Introduction
Bone tissue can be engineered in the laboratory using a bioreactor in which culture medium is perfused through a porous three dimensional (3D) scaffold. One important feature in bone tissue engineering is the configuration of placing the cells onto a porous 3D scaffold at the start of the culture period to create the tissue engineered construct. A perfusion bioreactor may be utilized to deliver cells at the start of culture. Mathematical modelling offers scientists assistance with regards to reducing the number of physical laboratory experiments needed for experimental characterisation and optimising cell seeding. We are utilising incompressible lattice Boltzmann (LB) modelling to investigate the parameters of culture for optimal cell adhesion and distribution.

Materials and Methods
Our first approach was to use microCT images of porous polylactic acid scaffolds to generate the 3D structure for the LB model. This approach modeled the hydrodynamics of the porous scaffold without cells to measure typical flow velocities, wall shear stress, scaffold permeability and tortuosity. The second approach coupled advection diffusion reaction equations to the LB method in order to model key components of the culture medium. Moreover, we considered dissolved oxygen, carbon dioxide and mesenchymal stem cell species together with a receptor ligand model of cell attachment. Simulations were performed to reproduce experimental findings and begin the optimization process.

Results
It was found that flow is highly inhomogeneous and the PLA scaffolds are anisotropic. These findings highlight that homogenous Darcy flow models must be used with caution in a bioreactor environment [1].

Discussion and Conclusions
LB code setup for this perfusion system was able to produce models for pressure profile, mass transport and shear stress in the scaffold placed in the bioreactor chamber. Laboratory experiments are now underway to validate the predicted cell attachment.

References

Acknowledgment and Disclosure
BBSRC grant BB/F013892/1. The authors have nothing to disclose.