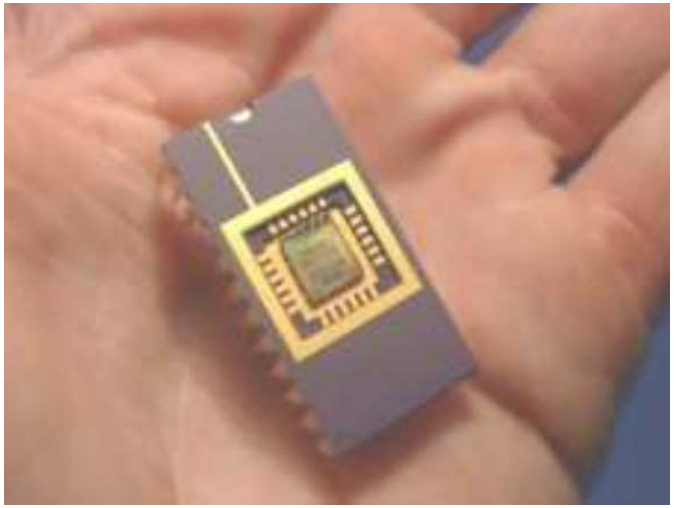
Biosensor



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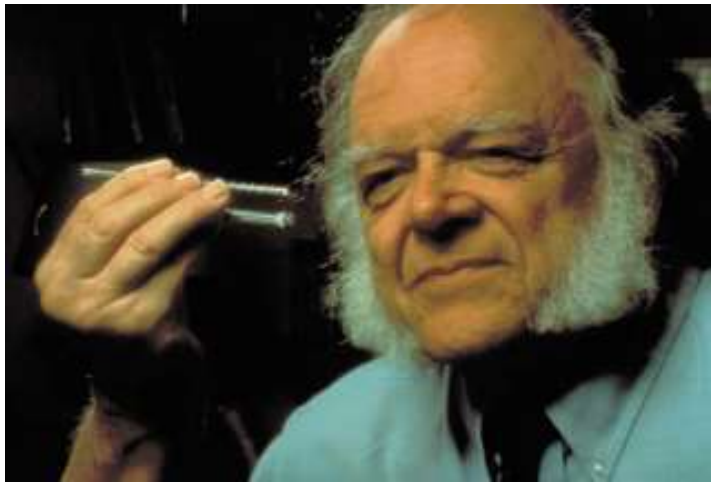
Introduction

• A biosensor is an analytical device which converts the **biological signal** into a **measurable electrical signal**.

- Self-contained integrated device that is capable of providing specific qualitative or semi-quantitative analytical information using a biological recognition element which is in direct-spatial contact with a transduction element.



Professor Leland C Clark is the father of Biosenor. **1918–2005**

A good biosensor

- It should provide accurate, precise, reproducible results.

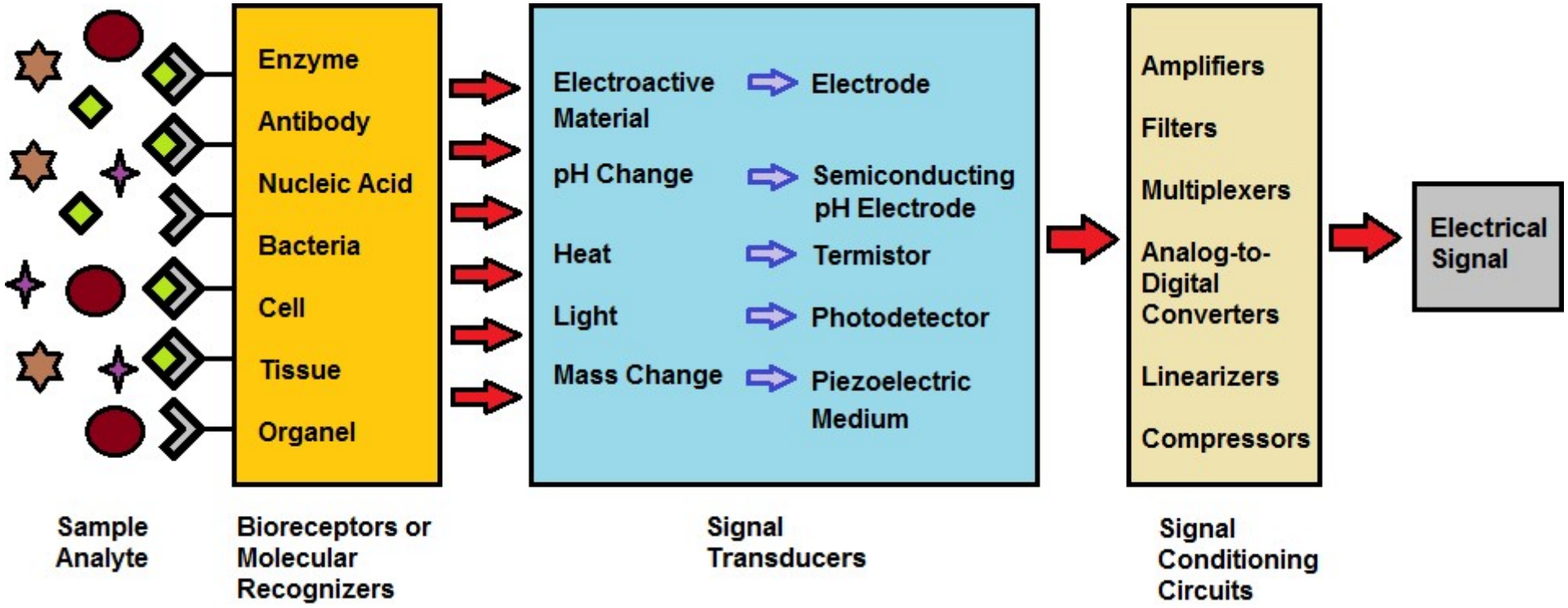
- It should be free from electrical noise.

