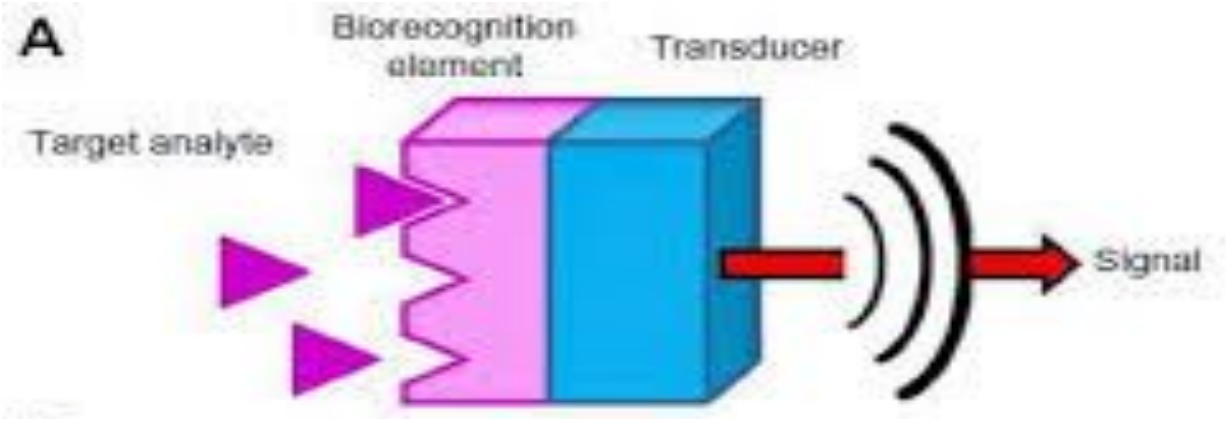
BIOSENSOR

What is a BIOSENSOR

- These are analytical devices, which measure concentration of an analyte.
- In biosensors, a biological material (such as enzyme, antibody, whole cell, nucleic acid) is used to interact with the analyte.
- This interaction produces a physical or chemical change, which is detected by the transducer and converted to an electrical signal.
- This signal is interpreted and converted to analyte concentration present in the sample.

