CHANDIGARH UNIVERSITY

Discover. Learn. Empower.

INSTITUTE-UNIVERSITY INSTITUTE OF ENGINEERING

ACADEMIC UNIT-II

Computer Science Engineering

Subject Name-Biology For Engineers

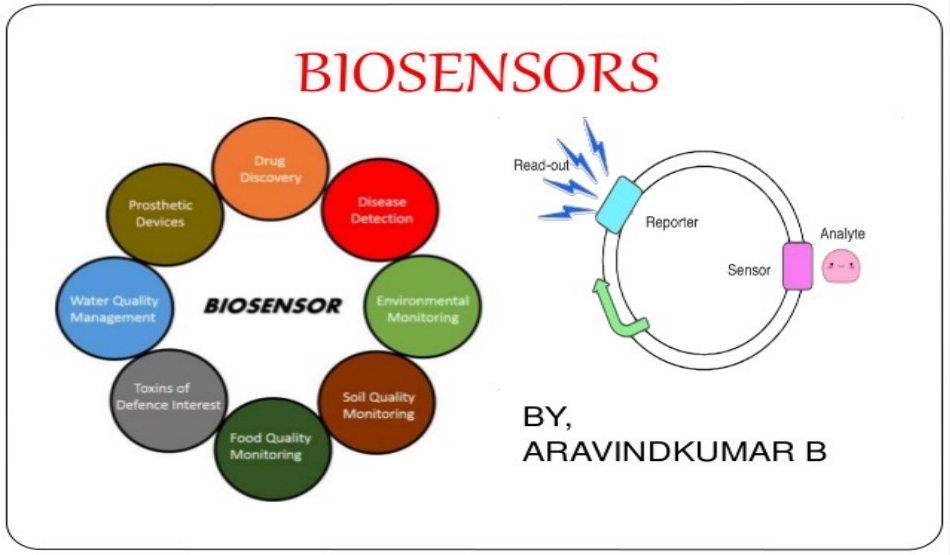
Subject Code- 20SZT148

BIOSENSORS

BIOSENSORS

Course Outcome

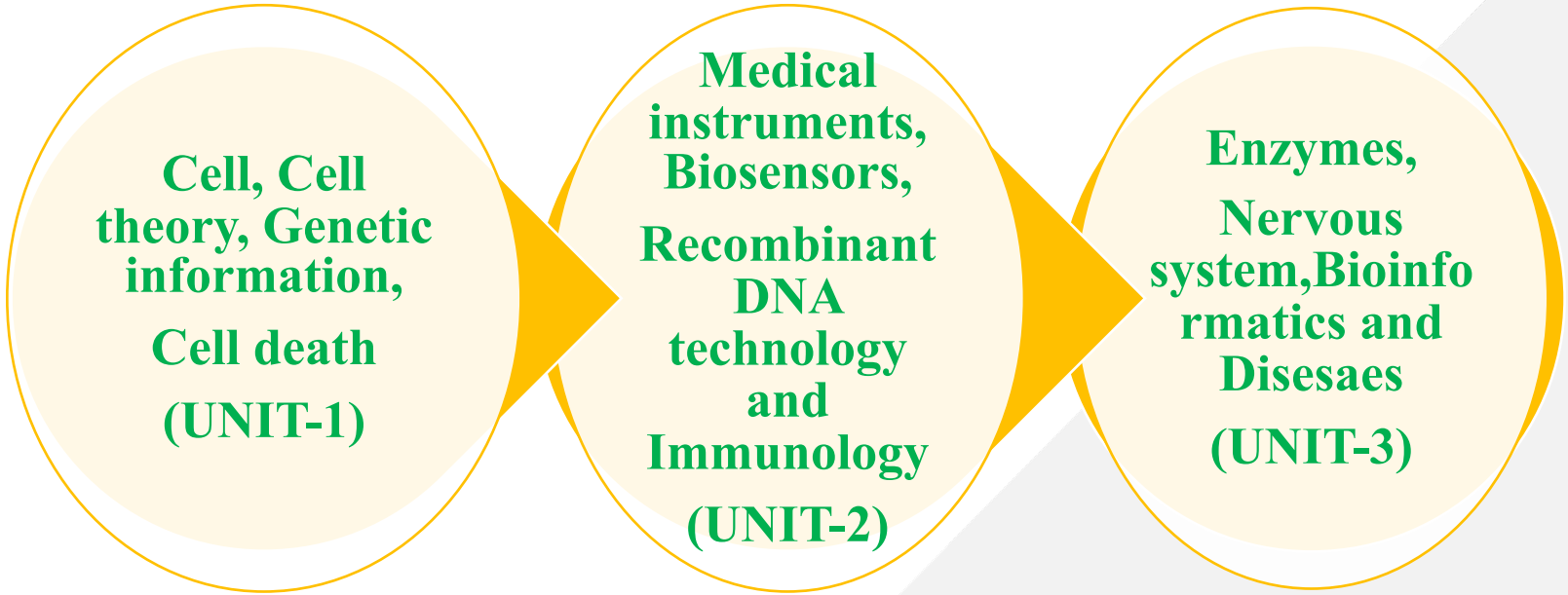
CO Number	Title	Level
CO1	It gives an idea about the about the basic cell biology.	**Understanding**
CO2	It deals with the idea of uses of biology in engineering.	**Understanding**
CO3	It provide knowledge about the uses of softwares in biology field.	**Remembering**



