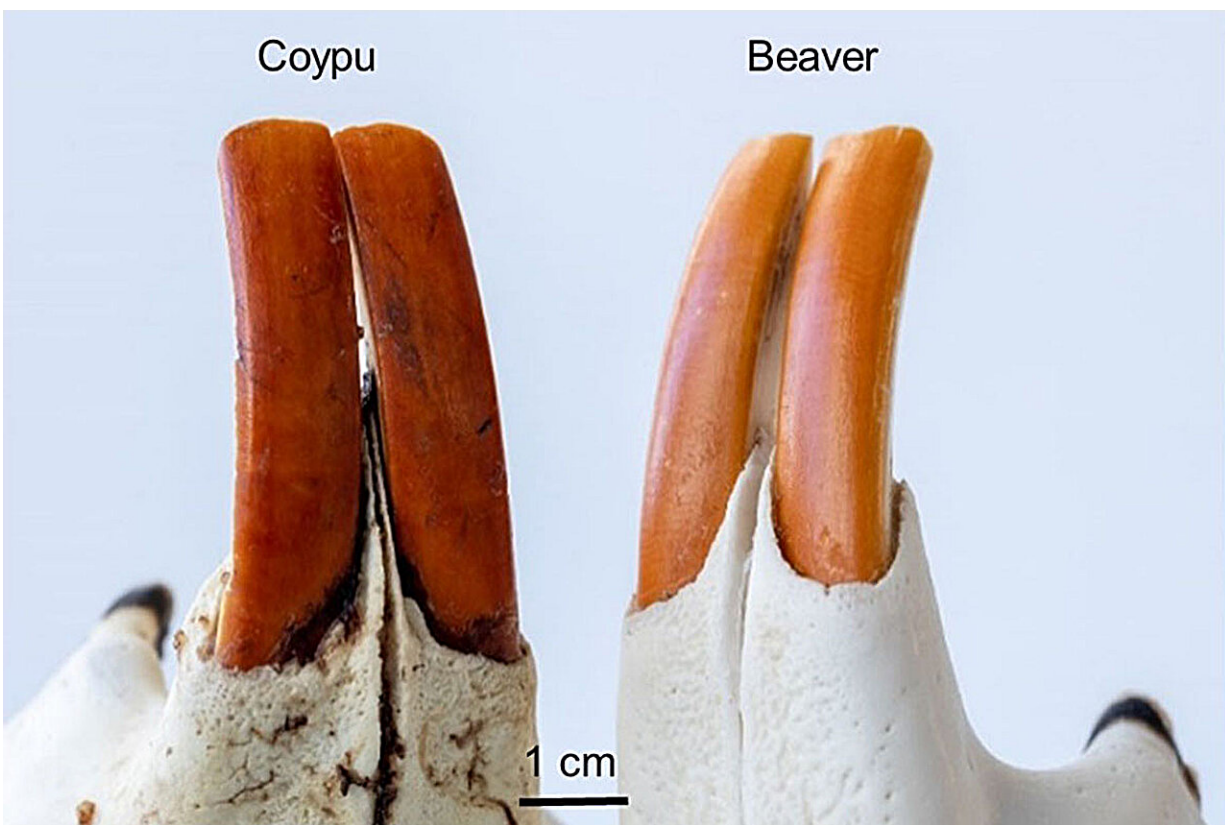


Study finds iron-rich enamel protects, but doesn't color, rodents' orange-brown incisors

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Nano-sized pockets of iron material in rodents' incisors (coypu on the left and beaver on the right) strengthen and protect the teeth. Credit: Adapted from *ACS Nano* 2024, DOI: 10.1021/acsnano.4c00578

Chattering squirrels, charming coypus, and tail-slapping beavers—along with some other rodents—have orange-brown front teeth. Researchers

have published high-resolution images of rodent incisors in *ACS Nano*, providing an atomic-level view of the teeth's ingenious enamel and its coating. They discovered tiny pockets of iron-rich materials in the enamel that form a protective shield for the teeth but, importantly, don't contribute to the orange-brown hue—new insights that could improve human dentistry.

Human and animal teeth are coated in a complex crystalline substance called enamel. And while enamel is the hardest tissue in our bodies, it's even harder in rodents. Their ever-growing incisors have an additional outer layer of acid-resistant, iron-rich enamel.

Previously, researchers suggested that this iron-rich material was also responsible for the striking orange to brown color of many rodents' incisors. However, the microscopic structure of the iron-rich enamel hadn't been fully characterized. To learn more about the composition of [rodent](#) tooth enamel, Vesna Srot and colleagues captured high-resolution images of incisor specimens from several species.

The researchers collected incisors from rodents that live in different environments: beavers, coypus, squirrels, marmots, rats, voles and mice. To investigate the structure, elemental composition and color transmission of the enamel, thin slices were taken from different sections of the teeth and prepared for imaging with [optical microscopy](#), 3D focused ion beam tomography and scanning [transmission electron microscopy](#). The micro- and nano-scale resolution images revealed:

- Initially, cells that synthesize enamel components produce 6- to 8-nanometer-wide particles of iron-storage proteins called ferritins, which are the source material for iron ions in matured enamel.
- As enamel matures and solidifies before the teeth erupt from the gums, iron-containing ferrihydrite-like material moves into the

outer layer of enamel, occupying empty spaces between calcium-containing hydroxyapatite crystals.

- The microstructure of the iron-rich enamel contains elongated nanometer-sized pockets filled with small amounts of the ferrihydrite-like material, which contribute acid resistance even though the filled pockets account for less than 2% of the volume of iron-rich enamel.
- While these results suggest that different types of rodents develop the iron-rich outer enamel layer in a similar way, the depth of the layer vary by species, with mice having the thinnest and coypus having the thickest layers.
- Finally, the intense orange-brown color of rodent incisors doesn't come from the filled pockets in the enamel, as was previously thought, but from a thin surface layer composed of [aromatic amino acids](#) and inorganic minerals.

The researchers suggest that adding small amounts of ferrihydrite-like or other colorless biocompatible iron minerals to dental care products could provide exceptional protection for human tooth enamel. In addition, incorporating small amounts of iron hydroxides into synthetic [enamel](#) could produce longer-lasting restorations for human [teeth](#).

More information: Ingenious Architecture and Coloration Generation in Enamel of Rodent Teeth, *ACS Nano* (2024). [DOI: 10.1021/acsnano.4c00578](#)

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