Theme 02: Framework for planning research

STUDENT EXAMPLE PROPOSAL: Annotations and Working Bibliography

TOPIC: A Critical Comparison of Bio-Inks used for Bioprinting

Annotated Bibliography

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| Skardal, A. and Atala, A. (2015). Biomaterials for Integration with 3-D Bioprinting. *Annals of Biomedical Engineering*, 43(3), 730-746. |
| Firstly, this article provides a series of backgrounds of bio-printing approaches and explores them such as laser-assisted bio-printers, encompassing use of inkjet-like printers, photocuring-based devices and extrusion devices. Then, various biomaterials such as naturally derived hydrogels, synthetic gels and curable synthetic polymers are evaluated. Specifically, it describes how they are integrated with the bio-printing technologies. They are soft lithography, extrusion-based technologies, cellular inkjet printing and laser-induced forward transfer to generate bio-printed constructs with practical application in medicine. Moreover, this article also discusses certain popular biomaterial and their applications. Biomaterials are a vital part existing on bioprinting. In some cases, biomaterials work as “glue” to connect the fabrication approaches and the biological cellular components. This article is relevant and written in 2014. In this article, there are a series of backgrounds, assessments and methodologies of a number of biomaterials. Furthermore, it discusses differences and relationship between biomaterials and bio-inks and current tendencies of biomaterials. Bio-inks I am going to explore are involved here and it is therefore sufficiently relevant to my report. I will be directed by the article to compare bio-inks such as hydrogels and microcarriers under some cases, which will be referred in my introduction and discussion. |

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| Hospodiuk, M. Dey, M. Sosnoski, D. and Ozbolat, I. (2017). The bioink: A comprehensive review on bioprintable materials, *Biotechnology Advances*, 35(2), 217–239. |
| Two major types of bio-inks are explored in this article. One is scaffold-based bio-ink such as hydrogels, decellularized matrix components and microcarriers, and another one is scaffold-free bio-ink which includes tissue spheroids, cell pellet and tissue strands. Then, they are mainly compared and evaluated based on bio-printability, biomimicry, resolution, affordability, scalability and practicality. Further, this article offers weaknesses of current bio-inks. It indicates that bio-inks should aim to reduce cell loss and enhance cell-cell interactions. In addition, there is rare research focusing on bio-inks even biomaterials and presents some fields that this technology needs to concentrate on in the future.Major types of bio-inks are introduced and explained in this article. Evaluation is also explained on a series of aspects. In my report, I am also going to compare separate bio-inks such as hydrogels and microcarriers. Therefore, it is almost entirely relevant to my report and is written in 2017. Moreover, there is a high reference value for me to compare and assess different bio-inks. Arranging this in my introduction and findings can be sensible and effective for reader to understand because it sufficiently introduces what is bio-ink and explores specific bio-inks. |

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| Donderwinkel, I. Hest, J. and Cameron, N. (2017). Bio-inks for 3D bioprinting: recent advances and future prospects, *Polym. Chem.* 8(31), 4451-4471. |
| This is a comprehensive review and prediction about bioprinting technology. The main techniques are mentioned in the article are extrusion-based, stereolithography, droplet-based, laser-induced forward transfer and integrated bioprinting. Then, bio-inks which are vital parts in bioprinting are concentrated on. The main kinds of bio-ink materials are microcarriers, decellularized matrix components, cell aggregates and hydrogels. It also analyses traits of these bio-inks and evaluates them separately. The article identifies future applications of these materials including tissue engineering, regenerative medicine, transplantation, drug-testing and cancer research. It also identifies current limitations in bioprinting which still need to be researched. The chief one is the resolution needs to be enhanced to fabricate structures with a complex inner architecture. This article is similar to the work of Hospodiuk, Dey, Sosnoski and Ozbolat (2017). They both discuss the methods of bioprinting and further analyse and evaluate bio-inks such as hydrogels. In addition, this article particularly concentrates on specific applications of different hydrogels, which will help me to compare bio-inks on specific applications and provides data that can be used to do my comparison. This paper is very recent, written in 2017, so it gives the most up-to-date and accurate research on this field. |

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| Stanton, M. Samitier, J. and Sanchez, S. (2015). Bioprinting of 3D hydrogels. *Lab on a Chip*, (15), 3111-3115. |
| An effective and feasible method has been put forward in this article is to utilize hydrogels as 3d scaffolds. This article introduces and explores hydrogels in two aspects of both bio-inks and hydrogel scaffolds, and then indicates that hydrogels have positive impacts on cell culture. It is said that this technology works through using biocompatible or cellular components to establish structures in an additive, layer-by-layer methodology for encapsulation and culture of cells. Moreover, due to the precise and feasible materials and approaches are supplied in this paper, the consequence from this article tends to be ample reliability.Bio-ink and hydrogel scaffolds supply artificial three-dimensional environments which are similar to internal tissue. Therefore, these can be alternative biomaterials. The article is written in 2015, which intends to introduce and explore a new biomaterial and offers some data and specific applications about hydrogels. In this article, it mainly focuses on hydrogels, helping me to compare hydrogels with other bio-inks such as microcarriers and is amply relevant and worthy to be a component in my findings and discussions.  |

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| Li, J. Chen, M. Fan, X. and Zhou, H. (2016). Recent advances in bioprinting techniques: approaches, applications and future prospects, *Journal of Translational Medicine*, 14(1), 271. |
| Certain advances in bioprinting techniques are mentioned in this article. Three main approaches of bioprinting are pressure-assisted bioprinting, inkjet-based and laser-assisted bioprinting. Also, it provides key points of bioprinting and evaluates specific applications and limitations of biomaterials including bio-inks, cell factors and cells on aspects of biocompatibility, porosity, interconnectivity and mechanical properties. This technology aims to fabricate 3D organs and tissues composed of a microenvironment and cells which imitate the real environment of human’s bodies. In addition, this article specifically focuses on advanced applications of bio-printed tissues and organs. Due to good resolution of the input cells, precisely printing organs has been greatly advanced. Likewise, it has strengths in precise control, individual design and repeatability, but some challenges still persist in building complex tissues.Comparing with other sources I have used, this one not only discusses and evaluates technologies of bioprinting and biomaterials, but also divides bio-inks into separate categories based on their biocompatibility, porosity and mechanical properties. It mentions perspectives that other sources have not mentioned and is written in 2016. Therefore, I am going to gather information to compare bio-inks from different perspectives mentioned here in my discussion. |

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