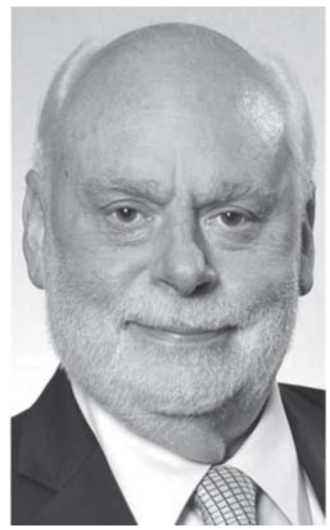
NOBEL PRIZES IN SCIENCE : 2016

CHEMISTRY

The Royal Swedish Academy of Sciences announced on October 5, 2016 their decision to award the Nobel Prize in Chemistry for 2016 jointly to Jean-Pierre Sauvage (University of Strasbourg, France), Sir J. Fraser Stoddart (Northwestern University, Evanston, IL, USA) and Bernard L. Feringa (Northwestern University, Evanston, IL, USA) *"for the design and synthesis of molecular machines"* that are a thousand times thinner than a hair strand. This is the story of how they succeeded in linking molecules together to design everything from a tiny lift to motors and miniscule muscles. They have developed world's smallest machines – molecules whose movements can be controlled and which can perform a task when energy is supplied to them. The prize money of 8 million Swedish krona is to be shared equally between the three Laureates.

Jean-Pierre Sauvage

Jean-Pierre Sauvage was born in 1944 in Paris, France. He obtained his Ph.D. degree in 1971 from the University of Strasbourg, France. He is now Professor Emeritus at the University of Strasbourg and Director of Research Emeritus at the National Center for Scientific Research (CNRS), France. Sir J. Fraser Stoddart was born in 1942 in Edinburgh, UK. He obtained his Ph.D. degree in 1966 from the Edinburgh University, UK. He is now Board of Trustees Professor of Chemistry at Northwestern University, Evanston, IL, USA. Bernard L. Feringa, was born in 1951 in Barger-Compascuum, the Netherlands. He obtained his Ph.D.degree in 1978 from the University of Groningen, the Netherlands. He is now Professor in Organic Chemistry at the University of Groningen, the Netherlands.



J. Fraser Stoddart

The discovery made by these three scientists is a fitting reply to the comment of another Nobel Laureate, Richard Feynman who said at the start of his visionary lecture in 1984: "Now let us talk about the possibility of making machines with movable parts, which are very tiny". In fact, Feynman is famed for his predictions (1950s) of the developments in nanotechnology. He believed, it was possible to build machines with dimensions on the nanometre scale since such machines already existed in nature. He cited the case of bacterial flagella as an example; when these corkscrew-shaped macromolecules spin, they make the bacteria move forward.

Bernard L. Feringa

But Feynman was perhaps unaware of the fact that the first step towards this direction had already been reported a year earlier. In 1983, this first step towards a molecular machine was achieved by a French group of researchers (working in photochemistry), led by Jean-Pierre Sauvage, who used copper ions to create a new class of molecular chains called *catenanes* (derived from the Latin word *catena* for chain), in which two ring-shaped molecules are interlocked, i.e. connected not by a covalent bond but by a freer mechanical bond. In order to perform a task, a machine must consist of parts that can move relative to each other. The two interlocked rings in a catenane exactly fulfilled this requirement. Later in 1994, Sauvage's group succeeded in creating a catenane, in which one ring rotated, in a controlled manner, one revolution around the other ring when energy was added. This was the first embryo of a non-biological molecular machine.

The second step towards building molecular machines was taken by Stoddart who was attracted to chemistry by the prospect of becoming a molecular artist, sculpting new shapes that do not exist in the world. In 1991, his group developed a *rotaxane* – a ring-shaped molecule that is mechanically attached to an axle, i.e. a long rod. When heat is supplied to the molecule, the ring was able to move along the axle in a controlled manner. Stoddart's group has since used rotaxanes to construct numerous molecular machines including an artificial lift (2004) which can raise itself 0.7 nm above a surface, an artificial muscle (2005) and a computer chip with a 20 kB memory.

