

THE NOBEL PRIZE IN CHEMISTRY 2018

Illustrations: Niklas Elmehed



Frances H.
Arnold

George P.
Smith

Sir Gregory P.
Winter

“for the directed
evolution
of enzymes”

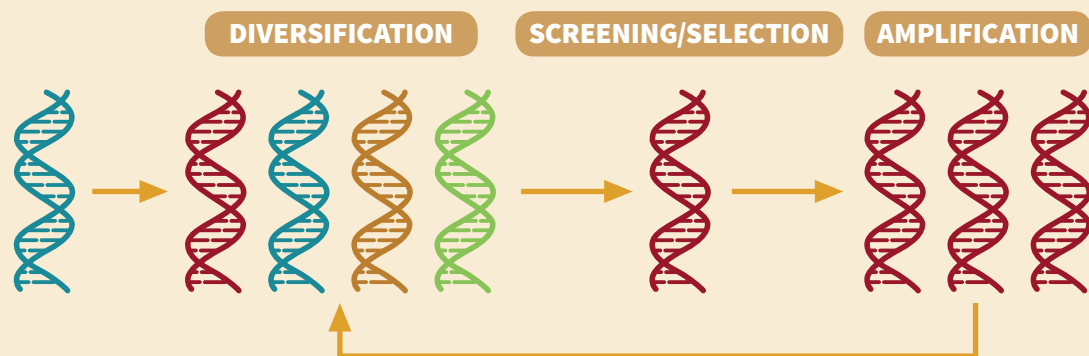
“for the phage display of peptides
and antibodies”

THE ROYAL SWEDISH ACADEMY OF SCIENCES

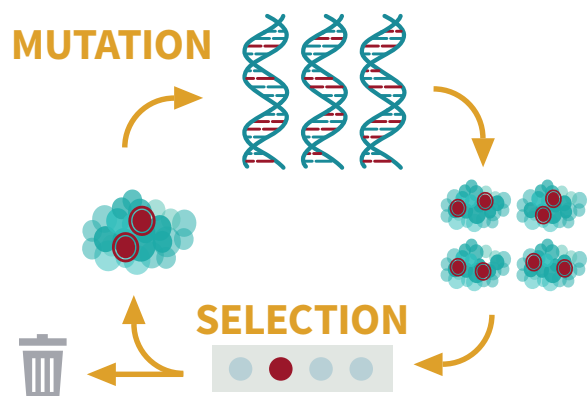
2018 NOBEL PRIZE IN CHEMISTRY



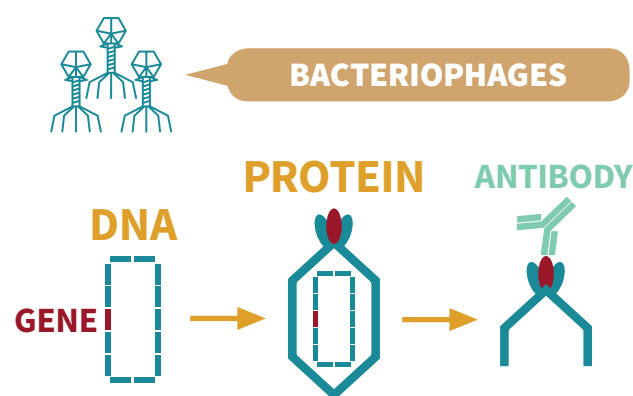
The Nobel Prize in Chemistry 2018 was awarded to **Frances H Arnold**, **George P Smith** and **Sir Gregory P Winter** for their use of directed evolution to produce new enzymes and antibodies.



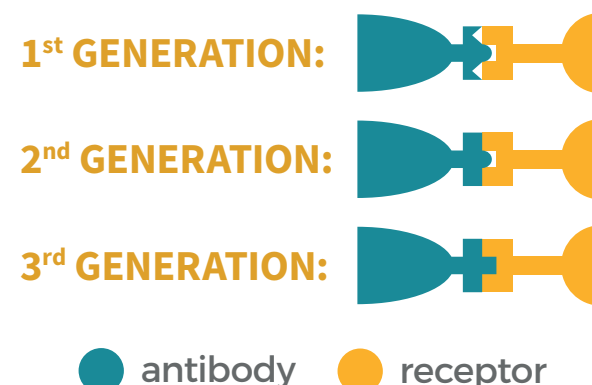
Directed evolution allows chemists to speed up the evolution process in the laboratory. Using it, enzymes can be tailored to catalyse reactions better, or catalyse new ones. Proteins can be made more selective for targets, leading to useful medicines.