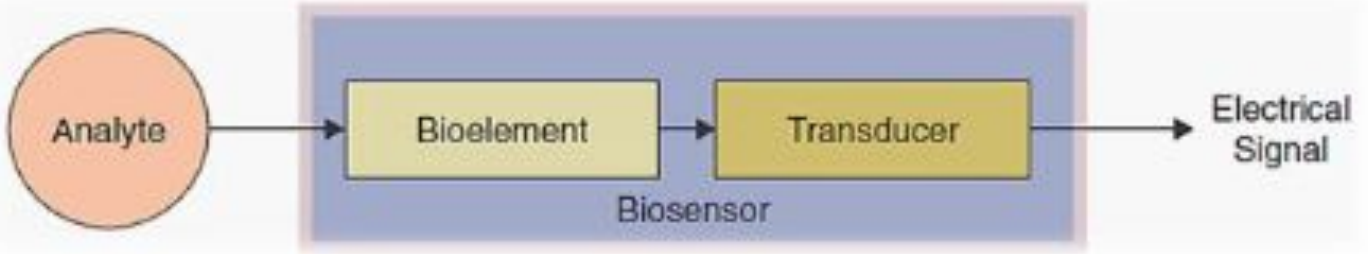


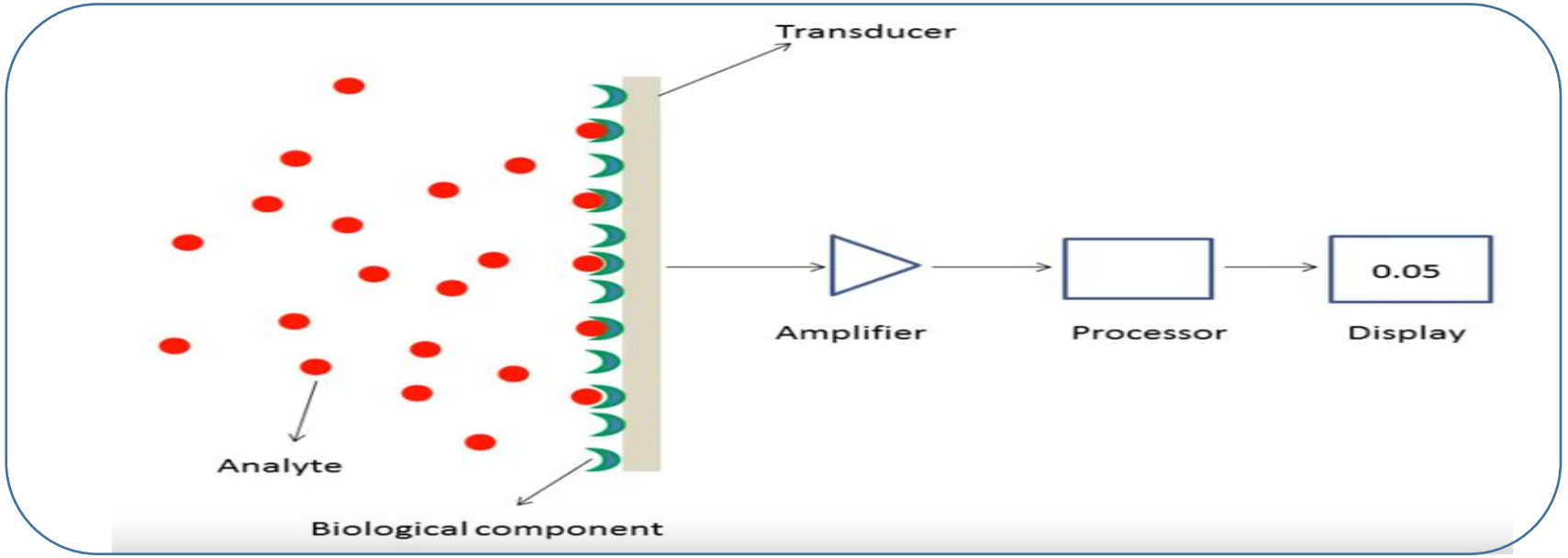
Father of Biosenser

Father of Biosensors **Leland C. Clark** invented the Clark Oxygen Electrode, a pivotal device that allows real-time monitoring of patient's blood oxygen levels and has made surgery Safer and more successful for millions around the world

Elements of Biosenser

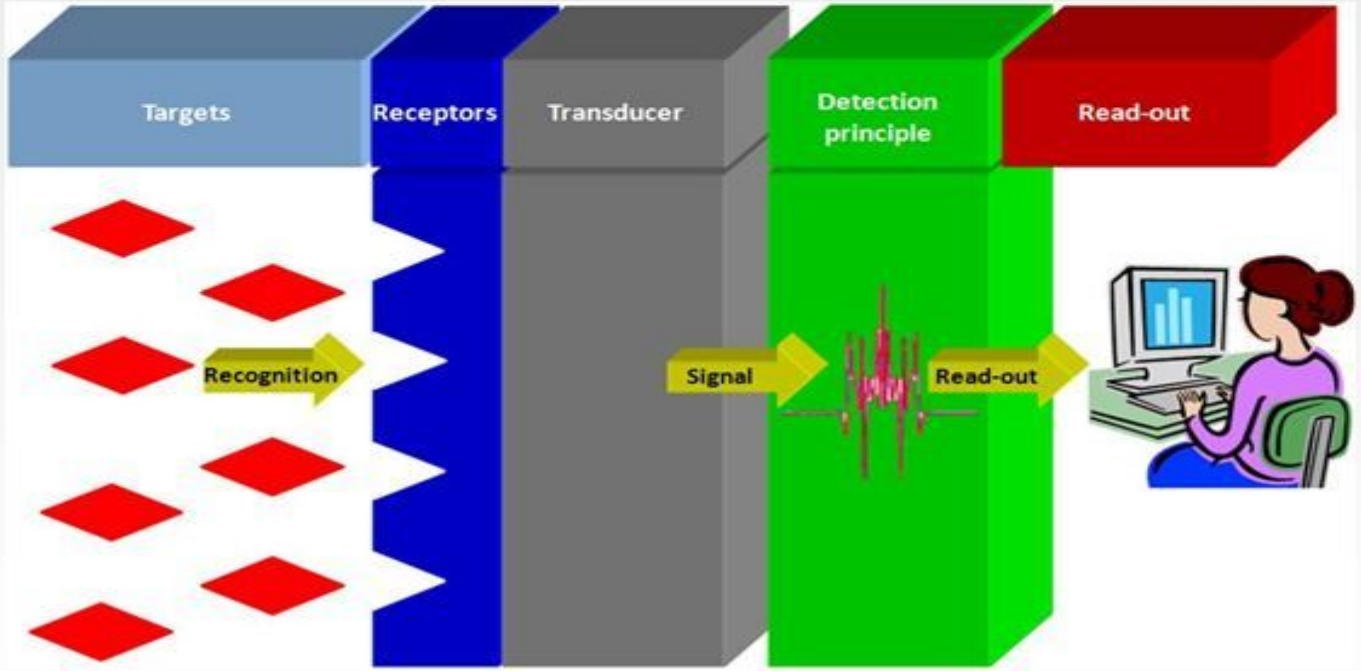
- Biosensor is an analytical device, which converts a biological response into electrical signal.



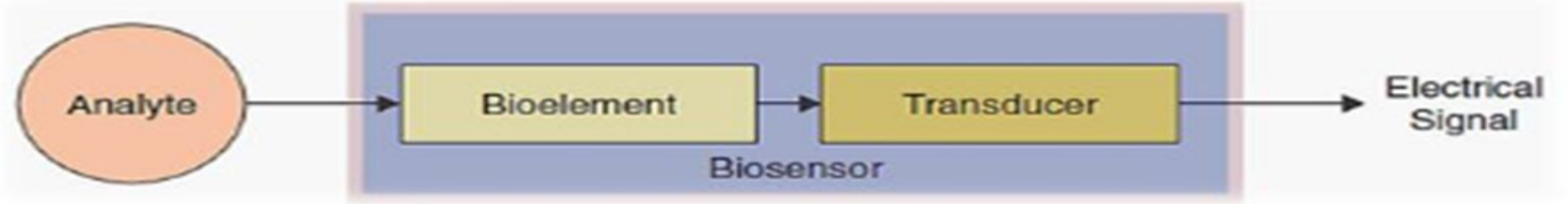


Working principle/ Basic concept

- Basic principle of biosensors involved three elements:
- 1) **biological recognition element** which is highly specific towards biological material analytes, integrated or connected to the physico-chemical transducer
- 2) **transducer** – transduces signal from biological target to electrical signal
- 3) **amplification and detection** - produce discrete or continuous digital electronic signal that is proportional to a specific analyte or group of similar analytes.



