Classification of Biosensors

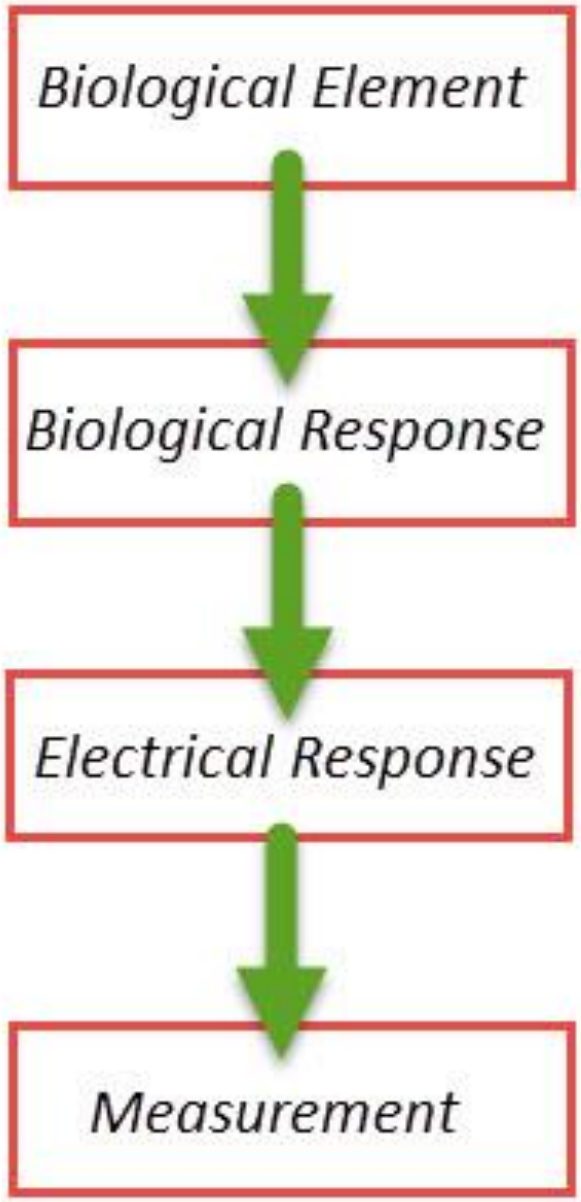
By

Assist.Prof.Dr. Fatimah AL-Hasani

Principle of a Biosensor:

The desired biological material is usually in the form of an enzyme. By a process known as Electroenzymatic approach, which is a chemical process of converting the enzymes into corresponding electrical signals (usually current) with the help of a transducer.

One of the commonly used Biological response is the oxidation of the enzyme. Oxidation acts as a catalyst and alters the pH of the biological material. The change in pH will directly affect the current carrying capacity of the enzyme, which is once again, in direct relation to the enzyme being measured. Output of the transducer i.e. the current, is a direct representation of the enzyme being measured. The current is generally converted into voltage so that it can be properly analyzed and represented.


