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Study on Biochips Technology

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Abstract

Biochip, the most exciting future technology is an outcome of the fields of Computer science, Electronics and Biology. It is a new type of bio-security device to accurately track information and who is actually doing it. Biochips promises to bring genomics. Biochips are fast, accurate, miniaturized, and can be expected to become as advantageous as a computer chip. The potential applications are vast, both for research and for clinical use with huge market potential. Besides, the efficiency of our approach is manifested by the preliminary succinctly study attempt to define biochip, and discuss its manufacturing techniques among others. This paper concludes that biochips have potential applications both for research and clinical use with huge market potentials.

Keywords: Biochip; Biology; Technology; Clinical; Security.

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1.0 Introduction

Biochips are any microprocessor chips that can be used in Biology. The biochip technology was originally developed in 1983 for monitoring fisheries, it's use now includes, over 300 zoos, over 80 government agencies in at least 20 countries, pets (everything from lizards to dogs), electronic "branding" of horses, monitoring lab animals, fisheries, endangered wildlife, automobiles, garment tracking, hazardous waste, and humans. 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. And most of these medical devices are carrying a "surprise" guest — a biochip. 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 "biochipped". To date, over 7 million animals have been "chipped". The major biochip companies are A.V.I.D. (American Veterinary Identification Devices), Trojan Identification Systems, and Destron-Fearing Corporation (IMTEK, 2013).

1.1 Background of the study

The current biochip implant system is actually a fairly simple device. Today's, biochip implant is basically a small (micro) computer chip, inserted under the skin, for identification purposes. The biochip system is radio frequency identification (RFID) system, using low-frequency radio signals to communicate between the biochip and reader (IMTEK, 2013).

1.2 Research Questions

I. Biochips- what are they?

II. How is Biochip manufactured?

III. What materials are used for the production of biochips?

IV. What are the implantable devices under development?

V. What implantable device is currently in market?

2.0 Literature Review

With the growth in population crossing 2 billion, health care is one of the niche areas where in lots of importance is being paid by both the government and private sector industries. In a society, public health plays an important role. There is no human being who is ideally healthy. Every family will have some ill health, sickness and a need exists for medication. In every locality a hospital is an essential establishment for the healthcare of its people. Various schemes are being offered by Indian government to offer health care at subsidized rates. Another major challenge is the availability of doctors. It is being projected that in 2020, the ratio of patients to doctors in India will be 1000:1 and worldwide will be 800:1. This puts lots of pressure and demand for doctors and medical practitioners will only rise. Automated drug delivery is one possible solution to overcome the gap between demand and supply in health care sector. With the growth in technology and emergence of nanotechnology, biochips (consisting of biosensors, signal processing and conditioning circuits and controllers for drug diffusion) provide easy and reliable solutions to mankind in tackling the health issues. Automated drug delivery is an interdisciplinary domain that involves biosensors (biology/electronics) for detection of virus, neural network for disease classification.

2.1 Traditional Drugs and Diagnosis

Age old practices of disease detection and curing are through seeking appointment with doctors and being tested as per the standard procedures. Treatment is provided based on the recommendations and observations made by the doctor during the test procedures. The drug is given to the patient as prescribed by the doctor and the patient is kept under observation. There are very few procedures for drug delivery and these include oral prescription and injections apart from the treatment procedure which a doctor may prescribe. When the patient goes to a doctor seeking diagnosis for a disease, the doctor generally prescribes drugs which are administered through oral delivery or injections. Problems with Oral delivery are often the liver cleans out a large portion of the drug. The acidic pH of the stomach can often destroy the drug, well before it is absorbed. This does not work for ionic water soluble drugs. The drugs can also be administered through Injections viz. Intravenous, Intramuscular or subcutan Food and Drug Administration has identified some of the implantable ID chips in humans, for medical purposes besides security, financial and personal identification or safety applications (IMTEK, 2013).

2.2 Categorization of Implantable Devices

Implantable devices can be categorized as Medical or Non-medical devices, both either Passive or Active devices. In Implantable medical devices the most passive implants are structural devices such as artificial joints, vascular grafts and artificial valves. On the other hand, active implantable devices require power to replace or augment an organ’s function or to treat an associated disease.

2.2.1 Medical Devices

The "Active Implantable Medical Device" means any active medical device which is intended to be totally or partially introduced, surgically or medically, into the human body or by medical intervention into a natural orifice, and which is intended to remain after the procedure (IMTEK, 2013).

2.2.2 Non-medical Devices

An example of a passive device is the Radio Frequency Identification (RFID) device. Active devices may use electrical impulses to interact with the human’s nervous system (IMTEK, 2013).

2.3 DNA Fingerprinting in Security System

i. It is an easy and painless method for the subject being tested. It is less invasive than taking a blood sample.

ii. It is an affordable and reliable technique.

iii. It can be conducted in a relatively short amount of time.

iv. Anyone at any age can be tested with this method without any major concerns (NSS, 2012).

v. There is a large variety of uses such as in legal claims, missing person's cases, identification for the military, and paternity and prenatal testing.

vi. The technique has used since 1984, making it highly developed and improved (NSS, 2012).

