

RIGHT UNDER OUR NOSES

Paule Dagenais – When we think about a dog’s nose, we mostly think about its incredible sense of smell. But what fascinated me was its shape. That wrinkled surface, with very regular grooves... Why does a dog’s nose look like that? And more importantly, how does that shape appear during development? My research starts from a fairly simple idea: the shapes of living systems are not dictated only by genes, but also by physical laws. In other words, to understand the dog’s nose, we need to look at both biology and mechanics.

So I studied how the nose forms in dog embryos—and also in other mammals such as ferrets and cows—at the stage when tissues are growing. What I discovered is that the skin of the nose does not grow uniformly. Some layers grow faster than others, and that generates mechanical stresses. When a tissue is constrained, it tends to wrinkle, to form waves. In the case of the nose, these waves become very organized folds that create, at the surface, a mosaic of polygons, often with five sides.

These polygons are not just geometric—they also have a function. The grooves help retain moisture at the surface of the nose. That moisture is essential for capturing chemicals present in the air or on the ground. These molecules are then guided into an organ located at the back of the palate, through a small canal, called the **vomeronasal organ**. This system lies somewhere between smell and taste, and allows mammals to analyze their environment very finely.

In developmental biology, shapes have long been explained through chemical signals that instruct cells where they are and how to behave—like the patterns of scales and colors in reptiles, fish, or even the stripes of zebras. But our work showed that this is not the whole story. Even before the skin wrinkles, a network of blood vessels forms just beneath the surface of the skin. These vessels are stiffer than the surrounding tissues. When the skin above them grows, it deforms around this vascular network. Therefore, the blood vessels provide a kind of hidden map—a mechanical positional information rather than a chemical one. Cells do not only receive molecular messages; they also “feel” the physical forces acting on them.

This principle is not unique to the dog’s nose. Similar mechanisms can be found elsewhere in living systems: in the folds of the brain, the internal ridges of intestines or the bronchi—all of these structures also emerge from mechanical constraints related to growth. Fingerprints are probably also linked, at least in part, to mechanical processes. These patterns are not perfectly reproducible. We compared the noses of cloned cows—genetically identical—and showed that

their patterns differ significantly, much like the fingerprints of twins. This shows that the final form is not written line by line in DNA: it emerges from a physical process, with a natural degree of variability. To go further, we reproduced these shapes using numerical models based on 3D reconstructions of nose geometries.

To summarize, a dog's rhinarium is not just a cute, wet nose. It is a physical system—a concrete example of how soft matter can fold and self-organize under mechanical constraints. More broadly, it compels us to rethink the development of living organisms not only in terms of genes and molecules, but also as a soft-matter process shaped by physical forces.

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