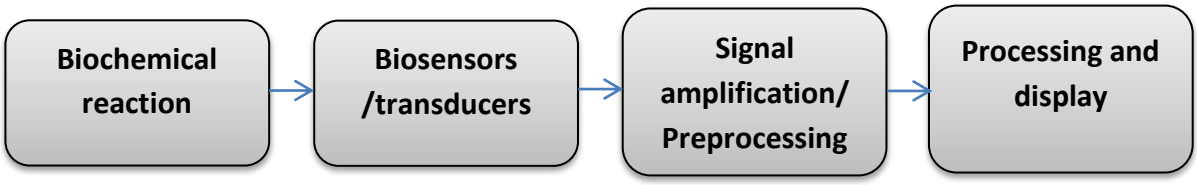
Biosensors in Biomedical Engineering

A biosensor is an analytical device which converts a biological response into an electrical signal. The term 'biosensor' is often used to cover sensor devices used in order to determine the concentration of substances and other parameters of biological interest



Biosensors are classified as the following depending on the quantity/phenomenon they sense.

1. Calorimetric biosensors - the heat output (or absorbed) by biochemical reactions.
2. Potentiometric biosensors (e.g. ISFETs and ENFETs) - changes in the distribution of charges causing an electrical potential to be produced.

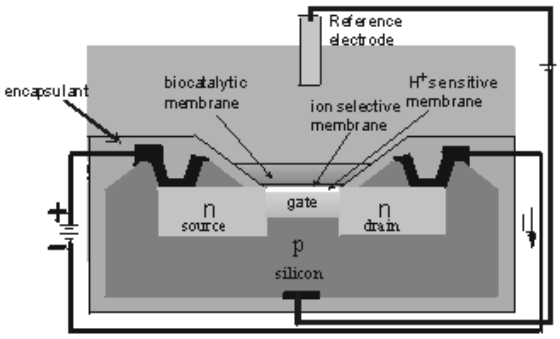


Figure 1A sketch showing the operation of an ENFET where ion sensitive membranes setup a potential difference which controls the gate bias and consequently the channel conductivity between the source and drain.

3. Amperometric biosensors - movement of electrons produced in a redox reaction.
4. Optical biosensors - light output during the reaction or a light absorbance difference between the reactants and products.
5. Piezo-electric biosensors effects due to the mass of the reactants or products.

A successful biosensor must possess at least some of the following beneficial features:

1. The biocatalyst must be highly specific for the purpose of the analyses, be stable under normal storage conditions and, except in the case of colorimetric enzyme

strips and dipsticks (see later), show good stability over a large number of assays (i.e. much greater than 100).

2. The reaction should be as independent of such physical parameters as stirring, pH and temperature as is manageable. This would allow the analysis of samples with minimal pre-treatment. If the reaction involves cofactors or coenzymes these should, preferably, also be co-immobilised with the enzyme.
3. The response should be accurate, precise, reproducible and linear over the useful analytical range, without dilution or concentration. It should also be free from electrical noise.
4. If the biosensor is to be used for invasive monitoring in clinical situations, the probe must be tiny and biocompatible, having no toxic or antigenic effects. If it is to be used in fermenters it should be sterilisable. This is preferably performed by autoclaving but no biosensor enzymes can presently withstand such drastic wet-heat treatment. In either case, the biosensor should not be prone to fouling or proteolysis.
5. The complete biosensor should be cheap, small, portable and capable of being used by semi-skilled operators.
6. The mode of operation of the sensor must meet ethical, religious and cultural acceptance, especially Government policies on implantable devices.