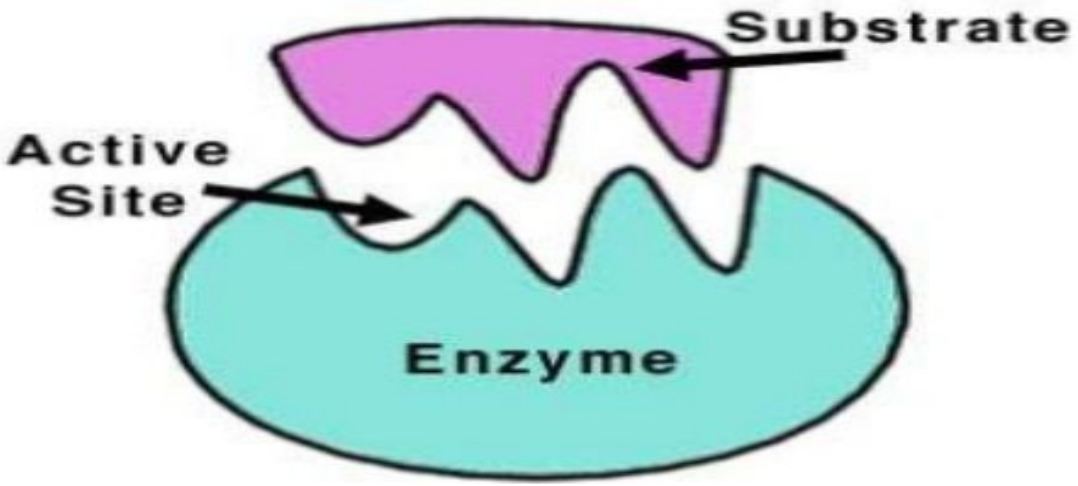
Components of Biosensor



1ST Component: Biological Element

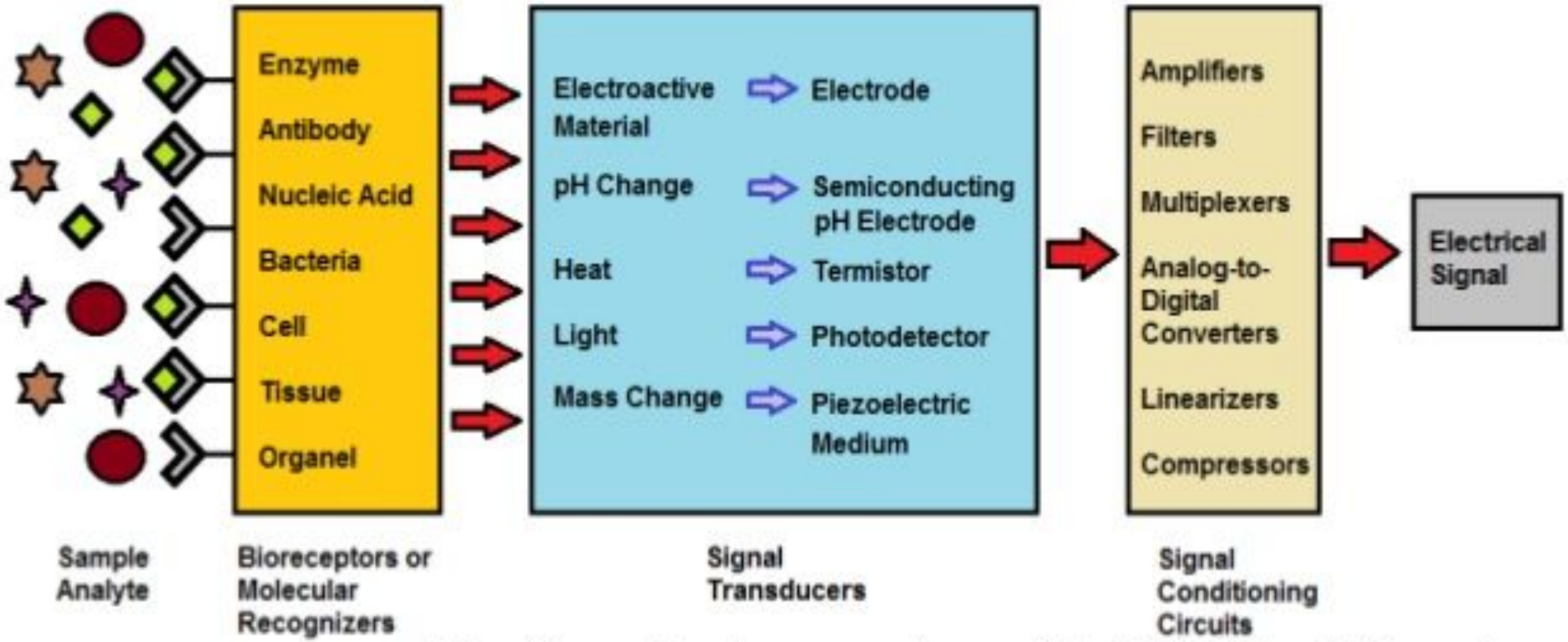
- The component used to bind the target molecule.
- Must be highly specific, stable under storage conditions, and immobilized.

