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Three Dimensional Bio-printing

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Abstract

Three-dimensional (3D) Bio printing plays an important to generate new cells of various organelles of human body. Modern medical sciences are now using this technique to develop damage part of human organelles. This technique is now becoming more popular using selective healthy cells of damage part of particular organelles and such cells are \implanted to particular part of damage part of those organelles. In this technique selective cell and selective medium is required. The generation and transplantation of several tissues, including multilayered skin, bone, vascular grafts, tracheal splints, heart tissue and cartilaginous structures have been studied by 3D Bio Printing. Drug discovery and toxicological study are taking 3D Bio-Printing as new asset to develop new methods for treatment of damage part.

Keywords: Bio-printing, 3D-printing, Modern medical science.

1. Introduction

3D-Bioprinting is one of the greatest discoveries of 20th century in the field of biological science by Thomas Boland and his co-researchers, University of Clemson, South Carolina in 2003. T. Boland used 3D printing technique for producing The 3D Bio-Printing Technique is very useful to generate tissues of damage part of organ against the cell matrices a cellular construction, in this process they utilized a modified spotting system for deposition of cells into organized 3D matrices placed on a substrate..

The primary purpose of 3D printing is to produce new organs for transplantation, using biological printing technique successfully developed organs are liver cells, blood plasma, bladders as well as urinary tables etc. Researchers have been currently carried out to print different complex and important organ such as heart, heart valve, kidney, liver; blood etc. 3D-Biological printer helps layer construction of a particular organ structure to develop a cell scaffold. This process can be followed by the process of seedling, in which inserted cells are pipette directly on the scaffold structure.

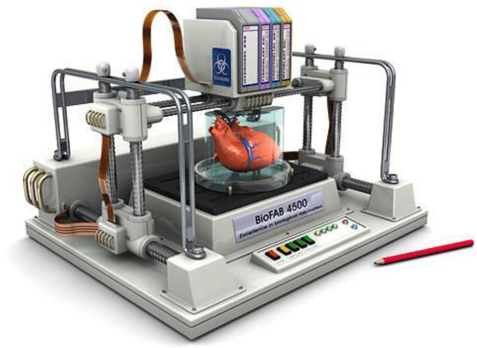

Figure 1: Concept model of Bioprinter

A further research team with the long-term goal of producing human organs-on-demand has created the Envisiontec Bioplotter like Organovo's Novo Gen MMX, this outputs bio-ink 'tissue spheroids' and supportive scaffold materials including fibrin and collagen hydrogels. Further,the Envisonch can be more useful to print and develop large number of biomaterial.

These include biodegradable polymers and ceramics that may be used to support and help in the formation of artificial organs, and which may even be used as bioprinting substitutes for bone. Jeremy Mao’s team at the Tissue Engineering and Regenerative Medicine Lab at Columbia University is working much heard on the application of bioprinting in dental and bone repairs. Already, a bioprinted, mesh-like 3D scaffold in the structure of an incisor has been placed into rat’s jaw bone. This

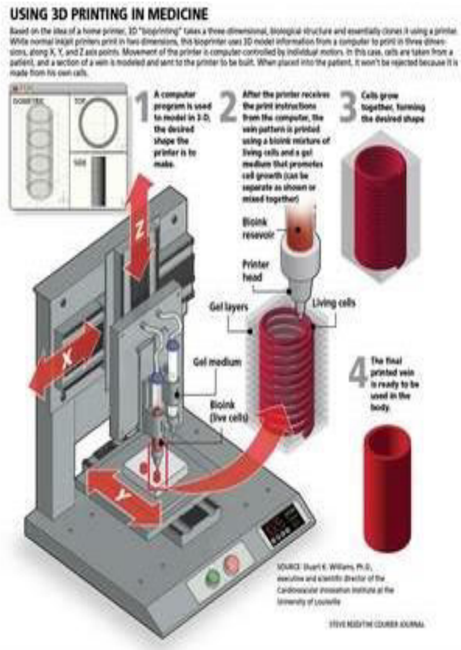

Figure 2: Concept of Bioprinting

featured tiny, interconnecting microchannels that contained 'stemcell-recruiting substances'. After implantation of nine weeks three is fast growth of peridopntal ligament and fresh alveolar bone are seen. This research helps to place boiprinteed teeth in living thing things. In another experiment, Mao's team implanted bioprinted scaffolds in the place of the hip bones of several rabbits. Again these were infused with growth factors, as reported in the Lancet, over a four month period; the rabbits all grew new and fully-functional joints around the mesh. Some even began to walk and otherwise place weight on their new joints only a few weeks after surgery. In near future, human patients may therefore be fitted with bio printed scaffolds that will trigger the grown of replacement hip and other bones. In a similar development, teams from Washington State University have also recently reported on four years of work using 3D printers to create a bone-like material that may in the future be used to repair injuries to human bones.