Biological Element
Biological Response
Electrical Response
Measurement

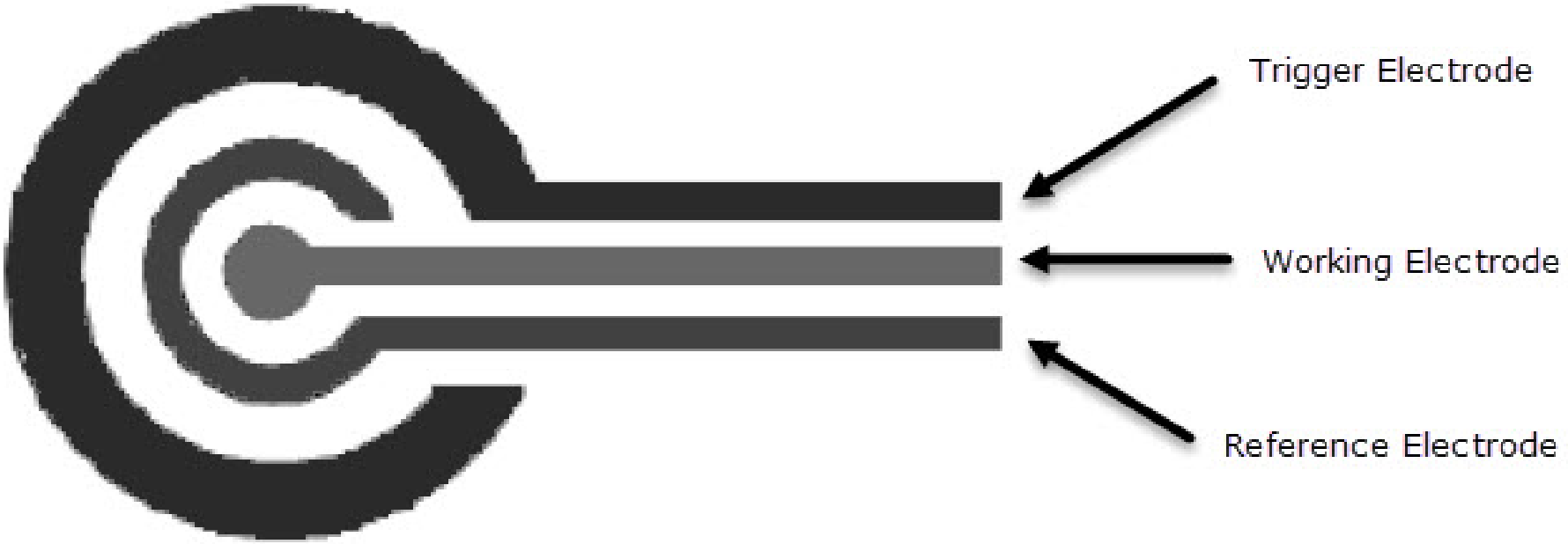
Working of Biosensors

- The combination of biological sensitive element and a transducer will convert the biological material into a corresponding electrical signal. Depending on the type of enzyme, the output of the transducer will be either current or voltage.
- If the output is voltage, then well and good. But if the output is current, then this current should be converted into equivalent voltage (using an Op-Amp based current to voltage converter) before proceeding further.
- The output voltage signal is usually very low in amplitude and superimposed on a high frequency noise signal. So, the signal is amplified (using an Op-Amp based Amplifier) and then passed through a Low Pass RC Filter.

- This process of amplifying and filtering the signal is the job of a Signal Processing Unit or a Signal Conditioning Unit. The output of the signal processing unit is an analog signal that is equivalent to the biological quantity being measured.
- The analog signal can be displayed directly on an LCD display but usually, this analog signal is passed to a Microcontroller, where the analog signal is converted into digital signal, since it is easy to analyze, process or store a digital signal

Example of Biosensor

- Before proceeding further with different types of Biosensors and applications of Biosensor, let us quickly take a look at a simple example of a Biosensor: The Glucometer, which is one of the most common applications (unfortunately).
- Diabetes is a disease characterized by the levels of glucose in the blood. Regularly checking the blood glucose levels is very important for diabetes patients. Glucometers are a type Biosensors, which measure the concentration of glucose in blood.
- Usually, they consists of a test strip, which collect a small sample of blood to analyze the glucose levels. This particular sensor implements the Electroenzymatic approach i.e. oxidation of glucose.

