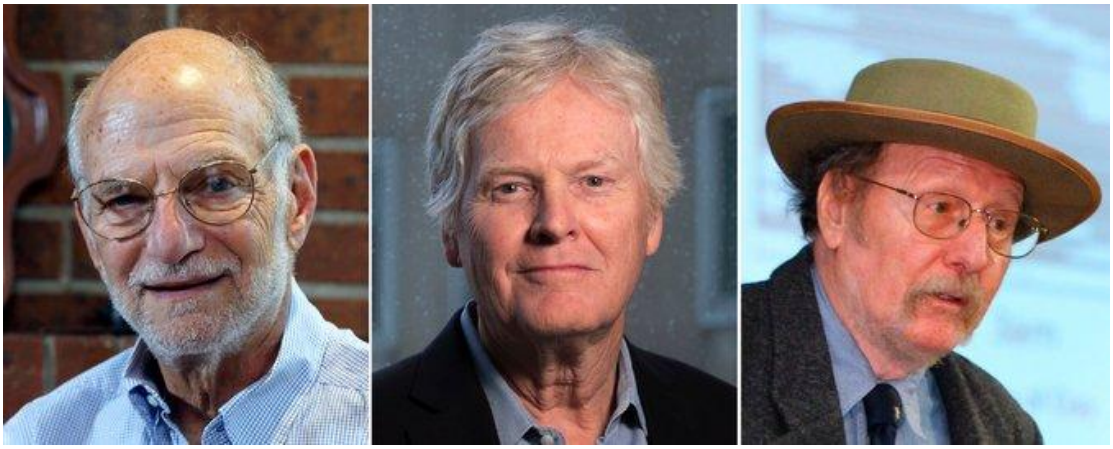
Nobel Prize in Physiology or Medicine 2017



Left to right: Michael Rosbash, Michael W. Young and Jeffrey C. Hall, have been awarded the Nobel Prize in Physiology/ Medicine, 2017.

Who has won the Nobel Prize in Medicine this year?

This year's Nobel Prize in the physiology or Medicine has been awarded to Three American scientists, Jeffrey C. Hall, Michael Rosbash and Michael W. Young for their work on clock genes.

Clock genes refer to specific genes that control the metabolic patterns of living beings including humans. Why do we feel sleepy after a certain period of being awake? How does our heartbeat vary during the various periods of a day? Etc. Such are the questions that have been answered by the work of these scientists who have been awarded this year's Nobel Prize in physiology.

Hall, a Geneticist and Rosbash, a Molecular Biologist who carried out their work at Brandeis University in Waltham, Mass. identified a gene called *Period* in 1984. At the same time, Young, a Geneticist from Rockefeller University in New York City was also working on the similar gene. In 1994 Young reported the discovery of another clock gene now known as *Timeless*. However, it took 20 years for these three to discover how these genes worked.

How these Clock Genes work?

Translation of *Period* and *Timeless* clock genes lead to PER and TIM proteins. These proteins are found virtually in every cell. Both these proteins bind together and slip into nucleus of the cell where they halt their own translation process *via* feedback mechanism. A number of other internal clock gears have been discovered by Hall, Roshbash and Young. All these Clock genes and its proteins govern a network of system termed as **"circadian"** rhythms (Figure 1).

