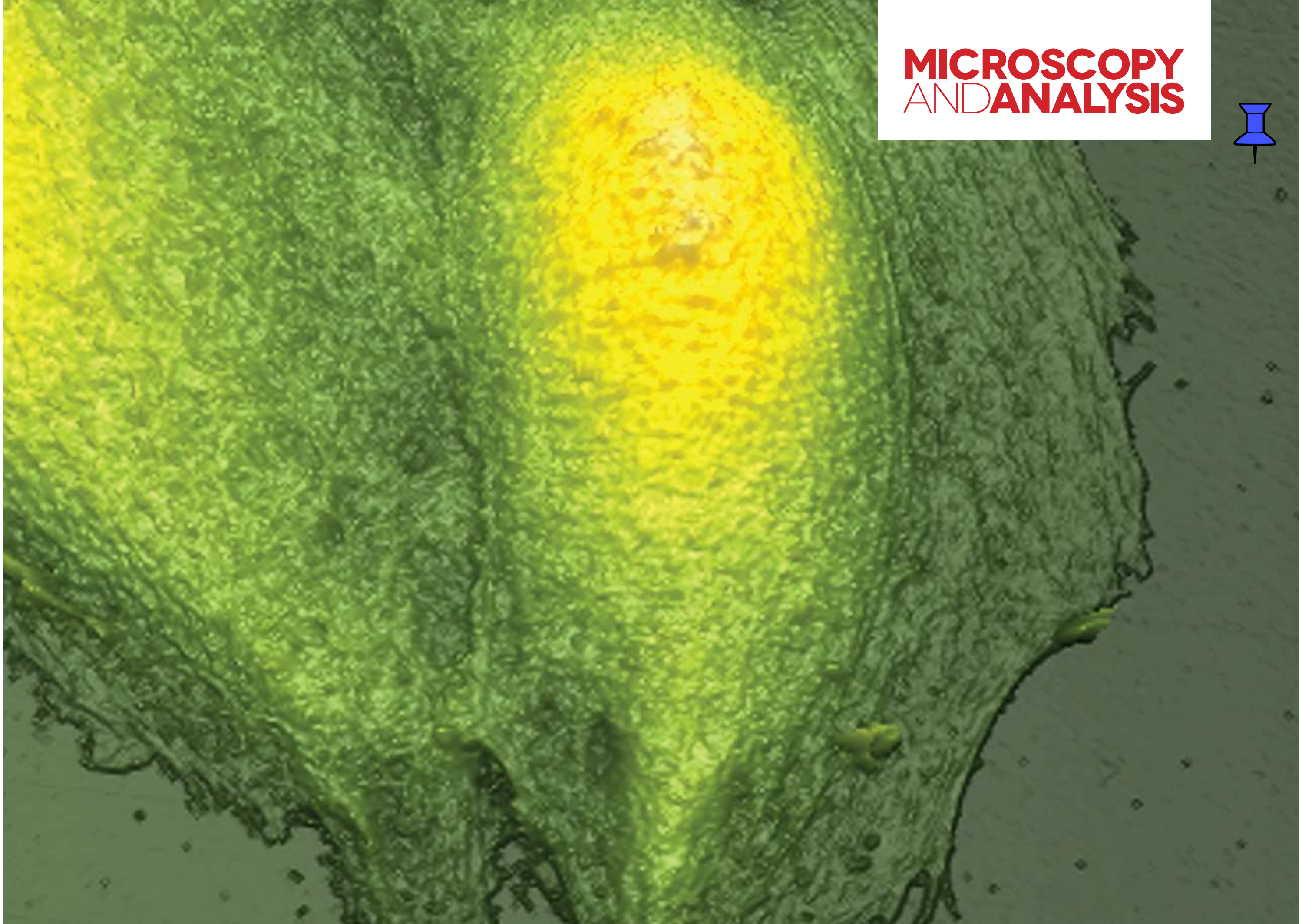

MICROSCOPY AND ANALYSIS

Atomic Force Microscopy for Life Sciences

Essential Knowledge Briefings

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Front cover image: PeakForce Tapping atomic force microscopy topography image of live Madin-Darby canine kidney (MDCK) cells (95µm image).

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About Essential Knowledge Briefings

Essential Knowledge Briefings, published by John Wiley & Sons, comprise a series of short guides to the latest techniques, applications and equipment used in analytical science. Revised and updated annually, EKBs are an essential resource for scientists working in both academia and industry looking to update their understanding of key developments within each specialty. Free to download in a range of electronic formats, the EKB range is available at www.essentialknowledgebriefings.com

INTRODUCTION

Atomic force microscopy (AFM) is becoming an increasingly important tool in biological and biomedical studies. This is due to its very high resolution, and also because, unlike other types of microscopy, it is not just an imaging technique. AFM can also provide nanometer-resolution surface mapping for many mechanical and electrical properties, such as elasticity, stiffness, conductivity and surface potential.

Life science researchers are increasingly aware that these properties can have a big impact on a range of cellular functions, including communication, signaling, cell division and differentiation, and even tumor metastasis and infection. In fact, understanding how these physical properties affect cells could be the key to differentiating between healthy and diseased states. They could also become a vital parameter in the study of pathophysiology, as well as in the development of new therapeutic approaches.

AFM uses a cantilever with a sharp tip attached to the free end to detect varying forces as the tip is scanned over a sample surface. It has proved ideal for observing, exploring and manipulating the surface of a variety of samples, ranging from individual biomolecules such as DNA or proteins to individual cells and even whole tissue samples.

There are many variations of this basic approach, which are usually referred to as AFM modes. These include several 'primary' imaging modes, which are used nearly universally and differ mainly in the way the tip interacts with the sample surface, as well as numerous 'secondary' or specialty modes, which often involve specialized tips and cantilevers. These secondary modes, which can usually be collected at the same time as primary mode topographic information, are being used to reveal novel information about cell properties.

One of the big attractions of AFM for life scientists is the possibility of conducting experiments with live cells under physiologically relevant conditions. Again, unlike many other microscopy techniques, AFM can operate under ambient conditions, even in liquid, and offers some benefits in sample preparation protocols as well.

This Essential Knowledge Briefing (EKB) introduces AFM and its life science research capabilities; it is one of a pair of EKBs on AFM, with its sister publication looking at materials research. Beginning with a detailed explanation of the operation of a typical AFM instrument, including the role of the tip, cantilever and photodetector, the EKB also outlines how AFM has evolved from primarily being a materials characterization technique to becoming an important life sciences research tool.

It describes the primary imaging modes and gives a brief introduction to some significant secondary modes, before moving on to explain some of the unique challenges involved in studying biological samples with AFM, including the always present concern of preparing biological samples and selecting the right probe. Finally, it looks at how newer AFM instruments are providing faster imaging and a larger selection of modes, and how AFM is being combined with advanced forms of light microscopy to specifically target biological applications. In addition, the EKB also includes several case studies detailing how life science researchers are using AFM in their work.