

# THE NOBEL PRIZE

## Nobel Prize Lessons

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### Speaker's manuscript – All Nobel Prizes 2018

#### The Nobel Prize

- Before Alfred Nobel died on 10 December 1896, he wrote in his will that the bulk of his fortune should be divided into five parts and to be used for prizes in physics, chemistry, physiology or medicine, literature and peace to “those who, during the preceding year, shall have conferred the greatest benefit to humankind.”



#### The Nobel Prizes 2018

- In the late 1960s, Sveriges Riksbank (Sweden's central bank) established a prize in economic sciences in memory of Alfred Nobel. The economics prize is awarded at the same time as the Nobel Prize, as part of the same ceremony.
- The Nobel Prizes are announced at the beginning of October every year. In 2018, 12 men and women were awarded a Nobel Prize.



Let's take a closer look at the achievements of the 2018 Nobel Laureates and how they have benefitted humankind.

#### Physics Prize 2018

- The Nobel Prize in Physics is about lasers - tools made of light.
- One half of the Prize, to Arthur Ashkin, is being awarded for a tool that can capture and manipulate various particles.
- The other half, to Donna Strickland and Gérard Mourou, rewards a technique for intensifying and speeding up pulsing laser light, beyond what was previously believed possible.
- Not only physics, but also chemistry, biology and medicine have gained precision instruments for use in basic research and practical applications.



## Optical tweezers

- A laser produces a very special kind of light. Ordinary light is a mixture of wavelengths (colours) that move at different intensities and in different directions. A laser generates a light that has exactly the same wavelength (colour), intensity and direction.
- Arthur Ashkin invented optical tweezers that grab particles, atoms and molecules with their laser beam fingers. Viruses, bacteria and other living cells can be held too, and examined and manipulated without being damaged.
- Ashkin's optical tweezers have created entirely new opportunities for observing and controlling the machinery of life.



## Speeding up pulsing laser light

- By the mid-1980s it was no longer possible to create more intensive or faster lasers. The lasers simply became overheated and were destroyed.
- To solve this problem, Donna Strickland and Gérard Mourou developed a technique called chirped pulse amplification, or CPA. It's about speeding up pulsing laser light to extreme levels.
- There are many ways to use pulsing lasers. They can cut and drill with great precision in sensitive materials. By adjusting the pulses, a laser can be used as an extremely sharp knife for eye surgery.
- Another application is to create images of very rapid events, such as chemical reactions and how electrons move.
- The use of laser for eye surgery was actually discovered by accident. Gérard Mourou said that shortly after his team had made these new lasers, a student got a laser in his eye when he was adjusting them. The student had to go to hospital where the surgeon examining him asked them what kind of laser it was because the damage was perfect: perfectly round, with no collateral damage.



## Chemistry Prize 2018

- Evolution is the change in the characteristics of a species over several generations and relies on the process of natural selection.
- This year's Chemistry Prize is all about imitating the techniques of evolution and developing proteins in laboratories to solve chemical problems.
- The laureates' methods are based on randomly creating numerous variants of a protein, testing how the different variants work and then selecting the protein that works best – a process known as “directed evolution”.



## Directed evolution of enzymes

- Enzymes are important proteins that control and regulate most of the chemical reactions that occur in an organism.
- One half of the Chemistry Prize is awarded to Frances Arnold for developing enzymes that can produce renewable fuels and pharmaceuticals in a better and more environmentally friendly way.
- Arnold came up with an idea for making pharmaceuticals, plastics and other chemicals in new ways.
- Instead of using strong solvents, heavy metals and corrosive acids to trigger the desired chemical reactions, her idea was to use enzymes that are found naturally in living organisms. She also wanted to improve these enzymes by using directed evolution.
- Arnold's specially developed enzymes have become important tools for the production of various chemical substances, such as pharmaceuticals.
- Alternative fuels – produced with the help of Arnold's proteins – can power both cars and planes. In this way, her enzymes are contributing to a greener world.



## Antibodies as medicines

- The other half of the Chemistry Prize is awarded to the George Smith and Gregory Winter.
- George Smith developed a method that enables researchers to develop new proteins. The method is called phage display.
- Gregory Winter refined Smith's idea and combined it with so-called directed evolution. He devised a method for making new antibodies, which are an important part of the immune system. Thanks to this method, today we have created new pharmaceuticals to combat rheumatoid arthritis and cancer.
- The methods that the 2018 Nobel Laureates in Chemistry have developed are now being internationally developed to promote a greener chemicals industry, produce new materials, manufacture sustainable biofuels, mitigate disease and save lives.



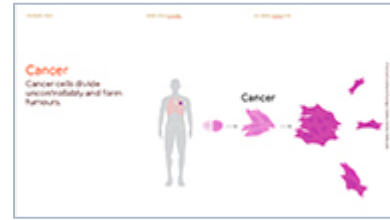
## Medicine Prize 2018

- The 2018 Nobel Prize in Physiology or Medicine is awarded to James Allison and Tasuku Honjo, who independently of each other discovered a new way to treat cancer.
- There are three established methods for treating cancer: surgery, radiotherapy (radiation) and anti-cancer drugs (chemotherapy). More methods of treatment are needed.
- Now Allison and Honjo have found a new method, "immune checkpoint therapy", which is based on making our own immune system fight cancer.



