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Biosensors: Wearable Trend & Monitoring Disease & Healthcare

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I. ABSTRACT:

Biosensors are now a day's present in biomedical diagnosis as well as monitoring of treatment & disease.enviornment monitoring, food control, drug discovery, biomedical research & forensics. The development of biosensors has been the center of scientist's attention for recent decades. Biosensors are essentially served as low cost & high efficient devices for these purpose day to day applications. Biosensor is a device that consists of main parts: A bio-receptor (detector) & transducer. Bio receptor is a biological component that recognizes the target analyte & transducer is a physicochemical detector component that converts the recognition event in to measurable signal. Biomolecules such as enzymes, antibodies, receptors, organelles & micro-organisms also tissue, animal cells used as biological sensing element. In that we review recent development in wearable technology used for reduces stress health care personnel & hospital space for care purpose & in future wearable biosensor prevents road accident saving their lives.

II. KEYWORDS: Biomolecules, Biosensor, biomedical diagnosis, wearable biosensor, food control.

III. INTRODUCTION:

Biosensor is an analytical device, used for the detection of a chemical substance that combines a biological component with a physicochemical detector. The biological element such as,

E.g. Tissue, micro-organisms, organelles, cell receptor, enzymes, antibodies, nucleic acids etc.

It is measuring biological or chemical reactions by generate signal proportional to the concentration of an analyte in the reaction.

Biosensors are work in applications such as disease monitoring, drug discovery & detection of pollutants, disease causing micro- organisms & markers that are indicators of disease in body fluids like blood, urine, saliva, sweat.[1]

Milestones of biosensor development

1906-M.Cremer demonstrated that the concentration of an acid in a liquid is proportional to the electric potential that arises between parts of the fluid located on opposite sides of a glass membrane.

1909-The concept of ph (hydrogen ion) concentration was introduced by Soren peder Lauritz Sorensen.

1922- An electrode for ph measurements was realized by Hughes.

1956- The first true biosensor was developed by Leland c.clark, Jr for oxygen detection. He is known as the father of biosensors and his invention of the oxygen electrode bear his name as'Clark electrode'.

1962- The demonstration of an Amperometric enzyme electrode for the detection of glucose by Leland Clark.

1969- The first potentiometric biosensor to detect urea by Guilbault & Montalvo.

1975- The first commercial biosensor was developed by yellow spring instruments.

1976- The first bedside artificial pancreas by Miles.

1980- The first fibre optic ph sensor for in vivo blood gases by Peterson.

1982- The first fibre optic-based biosensor for glucose.

Ever since the development of the i-STAT sensor, remarkable progress has been has been achieved in the field of biosensors. The field is now multidisciplinary area of research that bridge the principles of basic sciences (physics, chemistry & biology) with fundamentals of micro/nano- technology, electronics & applicatory medicine, The database 'web of science' has indexed over 84000 reports on the topic of 'biosensors' from 2005 to 2015.[1]

A biosensor is comprised of three essential components:

I. Detector- recognizes the biological element of interest (DNA, antibody, enzymes, cells, bacteria etc.)
II. Transducer- converts one form of energy in to another. In the biosensor, a transducer converts the biological element recognition to a signal
III. Output system- involves amplification & display of the signal(2)

The biosensor is depends on the bio recognition element such as catalytic enzymes, organelles, tissues binds (antibody-antigen) & biorecepters. The physical & chemical transducer have been used to monitoring the process of element recognition.[3]

