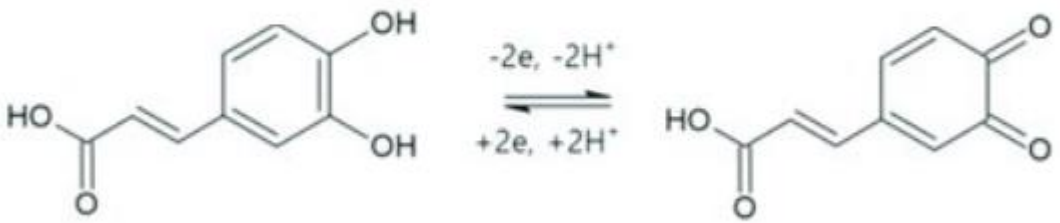
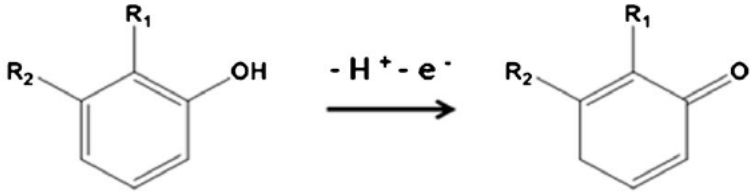
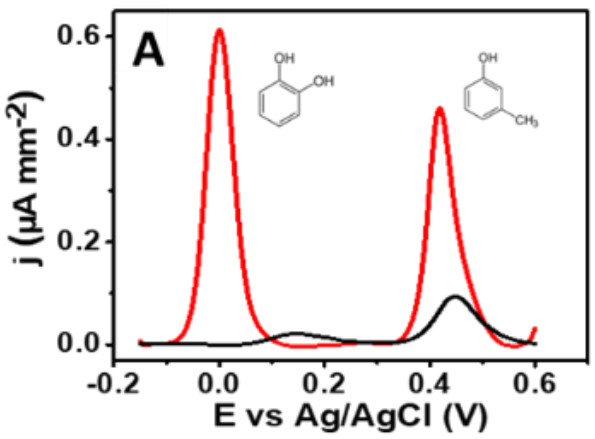
- **Overview: Example of DPV measurement.**
  O-diphenols and mono-phenols quantification by using DPV