Microorganism
Tissue
Cell
Organelle
Nucleic Acid
Enzyme
Enzyme Component
Receptor
Antibody

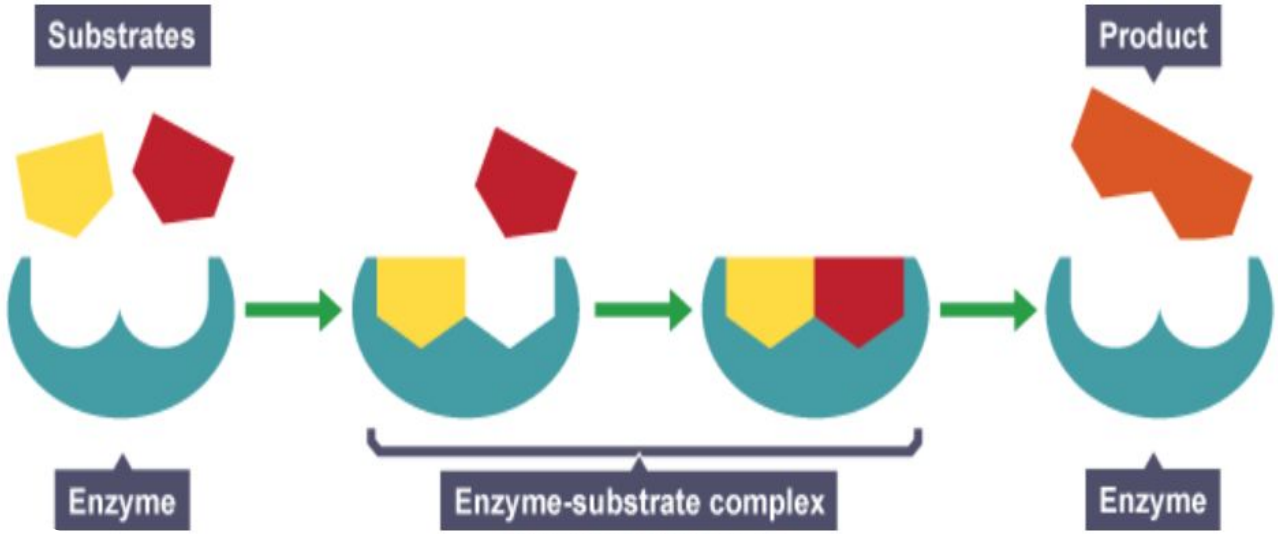


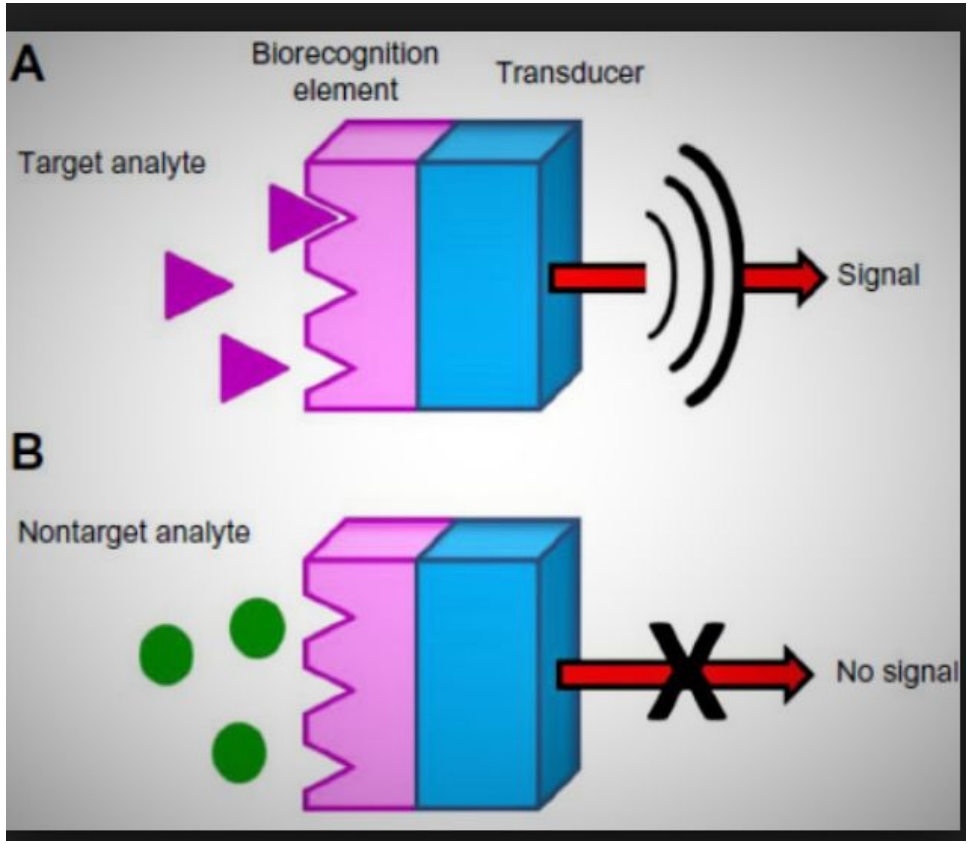
2^{ND} Component: Physiochemical Transducer

- Acts as an interface, measuring the physical change that occurs with the reaction at the bioreceptor then transforming that energy into measurable electrical output.