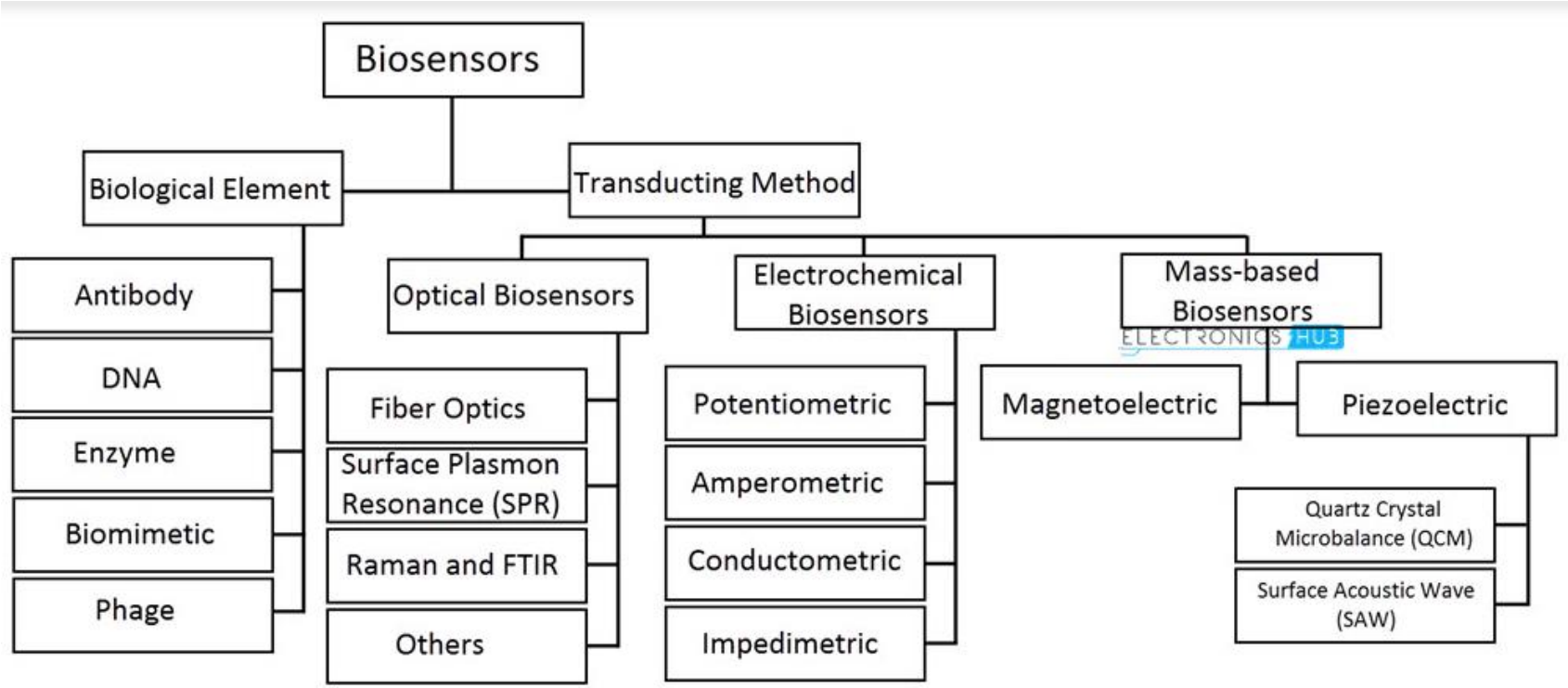


Glucometer Test Strip

- The test strip consists of a trigger electrode and a reference electrode. When blood is placed on the test strip, a simple chemical reaction takes place and an electrical current is generated, which is directly proportional to the concentration of glucose.
- Internally, the Glucometer consists of a powerful processor like a Cortex-M3 or Cortex-M4 along with current to voltage converter, amplifier, filter and a display unit.

Classification of biosensor

Biosensors can be classified either by the type of biological signaling mechanism they utilize or by the type of signal transduction they employ. Fig. (1)shows the different categories of biosensor.



Different kinds of biosensors being utilized based on two elements namely known as **sensing element and transduction** modes. Enzymes based biosensor, immunosensor which includes antibodies, DNA biosensor, Thermal and piezoelectric biosensor, biological tissues, organelles and microorganisms which can be detected with the help of whole cell biosensor comes under the category of sensing element. Transduction mode relies upon the physiochemical change coming about because of detecting component. Subsequently on the premise of various transducers biosensors can be electrochemical (amperometric, conductometric and potentiometric), optical (absorbance, fluorescence and chemiluminense), piezoelectric (acoustic and ultrasonic) what's more, calorimetric. Biosensors can likewise be arranged in view of their revelation arrange into original which is the easiest approach including direct discovery of either increment of an enzymatically created item or lessening of a substrate of a redox chemicals utilizing

characteristic go between for electron exchange e.g. glucose biosensor which utilizes chemical glucose oxidase and oxygen recognizing diminish in oxygen level or increment in hydrogen peroxide relating to the level of glucose. Second era biosensors utilizes manufactured redox middle people like ferrocene, ferricyanide and quinones for electron exchange which builds the reproducibility and affectability e.g. self-observing amperometric glucose biosensors. In conclusion, third era in which the redox compounds are immobilized on the cathode surface in such a way, to the point that immediate electron exchange is conceivable between the compound and transducer.