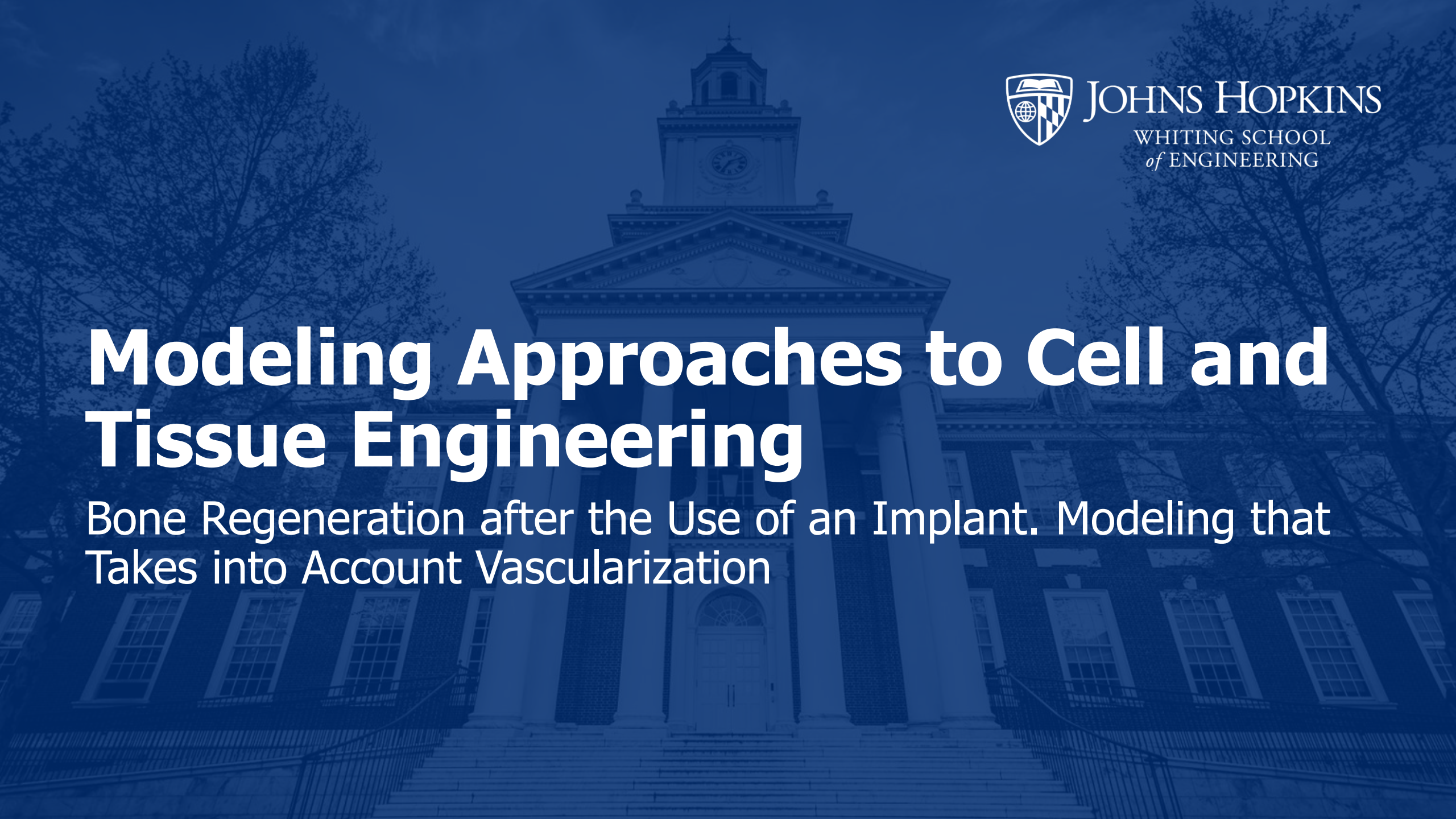


Modeling Approaches to Cell and Tissue Engineering

Bone Regeneration after the Use of an Implant. Modeling that Takes into Account Vascularization