- It should be cheap, small, portable and capable of being used by semi-skilled operators.

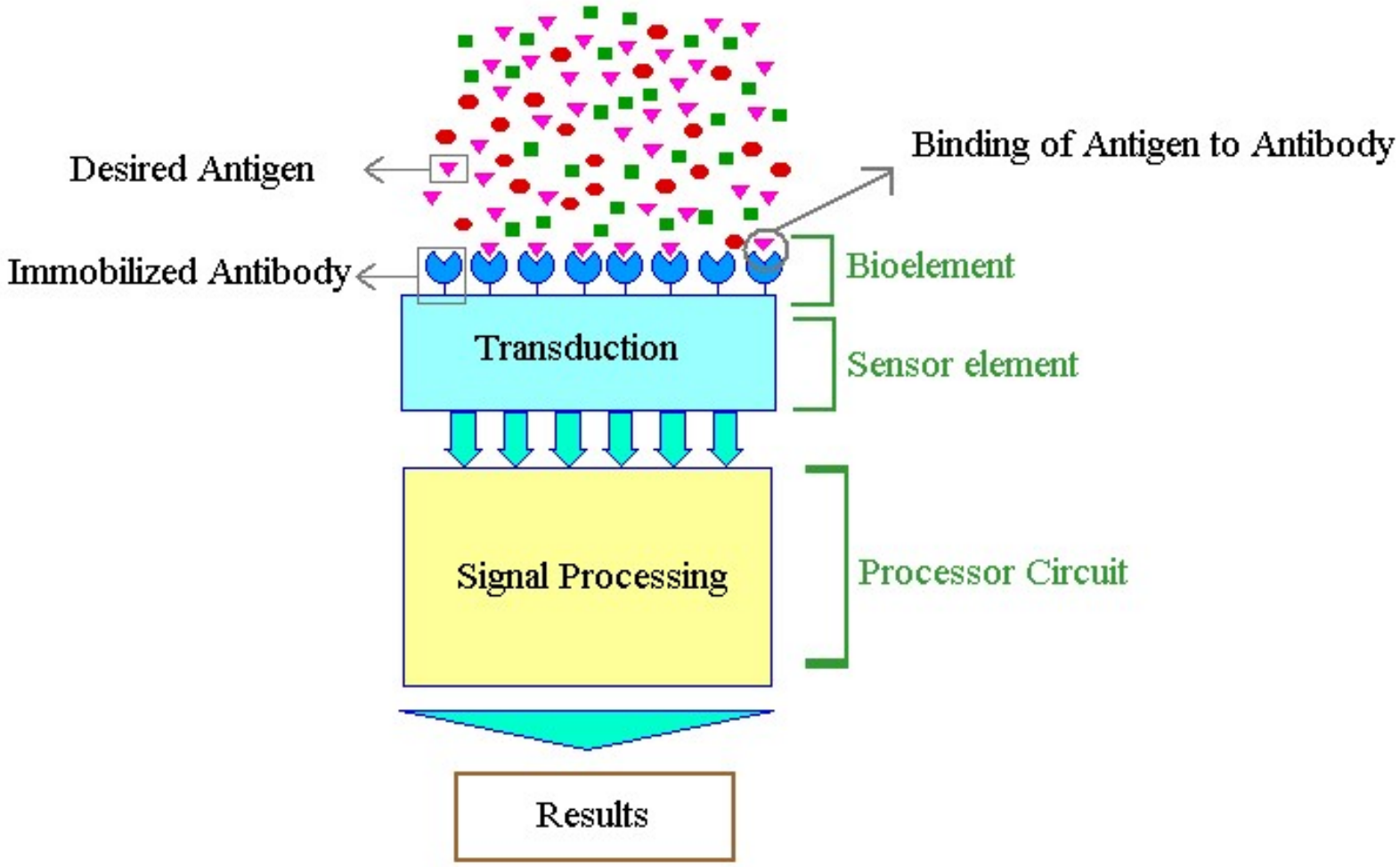
- The reaction should be independent from physical parameters (stirring, pH and temperature).