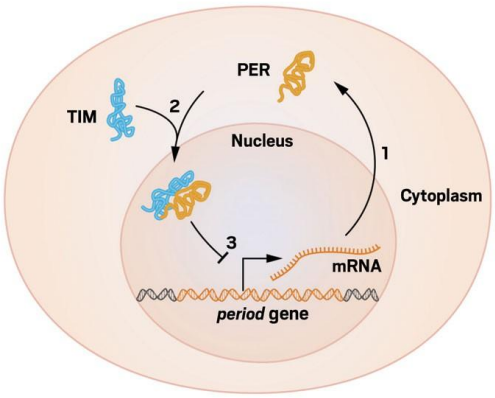


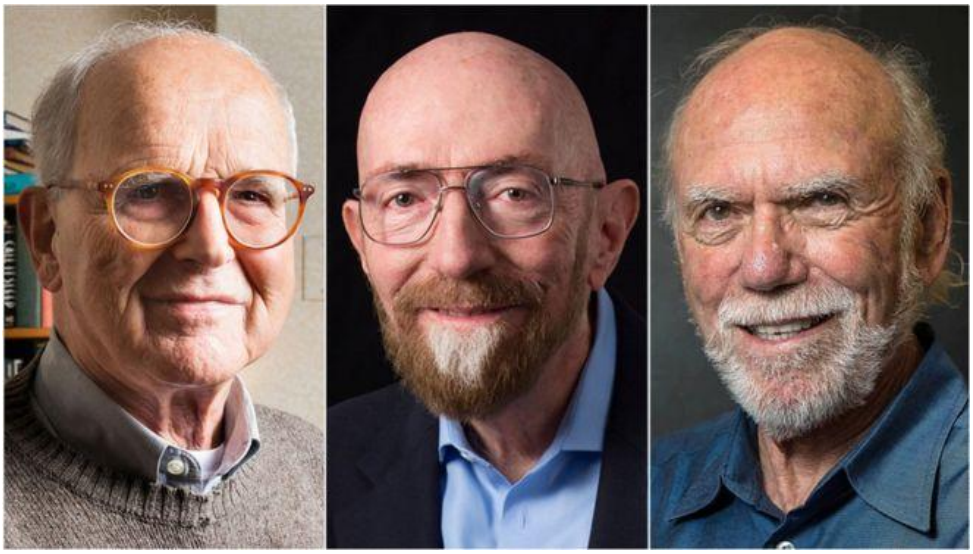
Figure 1. Simplified illustration of the molecular components of the circadian clock. (Credit: Nobel Assembly at Karolinska Institutet).

Significance of these genes

Circadian rhythms have significant impact on the living homeostasis such as controlling body temperature around a day, blood pressure, sleep patterns and release of hormones (e.g. Insulin). Every cell follows a certain circadian rhythm based on its function however master circadian is thought to exist in the Brain.

Troubles develop when these circadian rhythms lose their track and start to behave anomalously. Genes such as *cMyc* and *P53* are in part controlled by circadian system, which in their aberrant function are heavily involved in uncontrolled cell growth and division. As a further significance of these body clocks many scientists believe they can be used for administering drugs on a particular time where these drugs can be metabolized faster leading to their increased effectiveness.

Nobel Prize in Physics 2017



Left to right: Rainer Weiss, Kip Thorne and Barry Barish, have been awarded the 2017 Nobel Prize in Physics.

Ripples in space time

This year's Nobel Prize celebrates yet another modern Physics milestone by awarding Nobel Prize for Physics to a trio (Rainer Weiss, Kip Thorne and Barry Barish) who have made decisive contribution towards the Detection of Gravitational Waves and construction of LIGO (Laser Interferometer Gravitational Wave Observatory) instrument (Figure 2, Left).

Weiss was born in Germany and is associated with LIGO/VIRGO Collaboration, Massachusetts Institute of Technology (MIT), Cambridge, MA, USA. Barish and Thorne are from USA and are associated with LIGO/VIRGO Collaboration, California Institute of Technology (Caltech), Pasadena, CA, USA.

Figure 2 (Left): LIGO Observatory, Livingston (Credit: Colombia Data Institute), (Right): Artistic depiction of two black holes merging together (Credit: IGO/CALTECH/MIT/SONOMA STATE).

What does it mean?

When Einstein postulated his famous theory of General Relativity, he hypothesized that the mass of objects curves space-time leading to the phenomena of gravity. As a consequence, these gravitational forces also propagate through space in the form of gravitational waves travelling with the speed of light. These waves cause minute compressions and expansions of space-time in small, localized regions as they travel through space. Since then physicists have tried their best to observe these fluctuations in space to prove the existence of gravitational waves and to support the theory of general relativity. Due to the weakness of these effects it requires gravitational interactions involving very massive objects such as neutron stars or black holes to provide even a very weak, measurable signal (Figure 2, Right). It was LIGO which made it possible for the scientists to prove these space ripples with evidence after their initial prediction some 100 years ago by Einstein.

What comes next?

This discovery is expected to have a far reaching effect on Experimental Astrophysics, Theoretical Physics and Cosmology, where LIGO is viewed to lead to many new and exciting discoveries in coming years. Recently another LIGO/VIRGO based discovery has been made.

Nobel Prize in Chemistry 2017

Imaging Life's Complex Machineries

The Nobel Prize in Chemistry for 2017 honors chemists for developing techniques to image life's complex machineries with atomic resolution. The prize has been awarded to Jacques Dubochet, Joachim Frank and Richard Henderson for their discovery of Cryo-Electron microscopy and its use to unravel the high resolution structures of bio-molecules in solution.