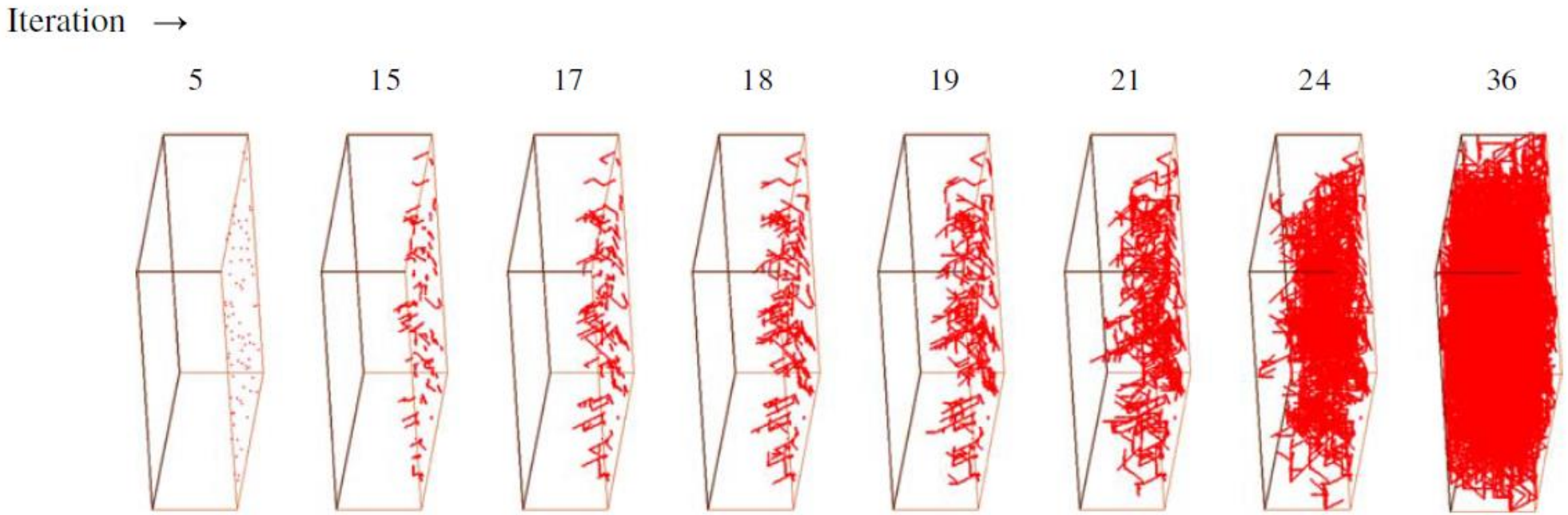
Bone Regeneration after the Use of an Implant. Modeling that Takes into Account Vascularization

Alexander A. Spector

1. Illustration of vessel growing in the tissue between the bone and implant
2. Distribution of the different cell phenotypes (force-control conditions, initial bone/implant displacement 117 μm)
3. Endothelial cell distribution (all endothelial cells within 100 μm, force-control conditions, initial bone/implant displacement 117 μm)
4. Distribution of the different cell phenotypes (force-control conditions, initial bone/implant displacement 231 μm)
5. Endothelial cells distribution (all endothelial cells within 100 μm, force-control conditions, initial bone/implant displacement 231 μm)
6. Distribution of the different cell phenotypes displacement-control conditions, initial bone/implant displacement 100 μm)
7. Endothelial cells distribution (all endothelial cells within 100 μm, displacement-control conditions, initial bone/implant displacement 100 μm)
8. Percentages of positions occupied of cells of different phenotypes

