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"Bio-Printing as a Boon to Humanity"

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Abstract: There is a rapid boost in the use of 3D-printer (Three Dimensional printer) in various fields like model designing, rapid manufacturing, building parts of different equipment, etc. Similarly, in the field of medical science, we are using it in anatomical models, making the biological model, etc. But in recent years we've been listening more about the 3D-Bioprinter. It is like a 3D-printer technique that is used to make tissue, organs, skin, etc. by using the cells, growth hormones, biomaterials, etc. in a suitable environmental condition to fabricate it as natural tissue characteristics. The whole process is divided into three steps. First is designing the structure of the tissue layer by layer. Second is the bioprinting of the designed layer. The third is the crosslinking of a different layer of the printed layer. In the 3D-Bioprinter we are going to use the Bio-ink which will be made of tissue's unit cells, water gel, water, hormones, etc. It has a huge scope in medical treatment as well as in the research field. But this technology is not fully functional because of some major problem faced by scientists is a mimicry of tissue and organs with natural. So that we are going to see the uses of Bioprinter, its scope in medical treatment, medical drugs pharmacy and what is the major problem faced by scientists in making this technology fully functional. We also see what are the field in which we need research work.

Keywords: 3-D Bioprinter; working; scope; challenges; uses

I. INTRODUCTION

3D-BioPrinter is a new area of medical research aimed to solve one of the biggest urgent problems in medical science – a lack of organs/tissues for transplantation. Getting the best matching body organs is more difficult. At present we need to give a regular dose of anti-suppressant of immunity, especially of T-cells to patients. Because of these anti-suppressant patient's T-cells is not work properly and got attacked by several diseases very easily and also rapidly. Many organ transplantations fail because T-cells attacked new organs (foreign parts). The main solution to this problem is to make the organs with their tissue of the same DNA and antigen by the help of 3D-bioprinter. Not only organs we can also replace damaged or infected tissue to new ones. The application of the 3D-bioprinter is many more in treatment as well as research. But we that many challenges also. The first challenge is 3D-Bioprinter itself. There are three methods of doing 3D-Bioprinting. First, by the help scaffolds technique, in which we made one mold of the organ in which we put the cells with growth hormones and nutrients (energy) in a suitable condition. Layer by layer we put these things in the mold so that it becomes a functional organ. The second method is making of organs from the tissue of a patient only so that the organ will have the same DNA and body will easily identify organ and they will not be attacked on the organs. The third is artificially designing of the organ with the best matching DNA of the patient. In this method, we need to design everything thing. It may take more time than the time doctors have to save the patient. All these methods are challenging within itself. The 3D-bioprinter is work on three-step that is pre bioprinting, bioprinting and post bioprinting. All the steps are mentioned in detailed. We have also discussed its future scope in medical science.

II. 3D-BIOPRINTER

2.1 3D-BioPrinter in general

Bioprinting is an additive manufacturing process where biomaterials such as cells and growth factors are combined to create tissue-like structures that imitate natural tissues. These tissues again used as a bioink to make the organ which we can replace the patient defective organ. This technology uses a material known as bioink to create these structures in a layer-by-layer manner. The technique is widely applicable to the fields of medicine and bioengineering. Recently, technology has even made advancements in the production of cartilage tissue for use in reconstruction and regeneration. Not only tissues, Israeli scientists create 3D-bioprinted heart from humans cells of rabbit's heart size, yes the heart is not beating, but this shows that 3D-BioPrinter is no more technology of the future. In essence, bioprinting works similarly to conventional 3D