Like Stoddart, Feringa too was attracted to chemistry by its enormous capability to create molecules and materials that never existed before. In 1999, Feringa constructed the first molecular motor which spins continuously in the same direction when UV pulse is applied. In 2014, his group optimised the motor so that it now rotated at a speed of 12 million revolutions per second. In 2011, the research group also built a four-wheel drive *nanocar*, in which a molecular chassis held together four molecular motors functioning as wheels. When the wheels span, the car moved forward over a surface. In another striking achievement, Feringa's group used molecular motor to spin a 28 µm long glass cylinder which was 10,000 times bigger than the motor.

Sauvage, Stoddart and Feringa, considered together, have developed numerous molecular machines that have resulted in a toolbox of chemical structures that are used by the global community of researchers to build increasingly advanced creations. A notable example is the building of a rotaxane-based molecular robot (2013) which can grasp and connect amino acids. The research groups of these three Nobel Laureates have developed artificial molecular systems that perform a controlled task, just as do the molecules of life. Their work has brought us into the first step of a new world.

When interviewed by the Chief Scientific Officer of Nobel media, some of the reactions of two of the Nobel Laureates were as follows: **Stoddart**: "— I'm overawed, and in a state of shock [Laugh]." "—, and so that's what's driven me through chemistry, its wonderful ability to express yourself in an artistic form." **Feringa**: "—. I'm emotional and I'm deeply honoured." "—, and this is our main goal of course, to build in all kinds of new functions. And in this case the function of transport, motion, machinery." ❐

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PHYSICS

This year's Laureates opened the door on an unknown world where matter exists in strange states. The Nobel Prize in Physics 2016 is awarded with one half to ***David J. Thouless****, University of Washington, Seattle, and the other half to* ***F. Duncan M. Haldane****, Princeton University, and* ***J. Michael Kosterlitz****, Brown Univer-sity, Providence. Their discoveries have brought about breakthroughs in the theoretical understanding of matter's mysteries and created new perspectives on the development of innovative materials.*

David J. Thouless

David Thouless, Duncan Haldane, and Michael Kosterlitz have used advanced mathematical methods to explain strange phenomena in unusual phases (or states) of matter, such as superconductors, super-fluids or thin magnetic films. Kosterlitz and Thouless have studied phenomena that arise in a flat world – on surfaces or inside extremely thin layers that can be considered two-dimensional, compared to the three dimensions (length, width and height) with which reality is usually described. Haldane has also studied matter that forms threads so thin they can be considered one-dimensional.

The physics that takes place in the flatlands is very dif-ferent to that we recognise in the world around us. Even if very thinly distributed matter consists of millions of atoms, and even if each atom's behaviour can be explai-ned using quantum physics, atoms display completely different properties when lots of them come together. New collective phenomena are being continually disco-vered in these flatlands, and condensed matter physics is now one of the most vibrant fields in physics.

F. Duncan M. Haldane

The three Laureates' use of topological concepts in physics was decisive for their discoveries. Topology is a branch of mathematics that describes properties that change step-wise. With modern topology as a tool, this year's Laureates presented surprising results, which have opened up new fields of research and led to the creation of new and important concepts within several areas of physics.

Quantum physics becomes visible in the cold

Deep down, all matter is governed by the laws of quantum physics. Gases, liquids and solids are the usual phases of matter, in which quantum effects are often hidden by random atomic movements. But in extreme cold, close to absolute zero (–273 degrees Celsius) matter assumes strange new phases and behaves in unexpected ways. Quantum physics, which otherwise only works in the micro-scale world, suddenly becomes visible (fig. 1).