Parts of biosensor

- Bioreceptors
- Signal Transducer
- Signal processor



Function Principle



Bioreceptor

- The bioreceptor is a biologically derived material such as tissue, microorganisms, organelles, cell receptors, enzymes, antibodies, nucleic acids, etc.

or

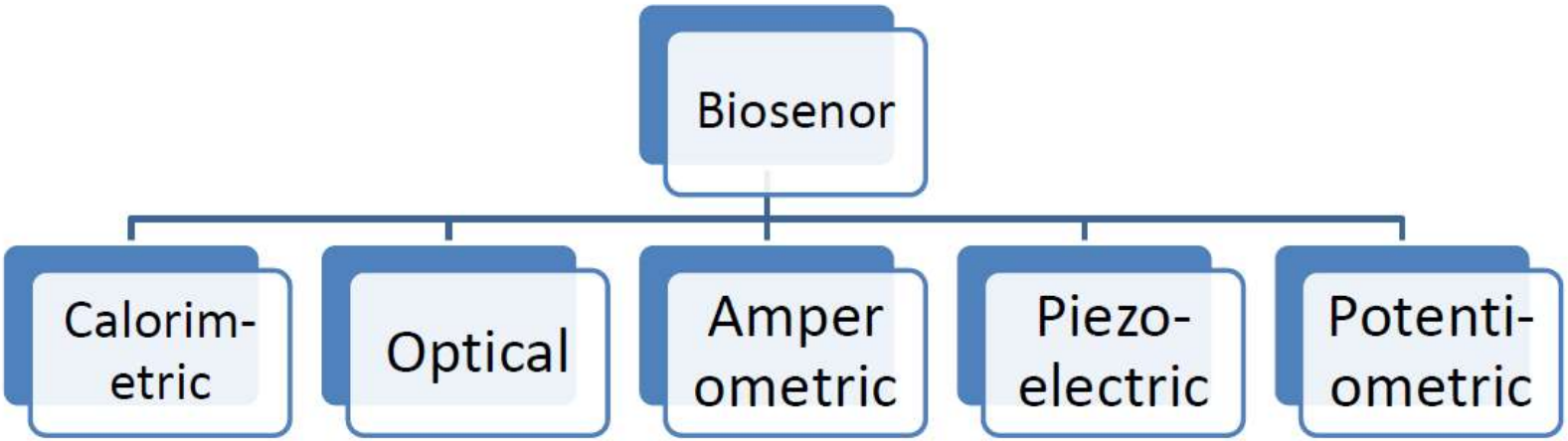
- Biomimetic component that binds or recognizes the analyte of interest.

Transducer

- When the analyte interacts with the bioreceptor, change in biological signals such as change in temperature, electrical charge occurs.

- The transducer transforms these signal into another signal which is easily measured and quantified.

