Probing metabolic shifts and gene expression via Raman imaging

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Oral contribution

Raman spectroscopy is a powerful tool for identifying the molecular composition of tissues and cells, as well as for detecting slow metabolic shifts over time, both ante- and post-mortem. One of my research goals is to explore and eventually provide evidence of a possible link between Raman spectral signatures and the dynamic gene expression of live cells. I will briefly introduce this emerging concept, which was first proposed in 2018. Using microbial lineages or stem cells, my investigations have highlighted that spectral signatures are good indicators of shifts in cell states and can, to some extent, be corroborated with changes in gene expression. With the ongoing development of fast-measurement Raman microscopes and high-dimensional machine-learning approaches, one can envision the possibility of identifying gene activity or functions using label-free measurements.

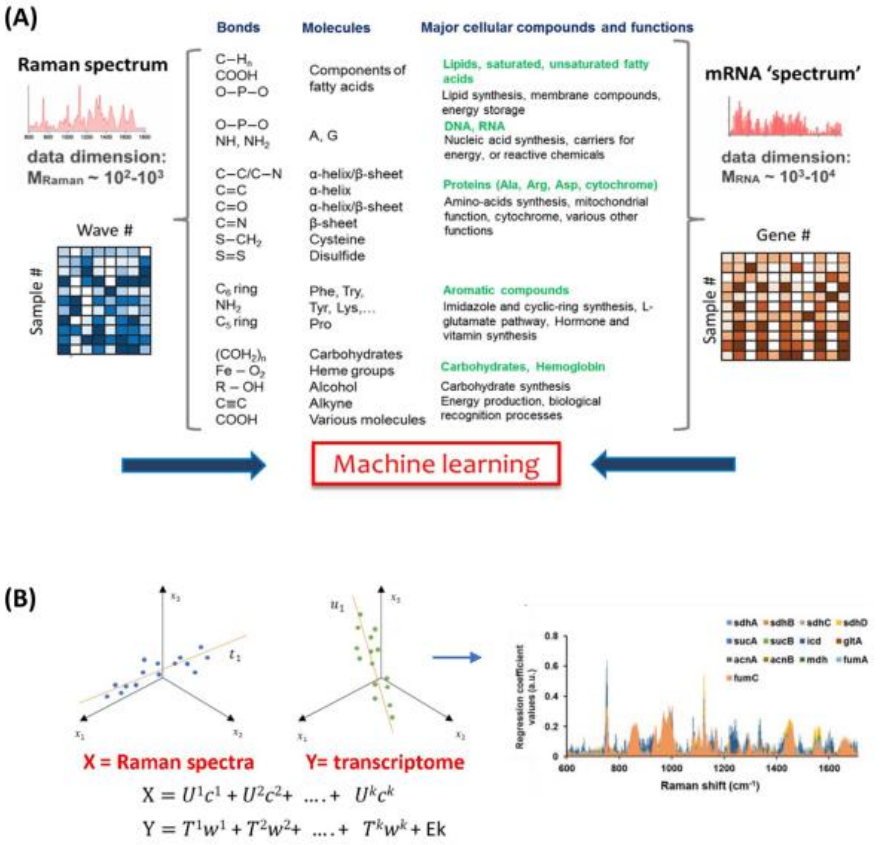

Fig. 1 (A) Raman signal information is composite and reflects the structural and metabolic composition of cells at a given time. Therefore, it may be loosely connected to gene expression through the complex network of cellular information. (B) PLS models have been used to integrate transcriptome and Raman information. One output of this integration is the regression coefficient, specific to each gene. This output can be leveraged to represent groups of genes and identify their activity from label-free spectral measurements, whether within single cells or tissues (spatial transcriptomics).[1]

References

[1] A. Germond & V. Kumar, Chap. 9 in Applied Raman Spectroscopy. Concepts, Instrumentation, Chemometrics and Life Science Application. V.Kumar Singh ed. (Elsevier, Amsterdam, 2025).