Will be covered in this lecture

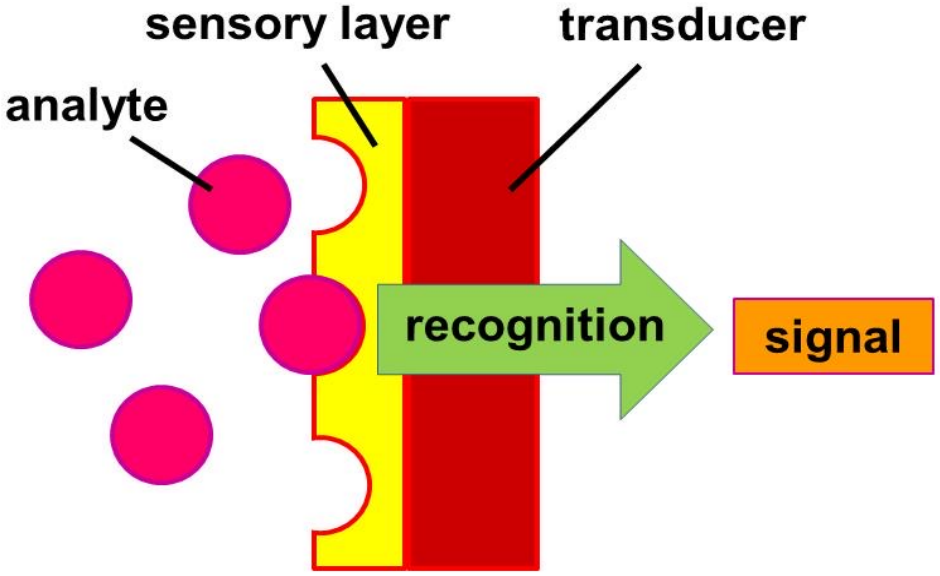
https://www.slideshare.net/yugaaravind/biosensors-179298473

BIOLOGY FOR ENGINEERS



BIOSENSORS

- A biosensor is an analytical device containing an immobilized biological material (enzyme, antibody, nucleic acid, hormone, organelle or whole cell) which can specifically interact with an analyte and produce physical, chemical or electrical signals that can be measured.
- An analyte is a compound (e.g. glucose, urea, drug, pesticide) whose concentration has to be measured.



https://www.elprocus.com/what-is-a-biosensor-types-of-biosensors-and-applications/

BIOSENSORS

•The first biosensor was invented in the year 1950 by American biochemist “L.L Clark”.