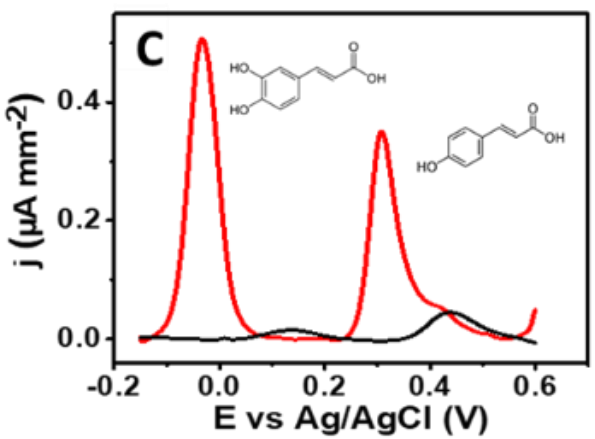
o-diphenols

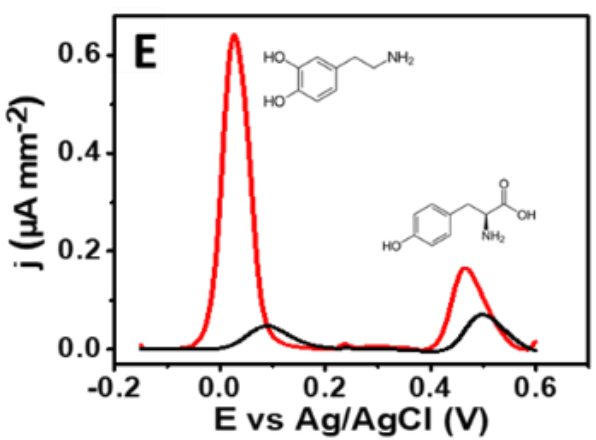


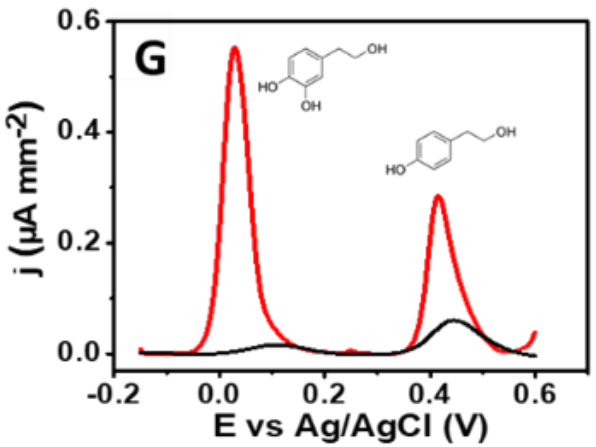
m-phenols











5.4) Caffeic acid evaluation in food sample

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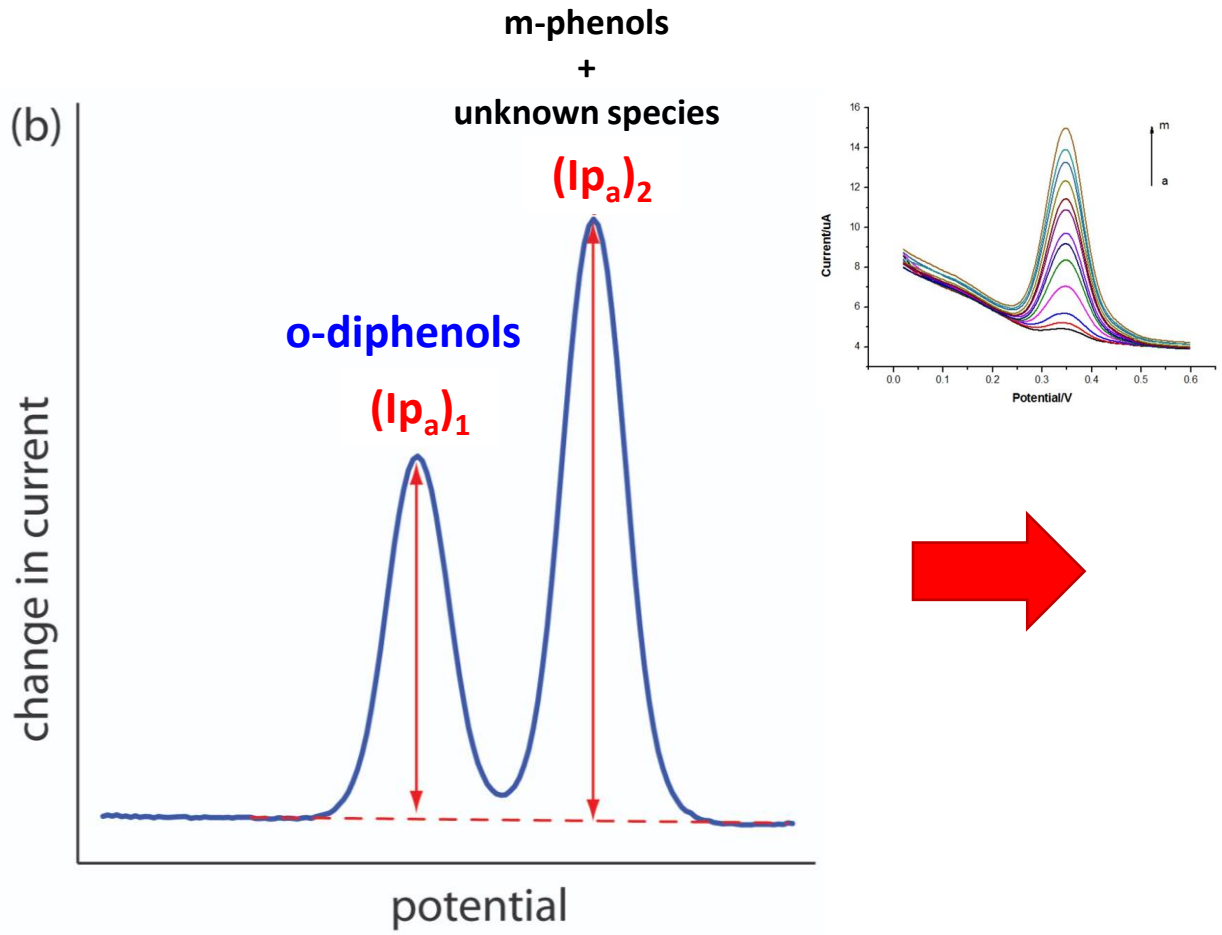
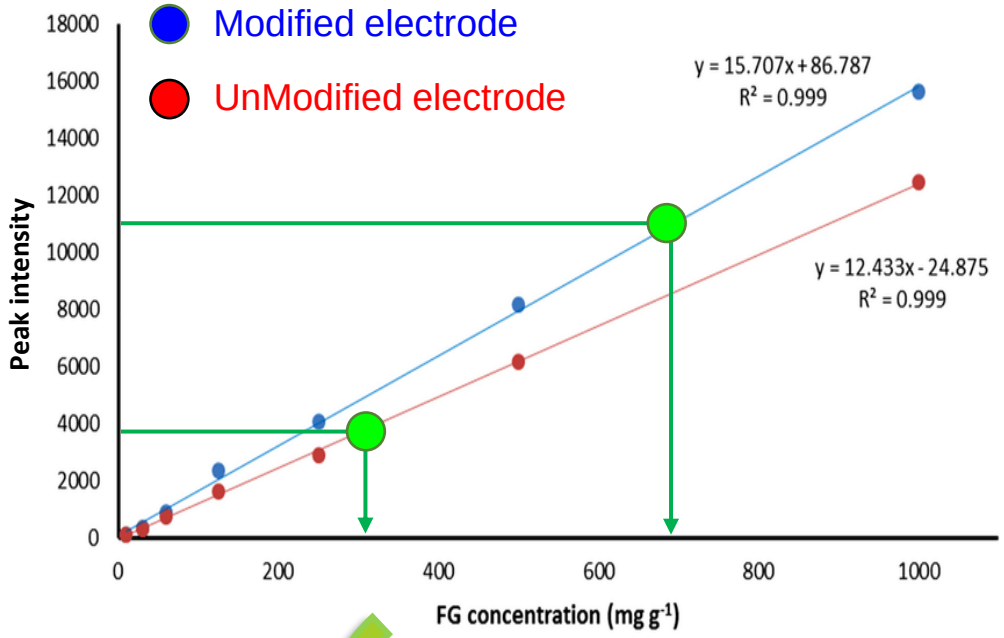
- Sample evaluation