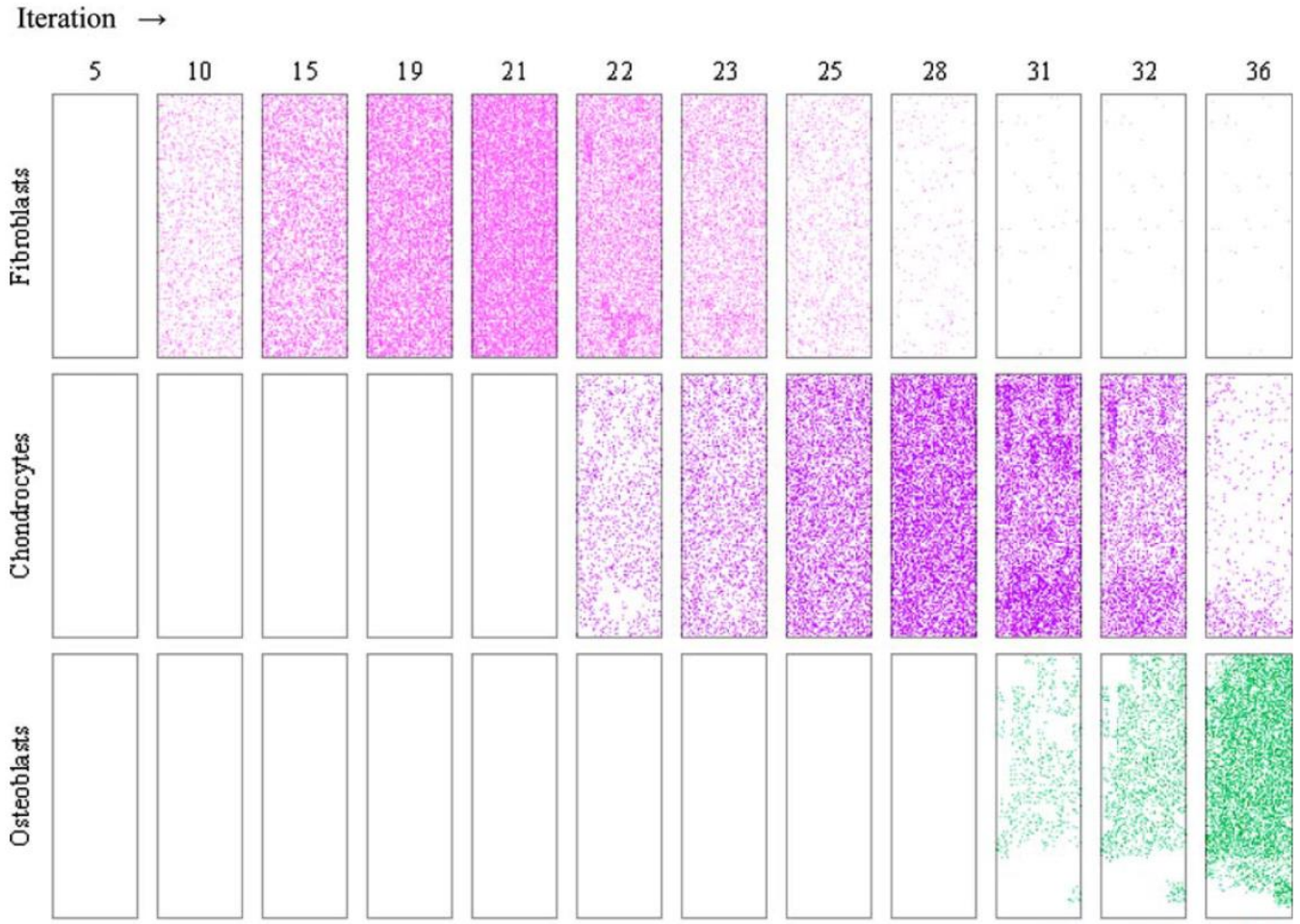
Force-Control Situation

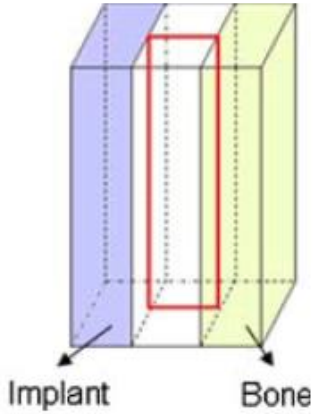
Under a force-control situation, with a shear load to give an initial relative displacement between the bone and the implant of 117 μm, initially the high mechanical environment at the bone/tissue interface prevented the growth of the vessels. After a certain time and due to the tissue differentiation process, the degree of micromotion decreased, reducing the mechanical stimuli at the site, allowing the vessels to grow.



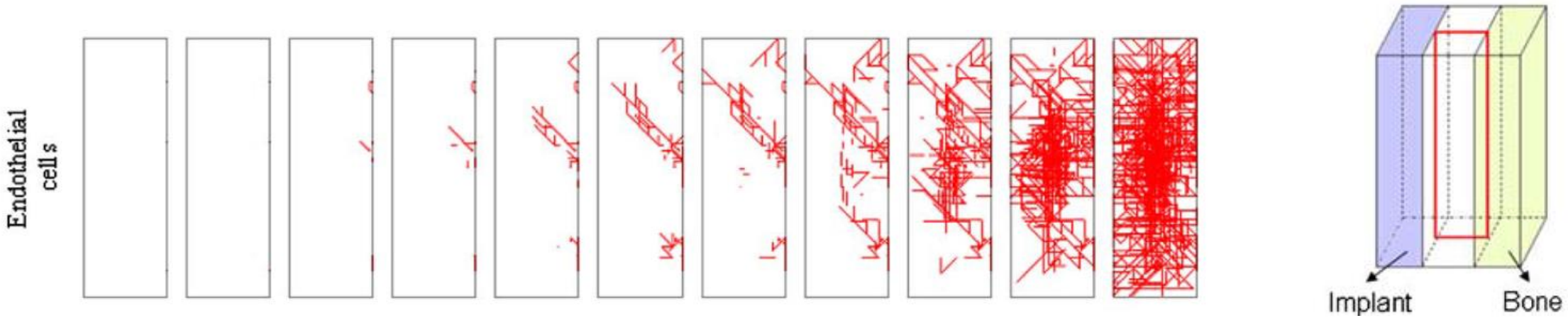
Cell Phenotypes

Distribution of the different cell phenotypes in a cross section through the middle of the regenerating tissue under force-control conditions (shear force to obtain an initial relative displacement between the bone and the implant of 117 μm).



