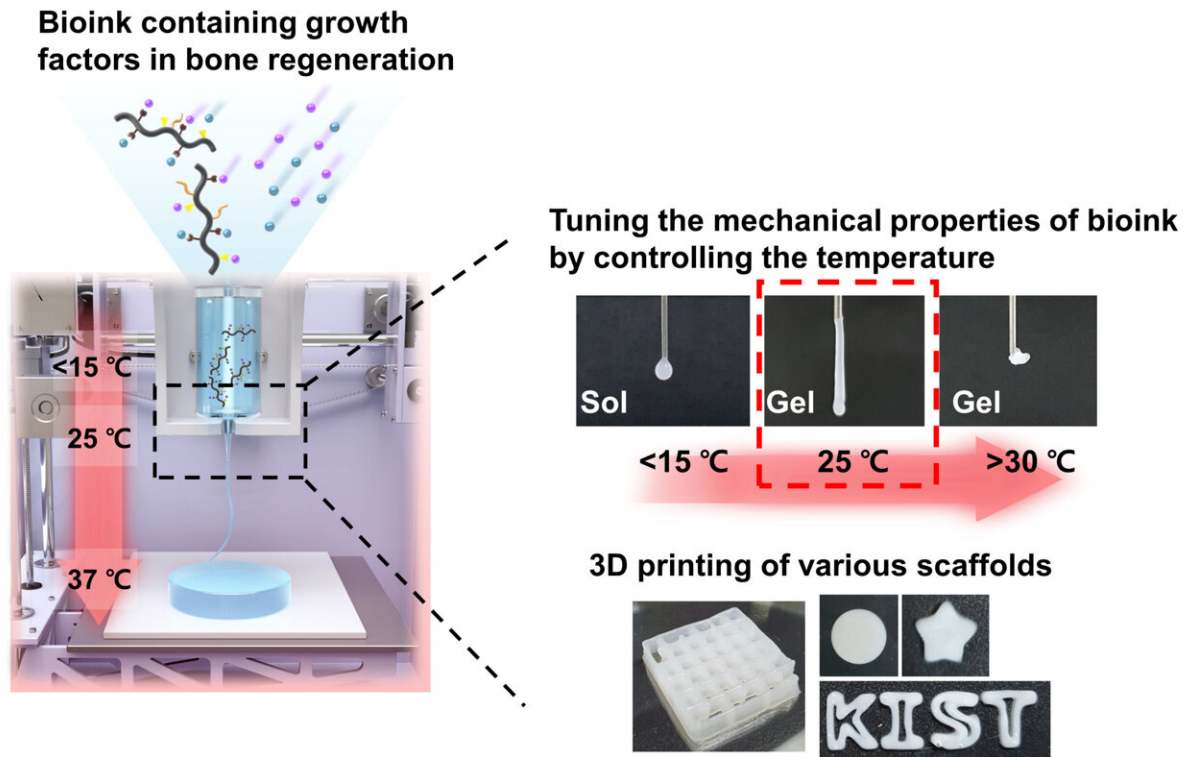


Safe bioink for artificial organ printing

April 14 2023



Tuning mechanical properties of bioink according to temperature and 3d scaffold printing. Credit: Korea Institute of Science and Technology

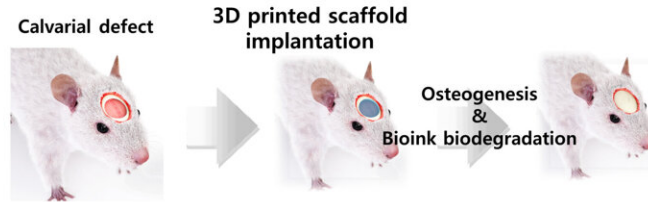
The development of biomaterials for artificial organs and tissues is an active area of research due to increases in accidental injuries and chronic diseases, along with the entry into a super-aged society. 3D bioprinting technology, which uses cells and biomaterials to create three-

dimensional artificial tissue structures, has recently gained popularity. However, commonly used hydrogel-based bioinks can cause cytotoxicity due to the chemical crosslinking agent and ultraviolet light that connect the molecular structure of photocuring 3D-printed bioink.