•Biosensors basically involve the quantitative analysis of various substances by converting their biological actions into measurable signals.

• A great majority of biosensors have immobilized enzymes.

•The performance of the biosensors is mostly dependent on the specificity and sensitivity of the biological reaction, besides the stability of the enzyme.

GENERAL FEATURES OF BIOSENSOR

•A biosensor has two components

1. Biological component—enzyme, cell etc.
2. Physical component—transducer, amplifier etc.

- The biological component recognises and interacts with the analyte to produce a physical change (a signal) that can be detected, by the transducer.

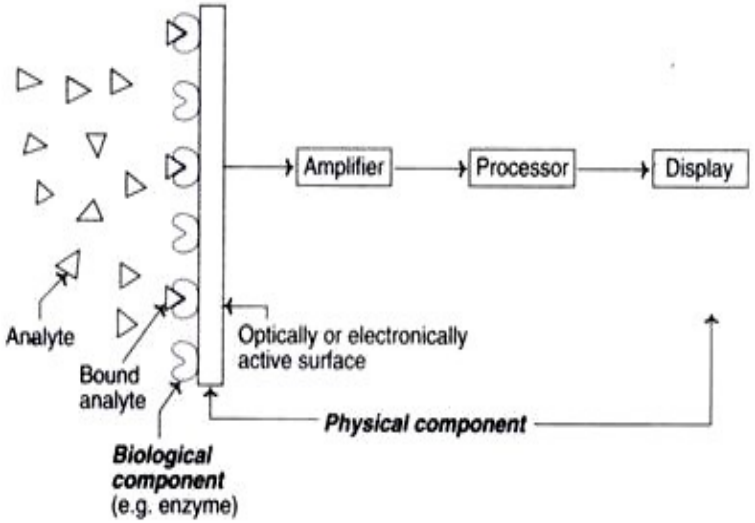
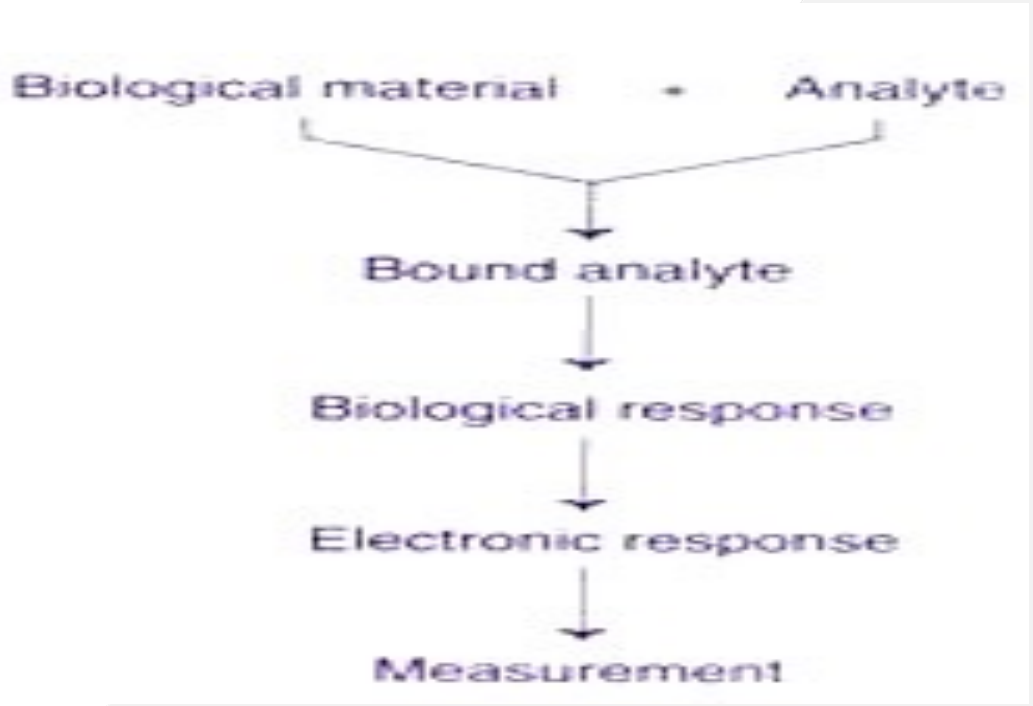


