

# Comparison of microscopic techniques/resolution

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## Introduction

A microscope is a device you use to look at objects, which are much smaller than everything your eye is able to see. In microscopy, resolution means the distance two structures at least need to have, to be identified as two different structures. It is considered to be, for example, the need for separate recognition minimum distance of two point objects or the minimum distance between the lines in an optical lattice. This article compares the resolution of different microscopes (optical microscope, confocal microscope, atomic force microscope, electron microscope and fluorescence microscope).

## Usage in medicine

Microscopic techniques and especially electron microscopes are used in medicine when it comes to renal diseases, tumor process, storage disorders and the identification of infectious agents. Light microscopes are still used everywhere where living biology is observed, for example if you want to take a look at the blood of your patient. So it is very helpful when trying to make a diagnosis. There are different types of microscopic techniques.

## Resolution of microscopic techniques

### Comparison

Optical microscopy is the oldest microscopic technique. Its resolution is about 200 nanometers, which is called the Abbe-Limit. Named after Ernst Abbe who developed the underlying regularities. Since 1963 there are several other optical microscopic techniques for example: 3D-SIM microscopy with a resolution of 105nm or 4Pi microscopy with a resolution of approximately 100-150nm.

A confocal microscope is a special type of an optical microscope. As generally with light microscopes the resolution is limited by the diffraction. The resolution of a confocal microscope can be up to 500-700nm.

An atomic force microscope does mechanical scanning of surfaces and measurement of atomic forces on the nanometerscale. So a atomic force microscope can have a resolution of 10-20nm.

Since 1930 there are electron microscopes with a higher resolution than optical microscopes, because electron waves have a 100,000 SHORTER wavelength than light. A transmission electron microscope can have a resolution up to 50pm.

Fluorescence microscopy is also a special form of optical microscopy. It is based on the physical effect of fluorescence. Since 1960s, fluorescence microscopes are usually constructed as reflected light microscopes, their resolution can be around 700nm.

### Present state of development

The Microscope with the best resolution in the world is located in California, US. It's name is TEAM 0,5 (transmission electron aberration-corrected microscope). It can resolve structures which are smaller than a hydrogen molecule (0,1nm). The technique to build this microscope is from the Technical University, Darmstadt, Germany. With this new sight of the TEAM-microscope, it is possible to watch how atoms form unions, how structures grow and react to factors from the outside. Perceptions, which science needs to understand even the smallest structures of our bodies.

Apart from that, there is a new microscopic technique which won the Chemistry Nobel Prize 2014. It is a kind of super-resolving fluorescence microscopy. Thanks to this technique physicians can now take a look deep inside a cell and watch processes on a molecular basis, with a resolution of 2,4nm, which is a big step for science. Indeed, electron microscopes had a better resolution long before, but because of the electron radiation it is not possible to examine living structures. Stefan Nell developed the underlying technique (STED) in 2000.

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