Biosensors

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Welcome to the world of Biosensors
Outline of the presentation

1. Introduction to biosensors
2. Working principle of biosensors
3. Different types of biosensors
4. A biosensor to monitor cell morphology
5. Lab-on-a-chip systems (DNA detection)
6. Glucose biosensors
7. Conclusions
What is a Biosensor??

A biosensor is a analytical device incorporating a deliberate and intimate combination of a specific biological element (that creates a recognition event) and a physical element (that transduces the recognition event).
Biosensor ........ ??

Basic Concepts of Biosensor
Applications of **Biosensors**

Diagram showing the applications of biosensors:
- Clinical
  - In vivo
    - Long-term implantable
    - Short-term invasive
  - In vitro
    - Single shot
    - Multi-analyses
    - Single analysis
    - Reactive monitoring
- Nonclinical
  - Artificial organs
  - Bedside glucose monitoring
  - Home blood glucose monitor
  - Pathology laboratory glucose monitoring
  - Fruit ripening
  - Pollution/effluent monitoring, fermentation processes

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Biosensor : Products

A needle-type glucose biosensor implanted tissue
Products ........(Pen)

Medisense glucose biosensor Pen
Products ........ (Big Display)

Medisense glucose biosensor : Big digital display
Products .......(Biodetector)

A handheld biodetector

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Elements of **Biosensor**

- **Bio-Element**
  - Enzyme
  - Antibody
  - Microbial
  - Tissue
  - Polysaccharide
  - Nucleic Acid

- **Sensor-Element**
  - Electric Potential
  - Electric Current
  - Electric Conductance
  - Electric Impedance
  - Intensity and phase of em radiation
  - Mass
  - Temperature
  - Viscosity

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Different types of **Biosensor**

- Resonant biosensors
- Optical-Detection biosensors
- Thermal-Detection biosensors
- Ion-Sensitive FETs (ISFETs) biosensors
- Electrochemical biosensors
## Biosensor types

- Conductimetric
- Amperometric
- Potentiometric

<table>
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<th>Characteristics</th>
<th>Conductimetric</th>
<th>Amperometric</th>
<th>Potentiometric</th>
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<tr>
<td>Measured Parameter</td>
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<td>Fabrication</td>
<td>FET+Enzyme</td>
<td>FET+Enzyme 2 electrodes</td>
<td>FET+Enzyme oxide electrode</td>
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Bio+sensor coupling: 4 types

(a) Membrane Entrapment

(b) Physical Adsorption

(c) Matrix Entrapment

(d) Covalent Bonding
Biosensor: Enzymes

Working Principle of Enzymes
Biosensor: Specificity

This specificity action is the basis of biosensors

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A Biosensor to monitor cell morphology
To monitor cell morphology .......

A cell in tissue culture medium

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To monitor cell morphology ..........

ECIS schematic diagram
To monitor cell morphology .........

ECIS: resistance and capacitance measurement
Biosensor for cell morphology

The advantages:

- The biosensor is less time consuming compared to the conventional methods.
- It is possible to automate and quantify cell morphology measurement.
- The fluctuating pattern can be used as signature for a cell.
Biosensor for cell morphology......

The disadvantages:

- The accuracy of the biosensor is doubtful, it may happen two cells can have almost similar pattern.

- If the average impedance is to be taken as a measure then it is possible that two entirely different patterns can have same average value.

- It is not clear if the biosensor is useful for non-mammalian cells and plant cells.
A microfluidic biodetector

Chamber Unit

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A microfluidic

Magnified view of chamber unit
A microfluidic 

Detection steps:

1. Some milliliters of sample solution are pumped into the chamber.
2. The sample is concentrated to a volume of a microliter.
3. Sample DNA are now extracted from sample solution.
4. PCR is performed.
5. Fluorescence probe DNAs bind the sample DNA.
6. When the LEDs cause the probe DNAs to fluorescent the glow is captured by photodiodes.
A magnetic **biodector**

Step 1. Single strands of sample DNA, tagged with biotin [silver ball] bind with probe DNA affixed to the chip’s surface.

Step 2. Magnetic microbeads coated with streptavidin bind with the biotin. Unbonded beads are washed away.

Assay 1

Assay 2

Magnetic sensor

Step 3. Magnetic sensors count the bound microbeads, indicating the identity and concentration of the pathogens in the sample. Although only two DNA assays are shown here, in fact a single chip can test for 64 different DNA sequences.

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Glucose **Biosensor**: Clark’s Experiment

- **Glucose**
- **Gluconic Acid**
- **Glucose Oxidase**

**Steps:**
- (a) Oxygen
- or
- (b) Oxidised Mediator
- (a) Hydrogen Peroxide
  - or
  - (b) Reduced Mediator

**Electrons**

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A disposable glucose **biosensor**

1. **Metallic substrate**
2. **Graphite layer**
3. **Isolating layer**
4. **Mediator modified membrane**
5. **Immobilized enzyme membrane**
6. **Cellulose acetate membrane**
A disposable ............

Assembled layers: the biosensor
A disposable ............

Calibration curve

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Biosensor: Difficulties

- Contamination
- Immobilisation of biomolecules
- Sterilization
- Uniformity of biomolecule preparation
- Selectivity and detection range
Conclusions

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THANK YOU