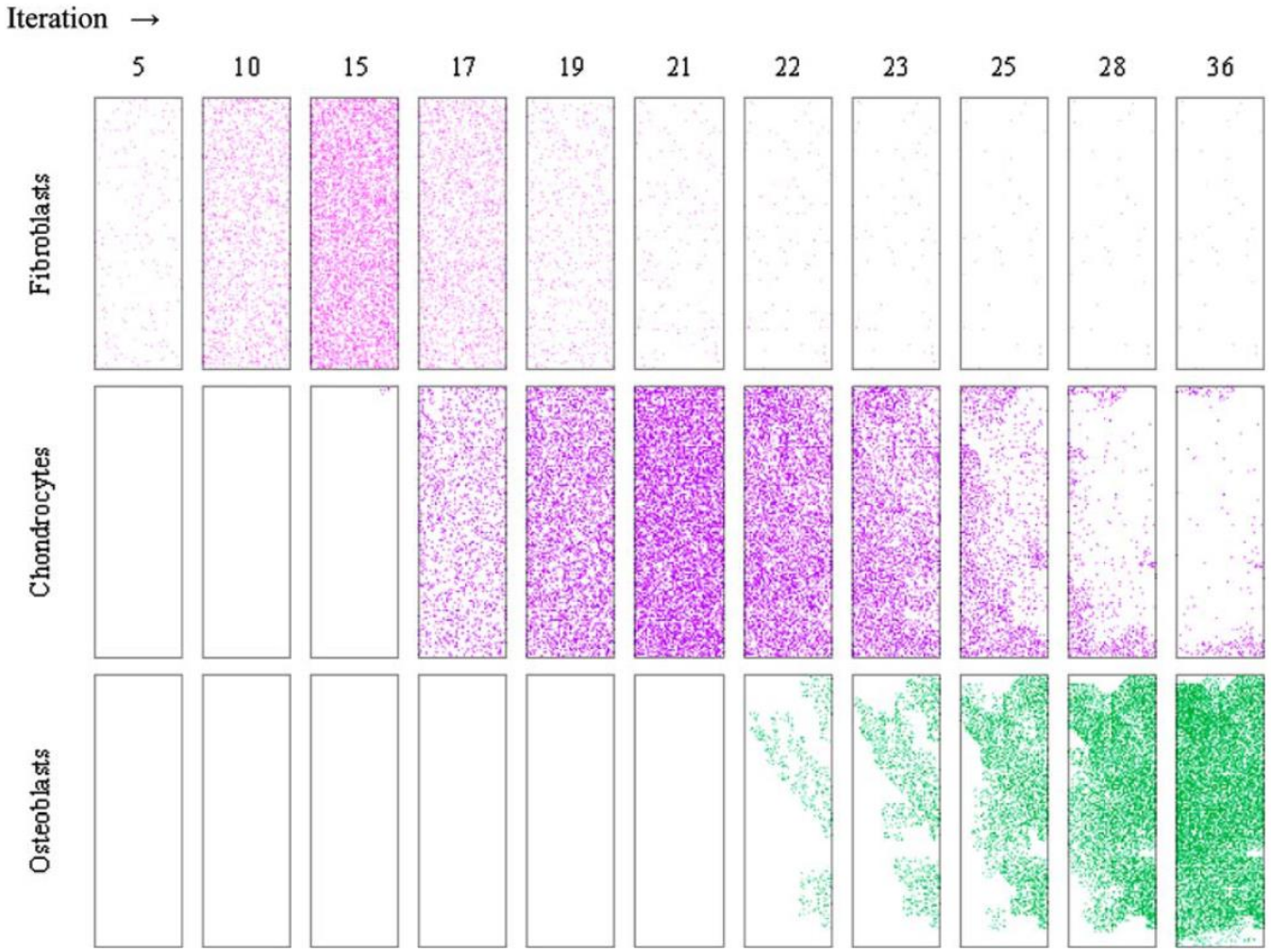


Endothelial Cell Distribution Example



The initial bone/implant displacement is the same that in the above slide. Also, the time moments are considered the same. Endothelial cell distribution includes all endothelial cells within 100 μm (oxygen diffusion distance) from the selected section. Each dot represents a cell occupying a lattice point.