Working principle of enzyme





An **enzymatic biosensor** comprises of an **enzyme**, which recognizes and then reacts with the target analyte producing a chemical signal, a transducer, which produces a physical signal out of that chemical one,

Types of Biosensor

Depending on transducing mechanism used, the Biosensors can be of many types such as:

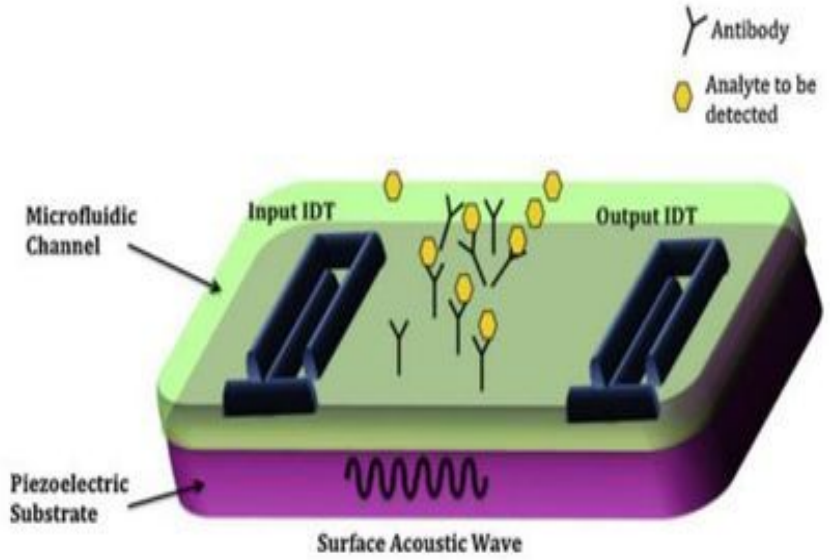
1. Resonant biosensor
2. Optical detection biosensor
3. Thermal detection biosensor
4. Ion selective field effect transistor biosensor
5. Electrochemical biosensor
   - Conductimetric
   - Amperometric
   - Potentiometric

Resonant Biosensor

Resonant Biosensors.

- An Acoustic Wave Transducer is coupled with Bioelement.
- Measures the change in Resonant Frequency.

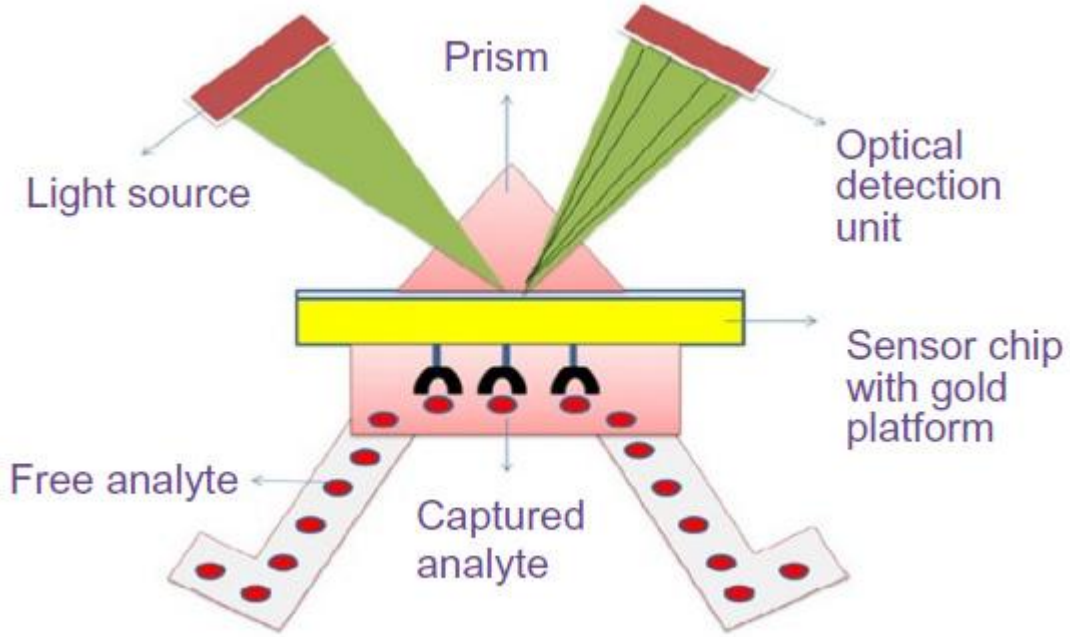
- Analyte - Antigen
- Bioelement – Antibody
- Transducer – Acoustic wave transducer
- Signal – Change in frequency/mass measured



Optical detection Biosensor

- The output transduced signal that is measured is light for this type of biosensor.