Richard Henderson is a Molecular Biologist from Cambridge University, Frank is a Biochemist at Columbia University and Dubochet is a biophysicist at University of Lausanne, Switzerland.

Left to right: Jacques Dubochet, Joachim Frank and Richard Henderson, winners of this year's Nobel Prize in Chemistry.

What does this discovery mean?

Using Cryo-electron microscopy researchers can now freeze biomolecules mid-movement and visualise processes they have never seen previously, 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 (Figure 3, Right).

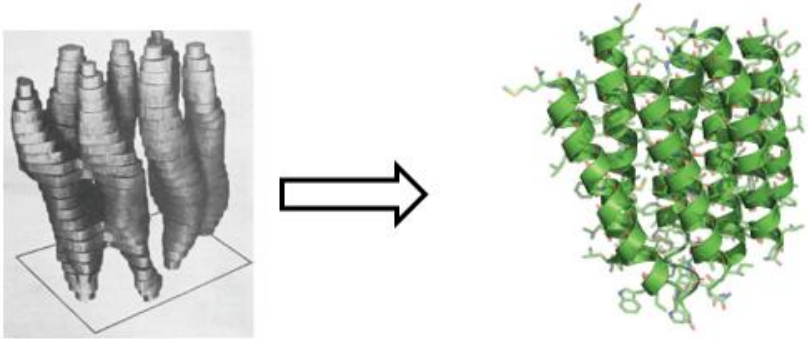


Figure 3. The first rough model of bacteriorhodopsin, published in 1975 (left). In 1990, Henderson presented a bacteriorhodopsin structure at atomic resolution (Right), Credit: Nobel Prize.org.

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. Dubochet principle for vitrification is illustrated by another recent study (Figure 4).

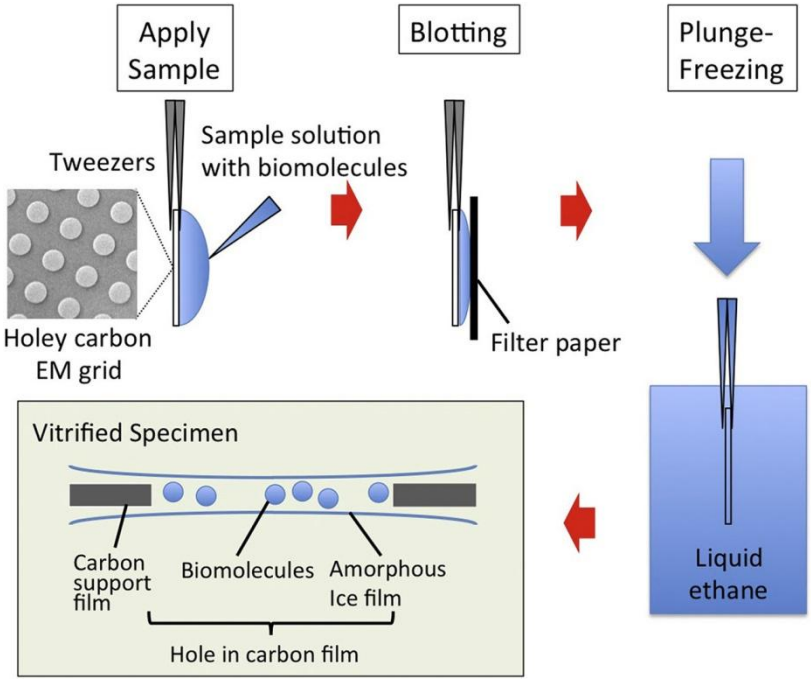


Figure 4. Vitrification method used for Cryo-Electron Microscopy*.

The ability to understand biological processes in real time will help enormously to escalate drug discovery efforts in the right direction. The effectiveness of this technique was truly demonstrated during recent Zika virus outbreak, scientists accurately predicted and generated the structure of this virus within few months to help identify the target for its therapeutic intervention. Many scientists including Ada Yonath, 2009 Nobel Laureate in Chemistry believes that the next revolution in chemistry and allied fields belongs to the splendor of resolution.

* Murata, K., & Wolf, M. (2017). Cryo-electron microscopy for structural analysis of dynamic biological macromolecules. *Biochimica et Biophysica Acta (BBA)-General Subjects*.