Figure 9



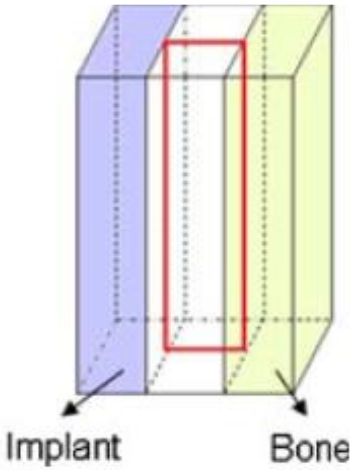
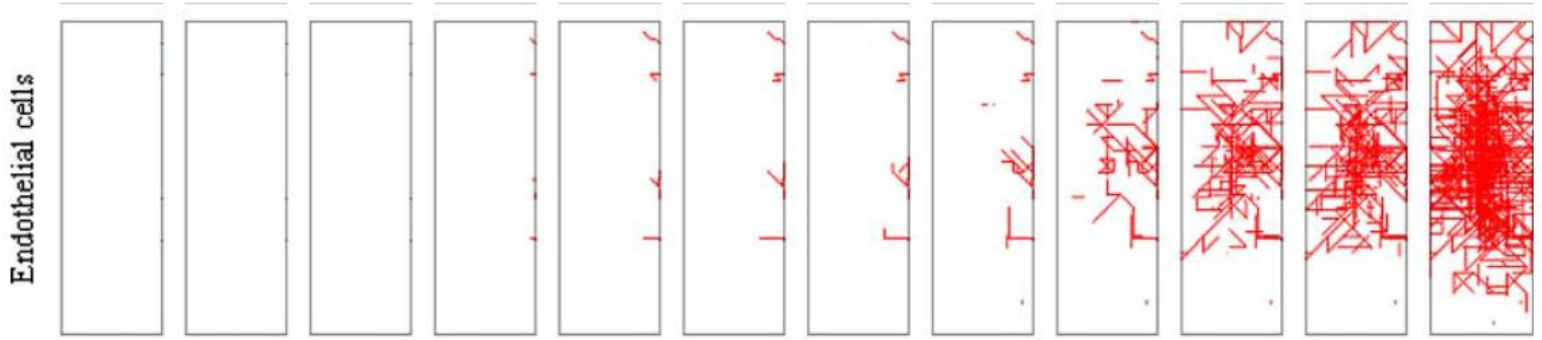
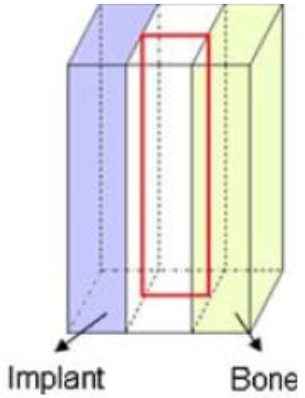


Figure 9: Distribution of the different cell phenotypes in a cross section through the middle of the regenerating tissue under force-control conditions (shear force to obtain an initial relative displacement between the bone and the implant of 233 μm)

