THE NOBEL PRIZE

Speaker's manuscript – Chemistry prize 2021
Tools that are revolutionising molecular construction

The Nobel Prize in Chemistry

- The Nobel Prize in Chemistry is one of the five prizes founded by Alfred Nobel and awarded on 10 December every year.
- Before Alfred Nobel died on 10 December 1896, he wrote in his will that the largest part of his fortune should be placed in a fund. The yearly interest on this fund would pay for a prize given to "those who, during the preceding year, shall have conferred the greatest benefit to humankind."
- The interest would be divided into five equal parts, with one part awarded "to the person who shall have made the most important chemical discovery or improvement".

Who is rewarded with the chemistry prize?

- The Nobel Prize in Chemistry is thus awarded to people who have made discoveries or improvements that have given us knowledge about the structure of various substances and how they are created and changed – how and why they react with each other, and even how we can create new molecules.
- This is Ada Yonath, who was awarded the 2009 Nobel Prize in Chemistry for her pioneering contributions to studies of the ribosome.

The 2021 chemistry prize

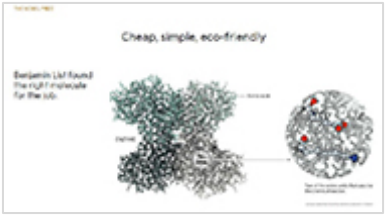
- Nature has incredibly precise tools – enzymes – for constructing different complex molecules that give colour, form and function to life.
- When chemists tried to imitate these tools in order to build their own complex molecules, it didn't go very well at first. The tools they developed were clumsy, and with them the chemists produced not only the desired molecules but a lot of unwanted ones as well.
- In time, these tools have been improved, and slowly but surely chemistry has evolved from carving stone with big, blunt chisels to something more akin to fine woodworking using precise, specialised tools.

- The tools for which the 2021 Nobel Prize in Chemistry is awarded have taken molecular construction to an entirely new level. They have made it possible for chemists to construct new molecules in ways that are faster, cheaper and more environmentally sustainable.

The 2021 chemistry laureates

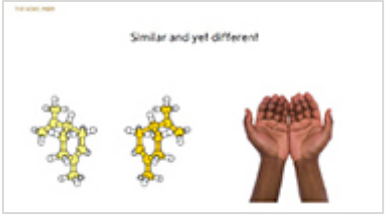
- The 2021 Nobel Prize in Chemistry is divided between Benjamin List and David W. C. MacMillan. Both have conducted research – though independently of each other at different universities – on how chemical reactions can be accelerated.
- One way of accelerating chemical reactions is to use a catalyst. A catalyst is a substance that accelerates a reaction without itself being affected by the reaction.
- Before the twenty-first century, the commonly used types of catalysts were either metal complexes or enzymes. Thanks to the work of this year's chemistry laureates, there is now a third kind of tool that can be used as a catalyst.

Cheap, simple and eco-friendly



- Benjamin List knew that only a few of the many amino acids in an enzyme are responsible for working as catalysts in a chemical reaction. Most of the enzyme has no catalytic function.
- List asked himself whether the entire enzyme was really needed if only a *single* amino acid was relevant in catalysing the chemical reaction.
- He tried extracting an amino acid called proline from an enzyme and used it in a number of different chemical reactions to join together two organic molecules.
- What he concluded from his experiments was that proline alone could be used to catalyse a certain kind of chemical reaction. Compared with both metal complexes and enzymes, proline is simpler, cheaper and more environmentally friendly.

Similar and yet different



- In parallel with List's efforts, David MacMillan was doing his own research on how chemical reactions can be accelerated with the help of small organic catalysts based on amino acids. He was also the one who gave the new concept for catalysis the name organocatalysis.
- When a chemical reaction occurs, two different variants of a molecule may be formed. These two may seem alike, but if we look closely enough at them we see they are mirror images of each other. We call these isomers, which are similar but mirror images rather than identical - like your right and left hands, they look different if you lay one on top of the other.

- In chemical reactions, often we're only interested in one of the isomers. For example, this is extremely valuable in the production of chemical compounds that are designed to interact with biological systems, like medicines, scents and flavourings, or pesticides. By using organocatalysis, a chemist can control the chemical reaction so that only the desired product is formed.

For the greatest benefit to humankind

- Independently of each other, Benjamin List and David MacMillan made discoveries that led to an entirely new concept of catalysis. Since then, they have designed lots of cheap and stable organocatalysts and inspired countless researchers to make new discoveries in the field.
- Today organocatalysis has become an important tool in pharmaceutical manufacturing, among other things. It makes it possible to produce pharmaceuticals that contain only the active substance and form only minimal unwanted by-products.
- Thus, the laureates' tools are being used to produce pharmaceuticals more efficiently, more sustainably and more cheaply. For example, the method is being used to make medications that treat depression and fight viruses.

“Making molecules is like creating something beautiful.”

- In an interview given in conjunction with the announcement of the 2021 chemistry prize, laureate Benjamin List speaks about the joy he finds in his work.