# The first map of lipids in the mouse brain

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**EPFL scientists have charted how lipids are arranged across the mouse brain, uncovering over 500 biochemical zones and how the map is redrawn during pregnancy.**

The brain is often described in terms of cells and wiring. However, much of it is made of lipids that form the membranes of neurons, wrap nerve fibers with myelin, and help brain cells send and receive signals.

Despite their importance, lipids have been a blind spot in neuroscience. Unlike genes and proteins, which have been mapped in detail standard imaging methods struggle to distinguish between lipid molecules.

“So scientists have had only a blurry picture of how lipids differ from one part of the brain to another,” says Giovanni D’Angelo, professor at The Kristian Gerhard Jebsen Foundation Chair in Nutrition and Metabolism at EPFL. “That gap matters, because changes in brain lipids are increasingly linked to conditions from depression to Alzheimer’s disease.”

Now, a team of scientists led by D’Angelo, Luca Fusar Bassini, and Gioele La Manno at EPFL has built a detailed atlas of lipids across the entire mouse brain. The Lipid Brain Atlas shows that these molecules follow a precise, orderly pattern that lines up with the brain’s known anatomy and reveals boundaries that anatomy alone has missed. The pattern is so distinctive that, from the lipids alone, the team could tell where in the brain a piece of tissue came from.

The study is published in *Nature*.

**Lipids in the mouse brain**

To build the Atlas, the team used a method called mass spectrometry imaging. Essentially, it fires a laser at thin slices of brain point-by-point, and records which lipids sit at each spot.

The scientists measured a total of 172 lipids across 109 slices from 11 mice. Turning roughly 7 million individual readings into one 3D model of the whole brain took new machine-learning tools, built specially for the project.

The finished map divided the brain into 539 distinct territories, which the team named “lipizones”, each with its own signature mix of lipids.

While many lipizones line up with known cell types and brain regions, others link a cluster of nerve cell bodies to the far-off areas that their fibers reach. This is a connection that gene-based maps have usually missed. “In effect, lipids work like postal codes, giving distant but related parts of the brain the same chemical address,” says D’Angelo.

The atlas also identified patterns that earlier methods have missed. The brain’s white matter, long thought to be fairly uniform, turned out to be a patchwork of distinct zones. “This shows that the cells which make myelin are far more varied in their chemistry than their genes alone would suggest,” says Luca Fusar Bassini. The Atlas found further chemical borders in the choroid plexus, the tissue that makes the brain’s fluid, and in the linings of its internal cavities.

**Mapping brain lipids in pregnancy**

The Atlas also captured how the brain's lipids change during pregnancy. In pregnant mice, lipids shifted across many regions, and these changes were larger overall than the usual differences between males and females. The cortex, the brain's outer layer, was heavily reshaped, while a key building block of myelin called galactosyl ceramide rose sharply across much of the brain's white matter.

"Together, these shifts suggest the brain retunes its own wiring to meet the demands of pregnancy," says Gioele La Manno. "The Atlas reveals that the brain constantly adjusts its lipids to meet the body's changing needs."

The Lipid Brain Atlas is freely available online, giving researchers a new layer of information to study alongside genetics and cell biology. It offers a healthy reference for asking where lipids go wrong, and how that connects to brain development, ageing and disease.

"What transfers to humans isn't the map, it's the method, and the fact that we now know that a healthy brain has a very organized lipid map at all," says Luca Fusar Bassini.

*This experiment, conducted at EPFL under conditions governed by Swiss animal welfare legislation, was approved by the relevant veterinary authorities, notably because the potential knowledge gain was deemed to outweigh the potential suffering inflicted on the animal.*

**Other contributors**

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