2.4 Limitation of Finger Print

i. The sample of DNA can easily be ruined during the process of DNA fingerprinting, causing the sample to become completely useless for testing (NSS, 2012).

ii. The process itself is complex and tedious, and can give results that may be hard to interpret.

iii. The test needs to be run on multiple samples with a numerous amount of times for ideal accuracy. Commonly, labs run each test twice with four samples (NSS, 2012).

iv. Privacy issues could occur if the information isn't kept secure at the lab. Personal information legally can only be released with a written order. This personal information if leaked, could potentially complicate insurance processes, health care and job prospects for an individual (NSS, 2012).

3.0 The Biochip

Here we will give solutions to research questions and methods on how the research work was carried out.

3.1 Source of Information

Basically the source of information was through tertiary source such as the internet.

3.2 Solution to Research Questions

Below are the solutions or answers to the research question as stated in section 1.2 of this article. From the word "bio" which means life and "chip" which means miniaturized wafer disc of silicon on which an integrated circuit is printed. The biochip then literally means an electronic device used for living organism. The biochip is basically a small (micro) computer chip inserted under the skin. It is a passive transponder, meaning it contains no battery or energy of its own because it activates only once injected to a living host.

A biochip is also a Radio Frequency Identification Device (RFID) it uses radio signals to "read" identification codes and other data stored in a transponder and is a reliable way to electronically detect, control, and track a variety of items, information, animals and people.

The Making of Biochip

The microarray the dense, two-dimensional grid of biosensors is the 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 Micro mechanical devices that perform or assist signal transduction. Surface chemistry is used to covalently bind the sensor molecules to the substrate medium. The fabrication of microarrays is non-trivial and is a major economic and technological hurdle that may ultimately decide the success of future biochip platforms. The primary manufacturing challenge is the process of placing each sensor at a specific position (typically on a Cartesian grid) on the substrate. Various means exist to attain the placement, but typically robotic micro-pipetting or micro-printing systems are used to place tiny spots of sensor material on the chip surface. As each sensor is unique, only a few spots can be placed at a time. The low throughput nature of this process results in high manufacturing costs.

Materials Used For the Production of Biochips

The current biochip implant system is actually a fairly simple device. Today's, biochip implant is basically a small (micro) computer chip, inserted under the skin, for identification purposes. The biochip implant system consists of two components; a transponder and a reader or scanner. The transponder is the actual biochip implant. The biochip system is radio frequency identification (RFID) system, using low-frequency radio signals to communicate between the biochip and reader. The reading range or activation range, between reader and biochip is small, normally between 2 and 12 inches.

Implantable Device under Construction

The Micro-Electro Mechanical Systems device (MEMS) is an implantable micro-sensor that can send data to a hand-held receiver outside the body, alerting doctors to a potential medical crisis, without using any wire or battery. This GPS monitoring could be used for several purposes, such as, In case of Medical emergencies, Heart attack, Epilepsy, Diabetes, and Implantable GPS microchip.

Implantable Device Are Currently In Market

Current active medical devices available in market are cardiovascular pacers for patients with conduction disorders or heart failure, Cochlear and brainstem implants for patients with hearing disorders.

3.3 How Biochip Works

The reader generates a low-power, electromagnetic field, in this case via radio signals, which activates the implanted biochip as depicted in figure 5. This activation enables the biochip to send the ID code back to the reader via radio signals. The reader amplifies the received code, converts it to digital format, decodes and displays the ID number on the reader's LCD display. The reader must normally be between 2 and 12 inches near the biochip to communicate. The reader and biochip can communicate through most materials.

Figure 1: Biochips reader

4.0 Biochips Technology

The notion of a cheap and reliable computer chip look-alike that performs thousands of biological reactions is very attractive to drug developers. Because these chips automate highly repetitive laboratory tasks by replacing cumbersome equipment with miniaturized, micro-fluidic assay chemistries, they are able to provide ultra-sensitive detection methodologies at significantly lower costs per assay than traditional methods—and in a significantly smaller amount of space. At present, applications are primarily focused on the analysis of genetic material for defects or sequence variations. Corporate interest centers on the potential of biochips to be used either as point-of-care diagnostics or as high-throughput screening platforms for drug lead identification. The key challenge to making this industry as universally applicable as processor chips in the computer industry is the development of a standardized chip platform that can be used with a variety of "motherboard" systems to stimulate widespread application (Deisingh, Wilson and Elie, 2009).

4.1 Historical perspective

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

In a broader sense, the very concept of a biochip was made possible by the work of Fred Sanger and Walter Gilbert, who were awarded a Nobel Prize in 1980 for their pioneering DNA sequencing approach that is widely used today. DNA sequencing chemistry in combination with electric current, as well as micro pore arose gels, laid the foundation for considering miniaturizing molecular assays. Another Nobel-prize winning discovery, Kary Mullis's polymerase chain reaction (PCR), first described in 1983, continued down this road by allowing researchers to amplify minute amounts of DNA to quantities where it could be detected by standard laboratory methods. A further refinement was provided by Leroy Hood's 1986 method for fluorescence-based DNA sequencing, which facilitated the automation of reading DNA sequence.