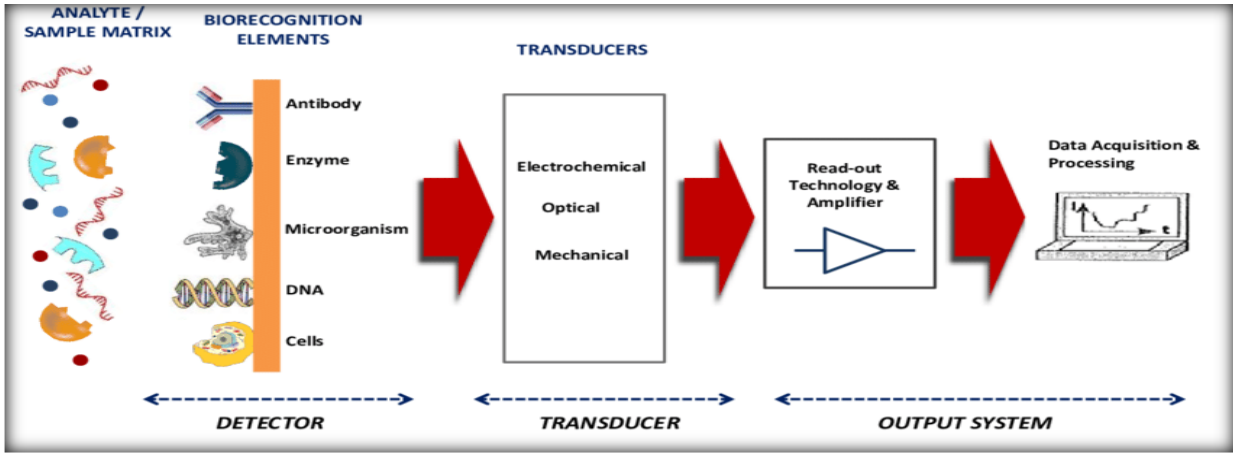

fig no.1 schematic diagram of biosensor

Classification of biosensors:

Biosensors can be classified according to transducer employed. The transducers having different types;

a. Electrochemical
b. Optical
c. Piezoelectric
d. Microbial biosensor
e. Enzyme biosensor

a) **Electrochemical Biosensor**-

The potentiometric or Amperometric are most popular because of their familiarize to chemist & biologist as operation. These biosensors have electrodes which translate the chemical signal in to an electrical signal. These are able to detect various molecules in the human body such as glucose, cholesterol, uric acid, lactate, DNA, hemoglobin, blood ketones etc [4]

b) **Optical Biosensor**-

These biosensors are works on optical measurement. They use fiber optics as well as optrode represents a compression of the two terms optical & electrode. These sensors involve antibodies & enzymes like the transducing elements.

Optical fibers play an important role in optical biosensors. The optical fibers allow detection of the sensing elements based on the different properties of light like absorption, scattering & fluorescence.[17]

c) **Piezoelectric Biosensor**-

Piezoelectricity is the process of using crystals to convert mechanical energy in to electric energy. These biosensors a uses the piezoelectric effect to measure changes in pressure, acceleration, temperature, strain or force by converting them to an electrical charge. The prefix piezo- is Greek for press or squeeze.[5]

d) **Microbial biosensor**-

A microbial biosensor is that couples micro-organisms with a transducer to enable rapid, accurate & sensitive detection of target analytes in fields as diverse as medicine, environmental monitoring, defense, food processing & safety. The earlier microbial biosensors used the respiratory & metabolic functions of the micro-organisms to detect a substance that is either a substrate or an inhibitor of these processes.[12]

e) **Enzyme biosensor**-

Those are based on biological recognition. In order to operate, the enzymes must be available to catalyze a specific biochemical reaction & be stable under the normal operating conditions of the biosensor. The enzyme biosensor is composed of a sensitive membrane- immobilized enzyme & electrode transducer system, which combined enzyme & electrode together.[6]

IV. Applications of Biosensor:

- Biosensors in food industry-
  - Biosensors are used for the detection of pathogen in food.
  - Presence of Escherichia coli in vegetables, is a bioindicator of faecal contamination in food. E.coli has been measured by detecting variation in pH caused by ammonia (produced by urease E. coli antibody conjugate) using potentiometric alternating biosensing systems.[7]