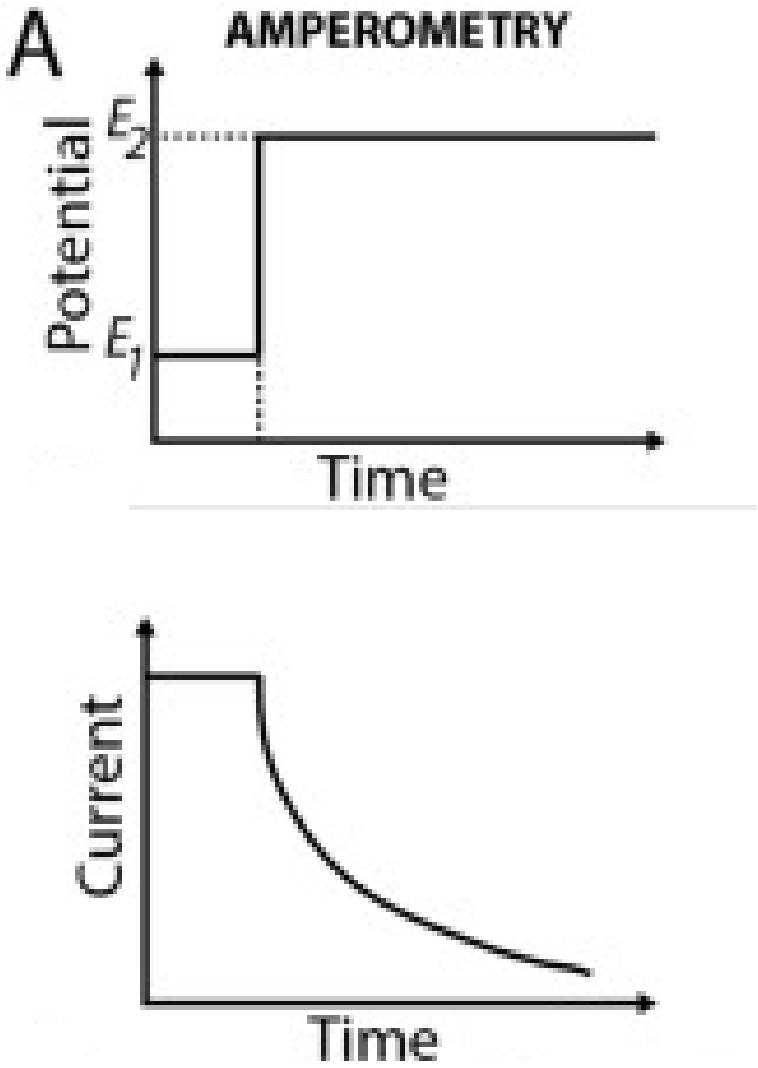


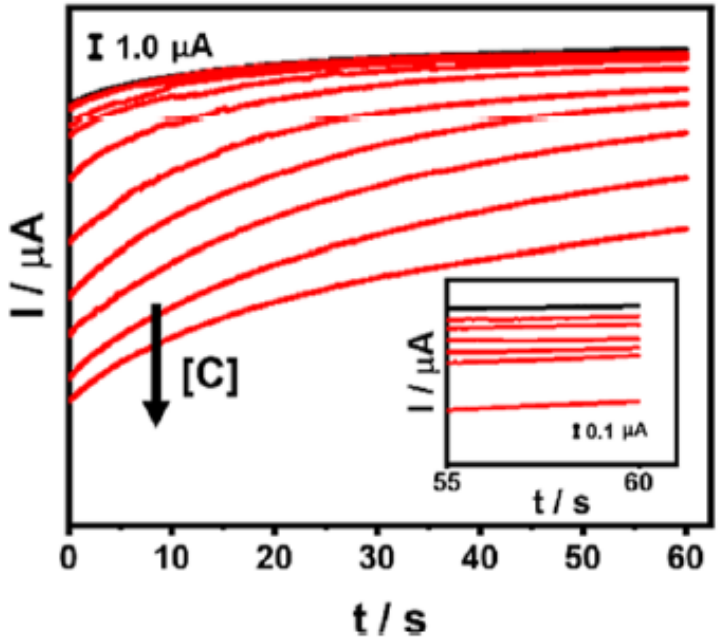
Unknown sample



$$x = \frac{y +/- q}{m}$$

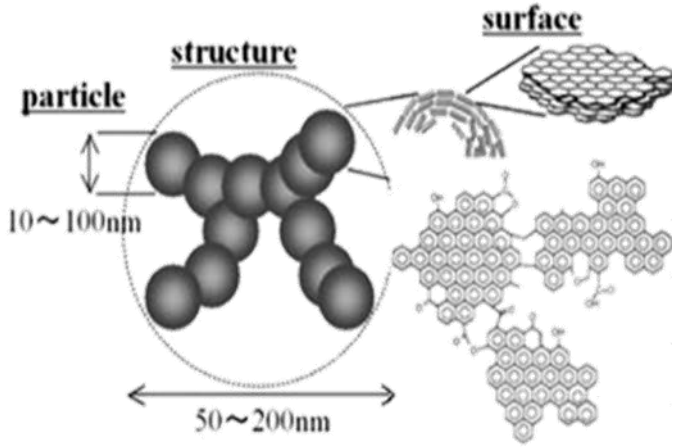
ELECTROCHEMICAL STRATEGIES: Amperometry





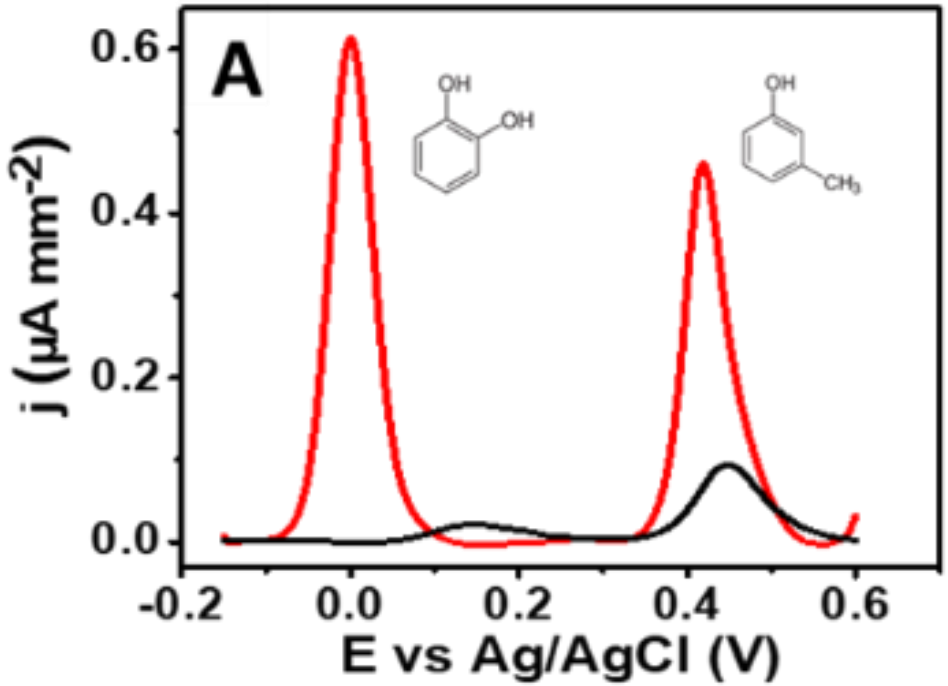
ELECTRODE funcionalization