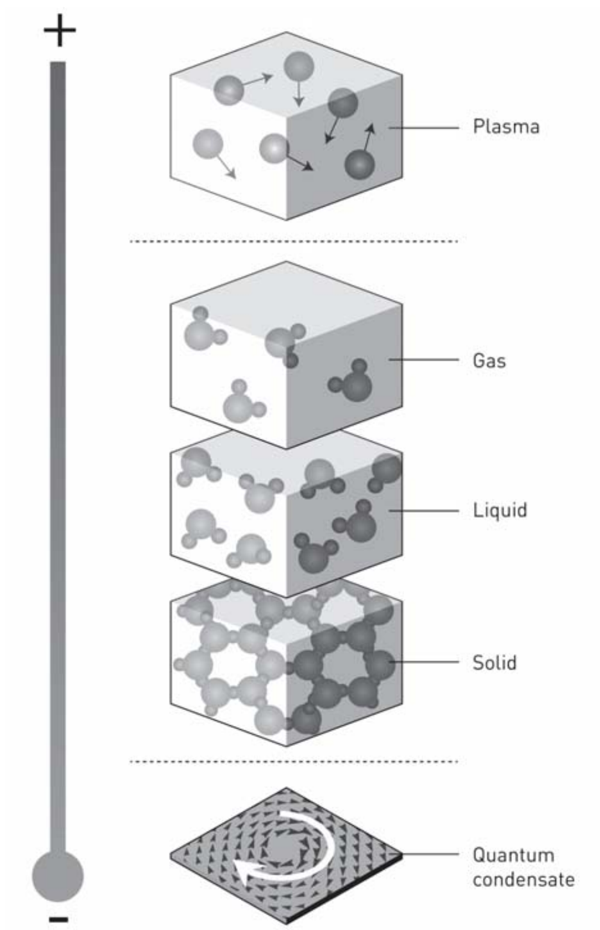

Fig. 1 Phases of matter. The most common phases are gas, liquid and solid matter. However, in extremely high or low temperatures matter assumes other, more exotic states.

Ordinary phases of matter also transition between each other when the temperature changes. For example, such a phase transition occurs when ice, which consists of well-ordered crystals, is heated and melts into water, a more chaotic phase of matter. When we look at matter's little

J. Michael Kosterlitz

known flat-lands, we find material phases that have not yet been fully explored.

Strange things can happen in the cold. For example, the resistance otherwise encountered by all moving particles suddenly ceases. This is the case when electrical current flows with no resistance in a superconductor, or when a vortex in a superfluid spins forever without slowing down.

The first person to systematically study superfluids was the Russian Pyotr Kapitsa, in the 1930s. He cooled helium-4, which is found in air, to –271 degrees Celsius and made it crawl up the sides of its holder. In other words, it behaved just as strangely as a superfluid should when viscosity has com-pletely vanished. Kapitsa was rewarded with the 1978 Nobel Prize in Physics, and since then several types of superfluids have been created in the laboratory. Superfluid helium, thin films of supercon-ductors, thin layers of magnetic materials and electrically conductive nanothreads are a few of the many new material phases that are now being intensively studied.

Vortex pairs provided the solution

Researchers long believed that thermal fluctuations destroy all order in matter in a flat, two-dimen-sional world, even at absolute zero. If there are no ordered phases, there can be no phase transitions. But in the early 1970s, David Thouless and Michael Kosterlitz met in Birmingham, Great Britain, and they challenged the then current theory. Together, they took on the problem of phase transitions in the flatlands (the former out of curiosity, the latter out of ignorance, they themselves claim). This coope-ration resulted in an entirely new understanding of phase transitions, which is regarded as one of the twentieth century's most important discoveries in the theory of condensed matter physics. It is called the KT transition (Kosterlitz-Thouless transition) or the BKT transition, where the B is for Vadim Berezinskii, a now deceased theoretical physicist from Moscow who had presented similar ideas.

The topological phase transition is not an ordinary phase transition, like that between ice and water. The leading role in a topological transition is played by small vortices in the flat material. At low temperatures they form tight pairs. When the temperature rises, a phase transition takes place: the vortices suddenly move away from each other and sail off in the material on their own (fig. 2).

