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BIOCHIP - A REVIEW ON CUTTING-EDGE BIOCHIP TECHNOLOGY

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ABSTRACT

The development of biochips is a major success in rapidly growing biotechnology industry, which is simply the fusion of biology and microchip technology. It encompasses a very assorted range of research efforts including genomics, proteomics and bio-diagnostics. Also efforts are made to use biochip in field of identification and tracking devices. Advances in all these areas are giving scientists new methods for unraveling the complex biochemical processes occurring inside cells, with the larger goal of understanding and treatment of human diseases. At the same time, advancement in the semiconductor industry has been steadily perfecting the science of micro-miniaturization. The fusion of these two fields in recent years has enabled scientists to begin compressing their traditionally large, bulky sensing tools into smaller miniaturized chip i.e. so called Biochips. These chips are not final product but are development platform and are essentially miniaturized laboratories that can perform hundreds or thousands of simultaneous biochemical reactions. These paper insights on how biochips enable researchers to quickly screen large numbers of biological analytes for a variety of purposes, from disease diagnosis to tracking devices.

KEYWORDS: *Genetics, Pretomics, Genomics, GPS, RFID, Microarraying.*

I. INTRODUCTION

A Biochip is a collection of miniaturized test sites (microarrays) arranged on a solid substrate that allows many tests to be performed at the same time in order to achieve higher throughput and pace [4]. Typically, a biochip's surface area is no larger than a fingernail. Like a computer chip that can perform millions of mathematical operations in one second, a biochip can perform thousands of biological reactions, such as decoding genes in few seconds. Biochip is a small-scale devices, analogous to an integrated circuit, constructed of or used to analyze organic molecules associated with living organisms. One type of theoretical biochip is a small scale device constructed of large organic molecules, such as proteins, and capable of performing the functions (data storage, processing) of an electronic computer. The other type of biochip is a small device of performing rapid, small-scale biochemical reactions for the purpose of identifying gene sequences, environmental pollutants, airborne toxins, or other biochemical constituents.

Biochips are silently inching into humans. For instance, at least 6 million medical devices, such as artificial body parts (prosthetic devices), breast implants, chin implants, etc. are implanted in people each year.

In 1993, the Food and Drug Administration passed the Safe Medical Devices Registration Act of 1993, requiring all artificial body implants to have implanted identification –the biochip.

So, the yearly, 6 million recipients of prosthetic devices and breast implants are bio-chipped.

Companies such as A.V.I.D (American veterinary identification), Electronic ID (Electronic Identification), and Affymetrix sell the biochips. The chip are of the size of an uncooked grain of rice, small enough to be injected under the skin using a hypodermic syringe needle. They respond to a signal from the detector, held just a few feet away, by transmitting out an identification number. This number

is then compared to a database listings of registered pets. Biochips are any microprocessor chips that can be used in Biology.

Figure 1: Biochip.

II. HISTORY

The development of biochip has a long history, stating with early work on the underlying sensor technology. Biochip was originally developed in 1983 for monitoring fisheries. The rapid technological advances of the biochemistry and semiconductor fields in the 1980s led to the large scale development of biochip in 1990s. At this time it became clear that biochips were largely a platform technology which consisted of several separate, yet integrated components.

It is important to realize that a biochip is not a single product, but rather a family of products that form a technology platform [2]. Many developments over the past two decades have contributed to its evaluation.

In a sense, the very concept of a biochip was made possible by Fred Sanger and Walter Gilbert, who have awarded a Nobel Prize in 1980 for their pioneering DNA sequence approach that is widely used today.

III. DESIGN AND ARCHITECTURE

The biochip implant system consists of two components

1. A Transponder
2. A Reader or Scanner

The transponder is the actual biochip implant. The biochip is a radio frequency identification (RFID) system, using low-frequency radio signals to communicate between the biochip and the reader. The reading range or activation range, between reader and biochip is small, normally between 2 and 12 inches.

