3D Bioprinting of Functional Organs

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Introduction

- 3D bioprinting is a promising technology that has emerged during the past decades in the biomedical field.
- 3D bioprinting is a method of imitating biomaterials such as cells to construct tissues and organs mimicking.
- 3D bioprinting involves a layer-by-layer printing of biomaterials.
- 3D bioprinting technology will help with the shortage of organ transplantation.

3D Bioprinting Technologies

- Inkjet-based 3D Bioprinting: is designed to bioprint biomaterials and cells layer-by-layer.
- Extrusion-based 3D Bioprinting: is used to produce the bioink that contains the biomaterials and cells with the help of CAD.
- Laser-based 3D Bioprinting: cells are bioprinted by using a laser beam.
- The goal is to combine biomaterials with living cells to fabric and construct tissues and organs to accurately produce the combined biomaterials.

Considerations for 3D Bioprinting

- Choosing cells and biomaterials that can mimic the functionality of the human tissues and organs for 3D bioprinting is crucial in order to create organs for transplantation.
- Cells and Biomaterials: 3D bioprinting of functional tissues and organs may be achieved by using natural and synthetic biomaterials such as alginate and polyglycolide.
- Vascularization: 3D bioprinted tissues and organs required a vascular tree that is well-developed in order to achieve vascularization.

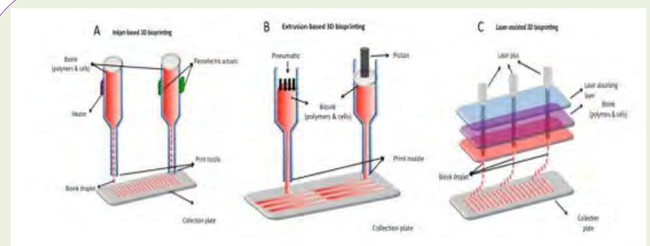

Figure 1: *3D bioprinting technologies. (A) Inkjet-based 3D bioprinting, (B) Extrusion-based 3D bioprinting, (C) Laser-based 3D bioprinting [1].*

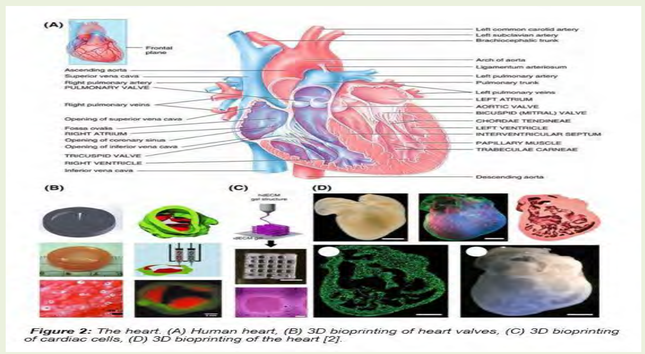

Figure 2: *The heart. (A) Human heart, (B) 3D bioprinting of heart valves, (C) 3D bioprinting of cardiac cells, (D) 3D bioprinting of the heart [2].*

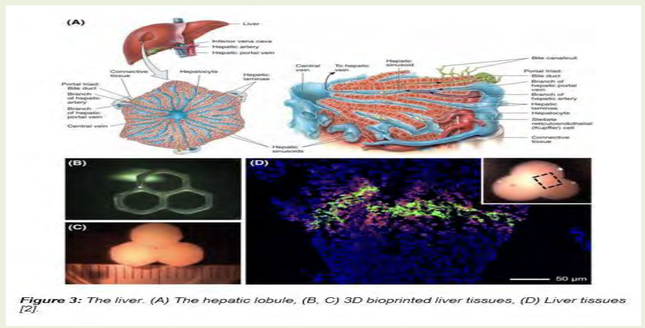

Figure 3: *The liver. (A) The hepatic lobule, (B, C) 3D bioprinted liver tissues, (D) Liver tissues [2].*

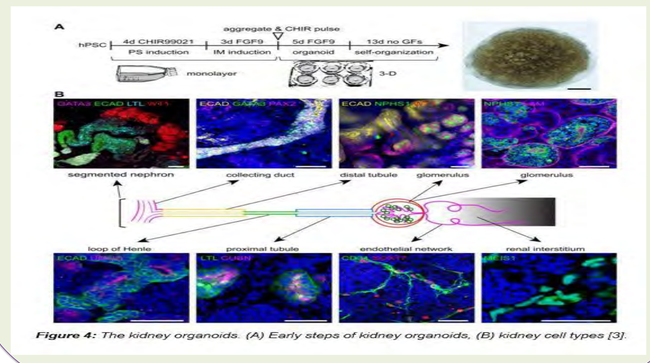

Figure 4: *The kidney organoids. (A) Early steps of kidney organoids, (B) kidney cell types [3].*

3D Bioprinting of Organs

- Heart: 3D bioprinting is a promising technique that can produce functional cardiac tissues.
- Liver: 3D bioprinting of liver cells such as hepatoma and hepatocytes is possible by using different hydrogels such as gelatin and alginate.
- Kidney: 3D bioprinting is a promising technology to 3D bioprint kidneys in order to solve the shortage of kidney transplantation.

Conclusions

- It is believed that 3D bioprinting will be able to create a variety of tissues and organs, and change the tissue engineering strategy.
- 3D bioprinting technology cannot create many organs that may be inserted into patients, but it is capable of assisting doctors and surgeons.
- Several challenges face 3D bioprinting such as selecting bioink or cells that can produce functions for the organs.

References

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[2] Y. S. Zhang, K. Yue, J. Aleman, K. Mollazadeh-Moghaddam, S. M. Bakht, J. Yang, et al., "3D bioprinting for tissue and organ fabrication," Annals of biomedical engineering, vol. 45, pp. 148-163, 2017.

[3] M. Takasato and M. H. Little, "A strategy for generating kidney organoids: recapitulating the development in human pluripotent stem cells," Developmental biology, vol. 420, pp. 210-220, 2016.