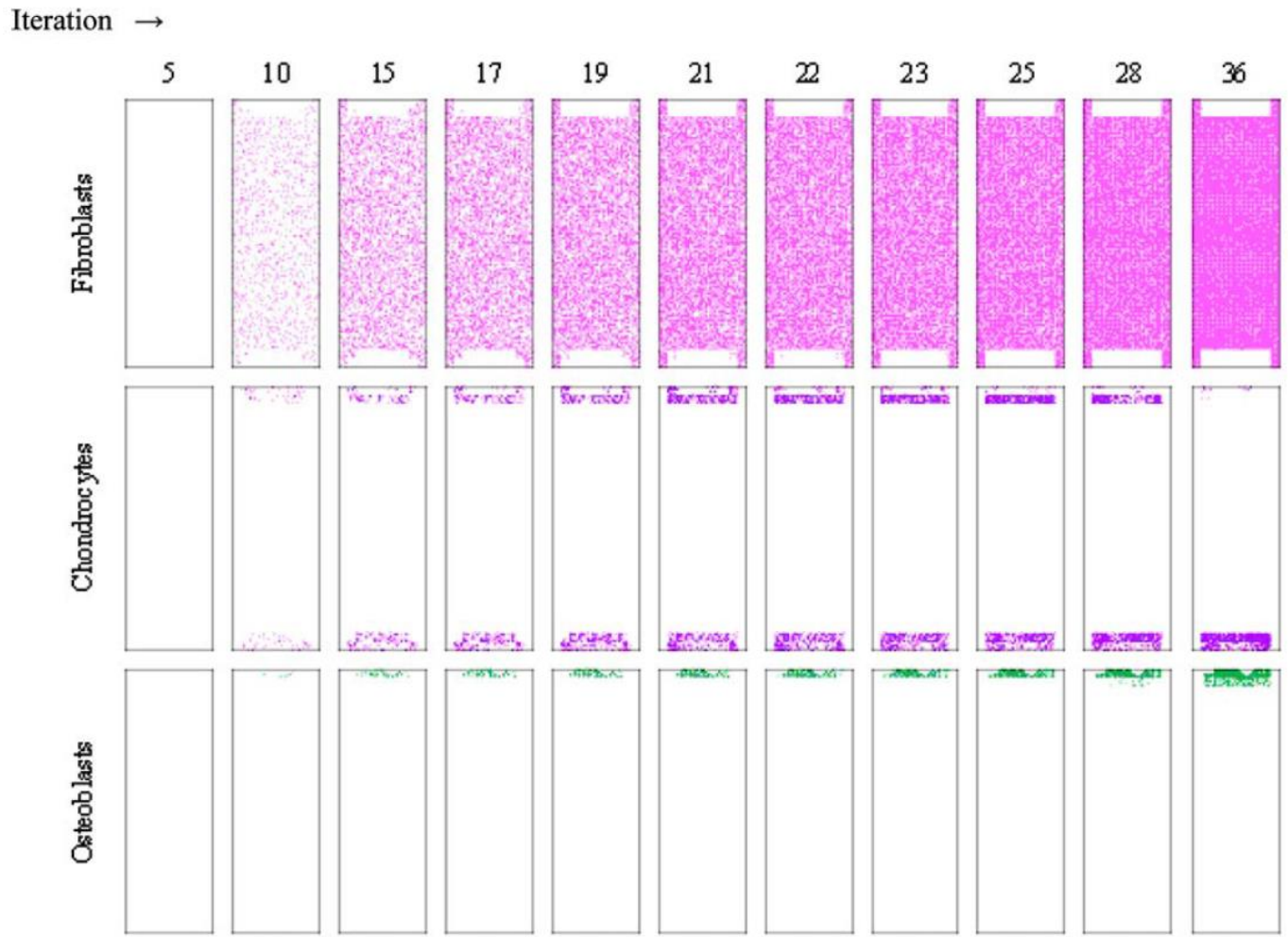
Endothelial Cell Distribution Example 2

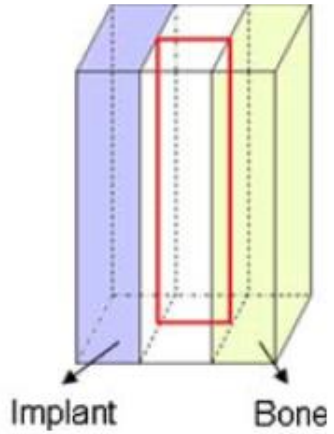




The initial bone/implant displacement is the same as in the previous slide. The moments of time are also considered the same. Endothelial cell distributions include all endothelial cells within 100 lm (oxygen diffusion distance) from the selecte section. Each dot represents a cell occupying a lattice point .