Fig no.2 detection of spoiled food & fresh food

- Biosensor in Medical field-
  - Glucose biosensors are widely used in clinical applications for diagnosis of diabetes mellitus.
  - A novel biosensor, based on hafnium oxide(HfO_2), has been used for early stage detection of human interleukin.
  - These are also used for detection of cardiovascular diseases.[8]
- Biosensors in Drug Discovery & Drug Analysis-
  - In pharmaceutical industry for monitoring chemical parameters in the production process(in bioreactors)
  - Affinity biosensors for high- through put screening of bioprocess- produced antibodies & for drug screening.
  - Oligonucleotide – immobilized biosensors for interactions studies between a surface linked DNA with the target drug.
- Epigenetic-
  - Photonic biosensors can detect tumor cell in a urine sample to an ultra-sensitivity level
  - Epigenetic modifications are detected after exploitation of integrated optical resonators.

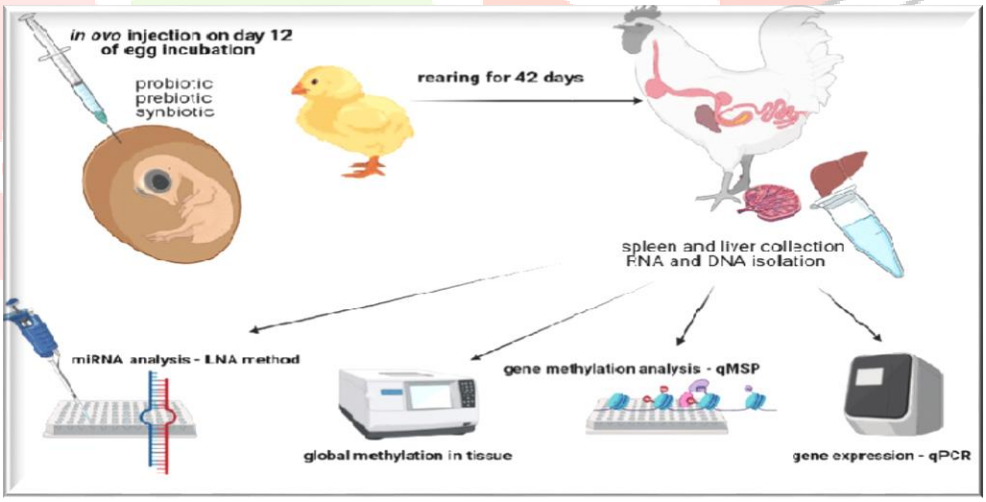

Fig no.3 experiment of epigenetics

- Role of biosensors in Environmental monitoring-
  - The biosensors find wide application for measurement, estimation & control of water, air & soil contaminants.
  - Potentiometric biosensor- pesticide determination.
  - Amperometric biosensor- Water pollution check from herbicide.
  - Concentration of ammonia can be defined with microbe biosensor with cells of *Nitrosomonas sp*.[9]

- Nano- Biosensors-
  - The ultimate goal is to detect any biochemical & biophysical signal associated with a specific disease at the level of a single molecule or cell.
  - They can be integrated in to other technologies such as lab-on-a-chip to facilitate molecular diagnostics.
    Eg. Detection of micro-organisms in various sample monitoring of metabolites in body fluids & detection of tissue pathology such as cancer.[17]

Wearable biosensors (WBS)-

- What is wearable biosensor?
  WBS is the digital devices that can be worn on the body. The wearable devices such as like smart shirts, smart watches, thin bandages, rings etc those are the wearable objects. These biosensors provide the vital monitoring of patients, athletes, premature infants, children, psychiatric patients, people who need long- term care & people in impassable regions far from the health & medical services. They are effective in the prevention, proper diagnosis, control & treatment of diseases.
  Types of Wearable biosensors & their application-
  - Smart watches-
    The smart watches are one of the most important wearable device. Usually, a smart watch monitors specific human physiological signals & biomechanics & therefore it acts as a fitness tracking device that helps users to log their daily activities such as automatically recording workout times, tracking heart rate, step counts & calories burnt. With the help of internal & external sensors integrated with a lithium-ion battery, smart watches collect information & further it transfer it to the server or smart phone for analytics & read ability.[10]

Fig.4 Smart watch

  - Smart socks-
    Those are equipped with sensors that can control walking & the manner by which the feet are placed on the ground in different situations, walking, running or sitting position.
  - Ring sensor-
    It is a pulse Oximetry sensor which permits monitoring of heart rate & Oxygen saturation which permits monitoring of heart rate & Oxygen saturation. The Device is shaped like a ring & it can be worn for extended period of time. Red LED. Infra-red

LED & photodiode are embedded in the ring. The whole process is control by single processor.