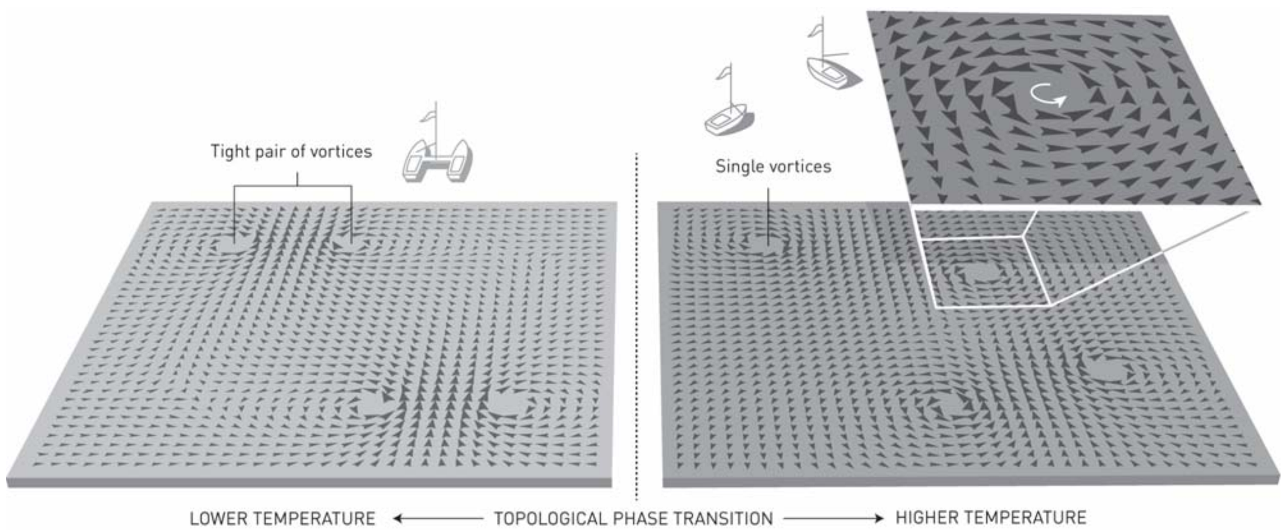

Fig. 2. Phase transition. This occurs when phases of matter transition between each other, such as when ice melts and becomes water. Using topology, Kosterlitz and Thouless described a topological phase transition in a thin layer of very cold matter. In the cold, vortex pairs form and then suddenly separate at the temperature of the phase transition. This was one of the twentieth century's most important discoveries in the physics of condensed matter.

The wonderful thing about this theory is that it can be used for different types of materials in low dimensions – the KT transition is universal. It has become a useful tool, one that is not only applied in the world of condensed matter, but also in other areas of physics, such as atomic physics or statistical mechanics. The theory behind the KT transition has also been developed by both its originators and others, and also confirmed experimentally.

The mysterious quantum leaps

Experimental developments eventually brought about a number of new states of matter that required explanation. In the 1980s, both David Thouless and Duncan Haldane presented ground-breaking new theoretical work that challenged previous theories, of which one was the quantum mechanical theory for determining which materials conduct electricity. This had initially been deve-loped in the 1930s and, a few decades later, this area of physics was considered to be well understood.

It was therefore a great surprise when, in 1983, David Thouless proved that the previous picture was incomplete and, at low temperatures and in strong magnetic fields, a new type of theory was necessary, one where topological concepts were vital. At around the same time, Duncan Haldane also arrived at a similar, and similarly unexpected, conclusion while analysing magnetic atomic chains. Their work has been instrumental in the subsequent dramatic developments to the theory of new phases of matter.

extremely precise, something that is unusual in physics. Measurements provide precisely the same results even if the temperature, magnetic field or the amount of impurities in the semiconductor vary. When the mag-netic field changes enough, the conductance of the layer also changes, but only in steps; reducing the strength of the magnetic field makes electrical conductance first exactly twice as big, then it triples, quadruples, and so on. These integer steps could not be explained by the physics known at the time, but David Thouless found the solution to this riddle using topology.

