SEMMELWEIS

Nanobiotechnology and In Vivo Imaging Center

"The pursuit of truth and beauty is a sphere of activity in which we are permitted to remain children all our lives."

Albert Einstein

Mission

The mission of the ***Nanobiotechnology and In Vivo Imaging Center*** is to provide an imaginative playground for innovative research, where fundamental questions may be addressed, by using novel instrumentation, at all levels of biological organization ranging from individual molecules to the whole organism.

History

Semmelweis Nanobiotechnology and In Vivo Imaging Center is maintained by the ***Department of Biophysics and Radiation Biology.*** The department, established in 1948, has traditionally been devoted to high quality of research and education. Its earlier directors were Gyula Koczkás (1948-1950), Imre Tarján (1950-1982), Györgyi Rontó (1982-1999) and Judit Fidy (1999-2008). The first biomedical radioisotope laboratory of Hungary was established here. A crystal physics research group of international renown had been in operation for decades. Current research activities cover the fields of molecular and cellular biophysics, nanobiotechnology and radiation biophysics, single-molecule mechanics, imaging and fluorescence. Outstanding problems of biology are explored with novel and continuously developed methodologies and instrumentation.

The Nanobiotechnology and In Vivo Imaging Center is an important element of the ***Semmelweis Nanosciences Network*** established by the Senate Decree of September, 2009. In addition, it is a member of the ***Semmelweis BioImaging Consortium***, and national and European BioImaging networks.

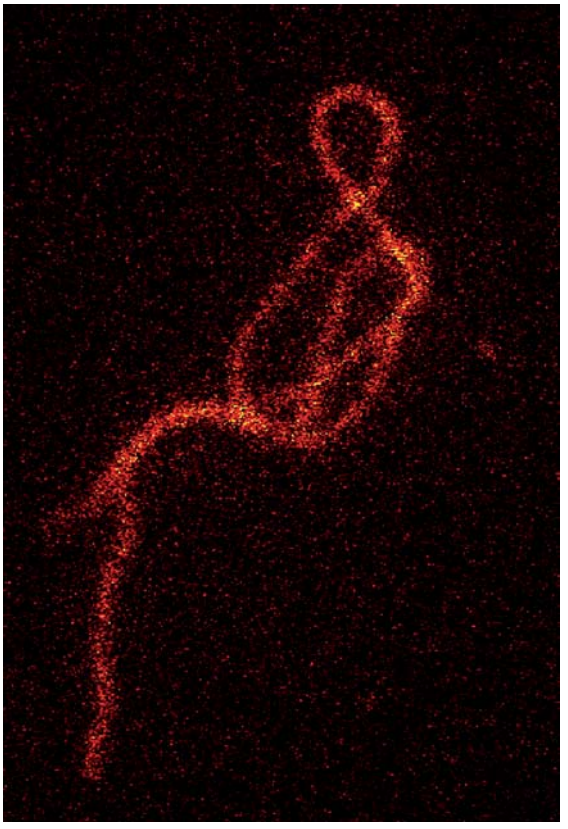
Education

Because of its physical location in the Basic Medical Science Center of Semmelweis University and its affiliation with the Department of Biophysics and Radiation Biology, the Nanobiotechnology and In Vivo Imaging Center is ideally positioned at the interface of innovative research and progressive biomedical training. Whereas departmental core curricular teaching activities currently involve "Biostatistics and informatics", "Medical biophysics", and "Medical imaging methods", novel training activities related to nanobiotechnology and nanomedicine are being developed and launched. Well-equipped lecture halls and student labs in close association with vicinal research facilities assist in high-quality education programs.