- Eye glasses-
  Those glasses are wearable head- mounted computer with a display property. The eye glasses are integrated with a nose pad consisting of a lactate biosensor was developed to simultaneously monitor sweat lactate & potassium level using bienzymatic Gel-Membrane using eyeglasses.(11)
- Clothing(smart shirt)-
  The shirt developed at Georgia tech used optical bears to identify wounds & Special sensors & interconnect to monitor the vital signs of the body this smart shirt provides a framework of monitoring, information processing devices & sensing of the wounds. The sensors can be positioned on the right places for all the users & it can be washed without any damage. It helps for monitoring the heart rate, respiratory rate & temperature. This clothing is composed of two layers; one layer is ordinary fabric & membrane which prevents excessive sweating in the baby.

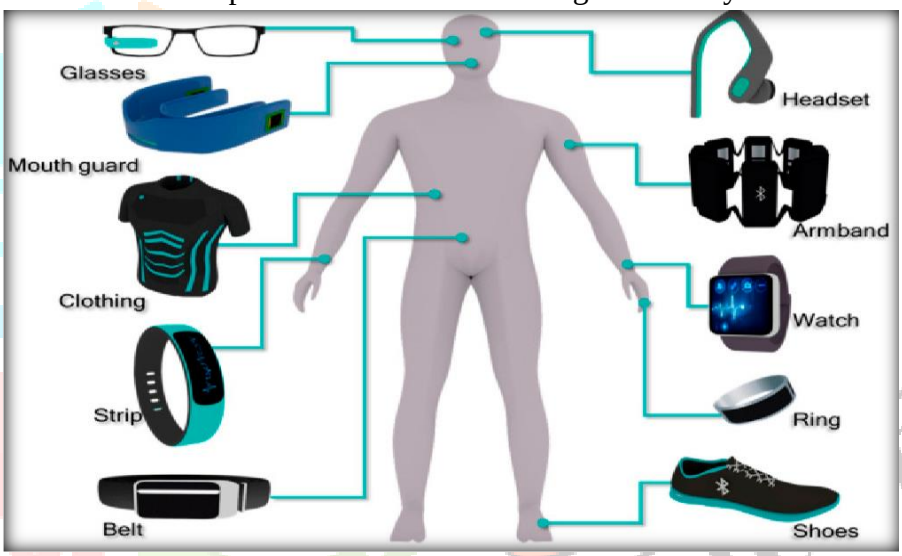

Fig.5 Wearable biosensors

UPCOMING WEARABLE BIOSENSOR:

- Wearable sensor for prevention of Road accidents-
  Because to solve the query of road accidents, different sensing techniques have been introduced such as measuring of vehicles characteristics (Steering wheel, breaks, gears etc.) & pattern of drivers behavior. Wearable sensors continuously monitor the safety for avoiding road accident & provide recovery the accident & also help for major cause of the road accident is the consumption of alcohol by driver, longer driving hours, lack of sleep etc
- Automatic stress Recognition-
  To mitigate the chronic physiological stress, the technologies are present to recognize the stress by their own that leads to wearable biosensors which are easy to wear. In this stress recognition technique, the loss function support machines is advanced to encode an individual's ability to feel greater Or lesser stressed.[14]

V. CONCLUSION:

Concluded that, Biosensors are very powerful technology, it is provide rapid detection with low cost & higher sensitivity & specificity. The wearable sensors have greatest impact on the health care & detection of disease.

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