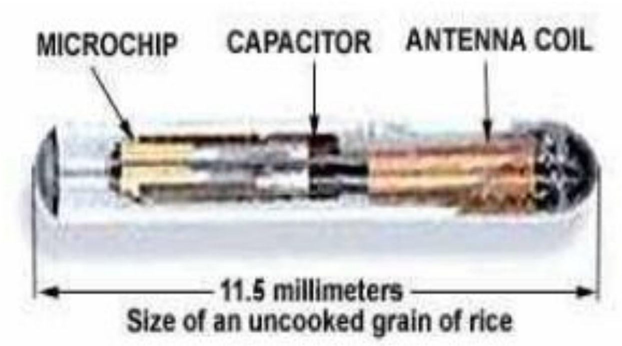

Figure 2: Structure of Biochip

4.2 Structure of Biochip

The biochip is inserted into the subject with a hypodermic syringe as shown in figure below Injection is safe and simple, comparable to common vaccines. Anesthesia is not required nor recommended. In dogs and cats, the biochip is usually injected behind the neck between the shoulder blades. According to AVID "Once implanted, the identity tag is virtually impossible to retrievell. The number can never be altered.

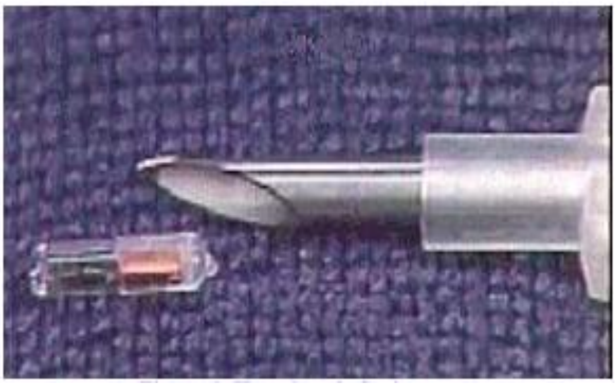

Figure 3: Hypodermic Syringe

4.3 Economic Advantages of Biochip

Applications of Biochip Tracing of a person/animal, anywhere in the world is possible Can store and update financial, medical, demographic data. Replaces passports, cash, and medical records Secured E- Commerce system (Ghosh, 2013).

Biochip as glucose detector:

The chip will allow diabetics to easily monitor the level of the sugar glucose in their blood. A light-emitting diode (LED) in the biochip starts off the detection process Glucose is detected because the sugar reduces the amount of light that the fluorescent chemical re-emits. The more glucose there is the less light that is detected (Ghosh, 2013).

Biochip as oxygen sensor:

Biochip as oxygen sensor: the oxygen sensor will be useful to monitor breathing in intensive care units; the oxygen-sensing chip sends light pulses out into the body. The light is absorbed to varying extents, depending on how much oxygen is being carried in the blood, the rushes of blood pumped by the heart are also detected, and so the same chip is a pulse monitor (Ghosh, 2013).

Biochip as Blood Pressure Sensor:

It is a continuous monitoring of BP is required in the aged people & Patients. A huge variety of hardware circuitry (sensors) is available in electronics to detect the flow of fluid are embedded into a biochip. It continuously monitor the blood flow rate and when the pressure is in its low or high extremes it can be immediately informed through the reader hence to take up remedial measures (Ghosh, 2013).

Saliva Alerts About A Heart Attack Via Nano-Bio Chip: Saliva alerts about a heart attack via Nano- bio chip Compact Nano-bio-chip sensor devices that are biochemically-programmed to detect sets of these proteins in the saliva. The chip provides information on current risk of the patient. These tests dramatically improve the accuracy and speed of cardiac diagnosis (Ghosh, 2013).

4.4 Impact of Biochip

Biochips are expected to have the greatest long-term impact in the molecular diagnostics market.

Here, the major challenges go well beyond the usual technological challenges of acceptable clinical detection limits, levels of sensitivity and specificity, dynamic range, repeatability and reproducibility, response time and immunity from false positives and false negatives. While important, these analytical parameters must be matched to the specifics of the assay that is targeted and to the decision context of the acquired data.

5.0 Conclusion

Biochips promises to bring genomics, the study of all the genes in existing organisms, 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. The biochip space lies at the intersection between high technology chip manufacturing, signal processing, software skills and more traditional molecular biology and genomics. The market for biosensors and biochips is interdisciplinary and growing and has applications in a number of core research areas. This paper presents a valuable context addition for those in both academia and industry. As this fast maturing field already boasts sales of products, biochips are likely to have a significant business future. We can expect that advances in micro-fluidic biochip technology will enable the miniaturization of devices that will allow highly sensitive analysis of complex biological interactions in real time that to with a low cost perception.

Recommendation

Biochips are fast, accurate, miniaturized, and can be expected to become economically advantageous attributes that make them analogous to a computer chip. One expects to see an accelerated trend of ultra-miniaturization since the potential applications are vast, both for research and for clinical use, the potential markets for biochips will be huge (Ghosh, 2013).

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