Facilities, Research, Innovation

In vitro motility assay

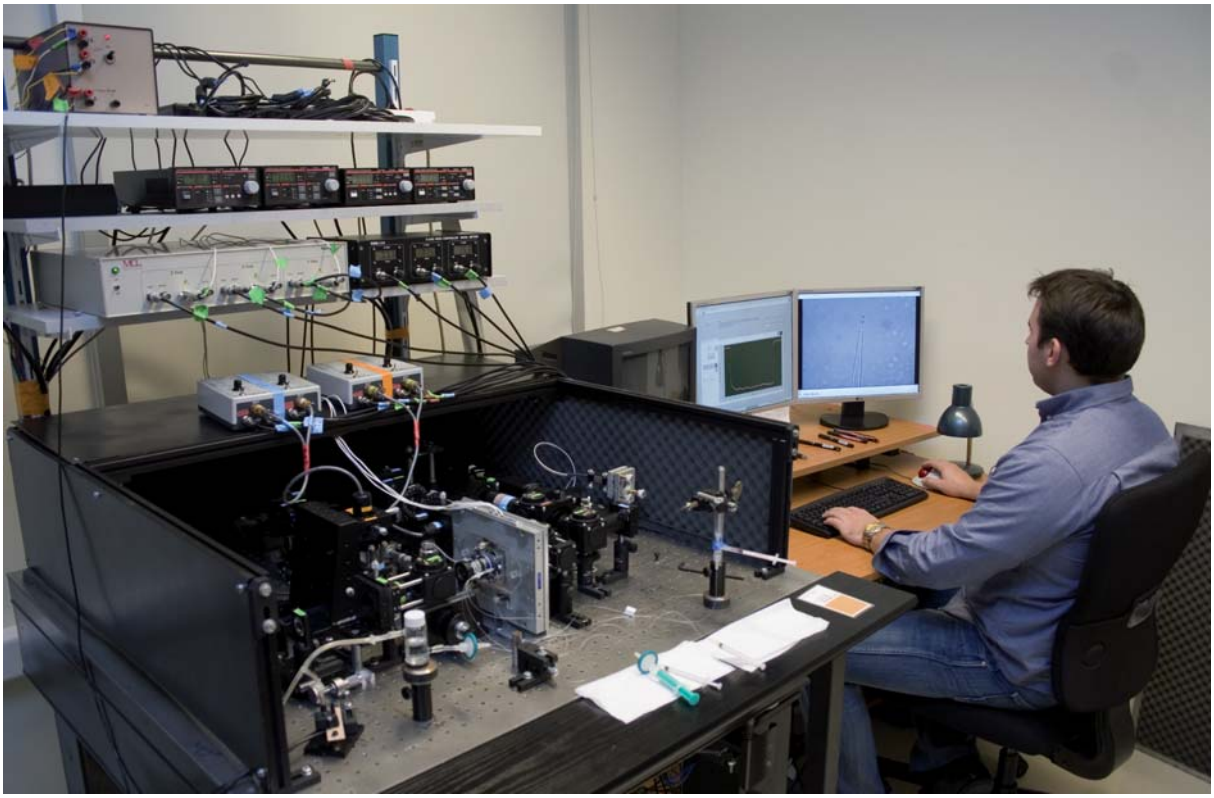
In the in vitro motility assay, individual actin filaments can be visualized in real time as they glide over a surface coated with the motor protein myosin. This experimental arrangement represents the molecular model of biological motion. Fluorescently labeled actin filaments are visualized with an epifluorescence microscope equipped with a microchannel-plate-intensified CCD camera.

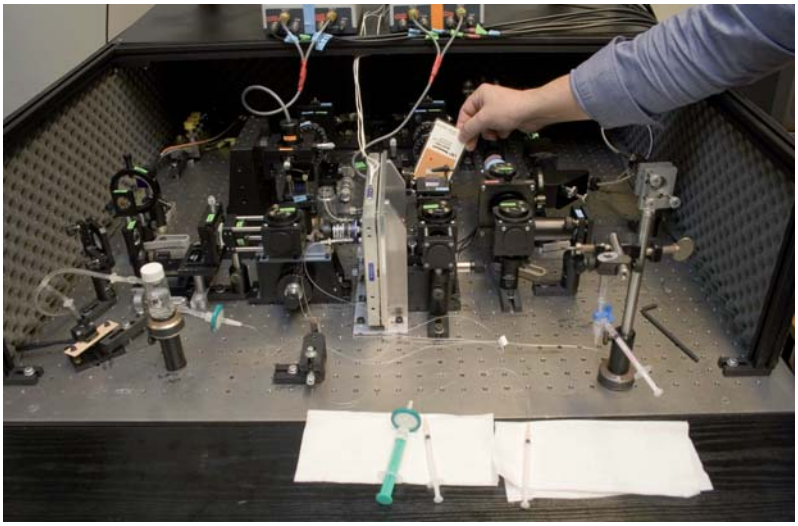


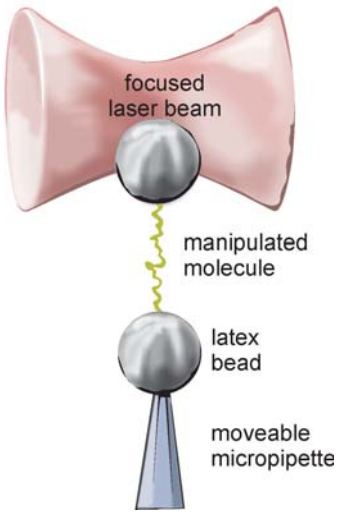
■ Actin "The Thinker"