Answered by topology

Topology describes the properties that remain intact when an object is stretched, twisted or defor-med, but not if it is torn apart. Topologically, a sphere and a bowl belong to the same category, because a spherical lump of clay can be transformed into a bowl. However, a bagel with a hole in the middle and a coffee cup with a hole in the handle belong to another category; they can also be remo-delled

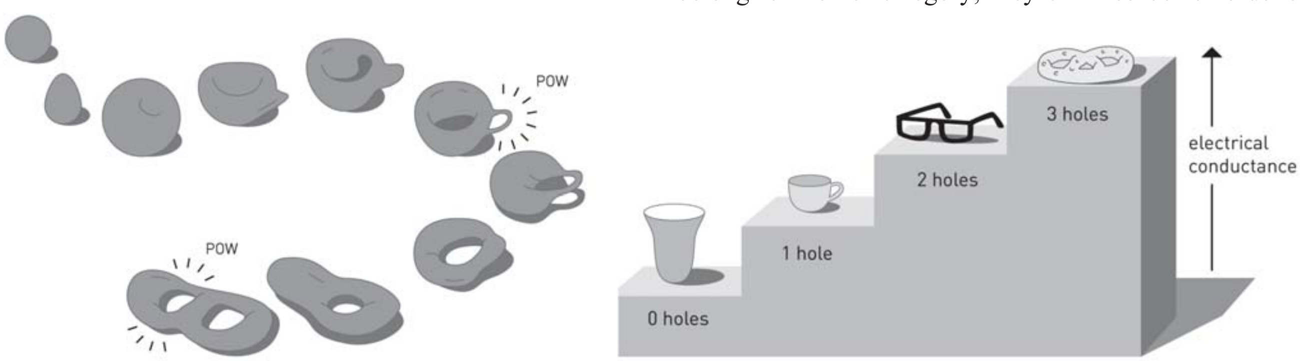

Fig 3. Topology. This branch of mathematics is interested in properties that change step-wise, like the number of holes in the above objects. Topology was the key to the Nobel Laureates' discoveries, and it explains why electrical conductivity inside thin layers chan-ges in integer steps.

The mysterious phenomenon that David Thouless described theoretically, using topology, is the quantum Hall effect. This was discovered in 1980 by the German physicist Klaus von Klitzing, who was rewarded with the Nobel Prize in 1985. He studied a thin conducting layer between two semi-conductors, where the electrons were cooled to a few degrees above absolute zero and subjected to a strong magnetic field.

In physics, it is not uncommon for drastic things to happen when the temperature is lowered; for example, many materials become magnetic. This happens because all the small atomic magnets in the material suddenly point in the same direction, giving rise to a strong magnetic field, which can also be measured.

However, the quantum Hall effect is more difficult to understand; the electrical conductance in the layer appears to only be able to assume particular values, which are also

to form each other's shapes. Topological objects can thus contain one hole, or two, or three, or four… but this number has to be an integer. This turned out to be useful in describing the electrical conductance found in the quantum Hall effect, which only changes in steps that are exact multiples of an integer (fig. 3).

In the quantum Hall effect, electrons move relatively freely in the layer between the semi-conduc-tors and form something called a topological quantum fluid. In the same way as new properties often appear when many particles come together, electrons in the topological quantum fluid also display surprising characteristics. Just as it can't be ascertained whether there is a hole in a coffee cup by only looking at a small part of it, it is impossible to determine whether electrons have formed a topological quantum fluid if you only observe what is happening to some of them. However, con-ductance describes the electrons' collective motion and, because of topology, it varies in steps; it is quantised. Another characteristic of the topological quantum fluid is that its borders have unusual properties. These were predicted by the theory and were later confirmed experimentally.

Another milestone occurred in 1988, when Duncan Haldane discovered that topological quantum fluids, like the one in the quantum Hall effect, can form in thin semiconductor layers even when there is no magnetic field. He said he'd never dreamed of his theoretical model being realised experimentally but, as recently as 2014, this model was validated in an experiment using atoms that were cooled to almost absolute zero.

New topological materials in the pipeline

In much earlier work, from 1982, Duncan Haldane made a prediction that amazed even the experts in the field. In theoretical studies of chains of magnetic atoms that occur in some materials, he discove-red that the chains had fundamentally different properties depending on the character of the atomic magnets. In quantum physics there are two types of atomic magnets, odd and even. Haldane demon-strated that a chain formed of even magnets is topological, while a chain of odd magnets is not. Like the topological quantum fluid, it is not possible to determine whether an atomic chain is topological or not by simply investigating a small part of it. And, just as in the case of the quantum fluid, the topological properties reveal themselves at the edges. Here, this is at the ends of the chain, because the quantum property known as spin halves at the ends of a topological chain.

