The first publication on the subject of this special issue appeared in 1926 [1]. This report described the analysis of halides in ~1 mL of sap taken from Nitella plant cells. While useful for giant plant cells, the technologies available at that time were not adequate for investigating non-plant cells, including mammalian cells. It was not until 1952, when immortal cell lines became available, that more sophisticated instrumentation for analytical cytology began to appear [2], thus marking the beginning of the current era of cell-based technologies. Since then, the publication output in this area has continued to grow, and now includes contributions from the fields of analytical chemistry, biochemical research, cell biology, biotechnology, biophysics, pharmacology, electrical engineering, and materials sciences.

Not surprisingly, sessions and workshops focusing on new developments in cell analysis are commonplace at major analytical and bioengineering conferences. Since 2004, the Integrated Functional Genomics core facility at the Medical Faculty of the University of Münster has hosted the Annual Münster Conference on Single Cell and Molecule Analysis (SiCA, the logo of which has been used as the cover image of this issue). This conference is an excellent venue to take the pulse in the field of single-cell and cellular materials analysis and to become aware of the technologies that are clearly moving in the direction of single-cell detection. Indeed, some of the authors who have contributed to this special issue participated at the SiCA conference and have further developed their respective technologies.

Despite the impressive advances in cell analysis reported at conferences and in the literature, there is still a need to improve such analyses to overcome many of the challenges imposed by the cell’s dimensions and volume, the low analyte levels found within cells, the subcellular organization, the coexistence of cell types in biological matrices, and the suitability of a single cell or a few cells for drawing statistical conclusions. It is only then that cell analysis can promote new discoveries on the biological nature of humans and other species, the treatment of diseases, and the biological response to nutrition, pollution, and the environment in general.

This special issue provides a glimpse into how scientists and technologists address the challenges of cellular analysis. We have included descriptions of recent key developments in the field (six reviews), exemplary reports on new advances in the field (twelve original papers), and new technologies that promise to revolutionize the field (seven trend articles). These contributions from leaders in their fields cover microfluidic approaches that are used to label, process and analyze cell-size samples; mass spectrometry techniques that are more conducive to the analysis of complex biological milieus; novel affinity reagents for the labeling and isolation of cellular material; subcellular analysis; short- and long-range temporal analyses of cell function and cell–cell interactions; and high-throughput analysis.

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References

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