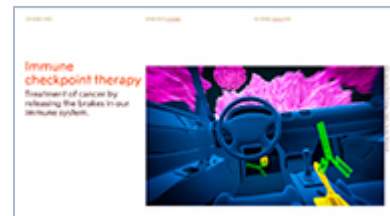
## Cancer

- Every second, a million cells die in your body. That's about one kilogram of cells a day, which are replaced with new cells formed through cell division.
- When a person gets cancer their previously healthy cells no longer know when it is time to stop cell division. This leads to a lump of cells being formed - a tumour.
- Our immune system includes a type of white blood cell called a T cell. T cells are trained to recognise foreign organisms, such as viruses and bacteria, but must not get carried away and start attacking our own healthy cells. Therefore, our immune system has a kind of acceleration and braking system.
- Cancer cells look so similar to our own healthy cells, T cells do not respond to them. The brakes, which are located on the surface of the T cells, prevent T cells from attacking cancer cells.
- This year's Medicine Laureates found a way to ease this brake so our immune system can be unleashed against cancer cells and destroy tumours.



## Immune checkpoint therapy

- James Allison developed an antibody that released the brakes (protein), blocking the immune system's braking mechanism and fully activating the T cells.
- In 1994 the first experiments using these antibodies were performed on mice, and mice with cancer were cured. In 2010 an important clinical study was published, showing good results in human patients with melanoma, a form of skin cancer.
- Tasuku Honjo, discovered an unknown protein on the surface of T cells. After a series of experiments, he and his colleagues were able to explain the function of this protein. It turned out that this protein also had a braking effect on the immune system, similar to the effect of the protein Allison had worked with.
- Honjo's group and other research groups performed animal experiments which showed that the blocking effect of this protein had promising results in cancer therapy. The next step was to develop therapy for cancer patients.
- Now we have an additional way of treating cancer. By combining this with traditional cancer therapy, we can cure more cases of cancer.



## Nobel Peace Prize 2018

- Half of the Prize is being awarded to Denis Mukwege from the Democratic Republic of Congo (DR Congo).
- Dr Mukwege works as a gynaecologist, and he has treated thousands of women and girls who have been subjected to rape and sexual violence in war-torn areas.
- The other half of the prize is being awarded to Nadia Murad, a human rights activist who belongs to the Yazidi minority in Iraq.
- In 2014 she was taken prisoner by Islamic State and held as a sex slave for three months before managing to escape. Today she is fighting to persuade world leaders to do more to stop sexual violence against women and girls.



## Denis Mukwege

- The civil war in DR Congo (1998-2003) is formally ended, fighting has continued, especially in the eastern parts. Rape is being used systematically as a weapon to harm and frighten the civilian population.
- Denis Mukwege lives and works in the city of Bukavu in DR Congo. In 1999 he established Panzi Hospital, which has treated tens of thousands of women and girls who were subjected to terrible atrocities. Many of the victims are children.
- In 2012 Mukwege delivered a speech at the United Nations, in which he criticised the Congolese government and other countries for not doing more to stop brutal sexual violence.
- When he returned home, he was the victim of an attempted murder, but he survived. At the risk of his own life, Mukwege has refused to give up his work.



## Nadia Murad

- Nadia Murad grew up in the village of Kocho in northern Iraq. She belongs to the Yazidi minority.
- In August 2014 Islamic State carried out attacks against Yazidi villages in northern Iraq.
- In Murad's village, hundreds of people were killed, including her mother and several of her brothers. Young women were abducted as slaves. For three months, Nadia Murad was subjected to torture and repeated rape, before she managed to flee.
- Today she is a human rights activist, who works very courageously and single-mindedly to increase public knowledge about trafficking and sexual violence against women and girls.



## Prize in Economic Sciences 2018

- The two American laureates, William Nordhaus and Paul Romer, have designed models that help us to understand how we can generate long-run economic growth that is also sustainable.
- Economics is all about ensuring that there are enough resources - such as labour, time, money, raw materials or knowledge. All resources are finite.
- By using knowledge, it is possible to use resources in ways that impact nature as little as possible, while creating a society where people enjoy better lives, both economically and socially.
- William Nordhaus and Paul Romer do not solve the actual problems of climate change, but they each deliver important research that will enable political leaders to make decisions leading to sustainable development and global economic growth.



## The market and technological change

- At an early stage of his career, Paul Romer became interested in why economic growth occurs. According to earlier economists, growth was due to technological change.
- But what drives technological change? Romer's research shows that the marketplace and how it is regulated influence such technological change.
- For example, he looked at how patents should be designed to ensure that they make things easier for inventors and innovations, while also enabling their ideas to spread.



## Climate change and the economy

- Human activity affects the climate, and average global temperatures have increased rapidly over the past century.
- In the 1970s, William Nordhaus became aware of global warming. He created a model for estimating various effects that the economy has on climate.
- His model enables us, for example, to calculate how high a tax on carbon dioxide emissions should be if we want to keep global temperatures from rising by more than 1.5 degrees celsius.



## Awarding the Nobel Prize

- On 10 December each year, the Nobel Prize is presented.
- The prize in each category consists of a medal, and a large sum of money. In 2018 the prize amount is nine million Swedish kronor, about a million US dollars.
- The Nobel Prize Award Ceremony is held at the Stockholm Concert Hall for all categories except the Peace Prize, which is awarded in Oslo, Norway.
- After the actual award ceremony, there is an elegant banquet in each city to honour the new Nobel Laureates.

