Physical, Chemical Science and Engineering

Manuscript info:
Received February 17, 2018., Accepted March 15, 2018., Published April 20, 2019.

THE ROLE OF BIOCHIPS IN MEDICAL INSTRUMENTATION: TERMINOLOGY AND COMPONENTS

Eng. Fadi T. Alasasfeh
Royal Medical Services, Amman - Jordan

http://dx.doi.org/10.26739/2573-5616-2019-2-17

Abstract: A biochip is defined as a combination of microarrays coordinated on a robust substance or layer which allows a lot of tests to be utilized simultaneouslyin order to obtain more throughput as well as speed.A biochip can execute thousands of biological processes in avery short time.Different kinds of biochips become one of the mostsignificant technologies in several biomedical areas[1, 2].

Keywords: Biochip, Transponder, Microchip,Microarray and Reader.

Recommended citation: Eng. Fadi T. Alasasfeh. THE ROLE OF BIOCHIPS IN MEDICAL INSTRUMENTATION: TERMINOLOGY AND COMPONENTS. 3-4. American Journal of Research P. 188-191 (2019).

1. Components of Biochips

The evolution of this technology began with preliminary labor on the implied sensor technology. In 1922, Hughes innovated the glass pH sensor. After a while, the k+ electrode was invented by integrating valinomycin into a tender film.Two well-known scientists in this field, Watson and Crick, produced the famous double spiral framework of DNA molecules and this invention was the ignition spark for genetic research which keeps going to improve until these days[3].

In fact, the biochip system is considered a radio frequency identification system. This system performs low-frequency waves to connect the biochip to the reader. This low amount of frequency waves ensures the safety of its usage.The distance between the biochip and the reader ranges between 5 and 30 centimeters.The biochi p implants appliance involves two important contents which are:

a) The transponder.

b) The reader or the scanner[4].

The first component (i.e. the transponder) is the de facto biochip implant. The transponder is categorized into two forms. The passive transponder which is characterized by not having a battery. This kind of transponders is capable of working for at least 99 years. It also does not require any maintenance.It works only when it receives a small-power electrical charge from the reader. Then, communication will happen between the reader and the biochi p. The second form of transponders is the active transponder. Here, the transponder employs its own energy source which is often a small battery.The transponder is made of four components which are computer microchip, antennacoil, capacitor and the glass capsule. Figure (1) below illustrates the components of the biochip, the size of biochip and the perspective of the actual size. The size of the biochip is about 11.5 millimeters from end to end. This small size is the same as the size of an uncooked grain of rice. The size is suitable for biomedical applications and to ensure safety to the human body[5].

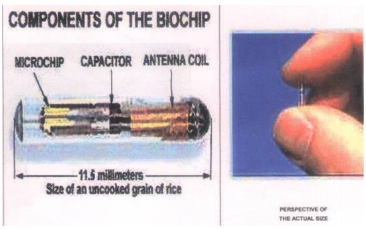

Figure (1): Components of the Biochip

Having considered the components of abiochip in general, it is also reasonable to look at these components delicately. The first component which is the microchip can store a singular identification number with a length of 10 to 15 digits. The American Veterinary Identification Devices which is abbreviated as AVID asserts that its microchips have the ability of more than 70k million unique numbers[6]. The identification number is being engraved using a laser at the exterior surface of the microchip.Then, it will be very difficult to change. This component involves also the circuits needed to forward the identification figure to the reader.The second component is the antenna coil. It is usually a plain, coil of copper filament round an iron rod. The teeny antenna can receive and send waves from the reader.

The third component is the tuning capacitor. As its name implies, this component can store <0.001 watts which sent from the reader that fires the transponder. The process enables the transponder to return the identification number etched in the microchi p. The tuning capacitor uses the same frequency as the scanner.All the three components are housed inside a glass capsule. Indeed, it is a very small house in size. It is manufactured mainly from biocompatible materials. After composition, the glass capsule is hermetically closed. Then, the electronic components become very safe inside the human body. To ensure that the biochip is in a persistent position inside the body, a polypropylene polymer envelope is connected to an end of the glass capsule.The biochip is injected to the body using a hypodermic syringe. The injection process does not require any anesthesia and is an easy, unharmed and plain process[7].

