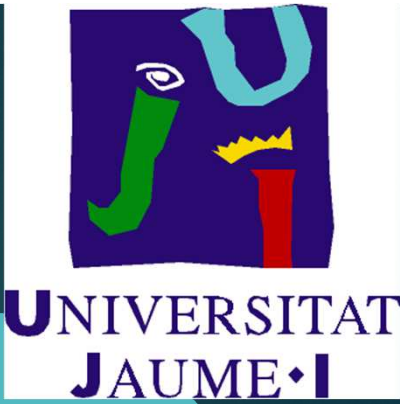
Welcome to Biosensor presentation



ET-1039 NANOTECHNOLOGY

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CONTENTS

1.What is a Biosensor?

A biosensor is a self-contained integrated device that is capable of providing specific quantitative or semi-quantitative analytical information using a biological recognition element which is in direct spatial contact with a transduction element (IUPAC, 1996)

1) Biosensor ≠ Bioanalytical system

2) An enzyme electrode is a biosensor

2. Historical background

1970 Discovery of ion-sensitive field-effect transistor (ISFET) by Bergveld

1975 Fibre-optic biosensor for carbon dioxide and oxygen detection by Lubbers and Opitz [8]

1975 First commercial biosensor for glucose detection by YSI

1975 First microbe-based immunosensor by Suzuki et al.

1982 Fibre-optic biosensor for glucose detection by Schultz

1983 Surface plasmon resonance (SPR) immunosensor by Liedberg et al.

1984 First mediated amperometric biosensor: ferrocene used with glucose oxidase for glucose detection

1990 SPR-based biosensor by Pharmacia Biacore

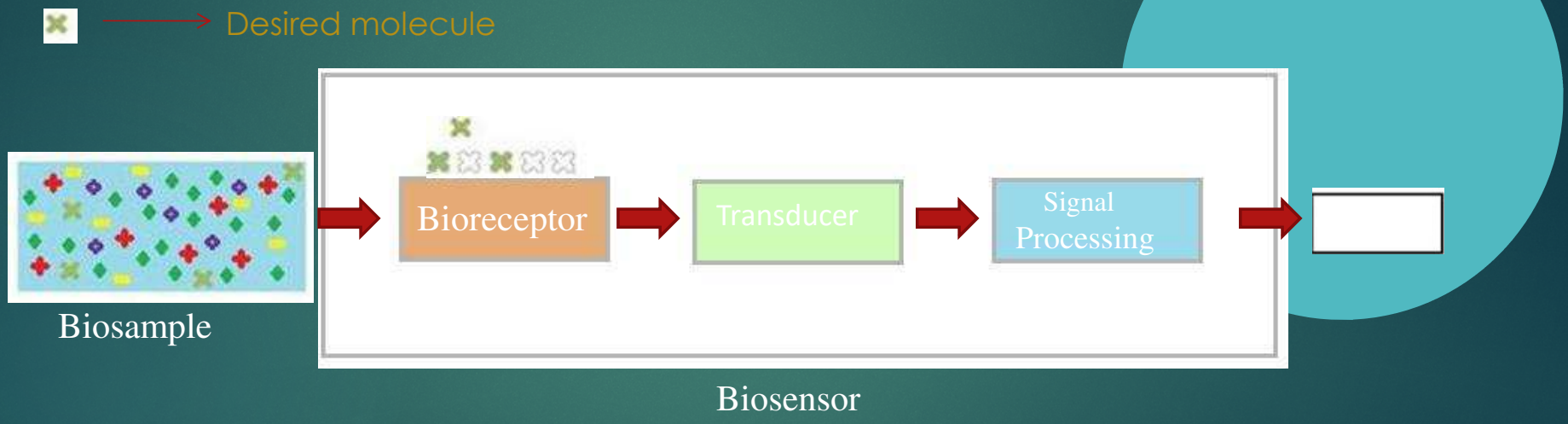
1992 Handheld blood biosensor by i-STAT

Father of the Biosensor

Professor Leland C Clark Jnr
1918–2005

3. Introduction to Biosensors

A biosensor is an analytical device which is used to determine the presence and concentration of a specific substance in a biological analyte



Recognition Transduction Signal Processing

4. Basic Characteristics of a Biosensor

1. LINEARITY	Linearity of the sensor should be high forthe detection of high substrate concentration.
2. SENSITIVITY	Value of the electrode response per substrate concentration.
3. SELECTIVITY	Chemicals Interference must be minimised for obtaining the correct result.
4.RESPONSE TIME	Time necessary for having 95% of the response.

