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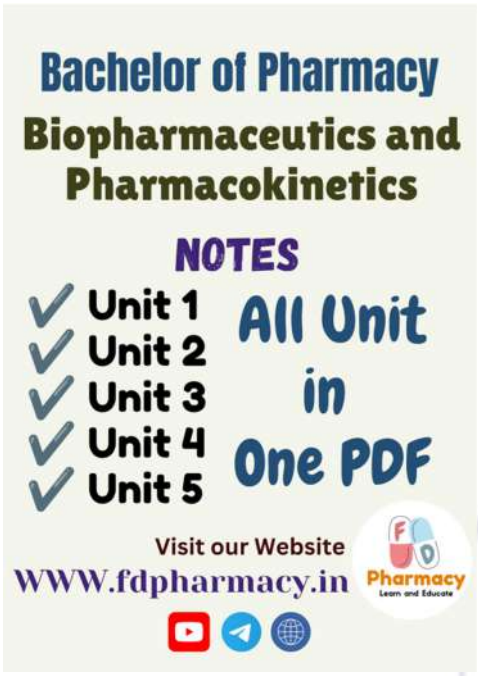
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PHARMACEUTICAL BIOTECHNOLOGY

UNIT 1

TOPIC :

- c) Biosensors- Working and applications of biosensors in Pharmaceutical Industries.

Biosensors

→ A biosensor is an analytical device that uses a biological component such as enzymes, antibodies, cells, or DNA to detect a chemical substance and convert it into a measurable signal, usually electrical.
→ Biosensors combine biology with electronics for rapid and accurate analysis.

Examples

- Glucometer
- pH meter
- Thermistor sensor

→ A biosensor is a device consisting of a biological sensing element and a transducer that converts a biological reaction into a measurable signal.

Components of Biosensors

A biosensor mainly consists of the following components:

1. Receptor (Bioreceptor)
2. Transducer
3. Amplifier
4. Processor
5. Display Unit

1. Receptor (Bioreceptor)

→ The receptor is the biological sensing element that specifically recognizes and binds with the target substance called analyte.

→ It produces a biological response when the analyte is present.

Types of Receptors

- Enzymes
- Antibodies
- DNA
- Microorganisms
- Cells

Functions

- Specific analyte recognition
- Initiates biochemical reaction
- Provides selectivity to biosensor

2. Transducer

→ The transducer converts the biological reaction between receptor and analyte into a measurable electrical signal.

→ It converts chemical or biological changes into physical signals.

Functions

- Signal conversion
- Accurate measurement
- Produces electrical output

3. Amplifier

→ The amplifier increases the strength of the weak signal produced by the transducer.

Functions

- Enhances signal intensity
- Improves sensitivity
- Enables accurate detection

4. Processor

→ The processor analyzes and processes the amplified signal.
→ It converts the signal into meaningful information and calculates analyte concentration.

Functions

- Data analysis
- Signal processing
- Calculation of concentration

5. Display Unit

→ The display unit shows the final result in a readable form such as numbers, graphs, or digital readings.

Example

- Glucose level displayed on a glucometer screen

Principle of Biosensors

→ The principle of biosensors is based on the specific interaction between the biological element (bioreceptor) and the analyte.
→ When the analyte reacts with the bioreceptor, a biochemical change occurs. This change is converted into an electrical signal by the transducer.
→ The signal is then:

- Amplified
- Processed
- Displayed as measurable output

Types of Biosensors

Main types of biosensors are:

1. Calorimetric Biosensors
2. Potentiometric Biosensors
3. Acoustic Wave Biosensors
4. Amperometric Biosensors
5. Optical Biosensors

1. Calorimetric Biosensors

→ These biosensors measure the heat produced or absorbed during a biochemical reaction.

Principle

When analyte reacts with bioreceptor, heat changes occur which are measured.

Example

- Enzyme thermistor

Advantages

- Simple operation
- Stable system

Disadvantages

- Low sensitivity
- Environmental temperature interference

2. Potentiometric Biosensors

→ These biosensors measure changes in electrical potential or voltage during a biochemical reaction.

Principle

Ion concentration changes produce measurable potential difference.

Example

- pH sensors
- Ion-selective electrodes

Advantages

- Simple and economical
- Good stability

Disadvantages

- Lower sensitivity compared to amperometric sensors

3. Acoustic Wave Biosensors

→ These biosensors work on the principle of sound wave vibrations.

→ When analytes bind to the sensor surface, the mass changes, causing a change in wave frequency.

Principle

Mass change alters acoustic wave frequency.

Example

- Quartz Crystal Microbalance (QCM)

Advantages

- Highly sensitive
- Real-time detection possible

Disadvantages

- Expensive instruments
- Sensitive to disturbances

4. Amperometric Biosensors

→ These biosensors measure electric current produced during a biochemical reaction.

→ The current generated is proportional to analyte concentration.

Principle

Oxidation-reduction reactions generate electrical current.

Example

- Glucometer

Advantages

- High sensitivity
- Fast response
- Widely used in diagnostics

Disadvantages

- Requires controlled conditions

5. Optical Biosensors

→ Optical biosensors detect changes in light properties during interaction between analyte and bioreceptor.

Principle

Interaction changes:

- Absorption of light
- Fluorescence
- Reflection
- Refraction

Examples

- Fiber optic biosensors
- Fluorescence sensors

Advantages

- Highly accurate
- Rapid analysis

Disadvantages

- Costly setup
- Complex instrumentation

Applications of Biosensors

1. Medical Field

Used for:

- Blood glucose monitoring
- Disease diagnosis
- Pregnancy tests
- Cholesterol detection

Example:

- Glucometer

2. Pharmaceutical Field

Used in:

- Drug analysis
- Quality control
- Monitoring fermentation processes
- Drug production monitoring

3. Environmental Monitoring

Used to detect:

- Pollutants
- Pesticides
- Heavy metals
- Water contamination

Helps in checking water quality and environmental safety.

4. Food Industry

Used for:

- Detecting food contamination
- Detection of toxins
- Food quality testing
- Food safety monitoring

5. Agriculture

Used for:

- Detection of pesticides
- Soil nutrient analysis
- Plant disease detection

Advantages of Biosensors

- High sensitivity
- Rapid response
- Specific detection
- Portable devices available
- Real-time monitoring possible
- Easy handling

Disadvantages of Biosensors

- High cost
- Limited stability of biological elements
- Calibration required
- Sensitive to environmental conditions