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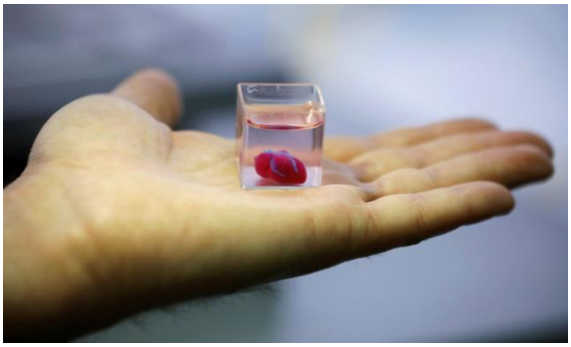
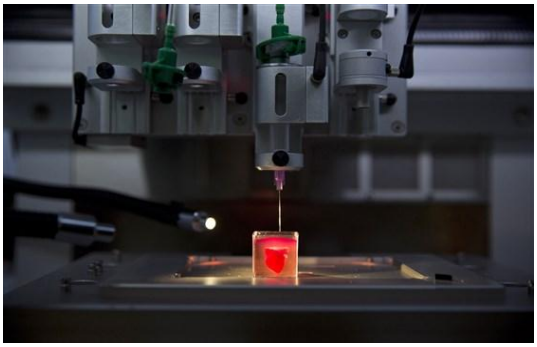
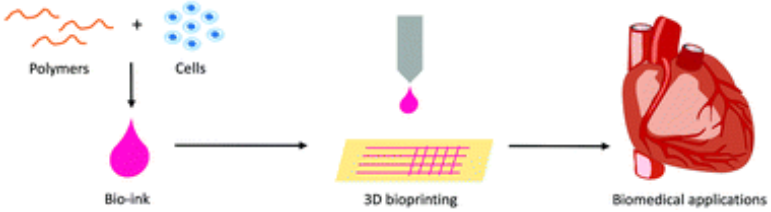
printing. A digital model becomes a physical 3D object layer-by-layer. In this instance, however, living cells/tissues suspension is utilized instead of a thermoplastic or a resin. For this reason, in order to optimize cell viability and achieve a printing resolution adequate for a correct cell-matrix structure, it's necessary to maintain sterile printing conditions. This ensures accuracy in complex tissues, requisite cell-to-cell distances, and correct output. To overcome this problem we are using the hydrogels. Researchers are working very aggressively on this topic to solve the problem faced in making 3D-Bioprinter fully functioned.





2.1 BioInk

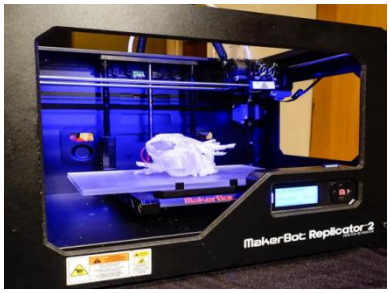
Bioink is a cartridge of a 3D-Bioprinter. It is made up of living cells/tissues, polymers, biomaterials and water. The materials used in the bioink is a mimic of natural tissue which supports the adhesion, proliferation, and differentiation of living cells. Polymers make a major role in the bioink. They fabricate the cell in the required manner to make tissue and also crosslinking the different layer of injected cells in the Bioprinter. The bioink is used in a suitable temperature to ensure the preservation of the living cells. The growth of hormones and nutrients (energy) is also added in the bioinks so that the cells can easily survive and also get cross-linked in the best manner. Common polymers used in the bioink are alginates, gelatin, decellularized extracellular matrix and pluronic. All of them makes the water more viscous so that cell cross-linked with each other more easily. The bioink is inserted in the piston of a very narrowed opening nozzle by which it was injected on the platform.



III. WORKING OF 3D-BIOPRINTER

There are many hypotheses/ techniques about how 3D-bioprinting will work by using different types of technique. But all of them follow the Three given processes.

1. Pre-bioprinting, we need to create a digital file of the organ design layer by layer so that the printer can read this data and inject the bioink to make that specific organ.



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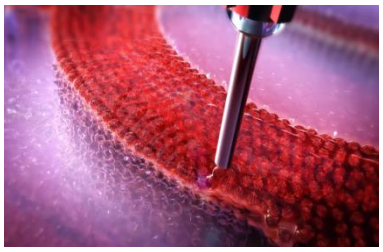
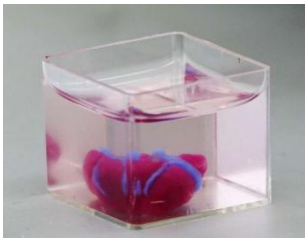
Today, these files are often based on CT and MRI scans of the patient organ so that it matched with the old one. But sometimes we cannot use the patient CT and MRI scans because of the infected deformed shape of the organ. In that case, we can use similar age group people data to design the organ for the patient. Then we prepare the cells/tissues and mix them with bioink.