Optical tweezers

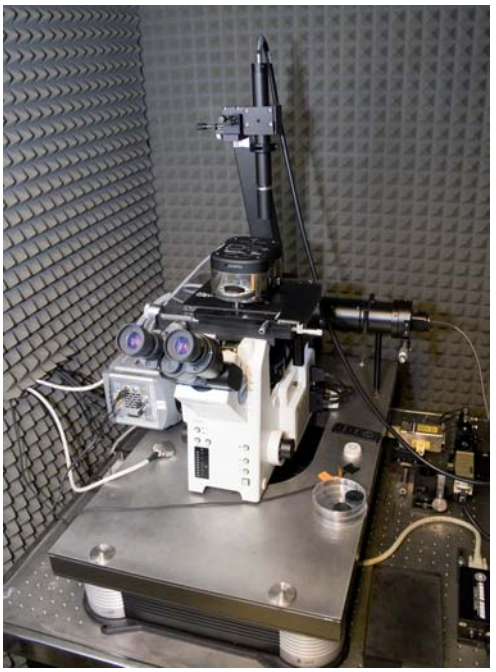
In optical tweezers tiny refractile microparticles are manipulated with a focused, powerful laser beam. Because optical tweezers function as picotensiometers, that is, they can be used to measure miniscule forces, it is possible to investigate the nanomechanics of individual molecules and intermolecular interactions. The optical tweezers instrument present in the Semmelweis Nanobiotechnology and In Vivo Imaging Center is a unique, counter-propagating, double-beam apparatus that directly measures molecular forces based on photon momentum exchange. The microparticles or microbeads function as handles by which individual molecules may be grabbed and manipulated. The available force range is between 0.1 and 150 piconewtons.



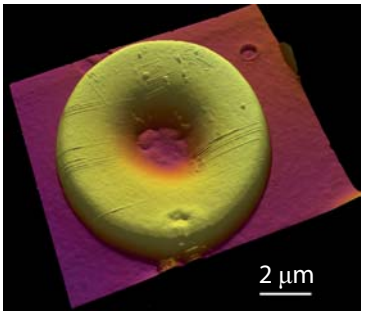




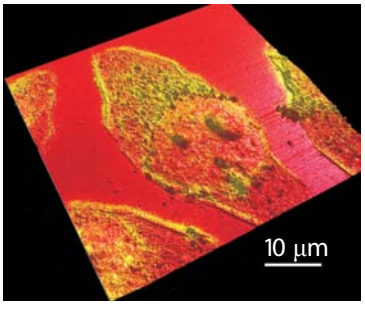
Atomic Force Microscopy (AFM) synchronized with Total Internal Reflection Fluorescence (TIRF) Microscopy



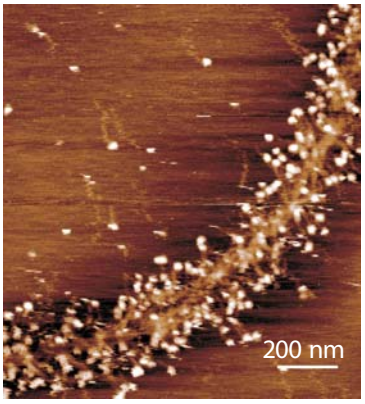
The atomic force microscope is a scanning probe microscope in which the sample surface is scanned with a sharp tip at the end of a flexible cantilever. Cantilever bending is monitored by measuring the position of a reflected laser beam while the sample is scanned with piezoelectric actuators. As a result, a topographical image with molecular resolution is obtained.
TIRF microscopy utilizes the phenomenon of total internal reflection that arises as light travels across media with different refractive indeces. A narrow electric field called evanescent field arises which excites suitable flurescent molecules. The instrumental arrangement is unique in that it allows for spatially and temporally synchronized acquisition of the fluorescence emission and topographical or mechanical data.