Fig. 21.13 : A diagrammatic representation of a biosensor.

https://www.biologydiscussion.com/enzymes/biosensors/biosensors-features-principle-and-types-with-diagram/10240

PRINCIPLE OF BIOSENSOR

•The desired biological material (usually a specific enzyme) is immobilized by conventional methods. This immobilized biological material is in intimate contact with the transducer. The analyte binds to the biological material to form a bound analyte which in turn produces the electronic response.



https://www.biologydiscussion.com/enzymes/biosensors/biosensors-features-principle-and-types-with-diagram/10240

TYPES OF BIOSENSORS

- There are several types of biosensors based on the sensor devices and the type of biological materials used. A selected few of them are discussed below.
- **Electrochemical Biosensors:**
- Electrochemical biosensors are simple devices based on the measurements of electric current, ionic or conductance changes carried out by bio electrodes.
- **Amperometric Biosensors:**
- These biosensors are based on the movement of electrons (i.e. determination of electric current) as a result of enzyme-catalysed redox reactions. Normally, a constant voltage passes between the electrodes which can be determined. In an enzymatic reaction that occurs, the substrate or product can transfer an electron with the electrode surface to be oxidised or reduced

TYPES OF BIOSENSORS

- **Thermometric Biosensors:**
- Several biological reactions are associated with the production of heat and this forms the basis of thermometric biosensors. They are more commonly referred to as thermal biosensors or calorimetric biosensors. A diagrammatic representation of a thermal biosensor is depicted . It consists of a heat insulated box fitted with heat exchanger .
- The reaction takes place in a small enzyme packed bed reactor. As the substrate enters the bed, it gets converted to a product and heat is generated. The difference in the temperature between the substrate and product is measured by thermistors. Even a small change in the temperature can be detected by thermal biosensors.

TYPES OF BIOSENSORS

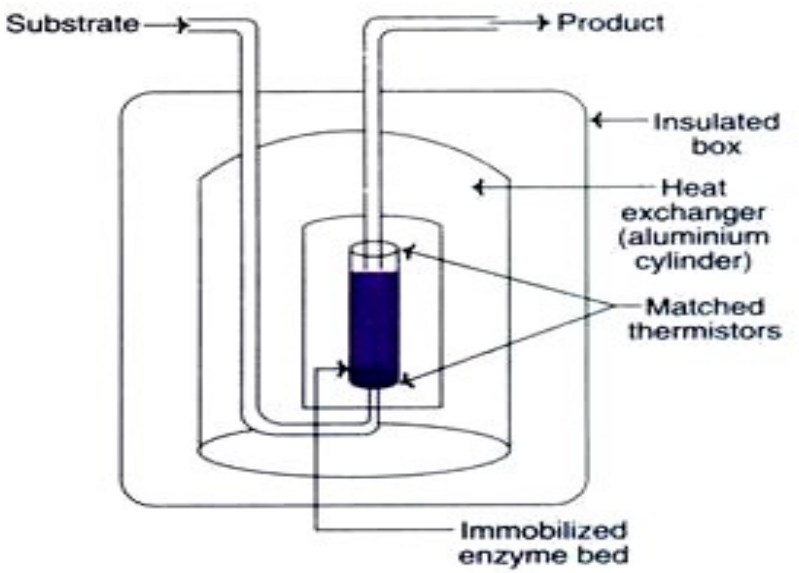


Fig. 21.16 : A diagrammatic representation of thermometric biosensor.

