3D Printing Human Organs

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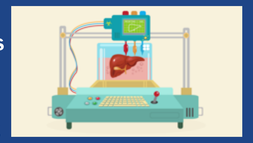
Introduction

A major problem today is the lack of transplant organs available for the patients needing them. With an increasing population and life expectancy, the number of people in need of organs is drastically increasing; however, the number of organs being donated is not. Many common medical problems in today's world contribute to organ failures, and though many people are willing to donate their organs, there is still a great lack of availability.



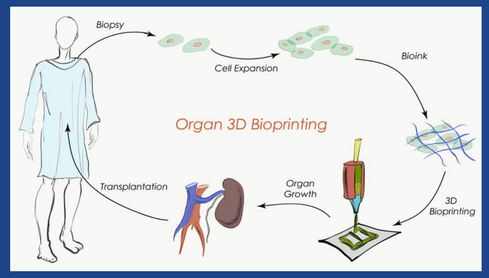
In order to combat this, bioengineers have created a way to 3D print organs. While there are many different ways to 3D print, the most common way to print organs is thermal inkjet printing. Engineers use digital software to create a computer model and print a decomposable full structure. They then use a liquid ink containing patients' own cells to attach to the scaffolding. From here the cells are encouraged to grow around the structure and proteins within the cells break down the original mold leaving behind an organ. This organ, when transplanted into a live patient, has the ability to function just as a donated organ would, with less chance to be rejected by the patient's own body.

Sustainability

Sustainability can be defined as a "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

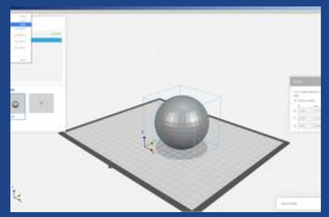
- Economic effects: there are both positive and negative effects include the increase of price of insurance for people and the increase in the number of jobs related to creating them.
- Social acceptance: negatives could include people thinking this technology perhaps seems unnatural
- Quality of life: the more common these organs become, the better people who need transplants lives' become because they don't have to worry about organs not being available and they don't have to worry about rejecting the organs they receive.

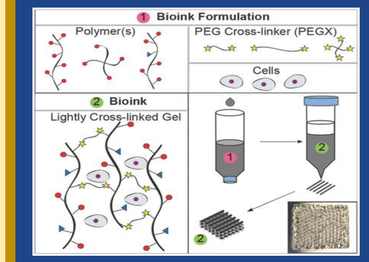
Thermal Inkjet 3D Printing



This picture organizes the overall process of 3D printing organs. It starts with a sick human who is in need of a new organ. Doctors then take some of the persons cells in order to form an ink that will then be used in the process to grow a new organ made specifically for them. This organ is then transplanted into the patient.

One of the first steps in the process is to use a computer-aided design(CAD) program to help create an online foundation for the object. The online program allows the researcher to focus on getting the correct size and shape of the organ for the specific patient before it is printed. This 3D model is then printed layer by layer using decomposable biomaterial to create a physical scaffolding of the organ.





At the same time the computer model and scaffolding is being made, the patients cells are being taken and used to create a liquid ink that will then be injected into the model organ. This ink consists of cells and other biomaterials such as collagen and must be made to gel quickly when used in the process.

As the name suggests, thermal inkjet printing involves a heating element to release the ink into the scaffold. In this process the print head is heated which creates air bubbles that when under pressure collapse and eject the ink drops from the nozzles.

Once the bioink is deposited, the cells are encouraged the grow and multiply, surrounding and breaking down the biodegradable scaffold, due to the proteins in the cells. What is left is the 3D printed replacement organ, complete with live cells. Once this process is complete the new organ looks the same and should function the same as a normal organ.

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Ethics

Researchers and developers of this technology must be careful to follow ethical guidelines to ensure the safety of the patients involved. Not only this, but the ethical dilemmas surrounding this research continue with how beneficial it is and the potential positive and negative impacts on the community.

Positive:

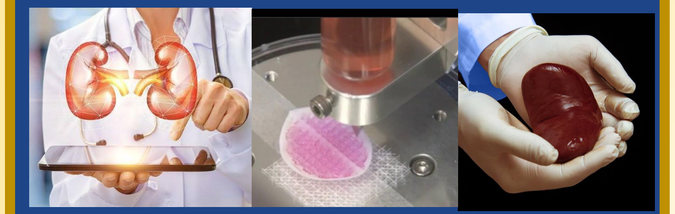
- Testing could be done on the 3D printed organ without affecting any animals or patients
- 3D printed organs can potentially model diseases outside of the patients' body for study.
- In the long run can reduced the number of operations and costs that go along with this.
- They have the ability to end the illegal trade of organs.

Negative:

- The process to make the organ could be expensive.
- This might not decrease the waiting time for patients to get organs.
- This brings up the question about ownership between the research and the patient.

A Specific Organ: Kidney

Due to its function the, the complexity of the structure of a kidney is much greater than other organs. This means that 3D printing kidneys presents more of a challenge to scientists and engineers. Kidneys are the most in demand organ for those in need of a transplant. Because of this, it is crucial that development on this is efficient and continuous, and especially up-to-date and current.



All of these advancements in kidney 3D printing are very exciting because of the potential to create high quantities for all of those who them. Out of the organs discussed, a 3D printed kidney could quite possibly be created the most and therefore, gaining as much knowledge as possible through research and testing is extremely crucial and beneficial.