- The biosensor can be made based on optical diffraction. In optical diffraction based devices, a silicon wafer is coated with a protein via covalent bonds. The wafer is exposed to UV light through a photo-mask and the antibodies become inactive in the exposed regions. When the diced wafer chips are incubated in an analyte, antigen-antibody bindings are formed in the active regions, thus creating a diffraction grating. This grating produces a diffraction signal when illuminated with a light source such as laser. The resulting signal can be measured.



Thermal detection Biosensor

- This type of biosensor work on the fundamental properties of biological reactions, namely absorption or production of heat, which in turn changes the temperature of the medium in which the reaction takes place.
- They are constructed by combining immobilized enzyme molecules with temperature sensors. When the analyte comes in contact with the enzyme, the heat reaction of the enzyme is measured and is calibrated against the analyte concentration.
- The total heat produced or absorbed is proportional to the molar enthalpy and the total number of molecules in the reaction.
- **The temperature were measured by a thermistor.**
- Common applications of this type of biosensor include the detection of pesticides and pathogenic bacteria.

Ion selective field effect transistor Biosensor

- The Ion Sensitive Field Effect Transistor (ISFET) can be constructed by covering the sensor electrode with a polymer layer. This polymer layer is selectively permeable to analyte ions. The ions diffuse through the polymer layer and in turn cause a change in the FET surface potential.
- This type of biosensor is also called an ENFET (Enzyme Field Effect Transistor) and is primarily used for pH detection.

Electrochemical Biosensor

Many chemical reactions produce or consume ions or electrons which in turn cause some change in the electrical properties of the solution which can be sensed out and used as measuring parameter.

- Classification

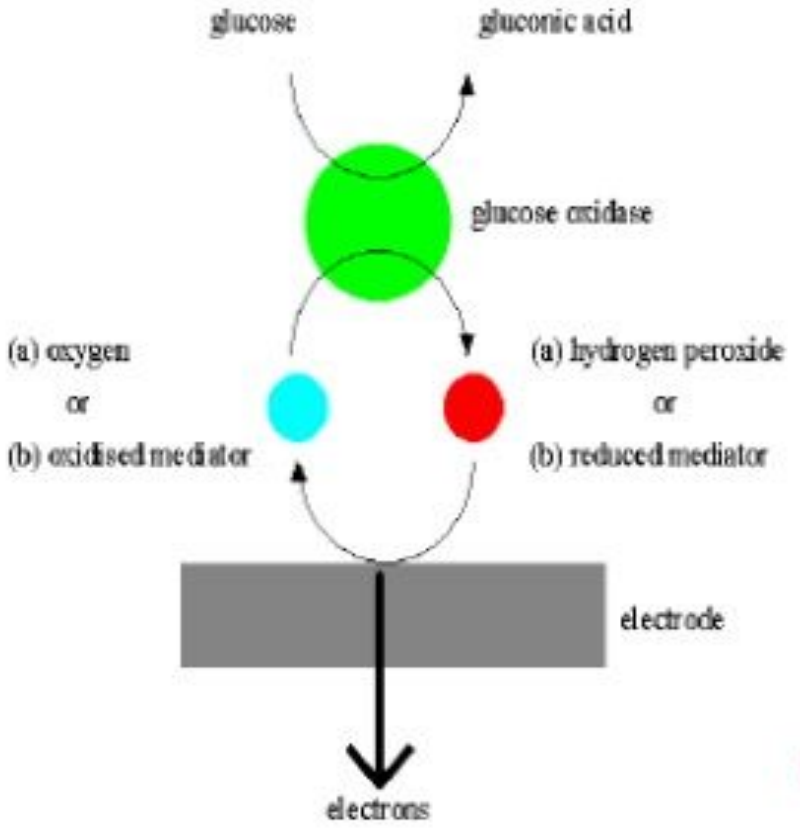
(1) Amperometric Biosensors
(2) Conductimetric Biosensors
(3) Potentiometric Biosensors

Glucose Biosensor

It is a amperometric glucose biosensor means measure the current (electron) arise during the reaction.

Principle:

1. Glucose reacts with glucose oxidase (GOD) to form gluconic acid while producing 2 electron and two protons, thus reducing GOD.
2. The reduced GOD with surrounded oxygen , electron and protons react to produce hydrogen peroxide and oxidised GOD (original form)
3. So lower glucose content in blood form more H_2O_2 and vice versa.
4. Consumption of oxygen or production of H_2O_2 can be detected with platinum electrode.