https://www.biologydiscussion.com/enzymes/biosensors/biosensors-features-principle-and-types-with-diagram/10240

- Thermometric biosensors are in use for the estimation of serum cholesterol. When cholesterol gets oxidized by the enzyme cholesterol oxidase, heat is generated which can be measured. Likewise, estimations of glucose (enzyme-glucose oxidase), urea (enzyme-urease), uric acid (enzyme-uricase) and penicillin G (enzyme-P lactamase) can be done by these biosensors. In general, their utility is however, limited.

TYPES OF BIOSENSORS

- This results in an altered current flow that can be measured. The magnitude of the current is proportional to the substrate concentration. Clark oxygen electrode which determines reduction of O_2, is the simplest form of amperometric biosensor. Determination of glucose by glucose oxidase is a good example.
- **Blood-glucose biosensor:**
- It is a good example of amperometric biosensors, widely used throughout the world by diabetic patients. Blood- glucose biosensor looks like a watch pen and has a single use disposable electrode (consisting of a Ag/AgCI reference electrode and a carbon working electrode) with glucose oxidase and a derivative of ferrocene (as a mediator). The electrodes are covered with hydrophilic mesh guaze for even spreading of a blood drop. The disposable test strips, sealed in aluminium foil have a shelf-life of around six months.

TYPES OF BIOSENSORS

- **Optical Biosensors for Blood Glucose:**
- Estimation of blood glucose is very important for monitoring of diabetes. A simple technique involving paper strips impregnated with reagents is used for this purpose. The strips contain glucose oxidase, horse radish peroxidase and a chromogen (e.g. toluidine). The following reactions occur.
- The intensity of the colour of the dye can be measured by using a portable reflectance meter. Glucose strip production is a very big industry worldwide.
- Colorimetric test strips of cellulose coated with appropriate enzymes and reagents are in use for the estimation of several blood and urine parameters.

TYPES OF BIOSENSORS

- **Immuno-Biosensors:**
- Immuno-biosensors or immunochemical biosensors work on the principle of immunological specificity, coupled with measurement (mostly) based on amperometric or potentiometric biosensors. There are several possible configurations for immuno-biosensors and some of them are depicted , and briefly described hereunder.