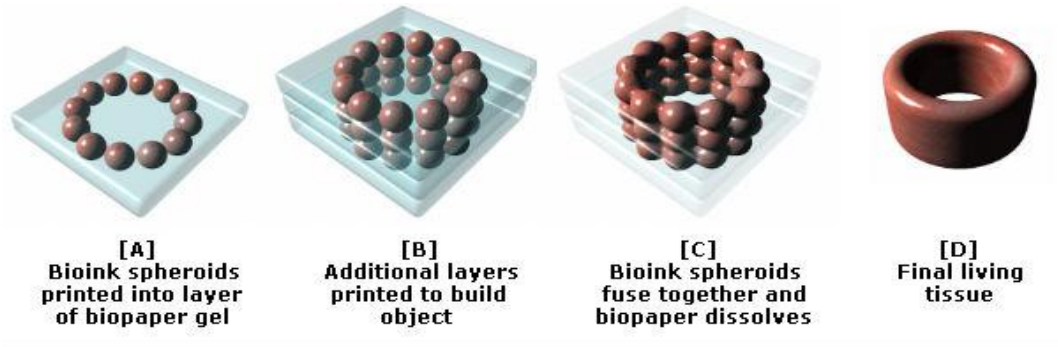
2.Bioprinting: The main process of the bioprinting that is the printing of layer that design in the 1st step. Load the cell/tissue-laden bioink into a cartridge and choose one or multiple printheads, depending on the structure to build into the scaffold. If we use the cells only in the bioink then different types of cells require different types of tissue. Also, different types of tissue required different energy levels for the development and crosslinking of cell layers.



3. Post-bioprinting: Most structures are crosslinked to become fully stable. Some Crosslinking is usually done by treating the construct with either ionic solution or UV light – the construct's composition helps determine what kind of crosslinking to use. Also, we need to check that all layer is healthy or not and fit for transplant in the body.



If perform all of these methods then the final product will be our organ part which is ready to transplant in the body. Not only the organ. We can also make different types of tissue that can be used at different types of medical treatment.



IV. SCOPE

3D-Bioprinter having a huge scope in medical science. Its application is rapid increases in medicine and tissue engineering. Using 3D bioprinter researchers are able to construct several tissues like bone, cartilage, skin, muscle and neural, etc. Today we have the technology to design the complex nerve system, veins system, etc bigger, very precisely by CAD and different software. The 3D bioprinted organs help us to gain knowledge of working of it. Wallace et al developed the 3D structure of the brain that was printed by 3D bioprinter. But we need more resolution to design a more complex network system of nerves and veins, cells layers, etc. then we can make the fully functional tissue/organs also which can be used in the

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transplantation. In recent years many companies have launched the bioprinter and also sold to both academic as well as a commercial institution. The 3D bioprinter is a new era in medical science as well as in cosmetic surgery also. There is a 3D printer is available which can print the skin of the consumer choice colors. Regenerative medicine has the potential to become a major application of 3D-bioprinter in the future. The 3D-bioprinter also plays the major in the discovery of new drugs. Currently, we need to so many tests on hybrid animals(rats) having similar genetics to find the reaction of drugs on humans organ, now we can create organs by the 3D-bioprinter and do test directly on the human organs. Thus the 3D-bioprinter have huge scope not only in medical science also in the cosmetic market and research field.