- Based on the type of transducer the Biosensor are classified as



ELEMENTS OF BIOSENSORS

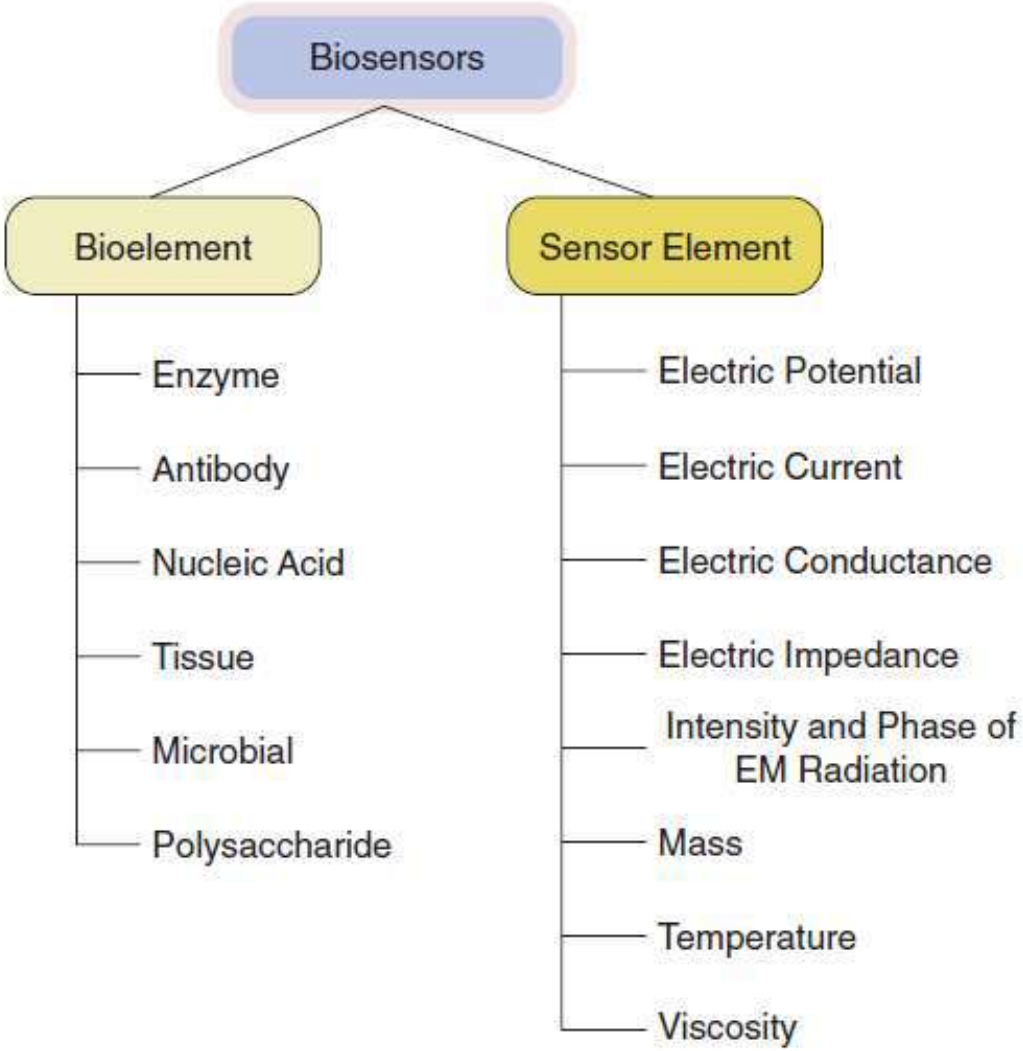
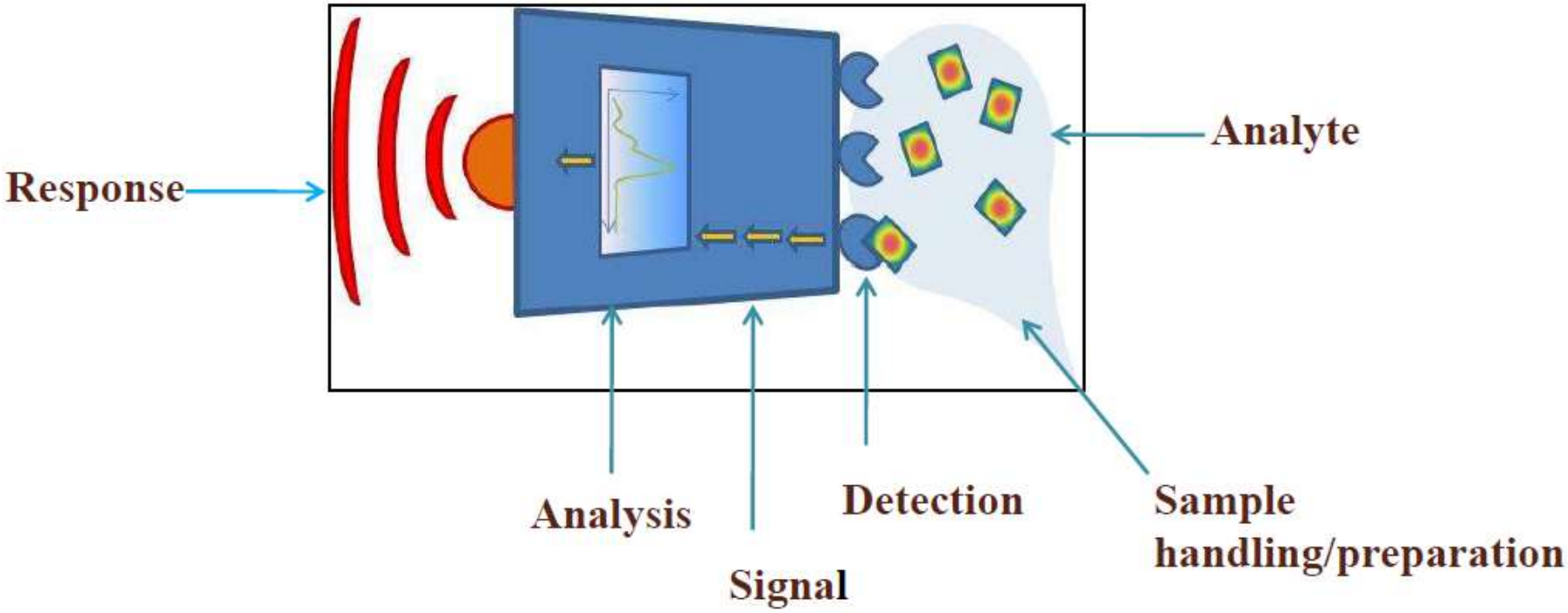