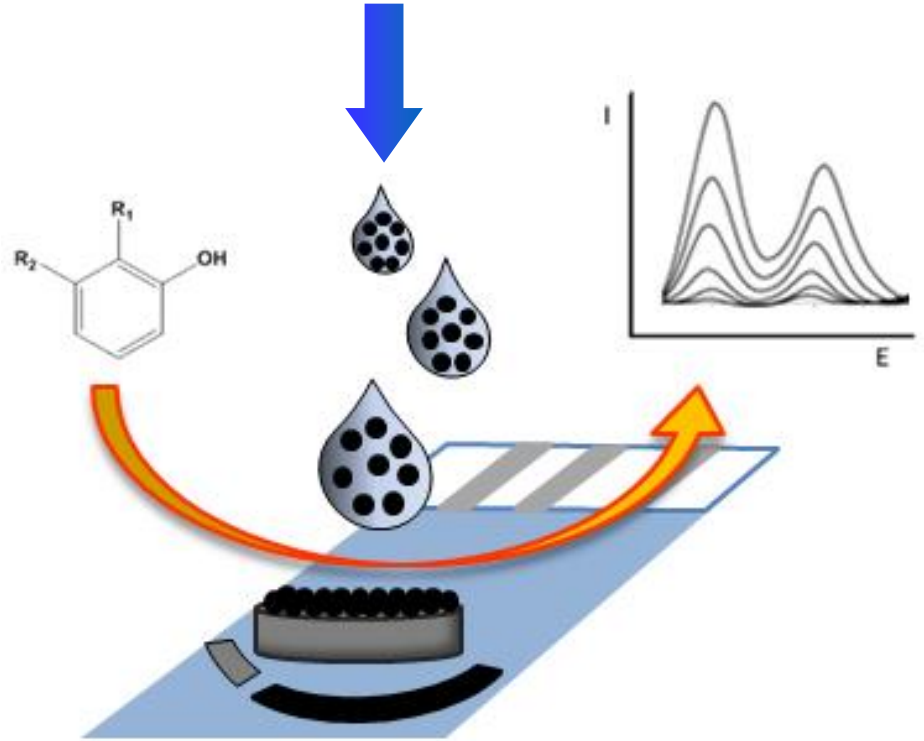
- WE surface modification



STEP 1: SPE modification

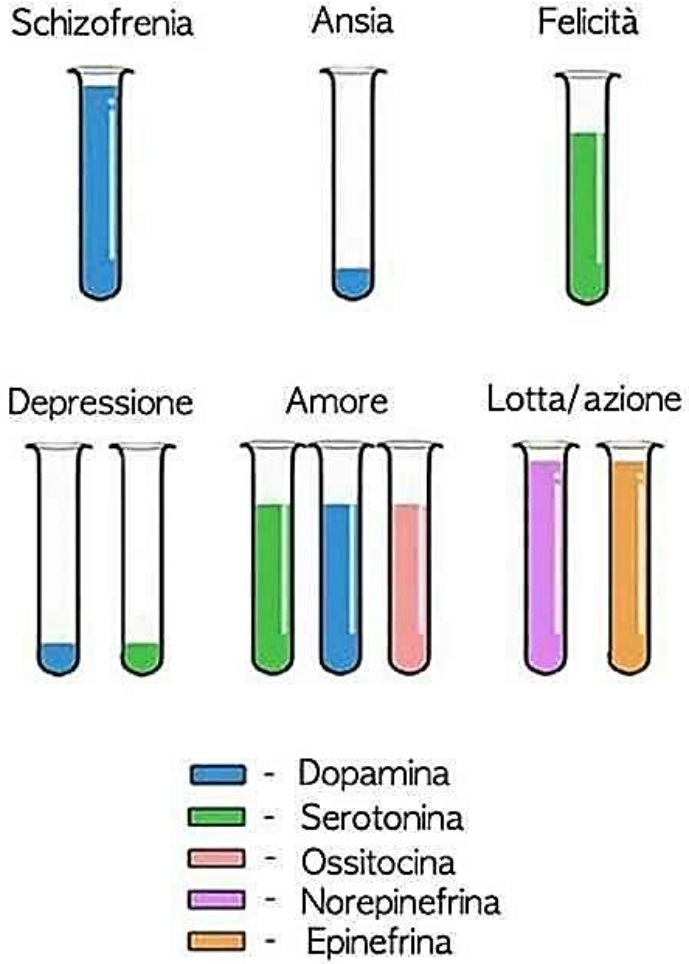
Modify the commercial SPEs by drop-casting 6 µL of carbon black (CB) dispersion (1 mg mL^{-1}) on to the working electrode surface.

