Il microscopio ottico atomico e l'intelligenza artificiale.

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Modern optical microscopes, from super-resolved fluorescence to label-free contrast mechanisms, are powerful tools that produce images rich in molecular information. This provides an unprecedented view of the morphological and functional properties of biological cells at the nanoscale. Optical microscopy reaches atomic precision, enabling subatomic localization accuracy of fluorescent molecules under ambient temperature and atmospheric pressure conditions. Furthermore, label-free methods, such as phase contrast or light polarization-based techniques, broaden the range of information acquired from the interaction between light and living systems. In this context, artificial intelligence—since the time of Hopfield and Hinton, which trained machines with examples—has become a critical component of modern optical microscopy. Optical microscopy is now becoming "intelligent," paving the way for the development of a "microscope-in-the-machine" capable of transforming label-free images into molecular-content images without the need to label samples. The equivalent in the medical field would be the ability to generate PET or MRI images directly from digital X-rays without the need for acquisition by a dedicated device.