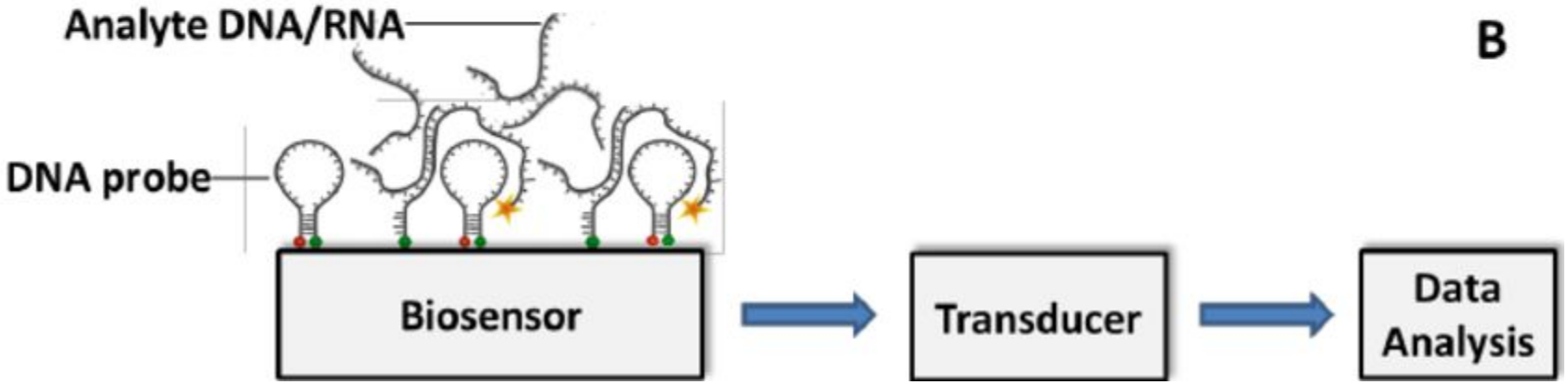


Biosensor Biodetector: DNA Detection

The category of Biosensor use for DNA detection is also known as biodetector
It senses the DNA-DNA/ Antigen –Antibody interaction.

- Methods
  - 1. Polymerase Chain Reaction (PCR) – multiple copies of DNA
  - 2. Force Amplified Biological Sensor(FABS)
  - 3. Force Differentiation Assay (FDA)
  - 4. Bead Array Counter (BAC)

- Uses – Detection of Anthrax, Botulinum, Harmful pathogens



Biosenser Detection of pollutants

Methods:

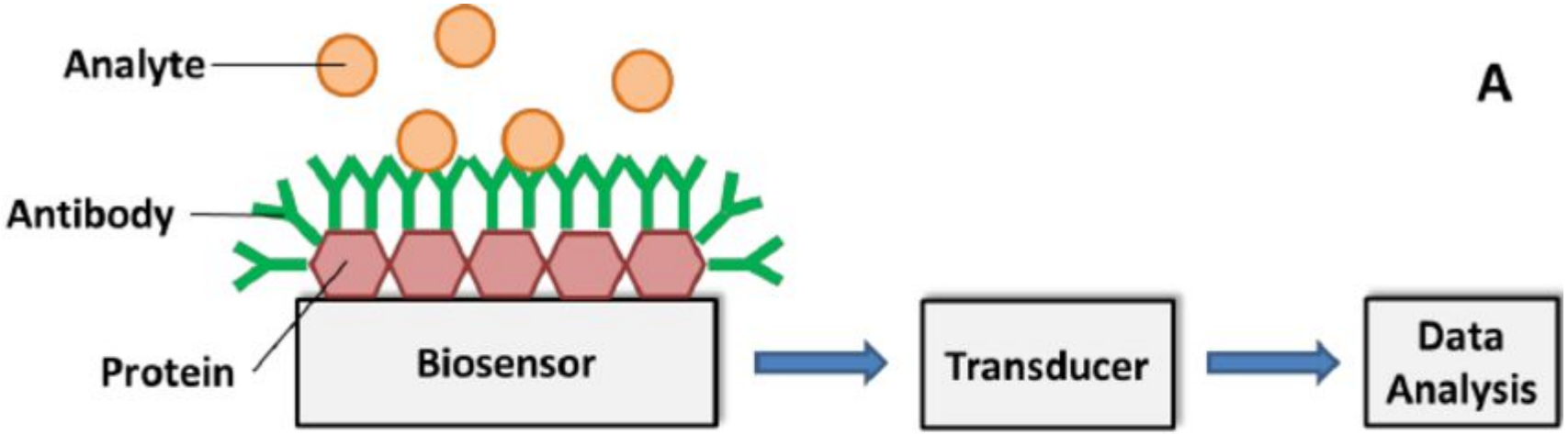
- Based on reporter gene
- Immunoassay

Based on reporter gene :

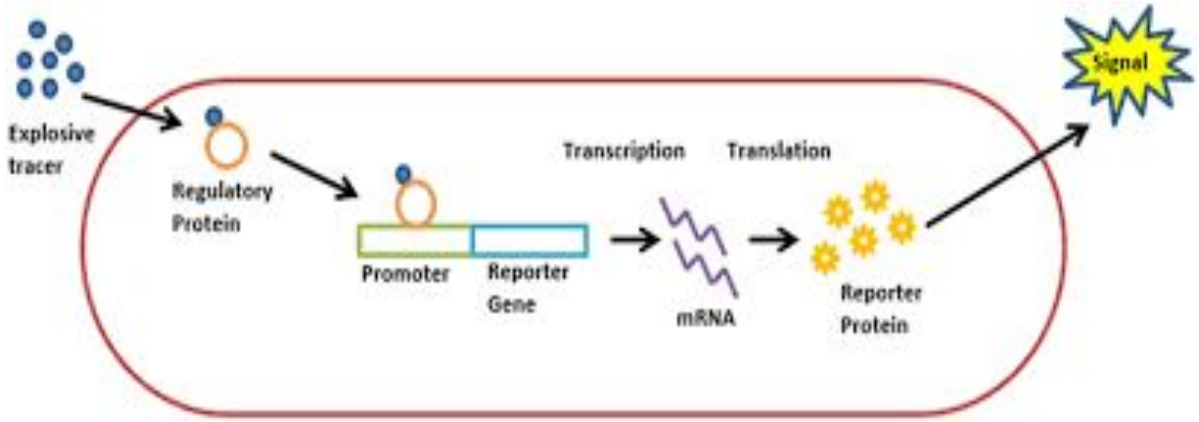
- Reporter gene of a cell can detect the external pollutants.
- This gene code for light, such as lux gene.
- When light is emitted indicating ,pathway induced in the presence of specific pollutant.