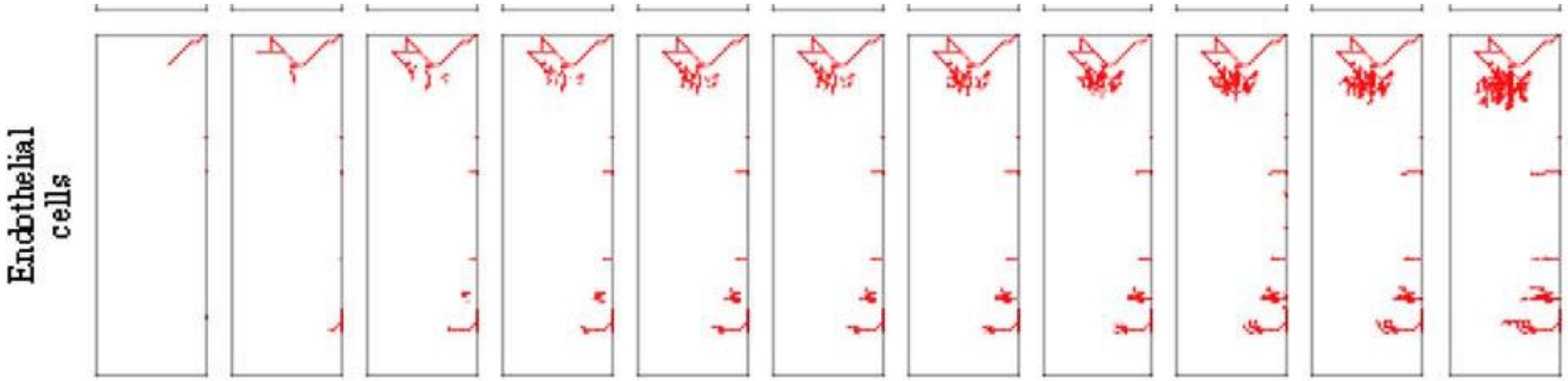
Relative Displacement 100 lm

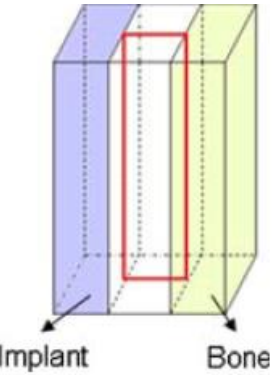




Distribution of the different cell phenotypes in a cross section through the middle of the regenerating tissue under displacement-control conditions (relative displacement 100 lm).

Endothelial Cell Distribution Example 3





The initial bonne/implant displacement is the same that in the above slide. Also, the moments of time are considered the same. Endothelial cell distributions include all Endothelial cells within 100 μm (oxygen diffusion distance) from the selected section. Each dot represents a cell occupying a lattice point .