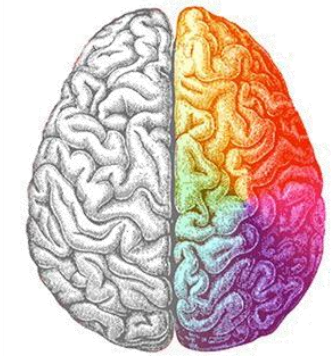


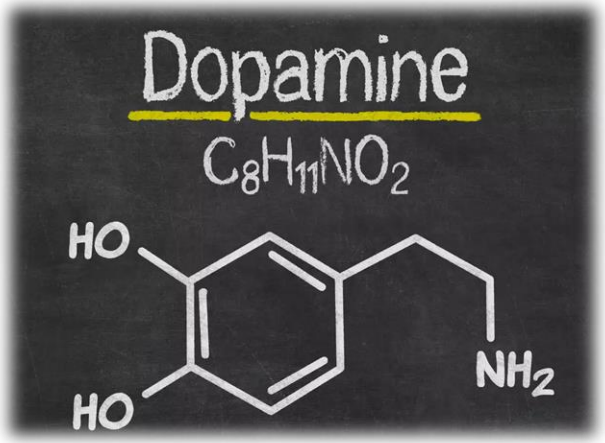


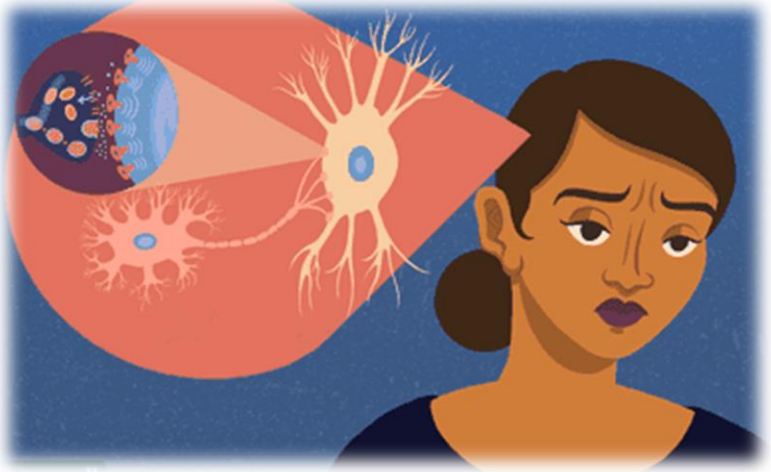
Analytes

Neurotransmitters





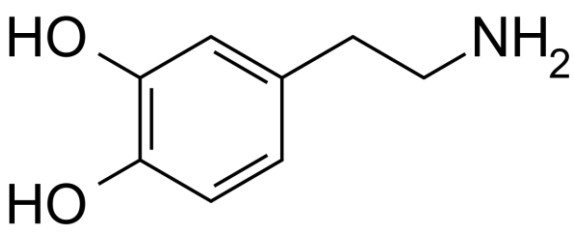




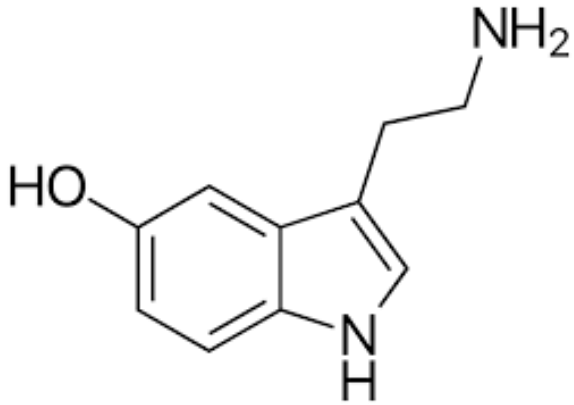
