Three-dimensional tissue culture based on magnetic cell levitation

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Abstract: Cell culture is an essential tool in drug discovery, tissue engineering and stem cell research. Conventional tissue culture produces two-dimensional cell growth with gene expression, signalling and morphology that can be different from those found in vivo, and this compromises its clinical relevance. Here, we report a three-dimensional tissue culture based on magnetic levitation of cells in the presence of a hydrogel consisting of gold, magnetic iron oxide nanoparticles and filamentous bacteriophage. By spatially controlling the magnetic field, the geometry of the cell mass can be manipulated, and multicellular clustering of different cell types in coculture can be achieved.

Magnetically levitated human glioblastoma cells showed similar protein expression profiles to those observed in human tumour xenografts. Taken together, these results indicate that levitated three-dimensional culture with magnetized phage-based hydrogels more closely recapitulates in vivo protein expression and may be more feasible for long-term multicellular studies.

• Magnetic levitation can be used to rapidly create 3D cultures
• Magnetically levitated 3D cultures approximate in vivo cell-cell and cell-ECM interactions and organization

2D v. 3D culture: Immunohistochemistry of a tumor xenograft (left), and 3D magnetically levitated cultures (center) and 2D cultures (right) of human glioblastomas for N-cadherin (red). Note the similarity in structure and stain intensity between the 3D culture and the explant, but not with the 2D culture. Scale bar = 10 μm.

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