

## Nobel Prize Lessons

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### Teacher's manuscript – the 2018 Chemistry Prize

#### The Nobel Prize in Chemistry

- The Nobel Prize in Chemistry is one of the five prizes founded by Alfred Nobel and awarded on December 10 every year.
- Before Nobel died on December 10, 1896, he wrote in his will that the largest part of his fortune should be used to fund a prize to those who “have conferred the greatest benefit to humankind.” One of the five prizes should go to “the person who made the most important chemical discovery or improvement”.



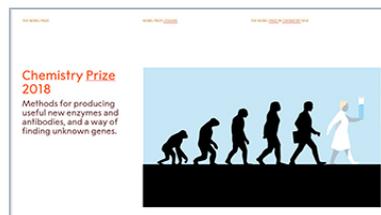
#### Who is rewarded with the Chemistry Prize?

- 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.
- Other Chemistry Prizes have been awarded to:
- Marie Curie, for the discovery of radioactive elements, and Dorothy Crowfoot Hodgkin, for the discovery of the structure of penicillin.



#### The 2018 Chemistry Prize

- Two of this year's Laureates in Chemistry have developed methods for producing new enzymes and antibodies in the lab. These enzymes can be used to speed up chemical reactions, and the antibodies can be used to produce pharmaceuticals. 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”.
- The third Laureate developed a method for finding which gene codes for a given protein.



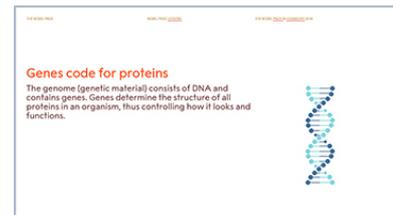
## The Nobel Laureates

- Frances H. Arnold is 62 years old and comes from the United States. She is receiving half the Chemistry Prize.
- George P. Smith is 77 years old and is also from the US.
- Sir Gregory P. Winter is 67 years old and comes from the United Kingdom.
- Smith and Winter are jointly receiving the other half of the Prize.



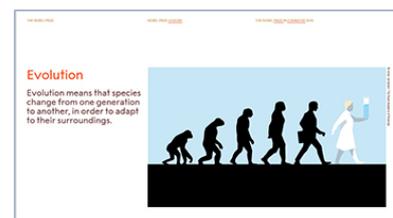
## Genes code for proteins

- The human genome consists of DNA. This DNA contains all our genes.
- A gene is part of a DNA molecule that codes for how a protein will be structured.
- Protein consists of amino acids, and a gene determines which amino acids will be connected to form a specific protein.
- Enzymes are important proteins that control and regulate most of the chemical reactions that occur in an organism. Enzymes are nature's own catalysts.



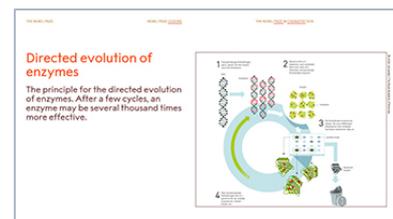
## Evolution

- Genes determine the properties of an organism.
- In an organism, random changes occur in the genes because of changes in the DNA molecule: so-called mutations. Sometimes these changes represent something positive for the organism. It functions better in its surroundings and it has an increased chance of survival. If the mutation is negative for the organism, it often dies early before having time to reproduce. In this way, the properties of a species gradually improve. This is a slow process.



## Directed evolution of enzymes

- 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.
- She produced many copies of a gene that coded for a given enzyme. Then she made random changes in the genes, which were introduced into the DNA of various bacteria. The bacteria began to produce the enzyme in different variants. Then she tested these enzymes and selected those that worked best. Using these, she repeated the process and finally managed to develop superior enzymes quickly. This was a much faster process than evolution.



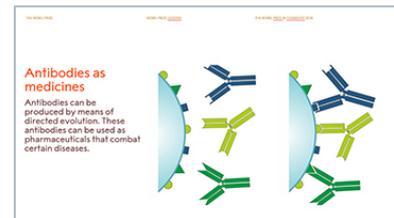
## Phage display

- Sometimes researchers may find a protein in the body that they are interested in knowing more about. If so, they also want to know what gene codes for that particular protein. If they find this gene, they will also learn what amino acids are connected to form the specific protein.
- George Smith developed a method that enables researchers to find an unknown gene for a known protein.



## Antibodies as medicines

- The body defends itself against bacteria and viruses by producing antibodies that attach themselves to these invaders and help the body to kill them.
- Antibodies can also recognise cancer cells and thus ensure that they are destroyed.
- Greg Winter applied Smith's phage display method and directed evolution in order to produce antibodies in a lab. These can be used as pharmaceuticals to fight diseases, such as cancer.



## The benefits

- Arnold's specially developed enzymes have become important tools for the production of various chemical substances, such as pharmaceuticals. Chemical reactions occur faster, lead to fewer by-products and in some cases enable manufacturers to avoid the heavy metals that traditional chemistry requires, thus greatly decreasing their environmental impact.
- 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. Today the methods developed by the 2018 Nobel Laureates in Chemistry are being used all over the world to promote a greener chemical industry, produce new materials, manufacture sustainable fuels, mitigate disease and save lives.

