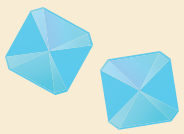
2017 NOBEL PRIZE IN CHEMISTRY

The Nobel Prize in Chemistry 2017 was awarded to Jacques Dubochet, Joachim Frank, and Richard Henderson for the development of cryo-electron microscopy for determining biomolecule structures.

X-RAY CRYSTALLOGRAPHY

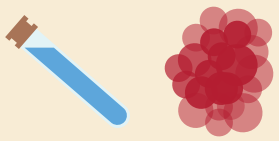


Structures of proteins that form crystals

NMR SPECTROSCOPY

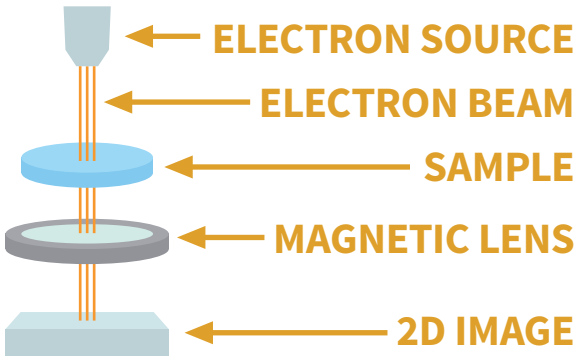
Structures of small proteins in solution

CRYO-EM

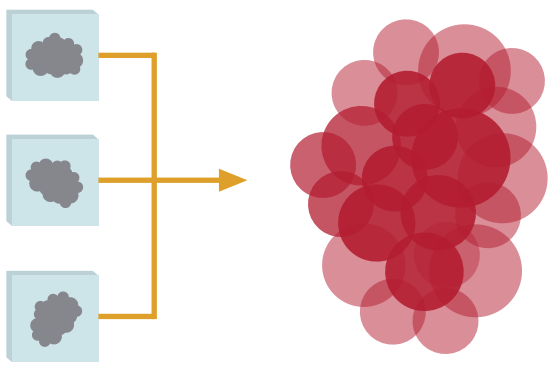


Structures of large, non-crystalline proteins

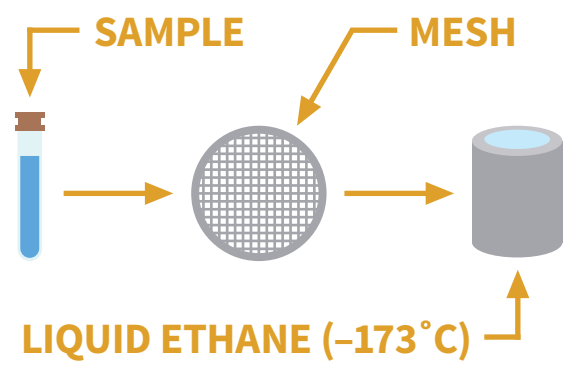
Cryo-electron microscopy (cryo-EM) is a technique that makes it possible to produce 3D images of biomolecules at atomic resolution. It can be used to capture images of biomolecules which could not be visualised with previously existing techniques.



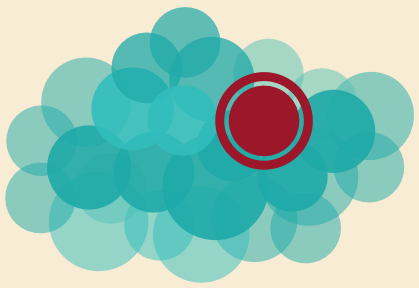
Henderson pioneered the use of electron microscopy (EM) to visualise proteins. Using it, he produced the first atomic resolution image of a protein, bacteriorhodopsin, in 1990.



Frank developed an image analysis method that allowed computers to assemble a high resolution 3D image from many 2D EM images, improving the quality of biomolecule images.



Biological samples dry out and are damaged when in vacuum during EM. **Dubochet** solved this by rapidly freezing samples in water at –173˚C to form an icy glass instead of crystals.



WHY DOES THIS RESEARCH MATTER?

Cryo-EM allows scientists to reveal how proteins move and interact with other molecules, freezing and observing them mid-process. It could improve our understanding of drug targets and biological processes.

Nobel Prize in Chemistry Press release: https://www.nobelprize.org/nobel_prizes/chemistry/laureates/2017/press.html

COMPOUND iNTEREST

The Nobel Prize in Chemistry 2017

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Chemistry 2017 to

Jacques Dubochet
University of Lausanne, Switzerland

Joachim Frank
Columbia University, New York, USA

Richard Henderson
MRC Laboratory of Molecular Biology, Cambridge, UK

"for developing cryo-electron microscopy for the high-resolution structure determination of biomolecules in solution"

Cool microscope technology revolutionises biochemistry

We may soon have detailed images of life's complex machineries in atomic resolution. The Nobel Prize in Chemistry 2017 is awarded to Jacques Dubochet, Joachim Frank and Richard Henderson for the development of cryo-electron microscopy, which both simplifies and improves the imaging of biomolecules. This method has moved biochemistry into a new era.

A picture is a key to understanding. Scientific breakthroughs often build upon the successful visualisation of objects invisible to the human eye. However, biochemical maps have long been filled with blank spaces because the available technology has had difficulty generating images of much of life's molecular machinery. Cryo-electron microscopy changes all of this. Researchers can now freeze biomolecules mid-movement and visualise processes they have never previously seen, which is decisive for both the basic understanding of life's chemistry and for the development of pharmaceuticals.

Electron microscopes were long believed to only be suitable for imaging dead matter, because the powerful electron beam destroys biological material. But in 1990, Richard Henderson succeeded in using an electron microscope to generate a three-dimensional image of a protein at atomic resolution. This breakthrough proved the technology's potential.

Joachim Frank made the technology generally applicable. Between 1975 and 1986 he developed an image processing method in which the electron microscope's fuzzy two-dimensional images are analysed and merged to reveal a sharp three-dimensional structure.

Jacques Dubochet added water to electron microscopy. Liquid water evaporates in the electron microscope's vacuum, which makes the biomolecules collapse. In the early 1980s, Dubochet succeeded in vitrifying water – he cooled water so rapidly that it solidified in its liquid form around a biological sample, allowing the biomolecules to retain their natural shape even in a vacuum.

Following these discoveries, the electron microscope's every nut and bolt have been optimised. The desired atomic resolution was reached in 2013, and researchers can now routinely produce three-dimensional structures of biomolecules. In the past few years, scientific literature has been filled with images of everything from proteins that cause antibiotic resistance, to the surface of the Zika virus. Biochemistry is now facing an explosive development and is all set for an exciting future.

Jacques Dubochet, born 1942 in Aigle, Switzerland. Ph.D. 1973, University of Geneva and University of Basel, Switzerland. Honorary Professor of Biophysics, University of Lausanne, Switzerland.

www.unil.ch/dee/en/home/menuinst/people/honorary-professors/prof-jacques-dubochet.html

Joachim Frank, born 1940 in Siegen, Germany. Ph.D. 1970, Technical University of Munich, Germany. Professor of Biochemistry and Molecular Biophysics and of Biological Sciences, Columbia University, New York, USA.

http://franklab.cpmc.columbia.edu/franklab/

Richard Henderson, born 1945 in Edinburgh, Scotland. Ph.D. 1969, Cambridge University, UK. Programme Leader, MRC Laboratory of Molecular Biology, Cambridge, UK.

www2.mrc-lmb.cam.ac.uk/groups/rh15/

Prize amount: 9 million Swedish krona, to be shared equally between the Laureates.
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