4.1 Basic Characteristics of a Biosensor

1. The Analyte

(What do you want to detect)

Molecule - Protein, toxin, peptide, vitamin, sugar, metal ion

2. Sample handling

(How to deliver the analyte to the sensitive region?)

(Micro) fluidics - Concentration increase/decrease), Filtration/selection

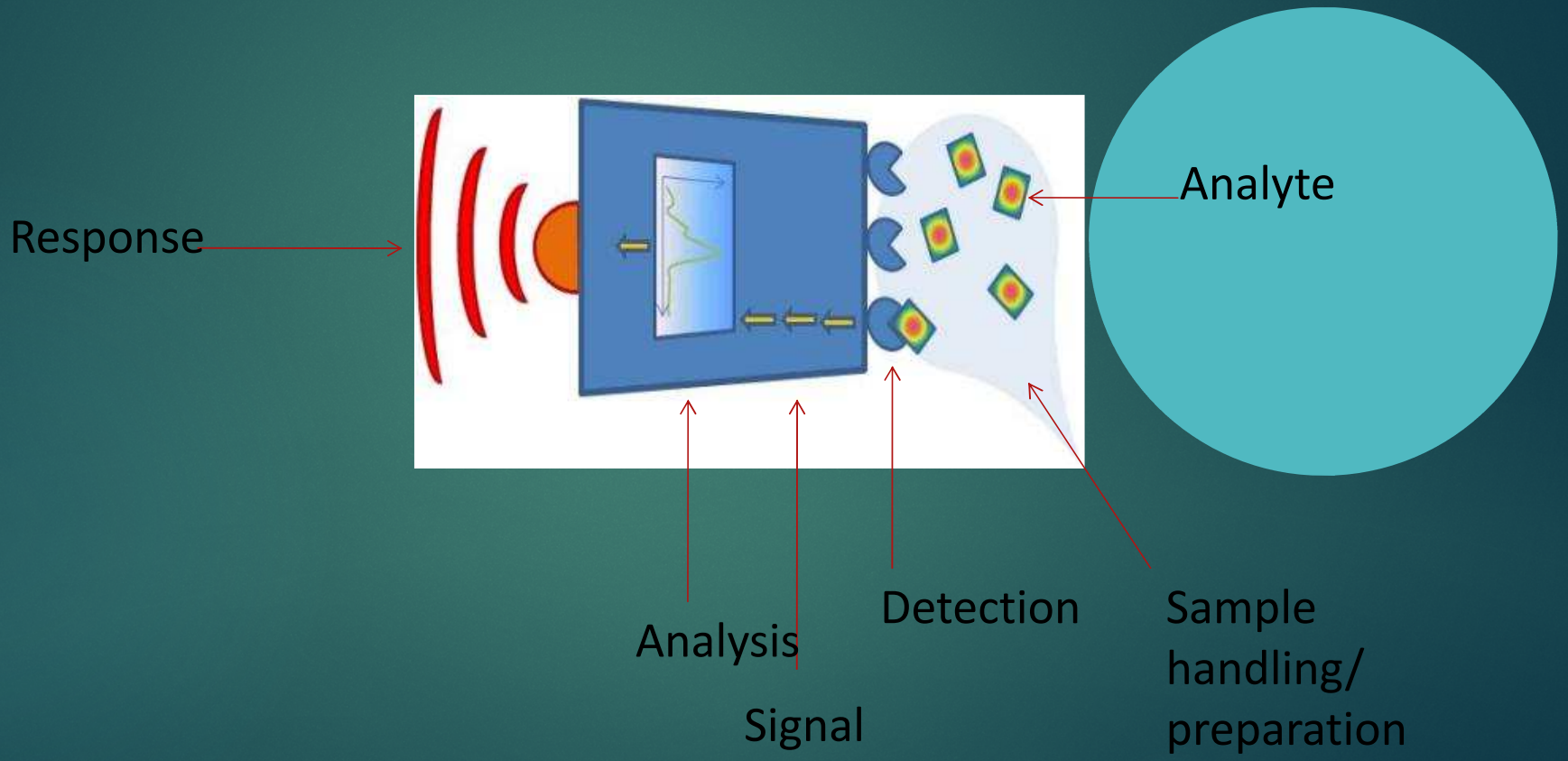
3. Detection/Recognition

(How do you specifically recognize the analyte?)

