

Construction and analysis of a Lipid Brain Atlas

Single-cell and spatial transcriptomics technologies have matured significantly in the last few years and are now extensively used to build comprehensive atlases of tissue gene expression heterogeneity. However, while datasets of this kind are accumulating, similar resources that describe biochemical heterogeneity of tissues are still lacking.

With the advent of super-resolved Imaging Mass Spectrometry, it is now possible to efficiently and rapidly measure the biochemical composition of tissues at micron-resolution. Using the technique, the laboratories of Giovanni D'Angelo and Gioele La Manno have recently found a substantial spatial organization of lipids in the brain, the regional specificity found was significantly more extensive than previously believed.

In the brain, the role of lipids is crucial for different functions; for example, it contributes to setting neuron firing properties, controls membrane conductivity and ion fluxes. Analyzing this unexplored heterogeneity is likely to reveal new biochemical processes and principles that characterize different neurons and brain areas. Our labs are actively working to collect an extensive dataset to build a resource that will serve as a powerful tool for neurochemical research.

The doctoral candidate will have a central role in this effort. She/he will develop new computational methods to process, analyze, and organize this extensive dataset. We expect the candidate to:

- Develop ad-hoc machine learning algorithms (e.g., latent variable decomposition, deconvolution approaches) for the analysis and interpretation of spatial lipidomic data.
- Use the tools developed to analyze the regional heterogeneity of the mouse brain lipidome.
- Organize this knowledge into a resource for the community.
- Construct a volumetric 3d model of the brain and register all the data obtained in this reference frame.
- Integrate the lipid atlas with gene expression brain atlases and build principled models that can predict one data type from the other.