Cell dynamics exposed in the light of interference microscopy

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Modern cellular science can't do without advanced optical techniques. Most of the cell imaging techniques are however more or less invasive as they imply dyeing or drying or mechanical coercion. This undesirely affects cell function and hence is the need in a powerful noninvasive technique. Intrinsic optical properties (IOP) like local refractive index (RI) or light scattering as a noninvasive probe have turned out to be the case. Laser interference microscopy (LIM) is a modern and unique cell imaging technique which allows to see real-time changes in the local IOP of a cell.

Here we present the results of the LIM application with consequent wavelet analysis for cell visualization and cellular dynamics study. We employ several cell types. The interference imaging of red blood cells reveals reorganization of the cytoskeleton and inhomogeneous distribution of haemoglobin in the case of disease. Intracellular compartmentalization and submembrane structures are clearly seen in isolated neurons and mast cells.

Temporal variations of the local RI were also studied. We learned that low frequency variations (0.5–6 Hz) result from plasma membrane processes as higher frequency variations (15–25 Hz) result from vesicle movements and cytoskeleton reorganization. The set of detectable rhythms in the RI variations and their modulation patterns revealed by double wavelet analysis were shown to depend on the cell type and to be affected by chemical agents.

We conclude that the combination of wavelet analysis and laser interference microscopy is indeed fruitful in unravelling the tight knot of cellular processes.