4. Signal

(How do you know there was a detection)

4.2 Basic Characteristics of a Biosensor



4.3 Basic Characteristics of a Biosensor

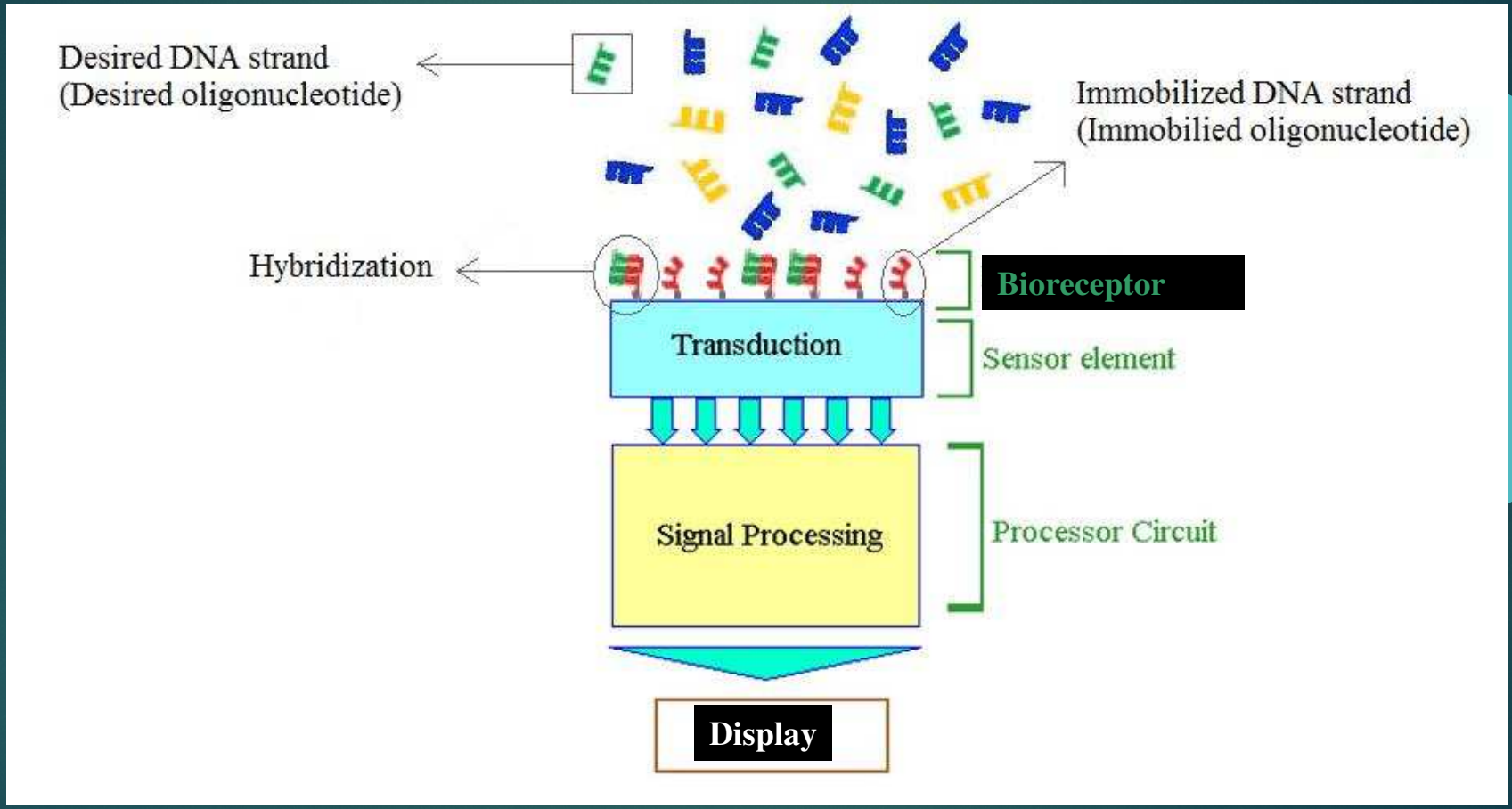
COMPONENTS

Biosensor Consists of 3 parts:

1. Biological component
2. Physiochemical component.
3. Signal processor.

5. Operating principles: Bioreceptors

5.1 Bioreceptors



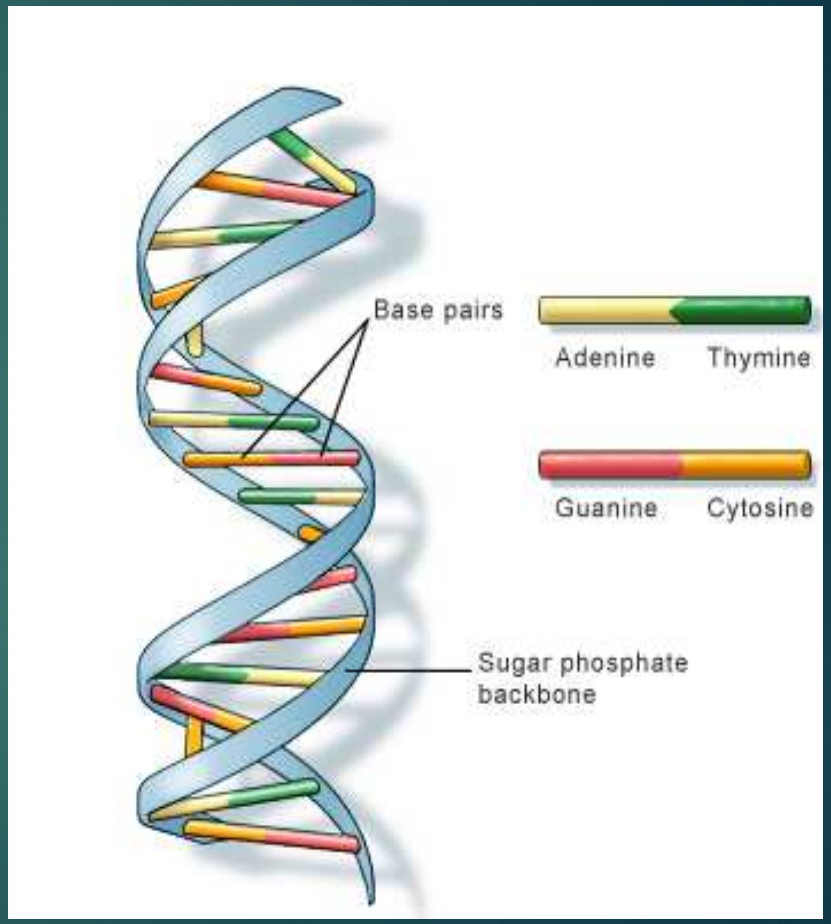
5.2 Bioreceptors

➢DNA structure

Another biorecognition mechanism involves hybridization of deoxyribonucleic acid (DNA) or ribonucleic acid (RNA), which are the building blocks of genetics.

Four chemical bases:

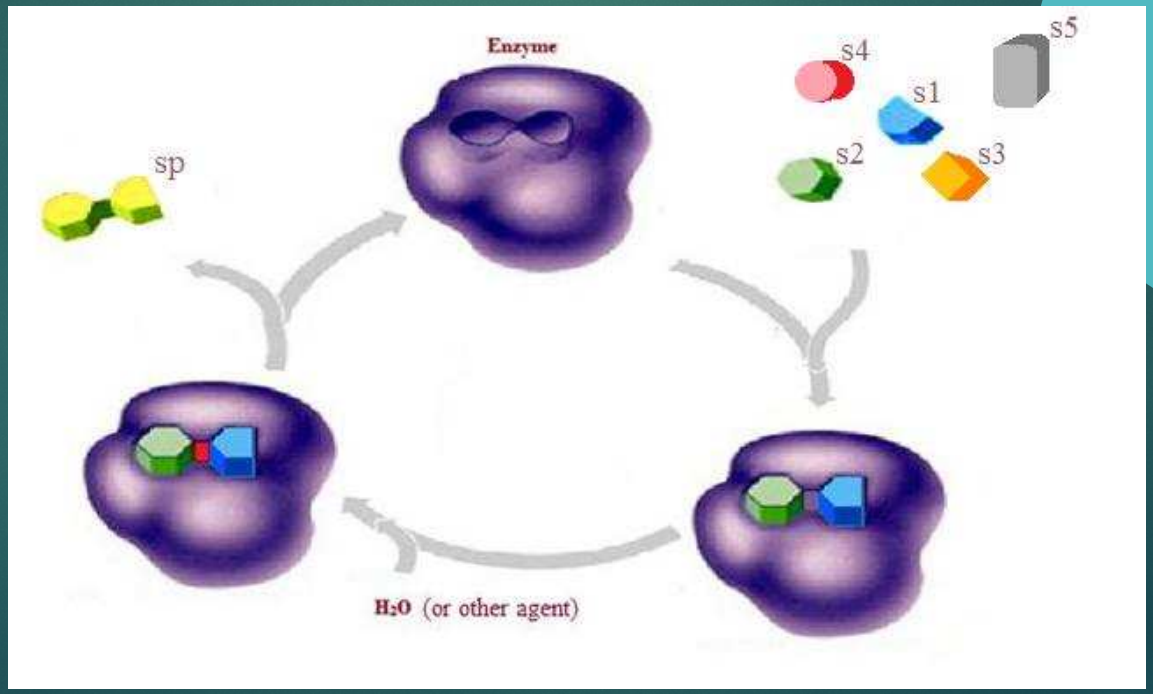
- adenine(A), guanine (G),
- cytosine (C), and thymine (T)