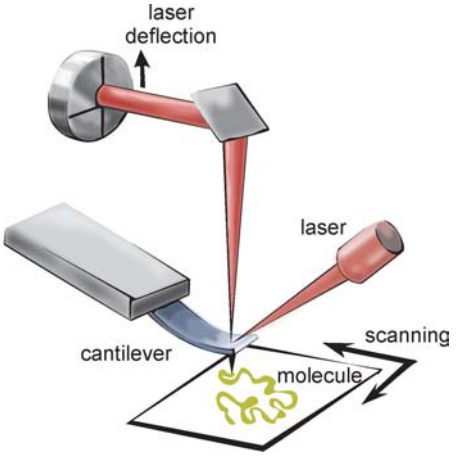
■ "Bloody" blood



■ HeLa cell, actin fluorescence

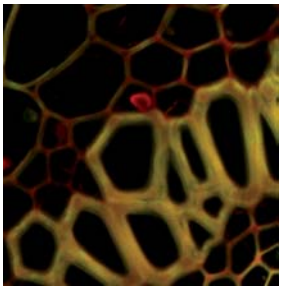


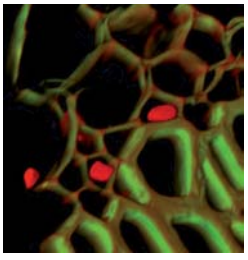
■ Myosin thick filament

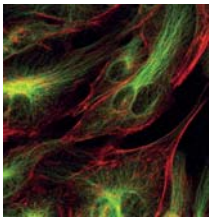


Confocal microscopy

Important features of the Zeiss LSM 710 Meta laser scanning confocal microscope are the 5 excitation wavelengths (458, 488, 514, 543, 633 nm) and simultaneous DIC and confocal imaging. The microscope is fully automated, motorized and computer controlled. The twin gate technology of the microscope enables virtually complete removal of the excitation wavelength from the image, while the photon recycling loop enhances the detection efficiency. The META detector simultaneously records 32 different wavelength regions allowing spectral imaging and decomposition of the contribution of overlapping fluorescence emissions.

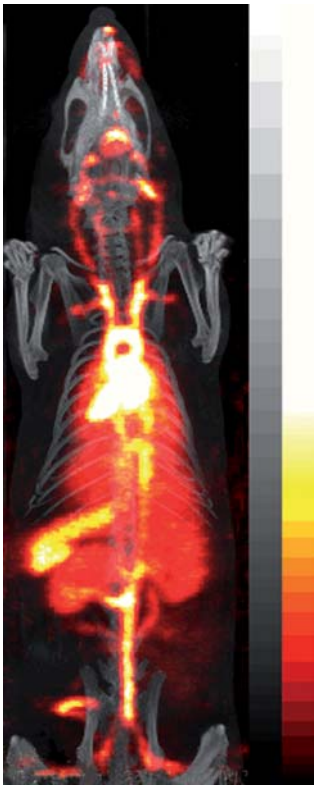






NanoSPECT/CT

NanoSPECT/CT is actually the world's highest performing in vivo animal Single Photon Emission Computed Tomography (SPECT) imaging system combined with a low-dose high-resolution micro X-ray CT scanner. It offers the unique combination of unparalleled resolution in the market (down to 0.4 mm or 120 nanoliters in SPECT) with high throughput and solid absolute quantitation of imaging data. With the use of isotopic labeling and tracing methods, almost any protein, peptide or small molecular biomarker can be imaged within the body of living animals without harming or interfering the subject. The device is of exceptional advantage for any researcher willing to see and quantify biochemical and physiological process throughout the whole body of laboratory animals (from mice to rabbits). It gives pharmacological scientists the opportunity to monitor the distribution and metabolism/excretion of their molecule of choice in vivo, in real time. It enables the detection of picomolar molecule quantities with precise anatomical details thanks to its high quality CT component. NanoSPECT/CT is manufactured in Hungary by Mediso, Ltd., the world's fourth market player in nuclear and hybrid imaging devices. It is actually in use in around 50 leading laboratories and pharmaceutical companies around the globe.



Nanobiotechnológiai és In Vivo Képalkotó Központ
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NIVIC
Nanobiotechnology and In Vivo Imaging Center

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Confocal microscopy
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Scanning AFM and optical tweezers
Room No. 0.202

Molecular force probe and in vitro motility assay
Room No. 0.201

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