Fig. 3 Elements of biosensors

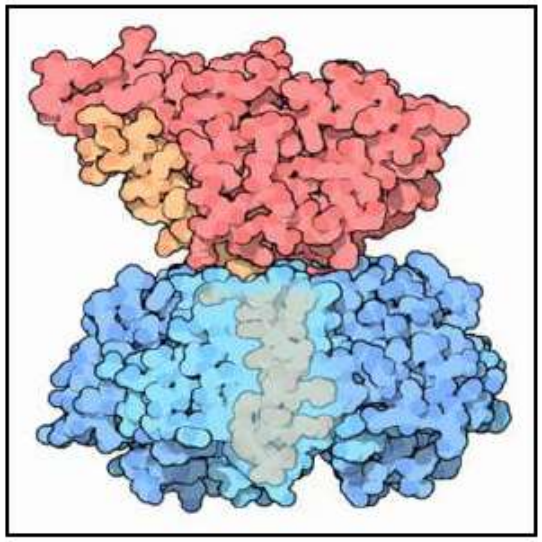
BIOSENSOR



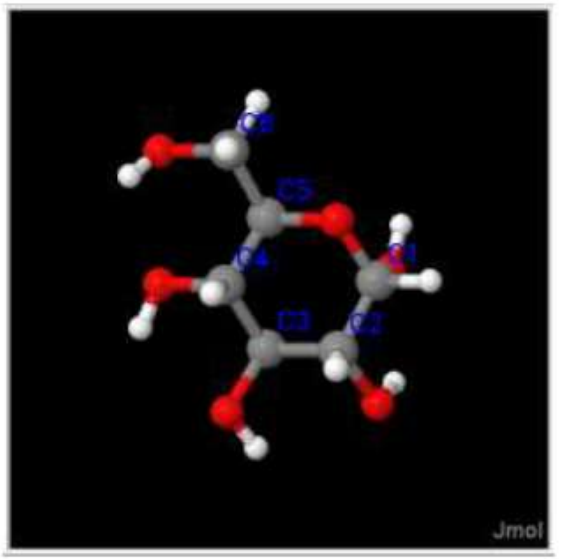
THE ANALYTE

(What do you want to detect?)

- Molecule
- Protein, toxin, peptide, vitamin, sugar, metal ion



Cholera toxin

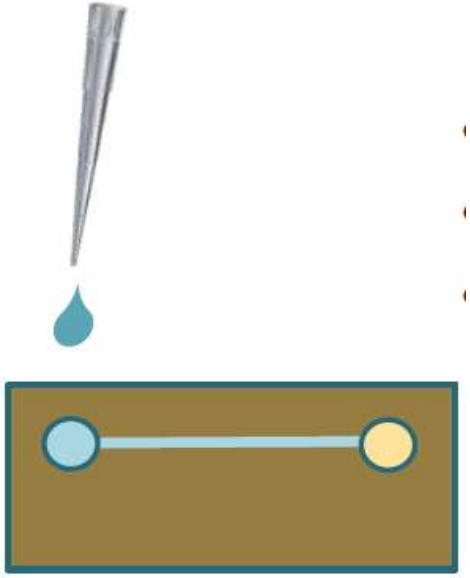


Glucose

SAMPLE HANDLING

(How to deliver the Analyte to the Sensitive Region?)