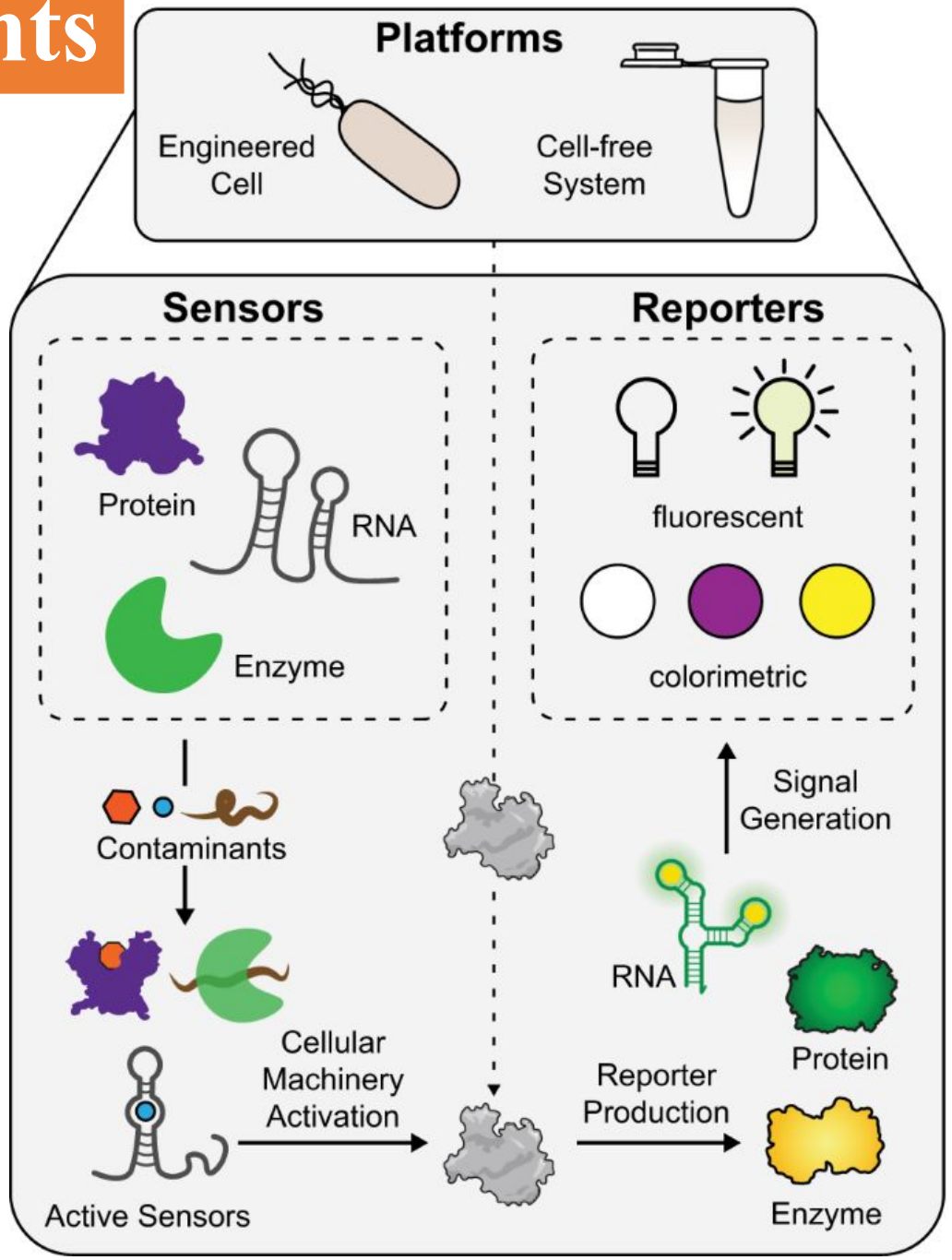
Immunoassay:

- Biosensors has developed to detect various organic molecule including benzopyrene and parathion
- Based on immunological reaction.
- Here antibodies employed to detect specific environmental pollutant.
- Antibodies coupled with transducer, which convert binding event to a signal that can be analysed.



Biosenser Detection of pollutants





Biosenser in food Industry

- Uses
  - Measurement of carbohydrates, alcohols
  - Sterility, food safety in meats, beverages (Beer, soft drinks) etc.
- Objective – Used in quality assurance
- Methods
  - 1. Flow injection system

Summary

- What is Biosensor
- Working principle of Biosensor
- Component of Biosensor
- Types of Biosensor
- Some examples of Biosensors