Neurodegenerative diseases markers

Analytes

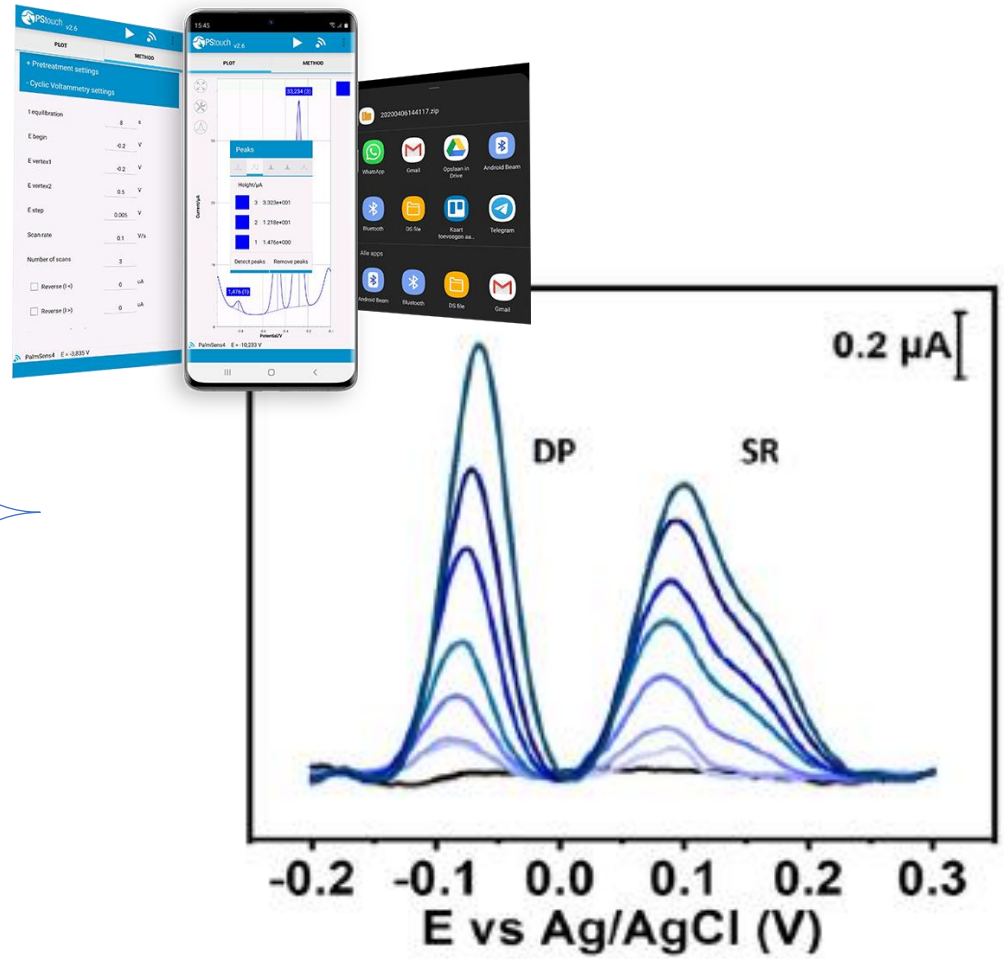
Detection elettrochimica e simultanea di dopamina e serotonina



Dopamina (DP)

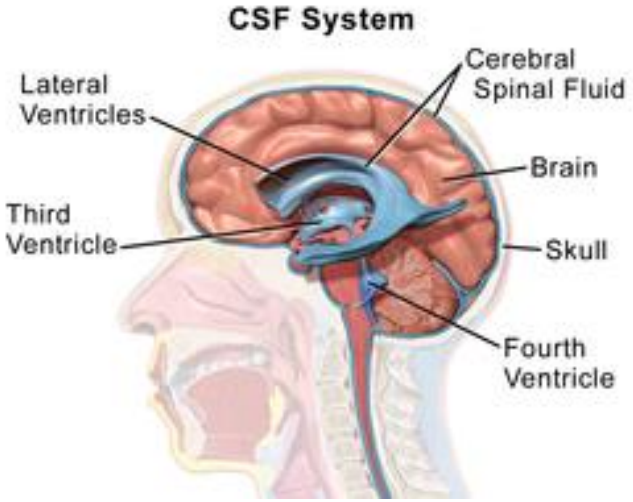


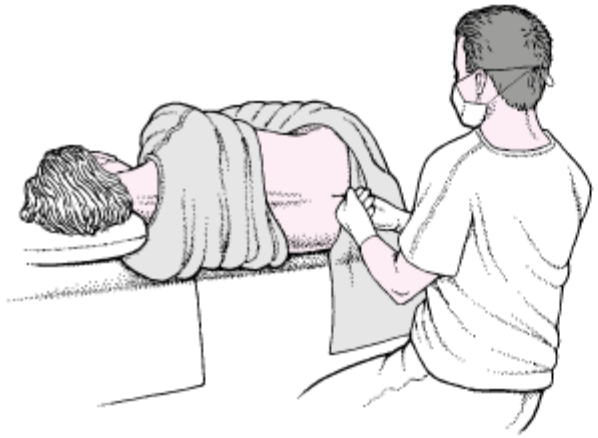
Serotonina (SR)

