

2017 Nobel Prize in Chemistry: All you need to know

Members of the Nobel Committee sit in front of a giant screen displaying the winners of the 2017 Nobel Prize in Chemistry (left to right) Jacques Dubochet from Switzerland, Joachim Frank from the U.S. and Richard Henderson from Britain on October 4, 2017 at the Royal Swedish Academy of Sciences in Stockholm, Sweden. | Photo Credit: [AFP](#)

The [2017 Nobel prize in Chemistry](#) has been awarded to Jacques Dubochet (University of Lausanne, Switzerland) Joachim Frank (Columbia University, New York) and Richard Henderson (MRC Laboratory of Molecular Biology, Cambridge, U.K.) "for developing cryo-electron microscopy for the high-resolution structure determination of biomolecules in solution".

For many years — in the 1970s, the electron microscope was the only way to look into the cell and observe the minute beings that play such an important role in our lives such as viruses. However, the powerful beam of the electron microscope would destroy biological material, so it was believed that such microscopy could only reveal images of dead cells and dead organisms. Also it was then impossible to view solutions as water would evaporate under the microscope's vacuum.

That was until this year's laureate Richard Henderson came on to the scene. To get the sharpest images he travelled to the best electron microscopes in the world. They all had their weaknesses, but complemented each other. Finally, in 1990, 15 years after he had published the first model, Prof. Henderson achieved his goal and was able to present a structure of bacteriorhodopsin at atomic resolution.

However the problem still remained of imaging biological molecules which got destroyed when the electron beam of the microscope was focused on them at normal temperatures.

"Cryo", short for cryogenic refers to very low temperatures. Though the actual temperature is not well defined, it is below minus 150°C. In the context of electron microscopy, it refers to the fact that the object to be imaged is frozen to such low temperatures to facilitate being studied under the beam of the electron microscope.

This method is so effective that even in recent times, it has been used to image the elusive Zika virus: When researchers began to suspect that the Zika virus was causing the epidemic of brain-damaged newborns in Brazil, they turned to cryo-EM to visualise the virus. Over a few months, three-dimensional (3D) images of the virus at atomic resolution were generated and researchers could start searching for potential targets for pharmaceuticals.

The question was whether the method could be generalised: would it be possible to use an electron microscope to generate high-resolution 3D images of proteins that were randomly scattered in the sample and oriented in different directions?

Prof. Frank had long worked to find a solution to just that problem. In 1975, he presented a theoretical strategy where the apparently minimal information found in the electron microscope's two-dimensional images could be merged to generate a high-resolution, three-dimensional whole. Between 1975 and 1986, Prof. Frank succeeded in merging two fuzzy images of a molecule to get a three-dimensional image.

In 1978, Prof. Dubochet was recruited to the European Molecular Biology Laboratory in Heidelberg to solve another of the electron microscope's basic problems: how biological samples dry out and are damaged when exposed to a vacuum. The solution he envisaged was to freeze water rapidly so that instead of solidifying into a crystalline solid, it freezes into a disordered state, which is like a

glass. Though a glass appears to be solid, it is actually what is called a supercooled liquid in which individual molecules are arranged at random instead of a periodic crystalline solid structure. Prof. Dubochet realised that if he could freeze the water to form a glassy state, what is known as vitrified water, it would not dry up when excited by the beam.

In the early 1980s, Prof. Dubochet 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. In 1984, he published the first images of a number of different viruses, round and hexagonal, that are shown in sharp contrast against the background of vitrified water.

A study of nearly 300 people living in different parts of India found that nine single-base variants (single-nucleotide polymorphisms or SNPs) account

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