- (Micro) fluidics
- Concentration (increase/decrease)
- Filtration/selection



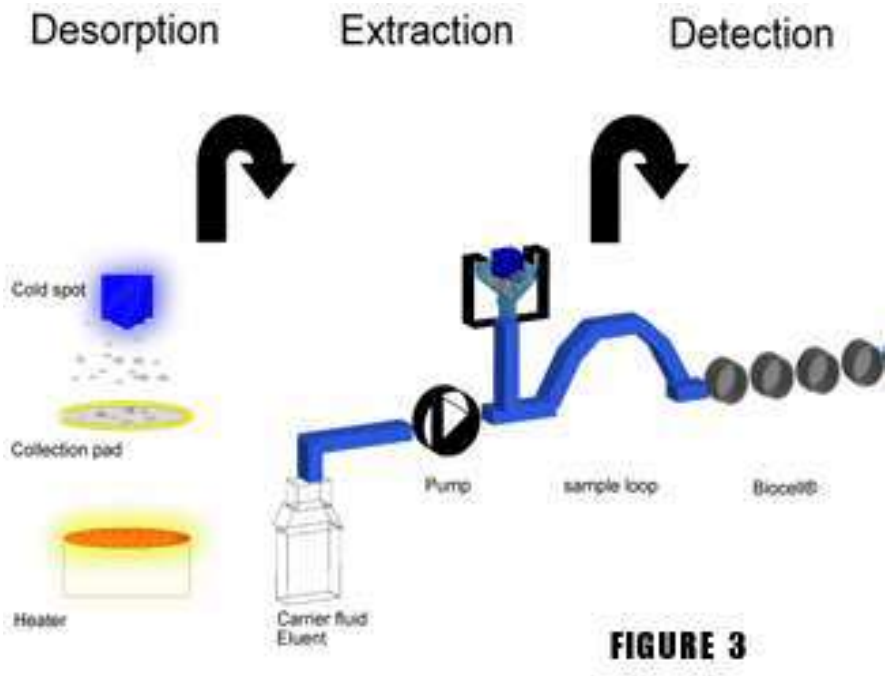
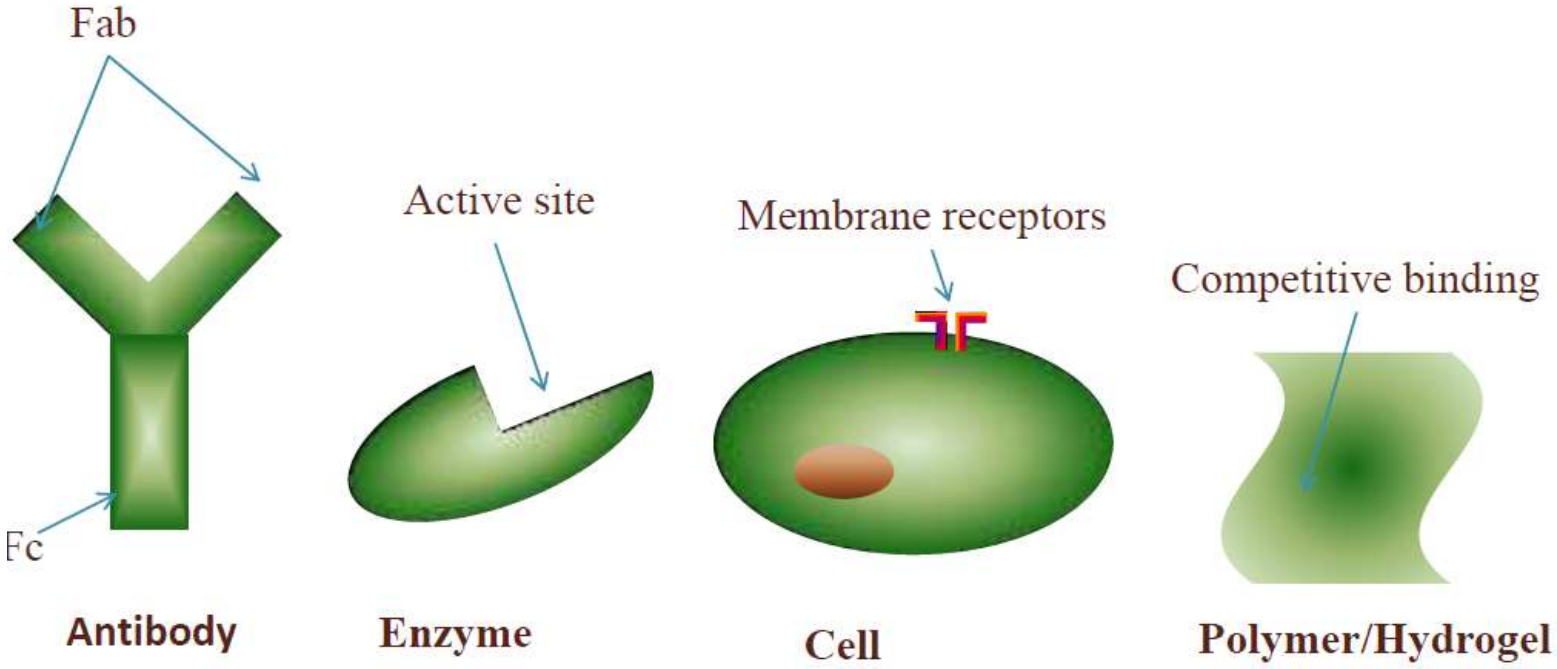