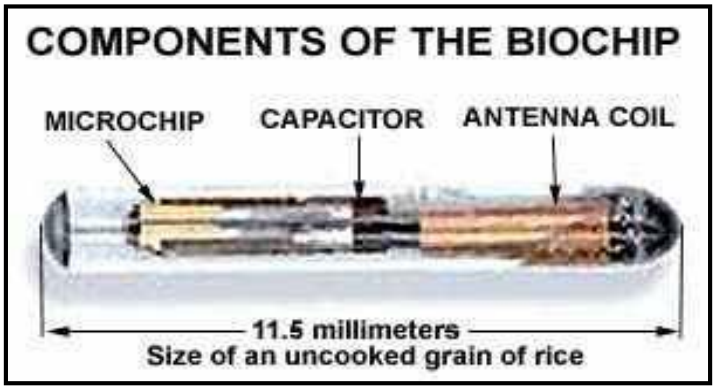

Figure 2: Components of Biochip.

3.1 Transponder

The transponder is the actual biochip implant. It is a passive transponder, meaning it contains no battery or energy of its own. In comparison, an active provide its own energy source, normally a small battery because the passive biochip contains no battery, o nothing to wear out with, it has a very long life, up to 99 years, and no maintenance. Being passive, it's inactive until the reader activates it by sending it a low-power electrical charge. The reader reads o scans the implanted biochip and receives back data (in this case an identification number) from the biochip. The communication between biochip and reader is via low-frequency radio waves.

3.1.1 Transponder components:

- **Computer microchip:** The microchip stores a unique identification number from 10 to 15 digits long. The storage capacity of the current microchips is limited, capable of storing only a single ID number. The unique ID number is etched or encoded via a laser onto the surface of the microchip before assembly. Once the number is encoded it is impossible to alter. The microchip also contains the electric circuitry necessary to transmit the ID number to the reader.
- **Antenna coil:** This is normally a simple, coil of copper wire around a ferrite or iron core. This is tiny primitive radio antenna receives and sends signals from the reader or scanner.
- **Tuning capacitor:** The capacitor stores the small electrical charge sent by the reader or scanner, which activates the transponder. This activation allows the transponder to send back the ID number encoded in computer chip. The capacitor is tuned to the same frequency as the reader**.**
- **Glass capsule:** The glass capsule stores the microchip, antenna coil and capacitor. It is a small capsule, the smallest measuring 11mm in length and 2mm in diameter the capsule is made up of biocompatible material such as soda lime glass.

The biochip is inserted into the subject with hypodermic syringe. Injection is safe and simple, comparable to common vaccines. Anesthesia is not required nor recommended for this insertion.

Figure 3: Biochip and Syringe

3.2 Reader

The reader consists of an excite coil which creates an electromagnetic field that, via radio signals, provide the necessary energy to excite or activate the implanted biochip. The reader also carries a receiving coil that receives the transmitted code or ID number sent back from the activated implanted biochip. Reader also contains the software to decode the received code and display the result in an LCD display.

Figure 4: Biochip Reader.

IV. WORKING

- **Microarray**: It is a two-dimensional dense grid of biosensors and also the most critical component of a biochip platform. Typically, the sensors are deposited on a flat substrate, which may either be passive (*e.g.* silicon or glass) or active, the latter consisting of integrated electronics or micromechanical devices that perform or assist signal transduction**.** Various means exist to achieve the placement, but typically robotic micro-pipetting (Schema, 1995) or micro-printing (Macbeth, 1999) systems are used to place tiny spots of sensor material on the chip surface. Microarrays are not limited to DNA analysis; protein microarrays, antibody microarray, chemical compound microarray can also be produced using biochips. Randox Laboratories Ltd. launched Evidence, the first protein Biochip Array Technology analyser in 2003[2], [3].
- **Transduction:** It is the process by which DNA is transferred from one bacterium to another by a virus. It also refers to the process whereby foreign DNA is introduced into another cell via a viral vector. Transduction does not require physical contact between the cell donating the DNA and the cell receiving the DNA, and is DBase resistant.
- **Signal processing:** Signal processing is an enabling technology that encompasses the fundamental theory, applications, algorithms, and implementations of processing or transferring information contained in many different physical, symbolic, or abstract formats broadly designated as signals [2].

