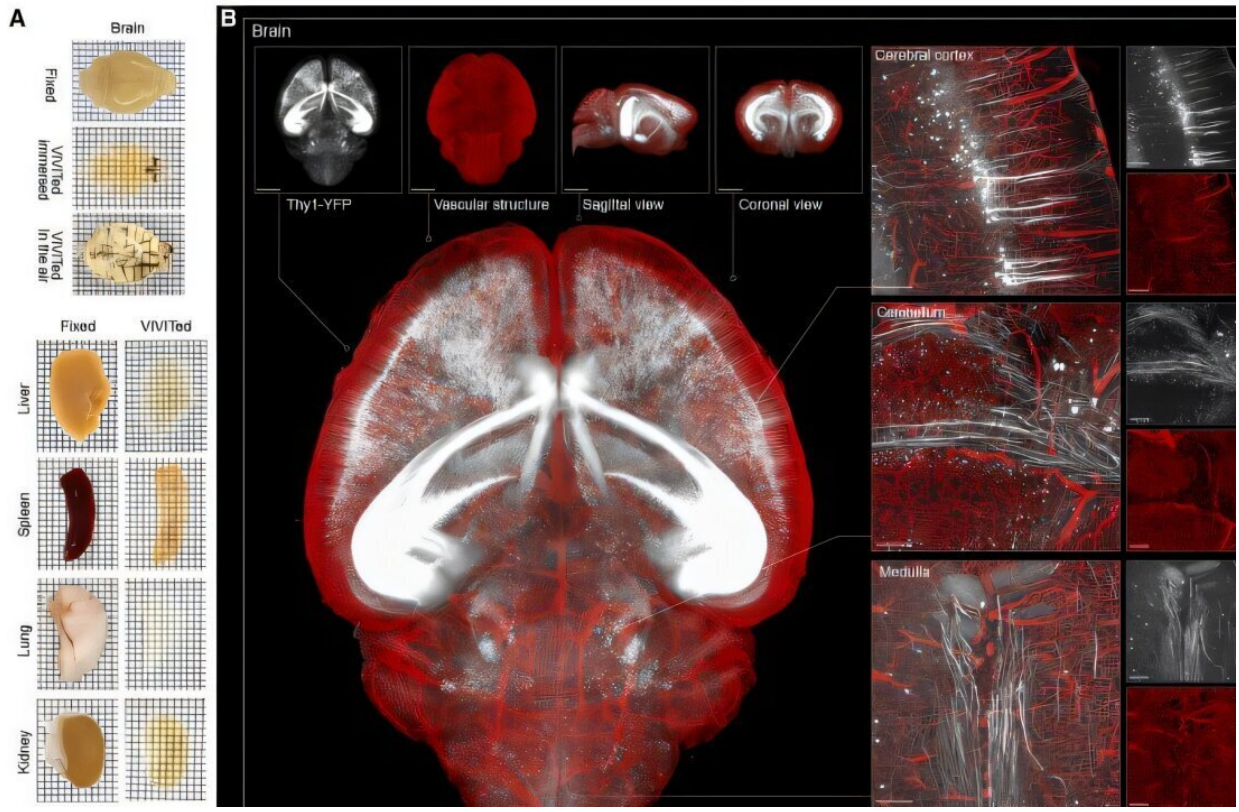
# Ionic liquids turn whole organs transparent like glass while preserving intricate tissue details

August 20 2025, by Sanjukta Mondal




VIVIT enables whole-organ transparentizing with high morphological fidelity. Credit: *Cell* (2025). DOI: 10.1016/j.cell.2025.07.023

Scientists have found a way to visualize delicate organs like the brain

and heart by letting light into the tissues and exposing their inner workings, no dissection required. In their study published in *Cell*, Chinese researchers introduce a new technique for converting biological tissue into a transparent and glass-like state, making it easier to visualize how biological tissues interact with each other at a microscopic level with exceptional resolution.