2. Material used in Biological printer

The term "bio-ink" has been used as broad classification materials that are compatible with 3D bioprinting in bioprinting process generally alginate or fibrin polymer are used, because that have been integrated with cellular adhesion molecules, which support the physical attachment of cells, such polymers specifically attach cells, and are specifically designed to maintained structural ability and are receptive to cellular integration. 'Hydrogel alginates' have immerged as one of the most commonly used material in organ printing research, as these are highly customizable and can be fine tunable in stimulating certain mechanical and biological properties, characteristic of natural tissue. The ability to hydrogels to be tailored to specific needs allows them to be used as adaptable scaffold materials that are suitable for a variety of tissue or organ structure and physiological construction.

3. Different technique in bio-printing

In bioprinting according to nature and type of tissue two different types of technique used

i) Drop based bioprinting

ii) Extraction bioprinting

3.1 Drop based bioprinting

Drop based bioprinting creates cellular constructs using individual droplets of a designated material, which often combine with cell line. Upon contact they form a large substrate surface, each droplets begins to polymerize, forming a large structure as individual droplets coalesce. Polymerization is instigated by the presence of calcium ion on the substrate, which diffuses into the liquid fid bio-ink and allows the formation of solid gel. Drop based bioprinting process is commonly used due to its efficient speed through this aspect makes it less suitable for complicated organ structure.

3.2 Extraction bioprinting

This process involves the constant deposition of a particular printing material and cell line from an extruder, a type of mobile print head. This tends to be more controlled and gentle process for material or cell deposition and allows for greater cell densities to be used in the 3D tissue or organ structures. After all good things of this technique there is drawback is slow printing. Extraction bioprinting is often coupled with UV light which photo-polymerizes the printed material to form a more suitable integrated construct.

3.3 Bioprinting stages

As Organovo have demonstrated, using their bioink printing process it is not necessary to print all of the details of an organ with a bioprinter, as once the relevant cells are placed in roughly the right place nature completes the job. This point is powerfully illustrated by the fact that the cells contained in a bioink spheroid are capable of rearranging themselves after printing. For example, experimental blood vessels have been bioprinted using bioink spheroids comprised of an aggregate mix of endothelial, smooth muscle and fibroblast cells. Once placed in position by the bioprint head, and with no technological intervention, the endothelial cells migrate to the inside of the bioprinted blood vessel, the smooth muscle cells move to the middle, and the fibroblasts migrate to the outside.

In more complex bioprinted materials, intricate capillaries and other internal structures also naturally form after printing has taken place. The process may sound almost magical. However, as Professor Forgacs explains, it is no different to the cells in an embryo knowing how to configure into complicated organs. Nature has been evolving this amazing capability for millions of years. Once in the right places, appropriate cell types somehow just know what to do. In December 2010, Organovo develop the first blood vessels to be bioprinted using cells cultured from a single person. The organization effectively implanted bioprinted nerve grafts into rats, and anticipates human trials of bioprinted tissues by 2015. However, it also expects that the first commercial application of its bioprinters will be to produce simple human tissue structures for toxicology tests. These are medical researchs which will be more applicable to test drugs on bioprinted models of the liver and other organs of body,which will reduce the need for animal tests. In time, and once human trials are complete,. To this end, researchers are now working on tiny mechanical devices that can artificially exercise and hence strengthen bioprinted muscle tissue before it is implanted into a patient. Organo hopes thatbioprinters which are used by him, will be more applicable in production of blood vessel grafts in bypass surgery of heart. The main theme is that to develop variety of tissue-on-demand and organs-on-demand technologies. At present scientists are now working on small technical devices which can work artificially and hence which acts as first human organ i.e., kidney considering in functional term of kidney which is most important part as human body and works as filter. The first bioprinted kidney may in fact not even need to look just like its natural counterpart or duplicate in all of its features. Rather, it will simply have to be capable of cleaning waste products from the blood.

