Investigating 3D Bioprinting and Bioinks for the Creation of Vascular Structures

Colin Marchus
Research Mentor: Dr. Nan Zhang
University College Dublin, Dublin, Ireland

Introduction

3D bioprinting is the additive manufacturing process in which a tissue construct is printed through the use of a bioink, the proper cell types, and a bioprinter. 3D bioprinting is a relatively new field of research that has only been around for a little over 15 years. Because of this much is unknown when it comes to the possibilities behind bioprinting. The main topic of this project is investigating the possibilities of printing functioning vascular structures. In order to do so understanding bioinks is key to understanding how to print the desired tissue construct. Bioinks play a major factor in determining how well the tissue structure that was printed will perform. Since, bioinks determine the properties that the resulting structure will have it also determines how well the cells will propagate and grow along with how mechanically stable the structure will be.
This study will be investigating what properties make a good bioink, the common types of bioinks, and the basic way they are created.

Methods

- The research on this subject was conducted through review numerous different articles.

Results

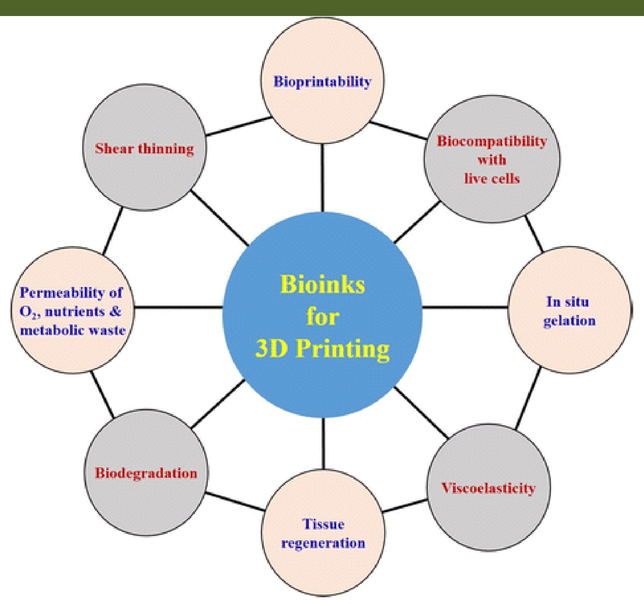

Figure 1[1]: A graphical representation of the properties that are important for a bioink to have.

Results

Along with the properties that are mentioned in Figure 1 there are several properties that are also important below:

- Biomimicking[1]
- High resolution[1]
- Avaliability[1]
- Low Toxicity[1]

Table 1: Pros and Cons of Biomaterials used as Bioinks

Type of Biomaterial	Pros	Cons
Alginate	Good biocompatibility[3], Low toxicity, Protects against processing pressure stress[2], Crosslinking is easily induced[3]	Relatively biologically inert[3], Limited cell attachment[3], Slow degradation[4], Poor cell proliferation[4]
Collagen	Favorable mechanical properties, High biocompatibility	Slow gelation[1], Low viscosity[2]
Polyethylene Glycol (PEG)	Tailorable[3], Strong mechanical properties[3], Relatively inexpensive	Water soluble[2]
Pluronic	Transitions between solid and gel through simply changing the temperature[5], Low toxicity[6], Can gel in physiological conditions at low concentrations[6]	Poor biocompatibility[3], Weak mechanical integrity[7]

The generalized steps in which bioinks can be made:

1. Dissolve, via stirring, the desired proportion of granular alginate powder into a solvent like water or phosphate-buffered saline (PBS).[8]
2. If the cells are to be apart of the bioink then warm the previous solution and mix the desired cells and solution.[9] If the cells are not being mixed in the skip to step 4.
3. Cool the new solution to room temperature.
4. The solution is a bioink and can be used in certain printers.

It is important to note that the method described above is specifically for alginate-hydrogel based bioinks.

Discussion

- In order for bioinks to be effective they have to meet certain parameters that are determined by the printing method and by the type of structure that is being created
- Out of all of the biomaterials that were investigated the most common one that was used was alginate, which has been used in several different experiments involving the printing of vascular constructs.
- Alginate may have the highest amount of disadvantages, but that is mostly due to the fact that is was the much more researched when compared to the other materials
- The process in which bioinks are formed that was examined basically is mainly just creating a solution that is capable of encapsulating cells and turning into some type of hydrogel.

References

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