Initially, no one believed Haldane's reasoning about atomic chains; researchers were convinced that they already completely understood them. But it turned out that Haldane had discovered the first example of a new type of topological material, which is now a lively field of research in condensed matter physics.POWPOW0 holes1 hole2 holes3 holeselectricalconductance

Fig 3. Topology. This branch of mathematics is interested in properties that change step-wise, like the number of holes in the above objects. Topology was the key to the Nobel Laureates' discoveries, and it explains why electrical conductivity inside thin layers chan-ges in integer steps. 5(5)

Both quantum Hall fluids and even magnetic atomic chains are included in this new group of topo-logical states. Later, researchers discovered several other unexpected topological states of matter, not only in chains and thin border layers, but also in ordinary three-dimensional materials.

Topological insulators, topological superconductors and topological metals are now being talked about. These are examples of areas which, over the last decade, have defined frontline research in con-densed matter physics, not least because of the hope that topological materials will be useful for new generations of electronics and superconductors, or in future quantum computers. Current research is now revealing the secrets of matter in the exotic flatlands discovered by this year's Nobel Laureates.

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https://sharepoint.washington.edu/phys/people/Pages/view-person.aspx?pid=85

F. DUNCAN M. HALDANE *:* Born 1951 in London, UK. Ph.D. 1978 from Cambridge University, UK. Eugene Higgins Professor of Physics at Princeton University, NJ, USA.

www.princeton.edu/physics/people/display_person.xml?netid=haldane&display=faculty

J. MICHAEL KOSTERLITZ : Born 1942 in Aberdeen, UK. Ph.D. 1969 from Oxford University, UK. Harrison E. Farnsworth Professor of Physics at Brown University, Provi-dence, RI, USA.

https://vivo.brown.edu/display/jkosterl ❐

Taken from "The Nobel Prize in Physics 2016 – Popular Information". Nobelprize.org. Nobel Media AB 2014. Web. 15 Jan 2017. <http://www.nobelprize.org/nobel_prizes/physics/laureates/2016/popular.html>" – S. C. Roy

PHYSIOLOGY OR MEDICINE

The Nobel Prize in Physiology or Medicine was awarded to Professor Yoshinori Ohsumi, Tokyo Institute of Technology, Japan for his discoveries of **"Mechanisms for Autophagy".** Through this process cells maintain homeostasis or normal functioning by protein degradation and turnover of the disrupted cell organelles for new cell formation. During cellular stress the process of **Autophagy** is increased.

Yoshinori Ohsumi

Autophagy (or **autophagocytosis**) derived from Greek word (auto-, "self" and phagein, "to eat"), thus it is natural destructive mechanism that disassembles, through a regulated process, unnecessary or dysfunctional cellular components. Thus, autophagy denotes "self eating". The process leads to the orderly degradation and recycling of cellular components.

Degradation – a central function in all living cells : In the mid 1950's scientists observed a new specialized cellular compartment, called an *organelle,* containing enzymes that digest proteins, carbohydrates and lipids. This specialized compartment is referred to as a "*lysosome*" the function of the lysosome is like a workstation responsible for degradation of cellular constituents. Christian de Duve a Belgian Scientist was awarded the Nobel Prize in Physiology or Medicine in 1974 for the discovery of the lysosome. The large amounts of cellular content, and even whole organelles, could sometimes be found inside lysosomes. The cell therefore appeared to have a strategy for delivering large cargo to the lysosome. Christian de Duve, coined the term autophagy, "self-eating", to describe this process. The new vesicles were named *autophagosomes*.