In SITU BIOPRINTING The above mentioned research progress will in time permit organs to be bioprinted in a lab from a culture of a patient's own cells. Such developments could therefore spark a medical revolution. Many scientists are doing further great research for the development of 3D bio printing technique by the way to place directly cells in vivo or invitro of human body organelles. Sometime in next decade, doctors may therefore be able to scan wounds and spray on layers of cells to very rapidly heal them.

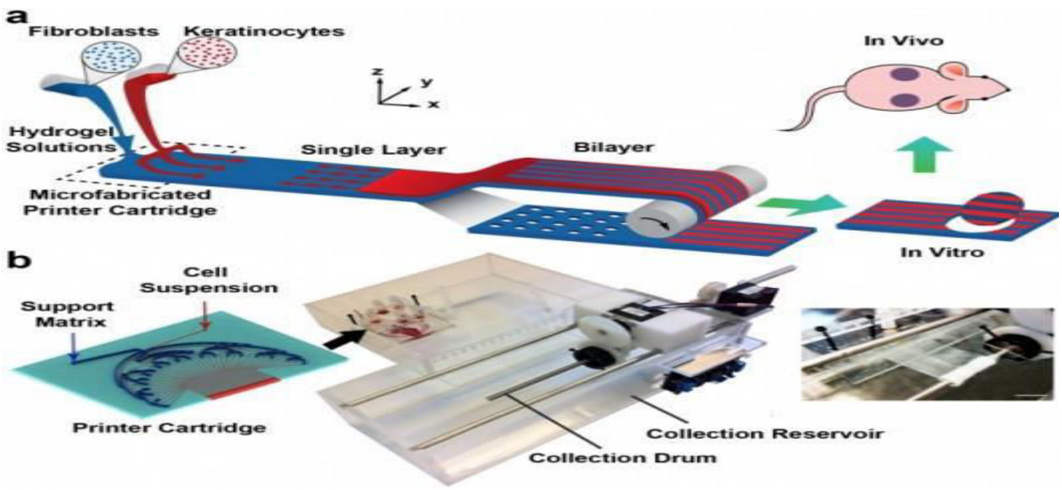

Figure 3: Mechanism of Bioprinting

4. **Some important spectrum of bioptinting material**

i) The resulting scaffolds formed in the 3D – bioprinting material should be physically and chemically appropriate for cell proliferation.

ii) The scaffolds must be biodegradable because artificial formed structure can be broken down up to successful transplantation to be replaced by a completely natural cellular structure.

iii) The material used must be customizable and adaptable being suitable to wide array of cell type and structural conformation.

5. Advantages of bioprinting

There are great advantages of bioprinting in the different field of biological science such as oncology, cardiology, herpetology, stem cell and development of different complex organ structure. This technique have allowed two or more cell types to be placed in discrete location relative to each other, thereby achieving compositional complexity in monolayer cultures or in culture that are 2-3 cell layer thick. Seeding cells onto porous scaffolding or within hydrogels have created thicker tissue.

It is unfortunate truth that on an average 20% people in world die every day due to the lack of organ donations (according to WHO).There are currently thousands of people waiting for a organ transplantation and there are simply not enough donors to meet the demand. Through bioprinting process we make artificial organ and fulfill those demand easily, which saved thousands of people. With the help of the current technique we can print liver within 10 days. But on improving this technology it is estimated that scientists could print a liver within a hour. That is the greatest news for the thousands of people who waiting for an organ transplant to save their life. The drug are developing for certain disease, it tests on animal which is very costly. With the help of the Combine efforts of nanotechnology and genetic engineering, 3D printing has now become a powerful instrumentation for increase of life span. From bioprinting, we can print a artificial organ and test the drug on the particular organ at very low cost.

References

1. https://en.wikipedia.org/wiki/3D_bioprinting.
2. Sean V Murphy & Anthony Atala, 2014, 3D bioprinting of tissues and organs Nature Biotechnology 32, 773–785.
3. Doyle, Ken, 2014, "Bioprinting: From patches to parts". *Gen. Eng. Biotechnol. News*. **34** *(10): 1, 34–5*
4. Thomas, D., 2014, "Engineering Ourselves – The Future Potential Power of 3D-Bioprinting?". *Engineering.com.*