Figure 12

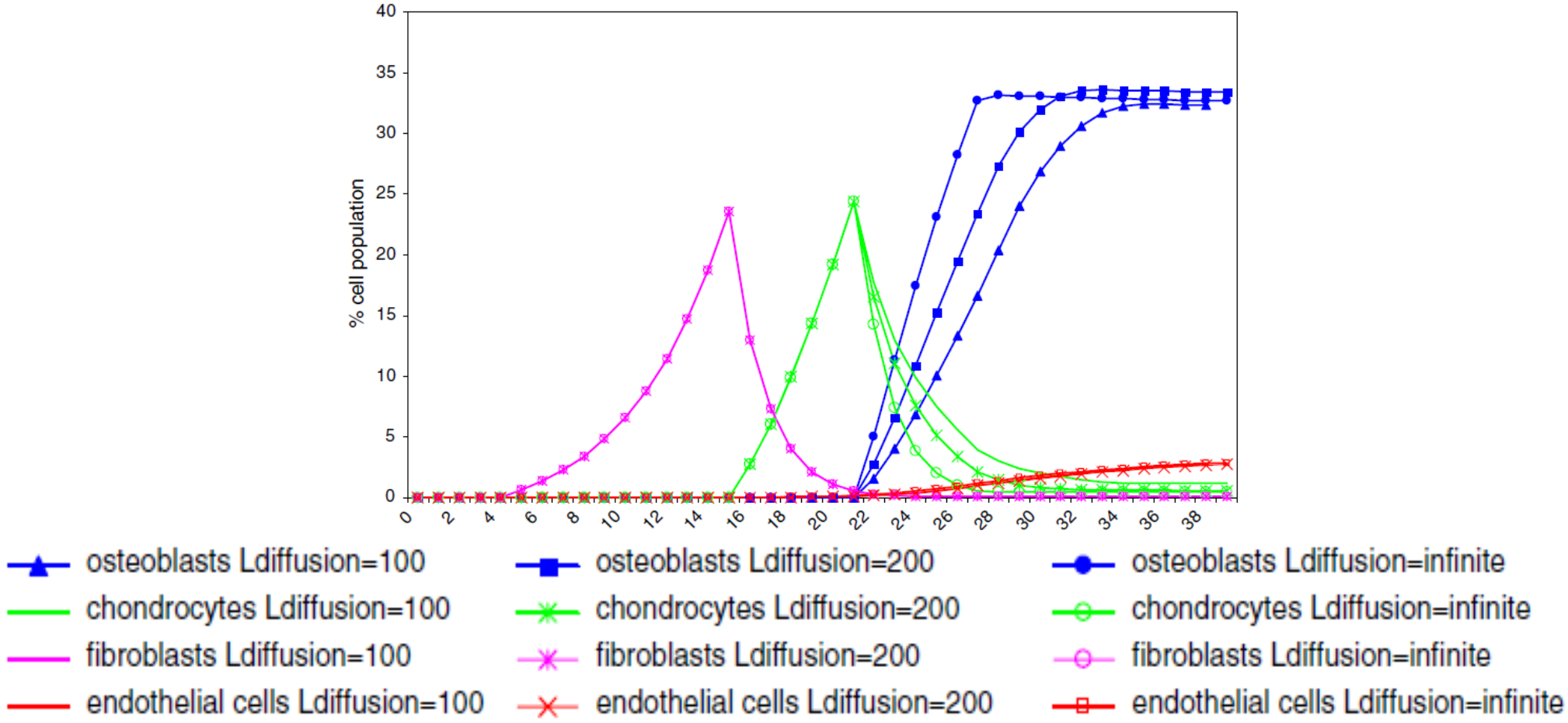
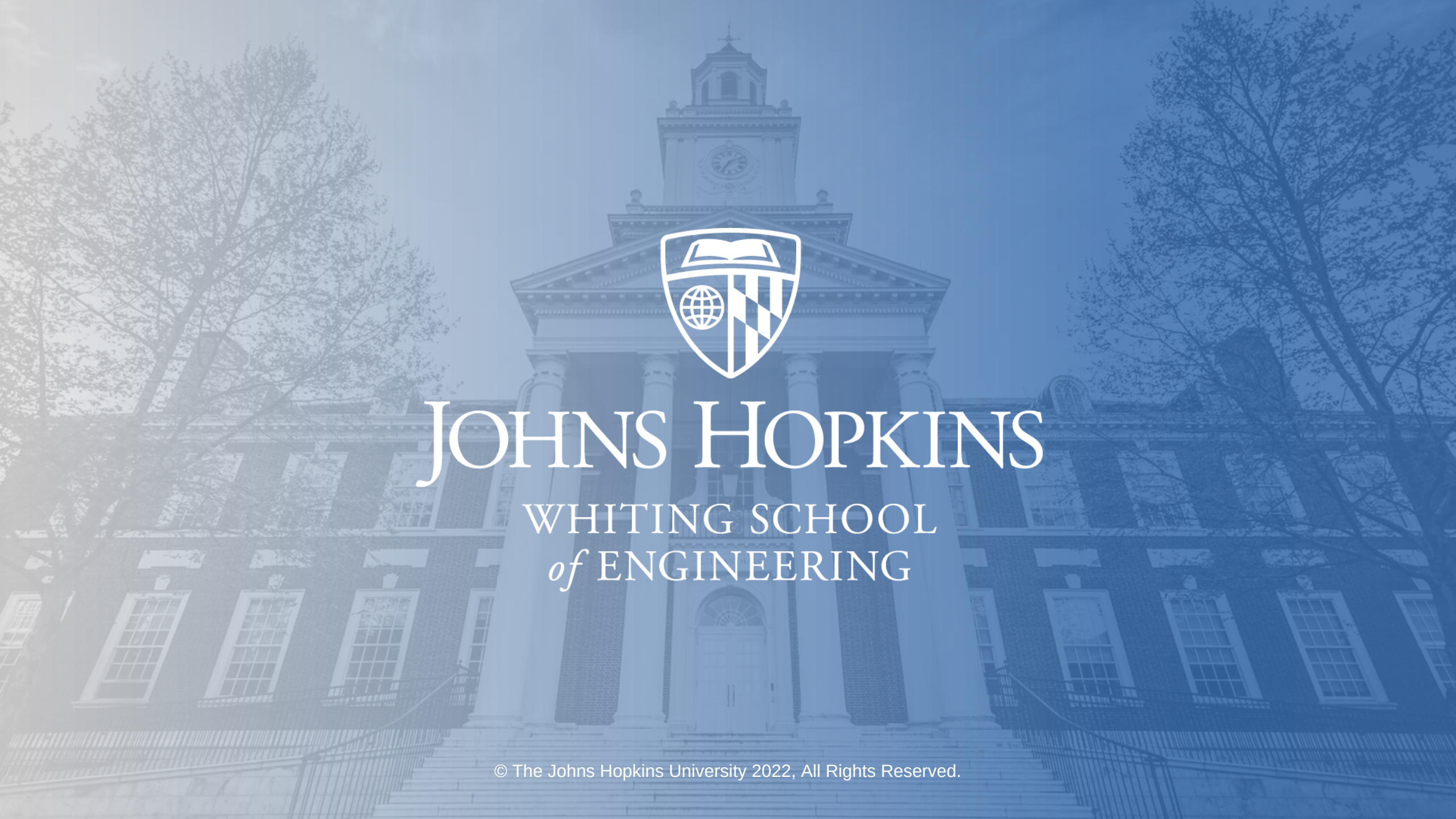


Figure 12: Percentage of cell positions occupied by fibroblasts, chondrocytes, osteoblasts, and endothelial cells for three different oxygen distances: 100 μm, 200 μm, and an infinite distance (equivalent to switching off the angiogenic rule in the tissue differentiation process but with endothelial cells occupying some of the cell positions). Shear force to obtain an initial relative displacement between the bone and the implant of 117 μm.



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