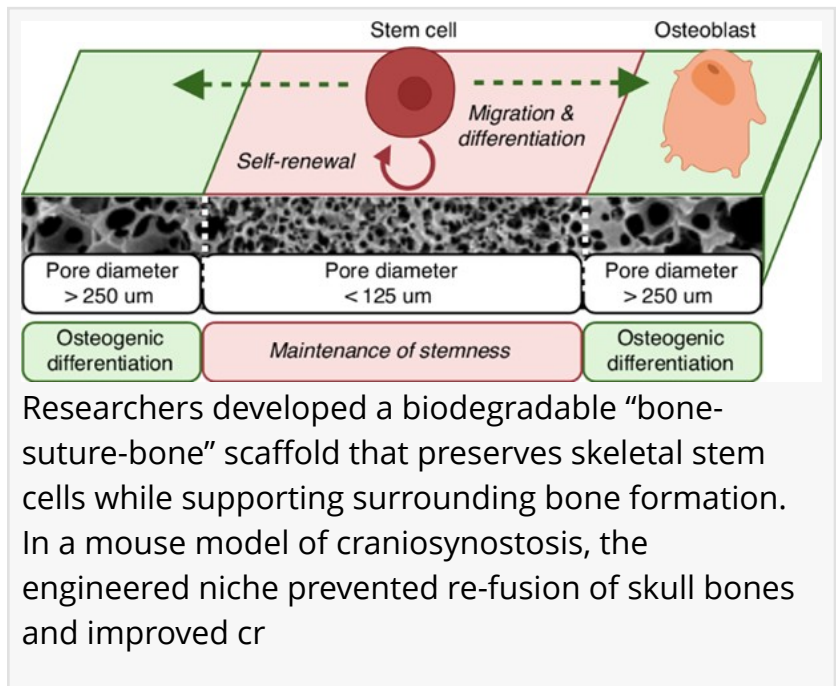


Engineered 'Bone-Suture-Bone' Implant Promotes Normal Skull Growth

Researchers developed a biomaterial scaffold that recreates a skull stem cell niche and reduces craniosynostosis-related deformities

CHINA, July 7, 2026 /EINPresswire.com/

-- An engineered triphasic biomaterial scaffold successfully recreated the cranial suture stem cell niche lost in craniosynostosis, a condition that causes premature fusion of skull bones. Using a pore-size-guided "bone-suture-bone" design, the scaffold maintained skeletal stem cells while supporting surrounding bone formation. In mouse models, the construct prevented re-fusion, restored craniofacial growth, and improved skull morphology. The findings may advance regenerative therapies that directly address the underlying causes of pediatric craniofacial disorders.



Researchers developed a biodegradable "bone-suture-bone" scaffold that preserves skeletal stem cells while supporting surrounding bone formation. In a mouse model of craniosynostosis, the engineered niche prevented re-fusion of skull bones and improved cr

Craniosynostosis is a congenital condition in which one or more of the fibrous joints between skull bones fuse too early during development. Affecting about one in every 2,500 births, the disorder can restrict normal brain and skull growth, leading to abnormal head shape, elevated intracranial pressure, developmental complications, and repeated surgeries. Current treatments rely on invasive procedures that reopen or reshape the skull, yet many patients experience re-fusion of the operated sutures, highlighting the need for safer and longer-lasting solutions.

Addressing this challenge, a research team was led by Professor Yuji Mishina from the Department of Biologic and Materials Science, School of Dentistry at the University of Michigan, USA, along with Dr. W. Benton Swanson from the Department of Oral Medicine, Infection and Immunity at the School of Dental Medicine, Harvard University, USA. The team focused on the underlying biological cause of craniosynostosis: the loss of skeletal stem cells that normally reside within cranial sutures and direct skull growth. Rather than simply preventing bone formation, they developed a regenerative strategy to rebuild the stem cell niche itself. Their

findings were published in Volume 14 of the journal Bone Research on May 28, 2026.