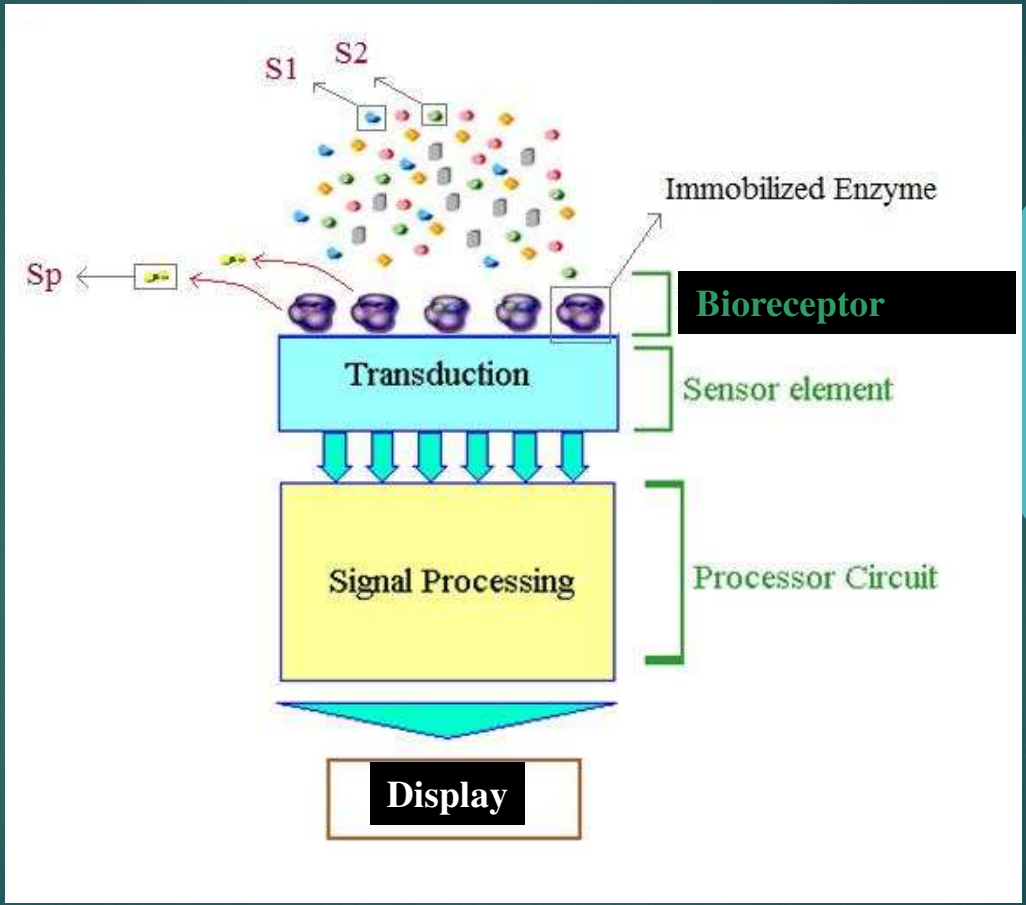
5.3 Bioreceptors

➢ Enzyme

Enzyme is a large protein molecule that acts as a catalyst in chemical reactions. Enzymes are often chosen as bioreceptors based on their specific binding capabilities as well as their catalytic activity



5.4 Bioreceptors



6. Typical Sensing Techniques for Biosensors

- ✓Fluorescence
- ✓DNA Microarray
- ✓SPR Surface plasmon resonance
- ✓Impedance spectroscopy
- ✓SPM (Scanning probe microscopy, AFM, STM)
- ✓QCM (Quartz crystal microbalance)
- ✓SERS (Surface Enhanced Raman Spectroscopy)
- ✓Electrochemical

7. Types of Biosensors

1. Calorimetric Biosensor
2. Potentiometric Biosensor
3. Amperometric Biosensor
4. Optical Biosensor
5. Piezo-electric Biosensor

8.1 Potential Applications

- Clinical diagnostics
- Food and agricultural processes
- Environmental (air, soil, and water) monitoring
- Detection of warfare agents.

8.2 Potential Applications

- remote monitoring of patients.
- training support for athlete
- monitoring of individuals who work with hazardous elements.
- tracking of professional truck driver's vital
- signs to alert them of fatigue.

8.3 Potential Applications

- Use of wearable monitoring devices allow coninuos monitoring of physiological signals
- Wereable systems are totally non-obtrusive devices that allow physicians toovercome the limitation of ambulatory technology
- Detects events predictive of possible worsening of the patient's clinical situations

9.1 Example of biosensors

Pregnancy test

Detects the hCG protein in urine.

Glucose monitoring device (for diabetes patients)

Monitors the glucose level in the blood.

9.3 Example of biosensors

Infectous disease biosensor from RBS

Old time coal miners' biosensor

10.1 Wearable Biosensor

- **RING SENSOR:**

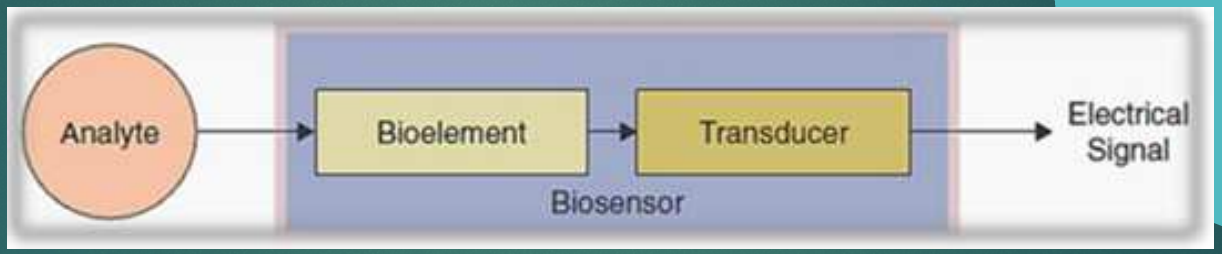
  It allows one to continuosly monitor heart rate and oxygen saturation. The device is shaped like a ring

- **SMART SHIRT:**

  This technology has been used to integrate sensors for monitoring the vital signs like temperature, heart rate and respiration rate

10.2 Wearable Biosensor

Biosensor is an analytical device, which converts a biological response into electrical signal



11. Other biosensors

- Cholesterol - based on cholesterol oxidase
- Antigen-antibody sensors - toxic substances, pathogenic bacteria
- Small molecules and ions in living things: H^+, K^+, Na^+, CO_2, H_2O_2
- DNA hybridization and damage
- Micro or nanoarrays, optical abs or fluor.

THANK YOU

FOR YOUR ATTENTION