It is important however to overemphasis the importance of the reader. It is composed of a coil that produces an electromagnetic field which using radio waves that can supply the needed power to fire the biochi p. Furthermore, it holds a receiving coil which draws the transferred code. The activation and receiving processes happen in a very short time which may reach milliseconds. This component has the software and electronic chips needed to decode the received code and show the outcome in a display. Moreover, it can be connected to a computer.

2. Microarray Technologies

This technology is not restricted to DNA analyses which was the first form of microarrays. There are different types of these microarrays such as protein ones, antibodies ones and chemical ones. These types of microarrays can be used to produce biochi ps. In protein microarrays, the biochip supersedes the ELISA layer as the reaction platform.This system analyzes the relevant tests at the same time on the same sample and then creates a patient profile. Consequently, this profile can be utilized to implement a full image of the patient and his/ her diagnoses and prognosis[8].

Moreover, executing many tests at the same time permits to reduce the time required to diagnose and treat the patient as well as reducing the number of tests needed. In fact, Biochip Microarrays Technology is considered a significant methodology inherited from a well-known system. This technology utilizes antibody-capture immunoassays.These novel immunoassays are characterized in its framework where the capture ligands are denoting chemical bonds formed by the sharing of electrons between atoms connected to the top layer of the biochip in aconsistent array.Biochi p Array Technology which implemented in sandwich platforms uses an enzyme-labeled antibody. The antibody-antigen binding executes a chemical reaction that generates light. A high-resolution camera is used to detect the light[9].

Another form of microarrays is tissue microarrays. These microarrays are composed of paraffin blocks where about one thousand distinct tissue cores are gathered in an array platform in order to permit multiplex histological analyses. When this technique is applied, a special hollow needle is utilized to extract tissue nuclei which are only 0.6 millimeters in diameter. The extraction is performed in tissues embedded with paraffin like clinical biopsies or tumor samples.

The tissue microarrays have been used widely to analyze and estimate cancer biomarkers in addition to immunohistochemistry technology. This association between the two forms of microarrays succeeded in defining cancer biomarkers in different defined cohorts.

3. Conclusion

The biochi p technology has achieved successive successes in many medical fields and the biomedical engineers have been updating this technology and taking advantages of the digital revolution to develop and improve this technology. These systems are safe for patients and do not take long to analyze the information taken from the patient and do not need to be maintained periodically.

References

1. Xiong, Q., et al., Magnetic nanochain integrated microfluidic biochips. Nature communications, 2018. 9(1): p. 1743.
2. Ali, S.S., et al., Supply-chain security of digital microfluidic biochips. Computer, 2016. 49(8): p. 36-43.
3. Pardatscher, G., et al., Gene Expression on DNA Biochips Patterned with Strand? Displacement Lithography. Angewandte Chemie International Edition, 2018. 57(17): p. 4783-4786.
4. Li, Z., et al. High-level synthesis for micro-electrode-dot-array digital microfluidic biochips.in 2016 53nd ACM/EDAC/IEEE Design Automation Conference (DAC).2016. IEEE.
5. Lin, P.C., D. Weinrich, and H. Waldmann, Protein biochi ps: oriented surface immobilization of proteins. Macromolecular Chemistry and Physics, 2010. 211(2): p. 136-144.
6.Chakrabarty, K., Design automation and test solutions for digital microfluidic biochips. IEEE Transactions on Circuits and Systems I: Regular Papers, 2010. 57(1): p. 4-17.
7. Grissom, D. and P. Brisk. Path scheduling on digital microfluidic biochips. in DAC Design Automation Conference 2012. 2012. IEEE.
8. Schena, M., Microarray analysis. 2003: Wiley-Liss New York.
9.Kricka, L.J., Microchips, microarrays, biochips and nanochips: personal laboratories for the 21st century. Clinica Chimica Acta, 2001. 307(1-2): p. 219-223.