The researchers engineered a biodegradable triphasic scaffold from poly(L-lactic acid), an FDA-approved biomaterial used in multiple medical applications. Inspired by the natural “bone-suture-bone” structure of the skull, the scaffold contains three interconnected compartments with different pore sizes. A central small-pore region was designed to preserve stem cell properties, while larger pores on either side promoted vascularization and bone formation. Together, these compartments created a microenvironment capable of maintaining stem cells while supporting normal skeletal development.

Experiments showed that the scaffold actively guided cell behavior. Skeletal stem cells placed within the central compartment retained their stem-like characteristics, whereas cells that began differentiating migrated into neighboring regions and contributed to bone formation. The design also generated distinct patterns of blood vessel growth and extracellular matrix organization that closely resembled those found in natural cranial sutures. Lineage-tracing studies further demonstrated that the scaffold maintained a reservoir of stem cells while allowing their descendants to participate in tissue regeneration.

To determine whether the construct could withstand disease-promoting signals, the team challenged it with excessive bone morphogenetic protein activity, a pathway associated with abnormal bone formation. Even under these conditions, the central compartment resisted ossification and preserved a non-bony stem cell niche. This finding suggested that the engineered microenvironment could counteract biological processes that normally trigger premature suture fusion.

The scaffold was then tested in a mouse model of midline craniosynostosis that closely resembles the most common nonsyndromic form of the condition in humans. After surgically removing the fused sutures, the researchers implanted the scaffold into the defect. Animals receiving conventional treatment experienced re-fusion, whereas those receiving the triphasic scaffold maintained an open, suture-like tissue and showed significantly improved craniofacial growth. Earlier intervention produced the strongest benefits, emphasizing the importance of restoring normal growth patterns during critical developmental windows.

“Our goal was not simply to reopen a fused suture, but to regenerate the biological niche that allows the skull to grow normally,” said Prof. Mishina. “By recreating the environment that maintains skeletal stem cells, we were able to redirect craniofacial development toward a healthier trajectory.”

Dr. Swanson added, “This work demonstrates how rational biomaterial design can control stem cell fate and tissue organization simultaneously. We believe the principles established here may be broadly applicable to regenerative therapies beyond craniosynostosis.”

Overall, the study demonstrates that rebuilding a stem cell niche can be a powerful therapeutic

strategy. By combining developmental biology with tissue engineering, the team created a biomaterial scaffold capable of preserving skeletal stem cells, preventing pathological bone fusion, and restoring more normal skull growth. Beyond craniosynostosis, the findings provide a framework for engineering functional stem cell niches that could eventually support regenerative treatments for other skeletal disorders and developmental conditions.

Reference

Titles of original paper: A tissue engineering approach to regenerate the cranial suture skeletal stem cell niche with a multicompartiment biomaterial scaffold

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About Professor Yuji Mishina

Yuji Mishina is the William R. Mann Professor of Dentistry in the Department of Biologic and Materials Sciences at the University of Michigan School of Dentistry and serves as Director of the OHS/PhD Program. He earned his B.S., M.S., and Ph.D. in Molecular Biology from the University of Tokyo and completed postdoctoral training at the University of Texas MD Anderson Cancer Center. Before joining Michigan in 2008, he led the Molecular Developmental Biology Section at the National Institute of Environmental Health Sciences. Prof. Mishina's research focuses on

bone morphogenetic protein signaling, skeletal biology, craniofacial development, mouse genetics, and regeneration.

About Dr. W. Benton Swanson

Dr. W. Benton Swanson is a researcher in the Department of Oral Medicine, Infection and Immunity at the Harvard School of Dental Medicine, Boston, Massachusetts, USA. His work focuses on biomedical entrepreneurship, polymeric biomaterials, regenerative engineering, and translational approaches that bridge fundamental science with clinical applications. Through interdisciplinary research, he investigates how biomaterial design can influence stem cell behavior, tissue regeneration, and skeletal repair. Dr. Swanson has authored numerous scientific publications and has received more than 1,100 citations, with an h-index of 14. His research aims to develop innovative regenerative therapies for unmet clinical needs.

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