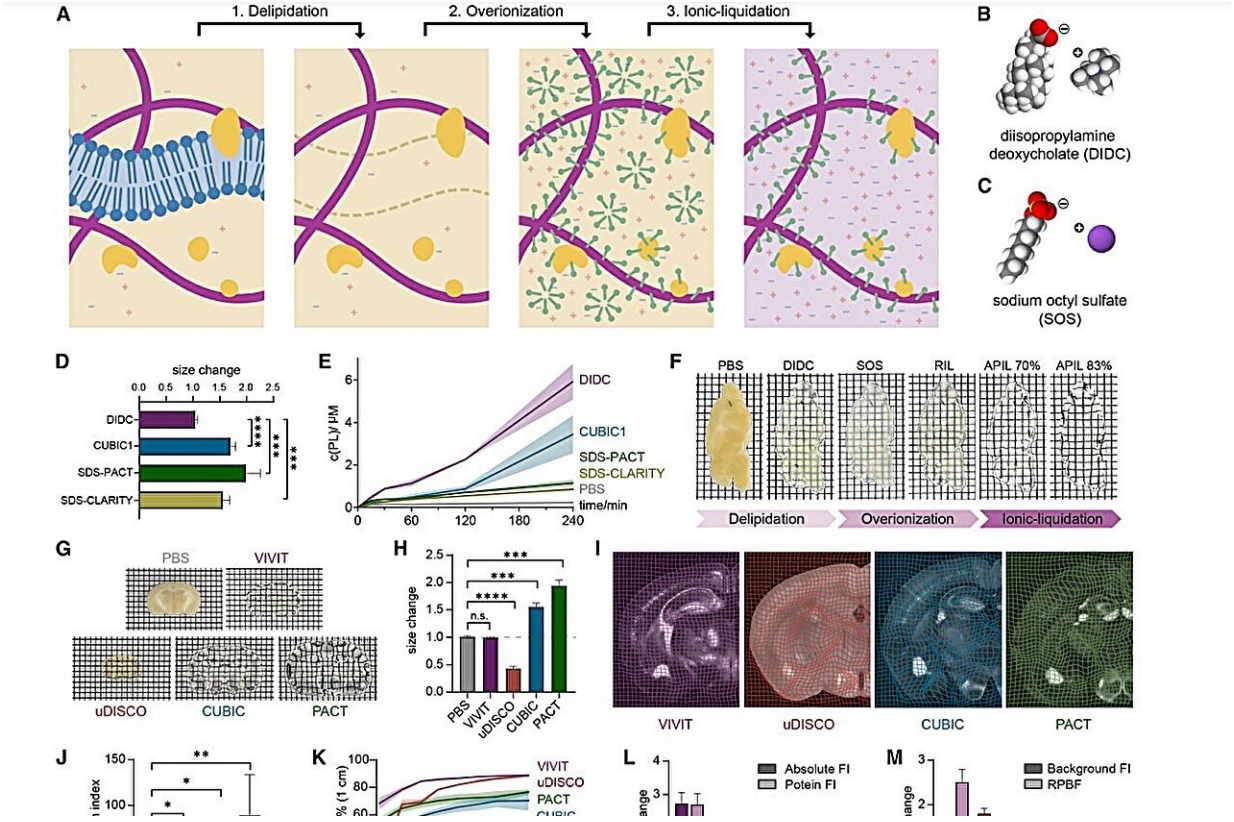
To obtain a transparent structure, the researchers developed a technique called vitreous ionic-liquid-solvent-based volumetric inspection of trans-scale biostructure or VIVIT.

The stars of the show were ionic liquids (ILs), which are salts that tend to exist in a liquid phase even at lower temperatures. Using VIVIT, researchers mapped how multisensory neurons in the brain's thalamus region connect to their incoming signals and target their brain-wide outputs, along with some new insight into inhibitory control in the human cortex.

Understanding complex biological systems requires visualizing their intricate structures and mechanisms up close and in detail. Techniques like tissue optical clearing allow scientists to image tissues in their 3D state, meaning whole organs can be seen without cutting them up.

However, most of these methods use either organic solvents or aqueous solutions to make tissues transparent, which accomplish the task but come with their own share of drawbacks. These liquids can cause tissue shrinkage or swelling—both of which distort the natural shape of the tissues.

The researchers of this study found that treating the biological samples with ILs initiated a process called vitrification where the tissues transformed into a solid glass-like structure without forming destructive ice crystals when cooled.




Adapting biological tissue to IL and enabling morphology-retained transparentizing with FP signal enhancement. Credit: *Cell* (2025). DOI: 10.1016/j.cell.2025.07.023

This non-destructive nature makes VIVIT a groundbreaking method, as it preserves delicate biological samples while allowing the team to visualize structures across scales—from whole organs down to the finest cellular connections.

Biologists often resort to high-resolution microscopy to get a better look at the structures within biological tissue. These microscopy machines do not work well with whole organ samples and thus require thinly sliced samples to attain clear images. This process damages the fine structure

and makes it difficult to reconstruct accurate 3D models from multiple slices.

VIVIT solves this problem by making the sample optically clear, thus providing a practical way to study biological structures without physically cutting the tissue. It also preserves the ability to precisely section samples in a frozen state without causing damage, thanks to the protective effects of vitrification.

An additional advantage of vitrification is its unexpected enhancement of fluorescent dye signals, increasing brightness by up to 38-fold for certain dyes, greatly improving high-resolution imaging.

The team also developed TARRS (Trans-scale Acquisition, Reconnection, and Reconstruction System), a software tool that virtually stitches sliced samples back into a 3D structure with high fidelity.

The researchers note that while VIVIT offers a practical solution for trans-scale interrogation, it remains necessary to clarify the mechanisms by which ILs interact with adapted tissues, induce non-crystalline states, and amplify fluorescence signals. Such insights can inspire the development of newer IL-based methodologies for studying complex biological systems.

**More information:** Yixiao Gao et al, VIVIT: Resolving trans-scale volumetric biological architectures via ionic glassy tissue, *Cell* (2025). DOI: 10.1016/j.cell.2025.07.023

liquids-transparent-glass-intricate.html