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Beyond Traditional Methods: Raman Spectroscopy for Breast Cancer Characterization

Raman spectroscopy is a promising investigative and diagnostic tool, which provides information about the molecular structure of a sample. Given the distinct molecular composition of each sample, the spectroscopic profile derived from Raman-active functional groups found in nucleic acids, proteins, lipids, and carbohydrates enables the categorization and differentiation of tissues or cell lines [1].

In this study, we aimed to differentiate between two HER-2 overexpressing breast cancer cell lines, JIMT-1 and SKBR-3, solely based on their Raman spectra. The key difference between JIMT-1 and SKBR-3 cells lies in their response to HER2-targeted therapies (trastuzumab), with JIMT-1 cells being resistant to the treatment, while SKBR-3 cells typically exhibit a favorable response [2].

To collect raman spectroscopic data from single cells, we used a spectro-microscope (LabRAM HR Evolution, Horiba Scientific), with 20x objective, 532nm excitation laser. Instead of using regular culture plate, the cells were seeded on special silica plates to optimize signal-noise ratio, as silica has a distinct raman peak at ~530nm, but is otherwise inert to Raman scattering. Preprocessing of the data was carried out before the analysis using custom software, which included baseline correction, vector normalization, and Savitzky-Golay smoothing.

We successfully developed the methodology required to carry out high-quality Raman spectro-microscopic measurements of single cells, using silica plates and special plating technique, resulting in significant reduction in background noise. We developed a custom, reusable data preprocessing software, to extract the relevant data from the measurements. The classification of the cell lines based on the first and second principal components using a support vector machine (SVM) achieved high accuracy, with a ROC-AUC of approximately 0.9.

Raman spectroscopy being non-invasive and label-free, may offer rapid molecular analysis of cells or tissues both in-vivo or in-vitro. There are several potential applications where the method can potentially be used, including in-situ biopsy assessment, cancer diagnosis, or laboratory analysis.

References

[1] Xu, J., Yu, T., Zois, C.E. et al. *Cancers,* 7 (2021) 1718
[2] Tanner, M., Kapanen, A.I., Junttila, T., Raheem, O. et al. *Mol Cancer Ther.* 12 (2004) 1585-92

Figures

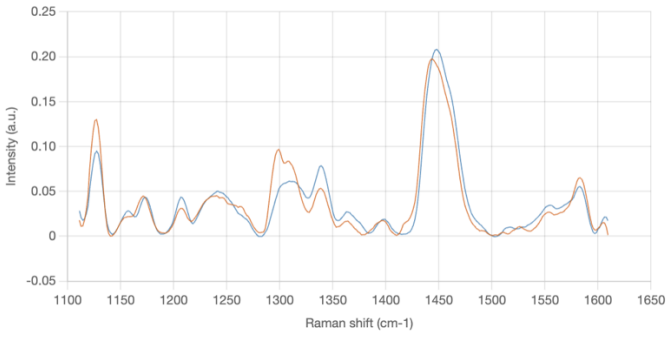

Figure 1: Raman spectra of JIMT-1 (blue) and SKBR-3 (orange) cells.