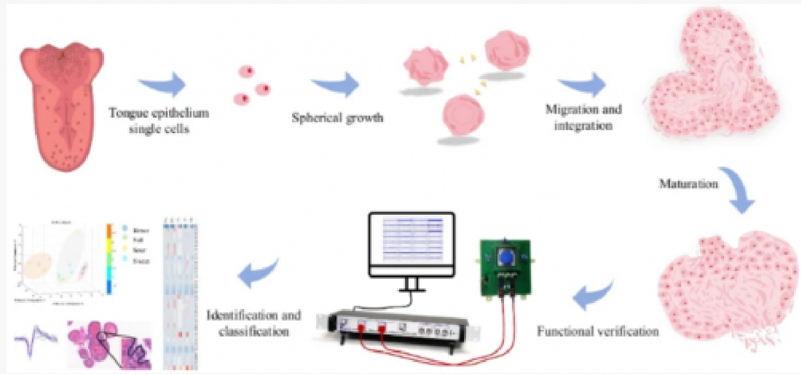
Biomimetic tongues: how cultured organoids are changing flavor detection



From Cells to Sensing: Building Taste Buds on a Chip.

FAYETTEVILLE, GA, UNITED STATES, August 7, 2025 /EINPresswire.com/ -- Scientists have engineered a biomimetic sensor that mimics human taste perception by harnessing lab-grown taste bud organoids and microelectrode arrays (MEAs). These 3D organoids, cultivated from mouse taste epithelial cells, were allowed to mature over 14 days, undergoing structural fusion and forming functional taste bud-like tissues.

For decades, food taste analysis has relied on either human panels or high-tech instruments like High-Performance Liquid Chromatography–Mass Spectrometry (HPLC-MS) and Nuclear Magnetic Resonance Spectroscopy (NMR). While effective, these approaches can be costly, slow, and ill-suited for real-time or portable use. Nature's taste system, by contrast, is highly efficient—relying on taste buds made of specialized receptor cells that decode flavor information with remarkable sensitivity. Inspired by this biology, scientists have attempted to build taste biosensors using cultured cells, but struggled with short-lived tissues and limited taste differentiation. Due to these limitations, there is an urgent need to develop advanced biosensors that faithfully replicate the structural and functional properties of natural taste systems.

Now, researchers from Xi'an Jiaotong University have unveiled a major advance in this field. Their study (DOI: 10.1038/s41378-025-00978-4), published on June 11, 2025, in Microsystems & Nanoengineering, introduces a long-term cultured taste bud organoid integrated with a microelectrode array (MEA) chip to simulate and discriminate taste stimuli. By monitoring electrical responses to flavor compounds, the team demonstrated that structural maturation of organoids greatly improves sensing performance and enables multi-taste classification with high precision.

To create functional taste bud organoids, scientists isolated epithelial cells from mouse tongues and cultured them for 14 days. During this time, the cells self-assembled into organoids that exhibited visible fusion and internal structural formation, resembling native taste buds. These matured organoids were then placed on MEA chips, which captured their electrical activity in response to five taste stimuli. Each flavor triggered unique discharge patterns—differences in spike frequency and amplitude—allowing the system to generate a sensory "fingerprint" for each taste. Principal component analysis (PCA) showed that responses to sweet, sour, salty, and bitter could be separated into distinct clusters, demonstrating the organoids' discriminative ability. Moreover, live/dead staining confirmed high cell viability throughout the process, supporting the feasibility of long-term use. Crucially, the fusion of organoids appeared to enhance signal regularity, pointing to structural maturity as a key factor in taste recognition.

"Our work demonstrates that structural maturation of taste bud organoids isn't just biological—it's functional," said Prof. Chunsheng Wu, corresponding author of the study. "By allowing the organoids to self-organize and fuse, we saw a dramatic improvement in signal clarity and stability. This lays a strong foundation for truly biomimetic, high-resolution taste sensors that could one day rival natural taste perception."

This innovation opens new horizons for objective taste evaluation in food quality control, personalized nutrition, and smart kitchen technologies. In the future, combining organoids with artificial intelligence and multi-sensory chips could create powerful platforms capable of decoding complex flavor mixtures or monitoring freshness in real time. Researchers also envision integrating 3D microelectrodes or temperature and osmotic sensors to mimic the full physiological environment of the tongue. Ultimately, this work brings science one step closer to creating artificial tasting systems that replicate not only how we sense food—but how we experience it.

References
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