The concept of Autophagy first came into mind to the researchers in 1960's, when it was observed that the cell could destroy its own contents by enclosing it in membranes, forming sack like vesicles that were transported to a recycling compartment for degradation, called the lysosome. It was difficult to study this phenomenon at that time since a very little information was available until in a series of important experiments were done by Yoshinori Ohsumi in 1990's in baker's yeast to identify genes essential for autophagy. He then extrapolated his investigation to elucidate the underlying mechanisms for autophagy in yeast and showed that similar sophisticated machinery is used in human cells.

During the 1970's and 1980's researchers focused on exploring another system used to degrade proteins, namely the "proteasome". Within this research field Aaron Ciechanover, Avram Hershko and Irwin Rose were awarded the 2004 Nobel Prize in Chemistry for "the discovery of ubiquitin-mediated protein degradation". The proteasome efficiently degrades proteins sequentially, however this mechanism did not explain how the cell got rid of larger protein complexes and worn-out organelles. The question came in mind if the process of autophagy be the answer and, if so, what were the mechanisms?

Autophagy – An Essential Mechanism in Our Cells

Ohsumi's discovery led to a new concept in our understanding of how cell recycles. The discovery opened up the path to understand the fundamental importance of autophagy in many physiological processes, such as in the adaptation to starvation or response to infection.

It is due to Ohsumi and others who followed in his footsteps, is now known that autophagy controls important physiological functions where cellular components are required to degrade and recycle. Autophagy can rapidly provide fuel for energy and building blocks for renewal of cellular components, and hence is considered to be essential for the cellular response to starvation and different types of stress. Following infection, autophagy can eliminate invading intracellular bacteria and viruses. The process contributes to embryo development and cell differentiation. Cells also use this to eliminate damaged proteins and organelles, a quality control mechanism which is critical for counteracting the negative consequences of aging.

Ohsumi's study is critical for cells to survive and to stay healthy. The autophagy genes and the metabolic pathways he discovered in yeast are used by higher organisms, including humans also and mutations in those genes can cause disease. His work led to a new avenue and inspired hundreds of researchers around the world to study the process and opened a new area of research.

"Without him, the whole field doesn't exist," said Seungmin Hwang, an Assistant Professor in the Department of Pathology at the University of Chicago. "He set up the field."

Dr. Ohsumi was born in 1945 in Fukuoka, Japan, and received his Ph.D. from the University of Tokyo in 1974. He started out in chemistry but found it was too established a field with few opportunities.

He therefore switched to molecular biology. But his Ph.D. thesis was not quite impressive, and he could not find a job. His adviser suggested to go abroad. He was offered a postdoctoral position at Rockefeller University in New York, where he was to study in vitro fertilization in mice.

He eventually switched over in studying the duplication of DNA yeast. He joined at the University of Tokyo as a junior professor where he picked up a microscope and initiated peering at sacks in yeast where cell components are degraded. In 2009 he moved to the Tokyo Institute of Technology as Professor and continued his work on "Autophagy" which brought him the honour of the Nobel Prize award.

The process Ohsumi studies is critical for cell survival and remain healthy. The autophagy genes and the metabolic pathways he discovered in yeast also exist in higher organisms including humans.mutation in those genes may lead to various diseases. His work would inspire hundreds of researchers around the world to study the important process and opened a new area of modern science. ❒

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ECONOMICS

Oliver Hart and BengtHolmström were jointly awarded The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel, commonly referred to as Nobel Prize in Econmics*"for their contributions to contract theory"*. Before getting the contributions of Professors Hart and Holmström, it is desirable to have a look into the connotation of contract - the importance of the issue that fetches a Nobel Prize. In Indian legal parlance, generally speaking, an agreement enforceable by law is referred to as the **contract**. On elaborating, a little, it may be mentioned that all agreements are contracts if they are made by the *free consent* of parties *competent* to contract, for a lawful *consideration* and with a lawful object, and are not hereby expressly declared to be void. Looking at the keywords in the definition it may be observed that there is *inter alia* emphasis on free consent and competence. Two or more persons are said to consent when they agree upon the same thing in the same sense and free consent is considered when it would not have been given but for the existence of such coercion, undue influence, fraud, misrepresentation, or mistake. Every person is competent to contract who has attained maturity and who is of sound mind and is not disqualified from contracting by any law. Without elaborating further, it may be mentioned that there are some essential components of contract, but most importantly, there has to be a proposal/ offer and acceptance for having contract. And there cannot be contract for unethical purpose say for committing a crime; in that case it will be null and void *ab initio*. It is more than obvious that contract has economic implications in addition to legal bindings. In this context it may be noted that this foregoing concept of contract in India is in vogue since the last quarter of the nineteenth century and is based on the British model. But there are still ancient instances, found in archaeological excavation near the edge of Mediterranean, of contract in form of an agreement, written literally on stone, taking place in the ancient Greek city of Teos about 2200 years ago; a fifty line property agreement has been found as chiseled inscription on white marble.

