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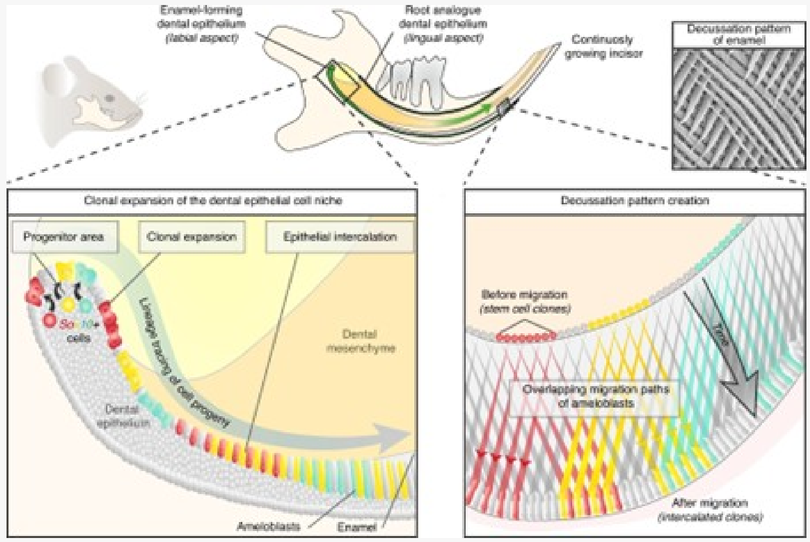
Decoding the Pattern and Mechanisms that Provide Hardness to Tooth Enamel

Using mouse incisor models, researchers reveal how coordinated cell movements form crack-resistant enamel in teeth



Tooth enamel gains its strength from the organized arrangement of microscopic enamel prisms in crisscross patterns, known as decussation patterns, which are generated by directional epithelial sliding of enamel-forming ameloblasts.

CHENGDU, SICHUAN, CHINA, March 12, 2026 /EINPresswire.com/ -- Tooth enamel is the hardest tissue in vertebrates, yet how its intricate structure forms, remains unclear. Using mouse models, researchers have now discovered how specialized enamel-forming cells move in coordinated, opposing directions to create a woven structure that boosts enamel's strength. By identifying the specialized cell population and tracking its descendants in mouse incisors, the researchers provide the first experimental evidence for enamel structure, providing new insights into dental biology.

Teeth are complex structures that perform various tasks in the body, from grinding tough foods to creating sounds during vocalization. The teeth gain their strength from enamel, the mineral-rich translucent layer which forms the outer covering of the teeth and shields it from damage. The enamel's hardness stems from its high mineral content and complex internal microstructure, consisting of enamel rod prisms arranged in intricate crisscross patterns called decussation patterns. While this is known, how these patterns form remains unclear.

In this context, a team of researchers led by Associate Professor Jan Krivanek from the Department of Histology and Embryology, Masaryk University, Czech Republic, has conducted a study on mouse incisors (flat, sharp teeth located at the front of mouth) to understand the cellular mechanism behind the unique decussation patterns of tooth enamel. The findings of the study were published in Volume 18 of the [International Journal of Oral Science on February 03, 2026](#).

“We discovered a cellular mechanism of enamel decussation pattern formation, by multicolor lineage tracing of early dental progenitors during their gradual specialization,” says Dr. Krivanek. The process starts with preameloblasts (immature enamel forming cells). As these cells mature, they turn into ameloblasts, which are highly specialized cells responsible for secreting the protein-rich matrix that later mineralizes into enamel. Each ameloblast forms a single enamel prism and therefore, their precise organization is essential in the creation of enamel.

To study the origin and organization of ameloblasts, the researchers used mouse incisors which are known for their high resilience and continuous growth. Using advanced genetic lineage tracing and live imaging techniques, they identified a rare population of dental epithelial stem cells marked by the gene Sox10.

Within dental epithelium these cells were found exclusively in the enamel-producing, labial aspect, of the tooth. By tracking these cells in the continuously growing mouse incisors, the researchers discovered that over time, they clonally give rise to ameloblasts and help to orchestrate the complex cellular movements and organization of ameloblasts.

“Our study for the first time experimentally demonstrates a cellular mechanism standing behind the origin of the enamel decussation pattern. It reveals that this pattern arises from the directional sliding and coordinated migration of ameloblasts. Clusters of ameloblasts originating from the same progenitor first split into nearly equal groups and migrate in opposite directions. As these groups interweave, they create a microscopic crisscross pattern that helps strengthen enamel,” says Dr. Krivanek.

With detailed 3D and 4D imaging, the researchers observed that ameloblast clusters first intercalate and rearrange within the tissue, before sliding past one another in coordinated sheets. Each migrating cell leaves behind a mineralized prism, collectively forming the enamel’s crack-resistant architecture.

Beyond uncovering a fundamental biological process, the study also reshapes the understanding of how dental stem and progenitor cells maintain and repair enamel-forming tissues. Furthermore, by revealing how nature engineers one of the body’s toughest materials, this study paves the way for development of stronger biomaterials, better dental approaches, and advanced regenerative therapies.

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Reference
Title of original paper: Enamel decussation pattern originates from directional sliding of ameloblasts
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About Masaryk University
Masaryk University, located in Brno, Czech Republic, is one of the country's leading public research universities. It was established in 1919 and now accommodates ten different faculties and over 35,000 students. Its mission is to enhance quality of life and foster a free, cohesive society through education, research, and social engagement. Upholding values of respect, freedom, and responsibility, the university aims to be an internationally recognized, interdisciplinary, and socially responsible academic community by 2028.
Website: https://www.muni.cz/en/about-us

About Associate Professor Jan Krivanek from Masaryk University
Dr. Jan Krivanek is an Associate Professor at the Department of Histology and Embryology, Masaryk University, Czech Republic. He gained his PhD in Anatomy, Histology, and Embryology from Masaryk University. He currently leads a research group focusing on developmental biology, dental biology, and regenerative medicine. He has authored over 30 peer-reviewed articles till date and his work integrates advanced imaging techniques, mouse genetics and molecular biology to explore stem cell behavior, organ development, and tissue engineering.

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