V. CHALLENGES

3D-bioprinter is looking very futuristic science fantasy which is going to be true in a practical world. The scientist has been solved many problems. But there are many challenges we need to solve to use it in our practical world. One of the main challenges is the mimicry of natural tissue and organ. The recent organ made by Isreali scientist is too small in size and not beating, this organ has all the veins and arteries in the heart but it doesn't work. Because of not proper mimicry of the organ, it is not working. Mimicry of the organ is an easy job in comparison to making the organ compatible with the patient's organ. Today mostly transplant gets either failed or the patient becomes weaker and gets ill (unhealthy) rapidly due to the anti-suppressant medicine given to the patient. To solve this problem, there is a solution to make the organs with the patient's tissue only so that the immunity T-cell can recognize it. It will also take care of the heart and make it healthy. But the main problem in this solution is the lack of patient tissue availability. The most suitable solution for all the problems is to make the full tissue designed with the patient DNA only. But this is a very complex job to design the organ with patient DNA. But it is not an impossible task, it will take too much time for making the organ. By the 3D-bioprinter we can also make the body parts like the ear, finger, hand, foot, etc. But the main challenge in this is making the nervous system in the body parts and then join it to the body's nervous system. But the nervous system is a challenge within itself. The bioprinter technology also needs to increase the resolution and speed of bioprinter. Higher resolution will help to design the most complex system of veins and nerves. The process of the bioprinter is very slow so the speeding of the bioprinter will meet the requirement of organs. The bioprinter is a boon to humanity, it should be commercially acceptable to reach of every class of society. One of the major limitations of the bioprinter is the biomaterials, most of the bioprinted parts are made up of either human being tissue or easily able in the environment. There is very limited synthetic tissue is available. We need a lot of research work in all these challenges. There may be more challenges in this technology which we can suffer after some research. Challenges never end it comes in different forms, that's why we need non stop research work in every field.

VI. USES

3D-BioPrinter has a wide area application in medical science. Some scientists give the hypothesis making a clone of the human being by using the 3D-BioPrinter. Yes, it is more futuristic but possible if the 3D-BioPrinter has become fully functional in the practical world. Currently, the main focus of the researcher is to make the organ as there is a lot of demand for organs for transplant. These printers can also use in the disease in which patient tissue gets damaged/infected which may cause cancer, then we can replace that with new tissues. A benign tumor can also be cured very easily with the help of 3D-Bioprinter. In the benign tumor, the surgeon removes the infected tissue and replace it with new tissue made. With the help of 3D-printer, we can also change the damaged ugly marked skin with new skin made by the printer. This useful for the victim of the acid attack, burn mark and patient of skin disease. The people met with the road accident many tissues get damaged in massive amounts and also cause internal damage. Most of the time doctors suggest cut out that part from the body. But with the help of 3D-BioPrinter, we can do treatment of damaged part by changing it with a new one. There are endless applications in veterinary medical science also. 3D-BioPrinter can also be used in the treatment of animals.. 3D-Bioprinter is also used in the discovery of new drugs which can save many lives. Currently, scientists are testing the drugs on the hybrid mouse in which genetics is similar to the human being but not açcurately matched. With the help of 3D-bioprinter, we can make organs and do the test of drugs on the organ, scientists will get better results than doing testing on the hybrid mouse. We got the new best medicine(drugs) for treatment.

VII. CONCLUSION

3D-BioPrinter is a very unique gift to humanity by science and technology. It started doing its work but not at full scale, many challenges that are to be solved. There are different technology on which 3D-bioprinter can work which can be used for different types of work in medical science. While the process of working of 3D bioprinting is the same in all methods that are Pre-bioprinting, bioprinting and post-bioprinting. Different types of printer can be used which is not mentioned but

all of them have the same objective that is printing layer by layer of the designed structure. The main challenges that scientists face in the concept of working of 3D-bioprinter are a complex structure of organs and tissue, lack of biomaterial, the time factor, not the proper way of giving nutrients (energy) and waste produced by the body. There are ethics challenges also that this technology will be available for all or it will be the use of rich people only. Instead of these challenges, it has ver huge scope in medical science as well as in the commercial market also. 3D-bioprinter can be used commercially in the cosmetics industry. In medical science the chances of discovery of new life-saving medicine. The regenerative medicine/parts have the potential to become the major application of 3D-bioprinter.

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