Arnold pioneered directed evolution of enzymes. She created random changes in an enzyme's DNA, then selected the variant that was most effective in a certain role.



Smith used bacteriophages (viruses that infect bacteria). He realised that if a gene was added to phage DNA, the protein it produces could be identified on the phage surface.



Winter genetically tweaked phages to produce antibodies on their surface. Through directed evolution, he made antibodies with stronger attachments to their targets.



WHY DOES THIS RESEARCH MATTER?

Custom enzymes produced via directed evolution are now used in the production of biofuels and medicines, while evolved antibodies can be used against autoimmune diseases and metastatic cancer.

Nobel Prize in Chemistry press release: <https://www.nobelprize.org/uploads/2018/10/press-chemistry2018.pdf>

3 October 2018

The Nobel Prize in Chemistry 2018

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Chemistry 2018

with one half to

Frances H. Arnold

California Institute of Technology,
Pasadena, USA

and the other half jointly to

George P. Smith and

University of Missouri, Columbia, USA

Sir Gregory P. Winter

MRC Laboratory of Molecular Biology,
Cambridge, UK

“for the directed evolution of enzymes” *“for the phage display of peptides and antibodies”*

They harnessed the power of evolution

The power of evolution is revealed through the diversity of life. The 2018 Nobel Laureates in Chemistry have taken control of evolution and used it for purposes that bring the greatest benefit to humankind. Enzymes produced through directed evolution are used to manufacture everything from biofuels to pharmaceuticals. Antibodies evolved using a method called phage display can combat autoimmune diseases and in some cases cure metastatic cancer.

Since the first seeds of life arose around 3.7 billion years ago, almost every crevice on Earth has filled with different organisms. Life has spread to hot springs, deep oceans and dry deserts, all because evolution has solved a number of chemical problems. Life's chemical tools – proteins – have been optimised, changed and renewed, creating incredible diversity.

This year's Nobel Laureates in Chemistry have been inspired by the power of evolution and used the same principles – genetic change and selection – to develop proteins that solve mankind's chemical problems.

One half of this year's Nobel Prize in Chemistry is awarded to **Frances H. Arnold**. In 1993, she conducted the first directed evolution of enzymes, which are proteins that catalyse chemical reactions. Since then, she has refined the methods that are now routinely used to develop new catalysts. The uses of Frances Arnold's enzymes include more environmentally friendly manufacturing of chemical substances, such as pharmaceuticals, and the production of renewable fuels for a greener transport sector.

The other half of this year's Nobel Prize in Chemistry is shared by **George P. Smith** and **Sir Gregory P. Winter**. In 1985, George Smith developed an elegant method known as phage display, where a bacteriophage – a virus that infects bacteria – can be used to evolve new proteins. Gregory Winter used phage display for the directed evolution of antibodies, with the aim of producing new pharmaceuticals. The first one based on this method, adalimumab, was approved in 2002 and is used for rheumatoid arthritis, psoriasis and inflammatory bowel diseases. Since then, phage display has produced antibodies that can neutralise toxins, counteract autoimmune diseases and cure metastatic cancer.

We are in the early days of directed evolution's revolution which, in many different ways, is bringing and will bring the greatest benefit to humankind.

Frances H. Arnold, born 1956 in Pittsburgh, USA. Ph.D. 1985, University of California, Berkeley, USA. Linus Pauling Professor of Chemical Engineering, Bioengineering and Biochemistry, California Institute of Technology, Pasadena, USA.

<http://fhalab.caltech.edu>

George P. Smith, born 1941 in Norwalk, USA. Ph.D. 1970, Harvard University, Cambridge, USA. Curators' Distinguished Professor Emeritus of Biological Sciences, University of Missouri, Columbia, USA.

<http://biology.missouri.edu/people/?person=94>

Sir Gregory P. Winter, born 1951 in Leicester, UK. Ph.D. 1976. University of Cambridge, UK. Research Leader Emeritus, MRC Laboratory of Molecular Biology, Cambridge, UK.

www2.mrc-lmb.cam.ac.uk/group-leaders/emeritus/greg-winter/

Prize amount: 9 million Swedish krona, with one half to Frances Arnold and the other half to be shared between George Smith and Gregory Winter.

Further information: www.kva.se and <http://nobelprize.org>

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The Royal Swedish Academy of Sciences, founded in 1739, is an independent organisation whose overall objective is to promote the sciences and strengthen their influence in society. The Academy takes special responsibility for the natural sciences and mathematics, but endeavours to promote the exchange of ideas between various disciplines.

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