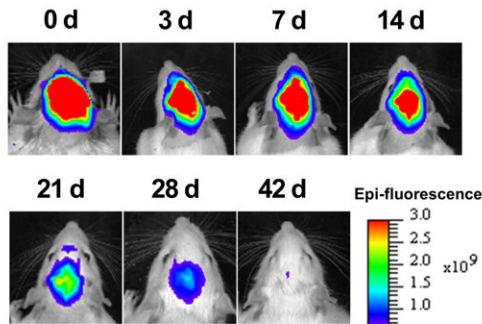
Dr. Song Soo-chang's research team at the Center for Biomaterials, Korea Institute of Science and Technology (KIST), revealed the first development of poly(organophosphazene) hydrogel-based temperature-sensitive [bioink](#) that stably maintained its physical structure by temperature control only without photocuring, induced tissue regeneration, and then biodegraded in the body after a certain period of time.

Current hydrogel-based bioinks must go through a photocuring process to enhance the mechanical properties of the 3D scaffold after printing, with a high risk of adverse effects in the human body. In addition, there has been a possibility of side effects when transplanting externally cultured cells within bioink to increase the tissue regeneration effect.

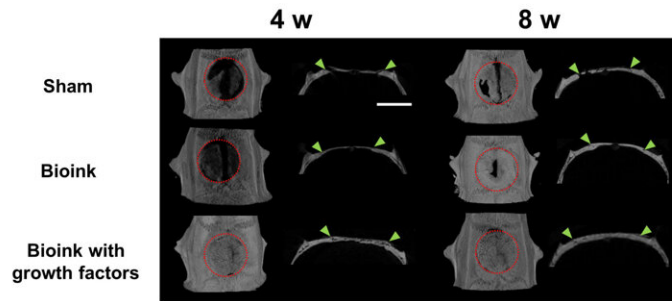
Accordingly, the research team developed a new bioink material using a temperature-sensitive poly(organophosphazene) hydrogel, which existed in a liquid form at low temperatures and changed to a hard gel at body temperature. This enabled the regeneration of tissues by temperature control only without chemical crosslinking agents or UV irradiation and the manufacture of a three-dimensional scaffold with a physically stable structure, which minimized the possibility of adverse immune effects in the human body.



▪ Biodegradation



▪ Bone defect healing



Biodegradation and bone regeneration effects after implanting the 3D-printed scaffold with bioink to the bone-damaged area. Credit: Korea Institute of Science and Technology

The developed bioink also had a [molecular structure](#) that could interact with growth factors, which are proteins that help in tissue regeneration to preserve [growth factors](#) that regulate [cell growth](#), differentiation, and immune responses for a long period of time. The research team was able to maximize the effect of [tissue regeneration](#) by creating an environment in which cell differentiation could be autonomously regulated within the 3D scaffold printed with bioink.

The research team fabricated the 3D scaffold by printing it with a 3D bioprinter using bioink containing transforming growth factor beta 1 (TGF- β 1) and bone morphogenetic protein-2 (BMP-2), which were required for cell infiltration and [bone regeneration](#), and conducted an experiment by implanting it into a damaged bone in a rat. As a result,

cells from the surrounding tissue were migrated into the scaffold, and the defected bone was regenerated to a normal tissue level, and the implanted 3D scaffold slowly biodegraded in the body over 42 days.

Dr. Song Soo-Chang of KIST said, "The research team has transferred technology for the thermo-sensitive polyphosphazene hydrogel to NexGel Biotech Co., Ltd. in June 2022, and the development of products such as bone graft materials and cosmetic fillers is underway. As the bioink developed this time has different physical properties, follow-up research to apply it to the regeneration of other tissues besides bone tissue is being conducted, and we expect to finally be able to commercialize bioink tailored to each tissue and organ."

More information: Jun Kim et al, Thermo-Responsive Nanocomposite Bioink with Growth-Factor Holding and its Application to Bone Regeneration, *Small* (2022). [DOI: 10.1002/smll.202203464](https://doi.org/10.1002/smll.202203464)

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