Raman and infrared micro-spectroscopy of individual cells: A summary

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This talk presents the state-of-the-art in infrared and Raman micro-spectroscopy of individual eukaryotic cells. The first Raman spectra of the nucleus and cytoplasm of an individual white blood cell were reported *[1]* as early as 1990. High quality infrared spectra of individual cells were published in 1998, using synchrotron-based *[2]*, and conventional instruments *[3]*. Infrared spectra of individual cells depend strongly on their metabolic activity. This was first reported for myeloid leukemia cells *[4]* and for exfoliated cervical cells *[5]*, for which different spectra were observed depending on the state of cell cycle activity and maturation.

The variations in spectra of single eukaryotic cells seem to be more pronounced than those in prokaryotes. We have collected thousands of spectra from individual cells to correlate spectral patterns with parameters inherent to cell growth and development, using a number of cell biological methods to correlate cellular activity and spectral characteristics. The results of these studies can be summarized as follows:

- Metabolic activity is the major factor influencing cellular spectra.
- The cell division cycle produces cellular changes, although a correlation between cell size and spectra could not be established.

The metabolic activity of a cell is manifested spectrally by contributions of phospholipids and RNA in the cytoplasm, and RNA and DNA in the nuclear regions. Distinct spectral differences between benign and malignant cell lines have not yet been found. Live cells show a characteristic intensity in the symmetric phosphate stretching region *[6]*.

Infrared spectral maps of individual cells, collected using both synchrotron and conventional light sources have revealed the distribution of cellular components *[7,8]*. However, Raman micro-spectroscopic methods are required to produce spatially resolved spectral maps of dividing cells *[9]* that approach the spatial resolution that can be obtained using visible microscopic methods.

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