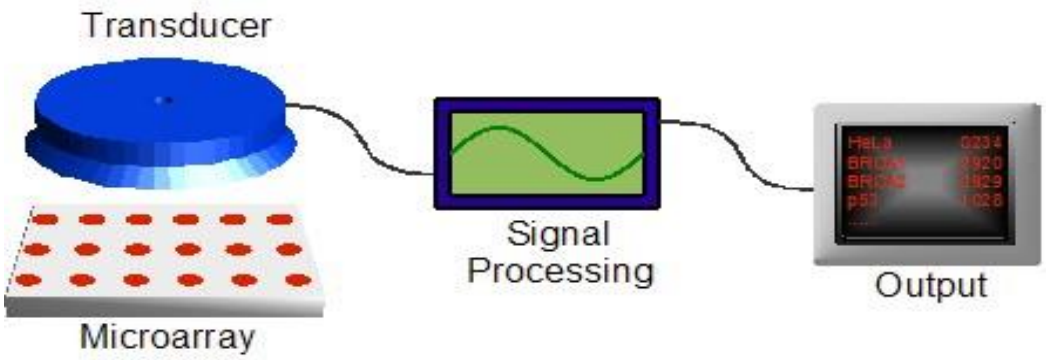

Figure 5: Signal receiving processing and output.

V. ADVANTAGES

There are numerous advantages of biochip. Some of them are listed below:

- The ability to detect multiple viral agents in parallel.
- To rescue the sick people so that at right time their disease can be diagnosed and they get proper treatment on time.
- In monitoring health conditions of individuals in which they are specially employed.
- In military it is use as a trekking device due to the integration of G.P.S (Global Positioning System).

- Increase peed of diagnosis of unknown pathogens.
- Operations performed by biochip is faster and powerful.
- They can perform thousands of biological reactions in one second.

VI. DISADVANTAGES

Having numerous advantages of biochips there are few disadvantages also. Some of the disadvantages are listed below.

- They can be implanted into someone's body without their knowledge.
- They raise critical issues of personal privacy as someone can watch our all activities without our knowledge. Our privacy can be lost.
- DNA chip cannot be fabricated at high density and mass production is limited. Thus, these method are applicable to a fabrication of a DNA chip for study.

VII. APPLICATIONS

- **Genomics**: Genomics is the study of gene sequences in living organisms and being able to read and interpret them. The human genome has been the biggest project undertaken to date but there are many research projects around the world trying to map the gene sequences of other organisms.
- **Pretomics**: Proteome analysis or Proteomics is the investigation of all the proteins present in a cell, tissue or organism. The use of Biochip facilitate: High throughput proteomic analysis, Multi-dimensional micro separations (pre LC/MS) to achieve high plate number, Electro kinetic sample injection for fast, reproducible, samples.
- **Bio-diagnostics:** Bio diagnostics or bio sensing is the field of sensing biological molecules based on electrochemical, biochemical, optical, luminometric methods. The use of biochip facilitates development of sensors which involves optimization of the platform, reduction in detection time and improving the signal-to-noise ratio.
- **Tracking Device:** Biochip can be integrated with the GPS (Global Positioning System) to work as a tracking device. Major use of this technology is in military and other armed forces. It works as beast which is very hard to be detect.

VIII. FUTURE SCOPE

One card or one chip and your life on it – This sounds so fascinating or some kind of stuff from a science fiction Hollywood movie but this is actually coming closer to reality. With the huge advancement and researches on microchip technology and sensors the days are coming where we can actually boost our body parameters with the help of a miniature chip. In future we don't have to carry our wallet, passport, ID credit or debit cards but just a single chip (biochip) which is inserted in our body serves the purpose for all. It just a tiny beast on which all the information can be coded and easily used when needed.

IX. CONCLUSION

The paper intended that Biochips are fast, accurate, miniaturized, and can be expected to become economically advantageous attributes that make them analogous to a computer chip. Biochips promises to bring genomics out of the research laboratory and into the everyday practice of medicine. If genomics delivers on its promise, health care will shift from a focus on detection and treatment to a process of prediction and prevention. As we know that future is of technology and Biochip is one of its major futuristic development which will transform the medical industry and works as a boon for patients suffering from deadly diseases. The miniaturization of devices that will also allow highly sensitive analysis of complex biological interactions in real time that too with a low cost perception. Biochip technology will further expand in the economic area where the era of digitalization take place where all our personal information can be integrated on a single chip.

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