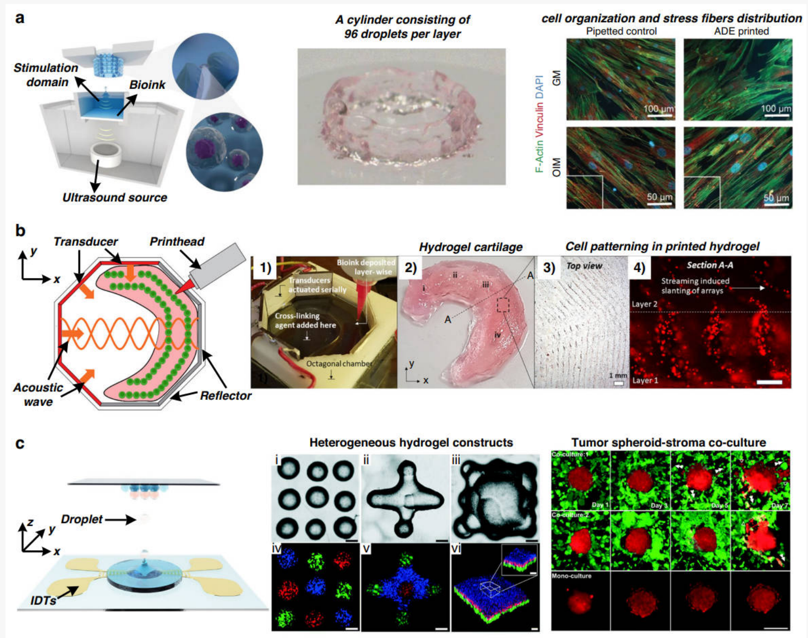
From sound to structure: how acoustic technologies are shaping the future of tissue engineering

GA, UNITED STATES, March 15, 2025 /EINPresswire.com/ -- A recent review has shed light on the transformative potential of acoustic technologies in the fields of biofabrication and tissue engineering. These sound-based methods, offering benefits such as non-contact manipulation, deep tissue penetration, and high precision, are revolutionizing how complex tissue constructs are created. By harnessing acoustic waves, researchers can assemble cells into spheroids, vascular networks, and organoids—ushering in more accurate disease models and regenerative therapies. With the ability to overcome the limitations of traditional biofabrication techniques, acoustic approaches are poised to drive significant advancements in the years to come.



Acoustic-based bioprinting.

Biofabrication seeks to create tissue constructs that replicate the complexity of native tissues, offering immense promise for applications in regenerative medicine and drug testing. However, traditional biofabrication methods face critical challenges, such as low throughput, limited precision, and biocompatibility concerns. Acoustic technologies have emerged as a groundbreaking solution to these issues, offering a non-invasive, versatile approach that enables precise manipulation of cells and biomaterials to form intricate 3D structures. Given the limitations of conventional techniques, there is an urgent need to explore and optimize acoustic-based methods to enhance biofabrication and tissue engineering capabilities.

In a recent review (DOI: 10.1038/s41378-024-00759-5) published in Microsystems & Nanoengineering on November 19, 2024, researchers from Dalian University of Technology, Duke University, Harvard University, and Columbia University highlight the emerging role of acoustic technologies in biofabrication. The study explores how sound waves can be employed to assemble cells into spheroids, vascular networks, and organoids—offering a novel solution to longstanding challenges in tissue engineering. The review emphasizes the potential of acoustic methods to address the key limitations of traditional biofabrication, including low throughput and issues surrounding biocompatibility.

The review delves into the mechanisms behind acoustic technologies, which leverage sound waves to manipulate cells and biomaterials with extraordinary precision. Techniques such as acoustic radiation forces and acoustic streaming enable the formation of spheroids, vascular networks, and complex organoids. For example, surface acoustic waves (SAWs) have been utilized to create high-throughput cell spheroids, while bulk acoustic waves (BAWs) support the generation of vascular-like structures. Additionally, acoustic holography allows for the creation of customizable 3D cell patterns, offering an unprecedented level of control in tissue engineering. Acoustic-based 3D bioprinting, which has shown potential in creating functional tissue constructs with high cell viability, is also highlighted. These innovations promise not only to enhance the precision and efficiency of biofabrication but also to pave the way for the creation of complex tissue models for drug testing and regenerative therapies.

"Acoustic technologies represent a paradigm shift in biofabrication," says Dr. Tony Jun Huang, a leading researcher in the field. "Their ability to manipulate cells and biomaterials with high precision and biocompatibility offers unprecedented opportunities for creating complex tissue constructs. This could significantly advance regenerative medicine and drug discovery, pushing the boundaries of what we can achieve in these fields."

The implications of acoustic technologies in biofabrication are vast. Their non-invasive, high-precision nature opens new avenues for creating tissue constructs that can be used for drug screening, disease modeling, and regenerative therapies. For instance, acoustic-based 3D bioprinting holds the potential to produce vascularized tissues, addressing one of the major challenges in tissue engineering. Furthermore, the ability to create intricate organoids using sound waves could revolutionize personalized medicine, enabling the development of patient-specific tissue models for drug testing. As these technologies continue to evolve, they promise to make biofabrication more accessible and efficient for both researchers and clinicians, accelerating the path to advancements in medicine and healthcare.

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