

SCAFFOLD INFORMATICS: TISSUE SCAFFOLDS BASED ON 3D IMAGE DATA

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Scanning modalities are increasingly able to segregate tissue by density, magnetic resonance and optical characteristics, and automated cell recognition [1]. We advocate using this information to design 3D tissue scaffolds incorporating both native anatomy and necessary tissue culture criteria. The goal of this research is to construct complex multi-material scaffolds, with regions of cells grown in specialized subunits of the same scaffold, the location and scaffold parameters defined by bioimaging data. Parameters include macroporosity, cell attachment properties, localized growth factor release, degradation, and mechanical properties. Fine control of these scaffold characteristics based upon native tissue could allow cells to grow where they are intended through local cellular competition.

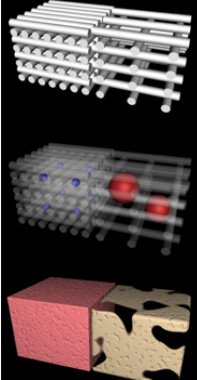
Cartilage Scaffold Hypoxic -low porosity -spread out diffusion network Growth Factors -100 µg/mL IGF-I -delivered through spaced chitosan elements -release over 3 weeks		Bone Scaffold Increased transport -high porosity -dense diffusion network Growth Factors -10 ng/mL BMP -delivered through spaced fibrin elements -release over 1 week
Figure 1: Scaffold manufacture strategies for a cartilage/bone interface scaffold		

Figure 1 is an illustration of a sample interface between a bone and cartilage region. A cartilage region would have reduced need for transport, hence a lower porosity and reduced access to transport channels or a diffusion network. By contrast, osteoblasts would require greater mass transport and greater space for migration. Growth factor responses for both cell types are known, so spacing of degradative release elements within the scaffold could maintain the desired concentrations of factors for the desired duration [2].

To illustrate the potential of bioimaging data to design the heterogeneous scaffold, 3D reconstruction was performed using publicly available CT data and optical sections from the Visible Human Project. After segregation through threshold and region-growing operations was performed, the resultant 3D models were characterized for tissue scaffold criteria. These biomimetic scaffolds were designed to be consistent with the known resolution capabilities of the Heteroform 3D multi-material printer and the properties of the four candidate scaffold materials.

SELECTED REFERENCES

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