FIGURE 3

DETECTION/RECOGNITION

(How do you specifically recognise the analyte?)

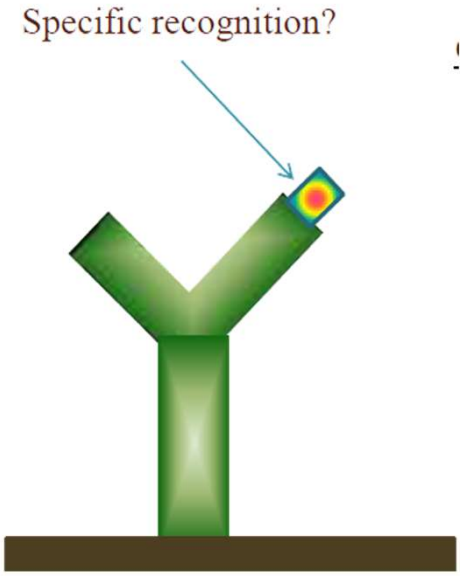


SIGNAL

(How do you know there was a detection?)

Common Signalling Principles

- Optical(SPR (Surface plasmon resonance),IR).
- Electrical(Voltametry, Potentiometry, Conductivity).
- Electromechanical(QCM quartz crystal microbalance).
- Thermal.
- Magnetic.
- Pressure.



Often the detector is immobilized on a solid support/sensor.
(The immobilisation permits repeated use of the costly Biological Molecule.)

WORKING PRINCIPLE

- Analyte diffuses from the solution to the surface of the Biosensor.
- Analyte reacts specifically & efficiently with the Biological Component of the Biosensor.
- This reaction changes the physicochmical properties of the Transducer surface.
- This leads to a change in the optical/electronic properties of the Transducer Surface.
- The change in the optical/electronic properties is measured/converted into electrical signal, which is detected.

ADVANTAGES

- Highly Specific.
- Independent of Factors like stirring, pH, etc.
- Linear response, Tiny & Biocompatible.
- Easy to Use, Durable.
- Require only Small Sample Volume.
- Rapid, Accurate, Stable & Sterilizable.

Calorimetric biosensors (MECHANISM)

- The heat produced (or absorbed) by the reaction.

Potentiometric biosensors

- Changes in the distribution of charges causing an electrical potential.

Amperometric biosensors

- Movement of electrons produced in a redox reaction.

Optical biosensors

- Light output during the reaction or a light absorbance difference between the reactants and products .

Piezo-electric biosensors

- Effects due to the mass of the reactants or products .

Signal processors

• Signal processor process the data obtained from the transducer and displays the result in user friendly way.

Example:

- **Pregnancy test**
- **Detects the hCG (Human chorionic Gonadotropin) protein in urine.**

Glucose monitoring device
(for diabetes patients)

- Monitors the glucose level in the blood.
- The enzyme glucose oxiadase is used by blood glucose biosensor to break down of blood glucose.
- First it oxidizes glucose and uses two electrons to reduce the FAD (flavin adenine mononucleotide) a component of the enzyme to $FADH_2$ which in turn is oxidized by the electrode in a number of steps.
- The resulting current is a measure of the concentration of glucose.
- In this case, the electrode is the transducer and the enzyme is the bioreceptor.