Oliver Hart

For their contribution into this ancient as well as highly complex domain of Contract, Oliver Hart and Bengt Holmström have been jointly awarded The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel, commonly referred to as Nobel Prize in Econmics for the year 2016. Oliver Hart, born in London, United Kingdom on October 9, 1948, remained affiliated to Harvard University, Cambridge, MA, USA when received the Prize. And Bengt Holmström, born in Helsinki, Finland on April 18, 1949, remained affiliated to Massachusetts Institute of Technology (MIT), Cambridge, MA, USA, at the time of the Award.

Bengt Holmström

It does not require elaboration that in today's world Contract has invaded all walks of life, ranging from job contracts with employers and loan contracts with financial institutions, insurance policies to immune us from the adverse economic impacts of diseases, death, disablements, accidents including fire, theft and what not. And even effective protection of one's creativity in the fields of literature, art, scientific discoveries require proper contracting for protecting the Intellectual Property; needless to mention that tangible properties obviously need contracting for effective protection. Contracts even pervade the domain of non - economic relationships. A well - documented contract can promote cooperation, create win - win situation and can facilitate getting rid of avoidable conflicts and disputes. Therefore it is not difficult to appreciate the importance of the theoretical principles governing the realm of contracts. Possibly hence this year's Prize in Economic Sciences has hence been awarded for theories about writing good contracts. Contracts generally state economic mechanisms for certain behaviors or outcomes. Bengt Holmström's work examines both the benefits and limitations of such incentives. A variable payment system has the potential to make us to become more goal-oriented and to work harder. But it may also make us take excessive, even unacceptable level of risks, focus on the wrong things and become less enthusiastic about the work. Holmström has also shown how contracts should be adjusted when the parties will be working together over a long period of time, and how good agreements can encourage an individual even though only team performance can be observed and adjudged. One common denominator is that contracts must be balanced and adapted to the specific situation. As we all know that the future is often too complex and unpredictable for a contract to be able to describe all conceivable circumstances, and in that case the contract can regulate who has the right to make decisions in what situations. Oliver Hart's research on incomplete contracts deals with how decision making rights should be allocated. Among other things, his works provide us with a rich theory of property rights. Hart's tool kit can be used to appreciate corporate mergers, acquisitions and take overs, which are often so hostile, how to design an effective bankruptcy law and whether to operate a particular welfare service in the private or public sector.After the announcement of the awards there have been expected debates, deliberations, discourses on the impact, applicability of the theories throughout the world including in India, particularly as it involves job contracting, corporate mergers, insurance sector in one hand, through post break up compensations to delivery of welfare services like subsidized food, healthcare, education to the people in need, especially in the era of structural adjustment programmes. It is all the more relevant in India, as the current scenario of Indian corporate and social sector is replete with instances of inadequacies in contracting mechanism leading to almost eroding of public faith in many vital institutions. It will perhaps not be absolutely out of context to refer to the observations of noted economist Pranab Bardhan in his satirical memoir *Smriti Kunduyan* that dearth of real heroes, Bengalees start almost worshiping of internationally acclaimed people like Nobel laureate Professor Amartya Sen. We would like to end the write up in an expectant note that in near future that the benefits of research of Professors Hart and Holmström will trickle to the last man in need of bare essentials in this country, as it encompasses the issues of welfare service, and we will get more and more number of sons of soil who will bring real fame, even Nobel Prize. ❐

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