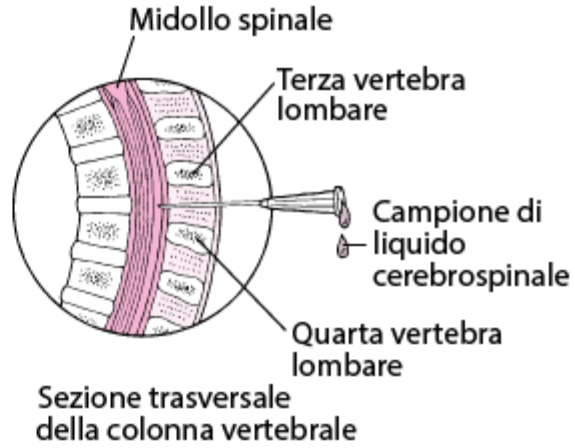


Sensore selettivo

Analytes

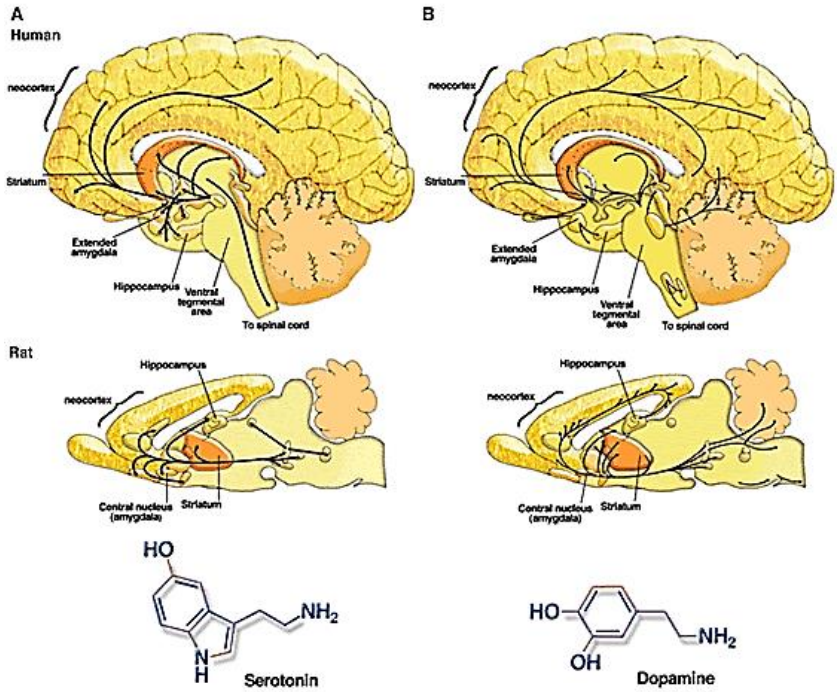


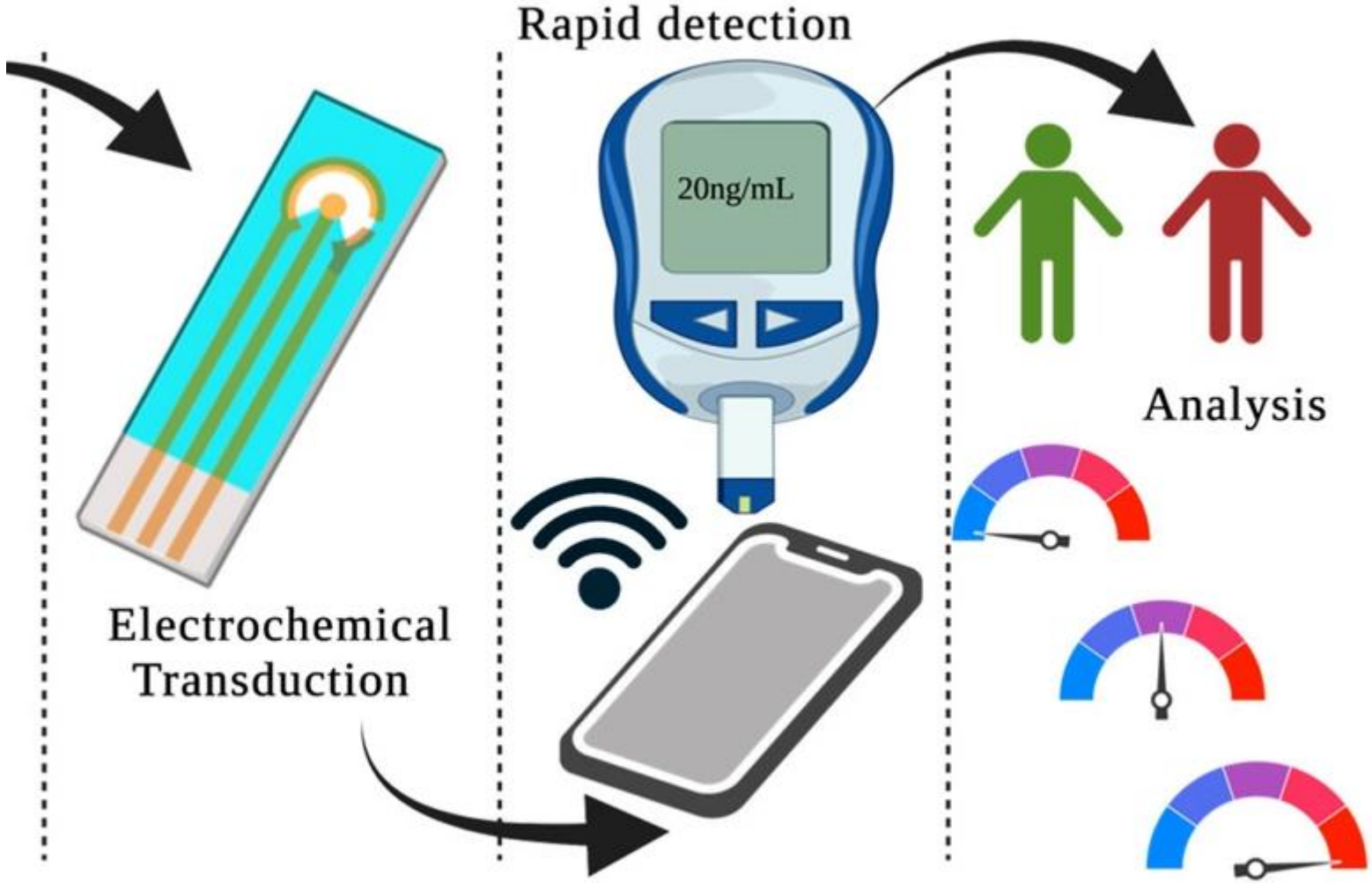




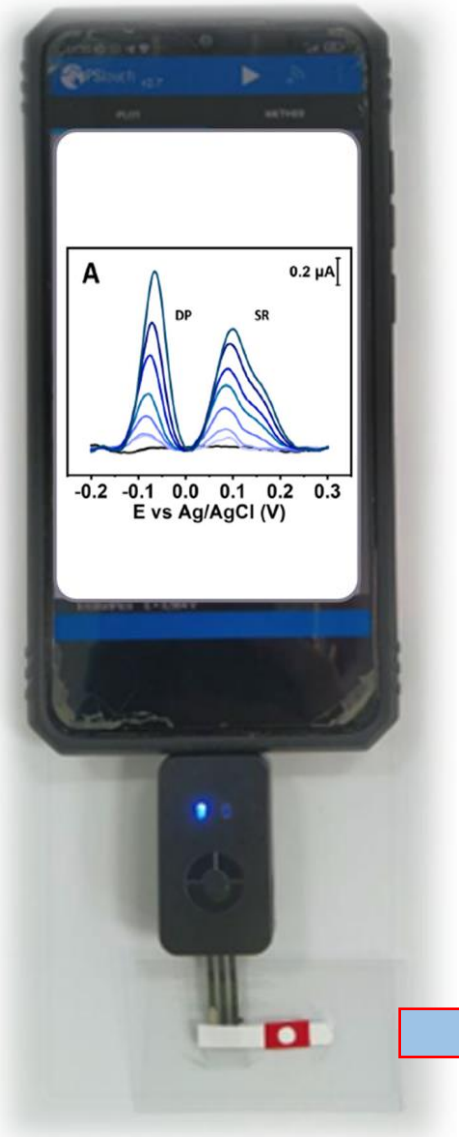
SCF/ liquor was prepared by mixing
NaCl (2.1 g),
KCl (0.07 g),
$CaCl_2$ (0.08 g),
glucose (0.2 g),
$NaHCO_3$ (0.32 g)
urea (0.002 g)
(in 250 mL)