APPLICATIONS

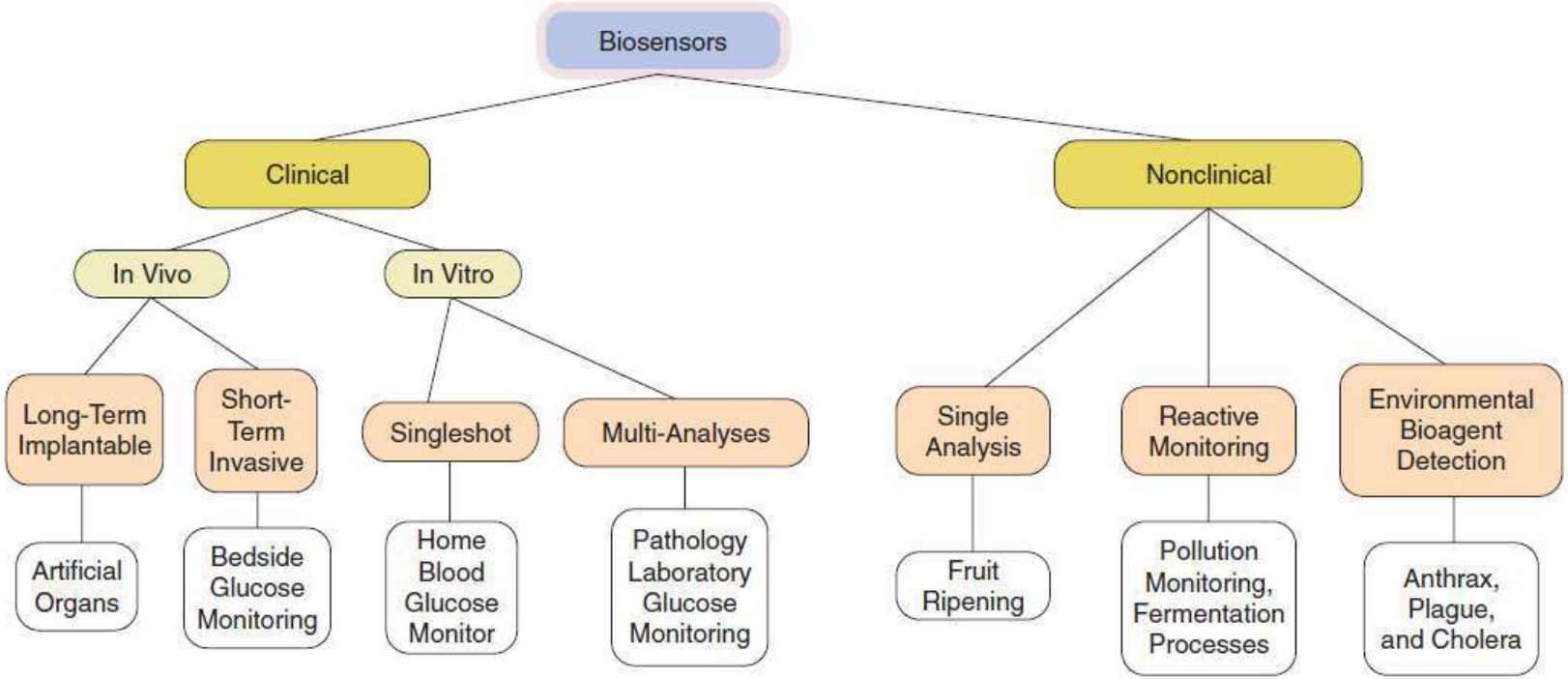


Fig. 2 Potential applications of biosensors

APPLICATIONS

- Food Analysis.
- Study of Biomolecules & their Interaction.
- Drug Development.
- Crime Detection.
- Medical Diagnosis (Clinical & Laboratory).
- Environmental Field Monitoring.
- Quality Control.
- Industrial Process Control.
- Detection Systems for Biological Warfare Agents.
- Manifestations of Pharmaceuticals & Replacement organs

Example of Biosensors

The DNA capture element instrument- for hereditary diseases

Glucometer- for measurement of glucose in blood.

Old time coal miners' Biosensor.
Data analysis and interpretation performed by the coal miner.

Pregnancy Test.
•***Detects the hCG protein in urine.***
• ***Interpretation and data analysis performed by the user.***

Infectious Disease Biosensor.
•***Data analysis and interpretation performed by a microprocessor.***

Image courtesy of GE Healthcare

Biosensor platform.
General and flexible, good tool for development of specific biosensors.

NEW GENERATION BIOSENSOR

THANK YOU

Happy to answer if you have any question.....?