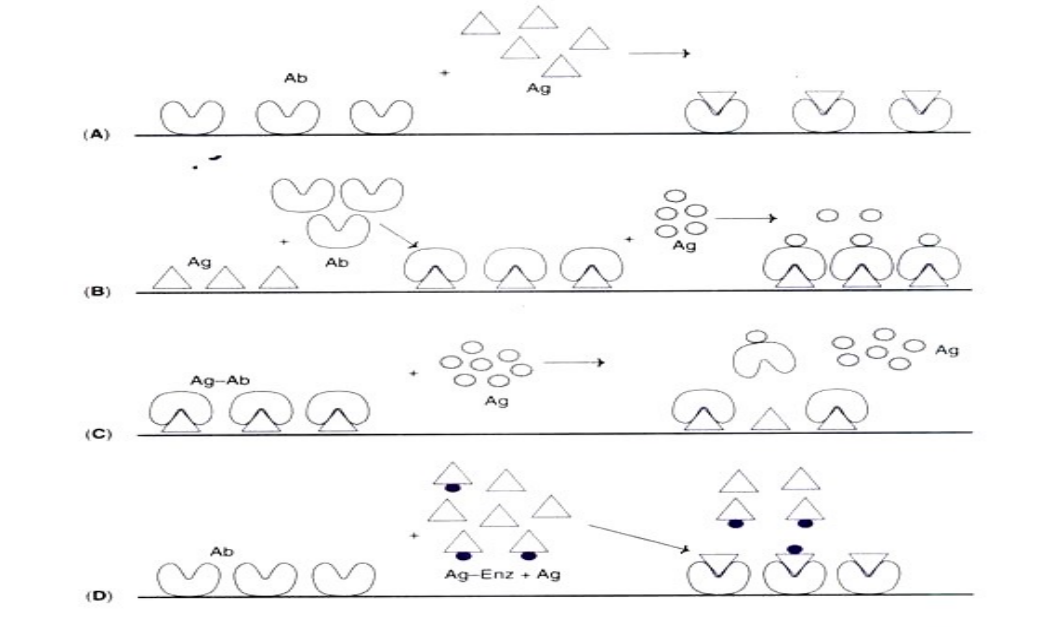


Fig. 21.18 : Diagrammatic representation of selected immunobiosensors (A) Direct binding of antigen to immobilized antibody, (B) Antigen–antibody sandwiches (immobilized antigen binds to antibody and then to a second antigen), (C) Antibody binds to immobilized antigen which gets partially released by a competitive free antigen, (D) Immobilized antibody binds to free antigen and enzyme labeled antigen (in competition).

https://www.biologydiscussion.com/enzymes/biosensors/biosensors-features-principle-and-types-with-diagram/10240

TYPES OF BIOSENSORS

1. An immobilized antibody to which antigen can directly bind (Fig. 21.18A).

2. An immobilized antigen that binds to antibody which in turn can bind to a free second antigen (Fig. 21.18B).

3. An antibody bound to immobilized antigen which can be partially released by competing with free antigen (Fig. 21.18C).

4. An immobilized antibody binding free antigen and enzyme labeled antigen in competition (Fig. 21.18D).

APPLICATIONS OF BIOSENSORS

- Some examples of the fields that use biosensor technology include:

- General healthcare monitoring
- Screening for disease
- Clinical analysis and diagnosis of disease
- Veterinary and agricultural applications
- Industrial processing and monitoring
- Environmental pollution control

APPLICATIONS OF BIOSENSORS

•Biosensors are used in the food industry to measure carbohydrates, alcohols and acids, for example, during quality control processes. The devices may also be used to check fermentation during the production of beer, yoghurt and soft drinks. Another important application is their use in detecting pathogens in fresh meat, poultry or fish.

•Biosensors are used to check the quality of air and water. The devices can be used to pick up traces of organophosphates from pesticides or to check the toxicity levels of wastewater

CONCLUSION

- **Biosensors** can be defined as analytical devices which include a combination of biological detecting elements like sensor system and a transducer.
- When we compare with any other presently existing diagnostic device, these sensors are advanced in the conditions of selectivity as well as sensitivity.
- **Biosensors** are used in the food industry to measure carbohydrates, alcohols and acids, for example, during quality control processes.
- The devices may also be used to check fermentation during the production of beer, yoghurt and soft drinks.

ASSESSMENT PATTERN

Assessment Pattern	Total Marks
1st Hourly Test	36
2nd Hourly Test	36
Surprise Test	12
Assignment (3)	10
Quiz	4
End Semester Examination	60

REFERENCES

- C.B.Powar, 2010.Cell Biology.5th Ed,Himalyan Publishing House.
- Leshie Cromwell, Fred.J. Weibell and Erich.A.Pfeiffer. 2003. Biomedical instrumentation and measurements. 2nd edition, PHI.
- John G. Webster 1998. Medical Instrumentation: Applications and Design, 3rd edition, Jon Wiley and Sons, New York.
- Jeremy M. Berg, John L. Tymoczko and Lubert Stryer. 2006. "Biochemistry," 6th Ed. W.H. Freeman and Co. Ltd.
- Robert Weaver. 2012 "Molecular Biology," 5th Edition, MCGraw-Hill.
- Jon Cooper, , **2**004. "Biosensors A Practical Approach" Bellwether Books.
- Martin Alexander, 1994 "Biodegradation and Bioremediation," Academic Press.

THANK YOU

For queries
Email: subject_code_2020@gmail.com