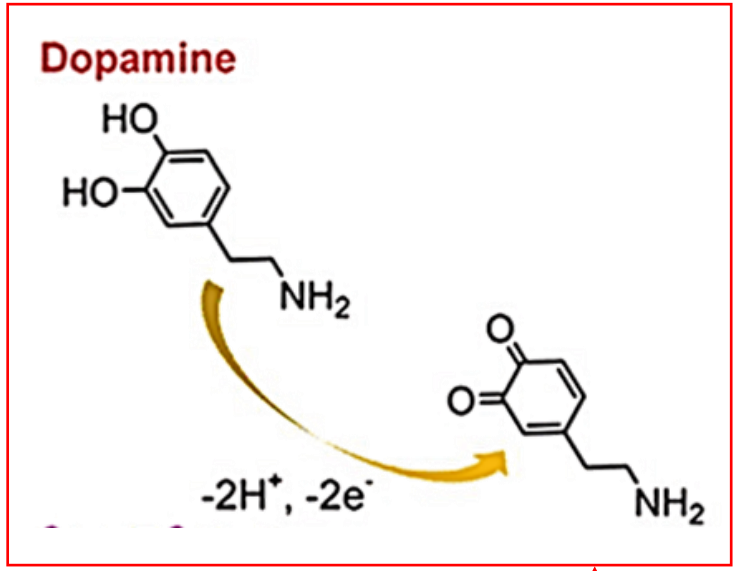
Detection elettrochimica e simultanea di dopamina e serotonina

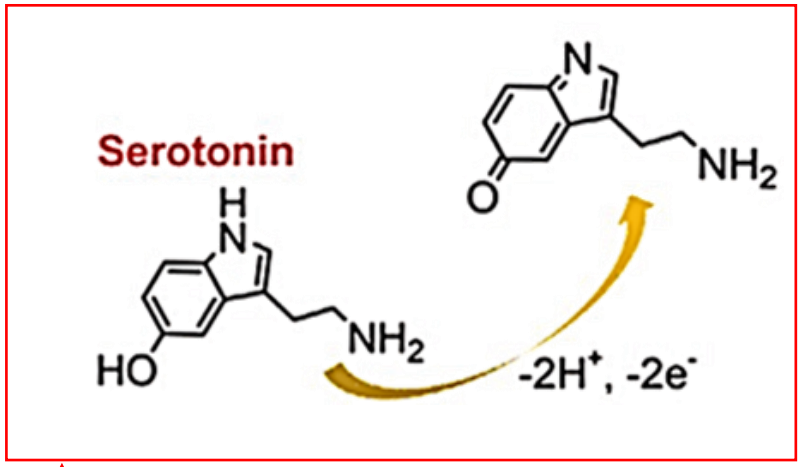


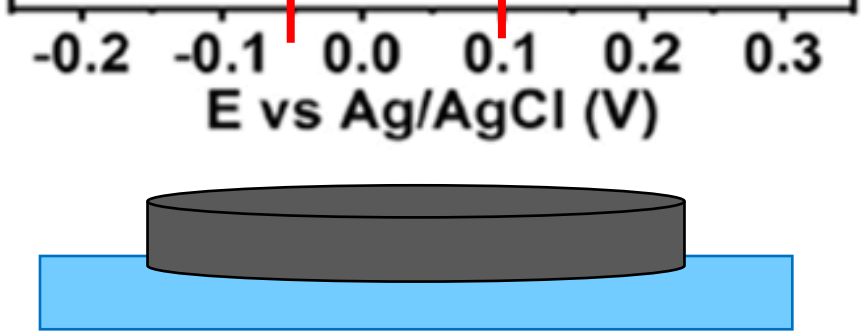


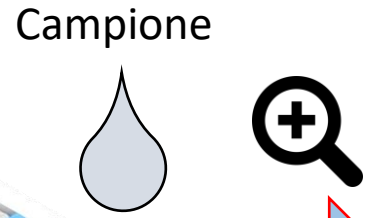
Detection elettrochimica e simultanea di dopamina e serotonina











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