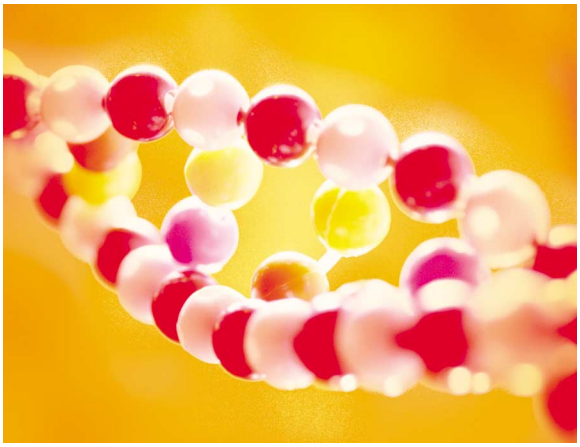
DNA

- Physicist Francis Crick helps discover the DNA "double helix" at Cambridge University, enabling scientists to understand the genetic make-up of all forms of life
- Medical research can now identify genes susceptible to diseases
- Research funded by the UK sequences a third of the human genome

What is it

How many of your colleagues know that DNA stands for deoxyribonucleic acid? More importantly, do they know what it is, and what it does? DNA is in every single cell in every single person across the world. It is the fundamental essence that describes who we are as individuals. It is the reason your eyes are the colour they are, why you are the height you are and why you prefer to use your left or right hand!



DNA is the code embedded in the body that defines us as human beings. Made up of four chemicals, the individual pattern it creates in each person makes us ultimately different from one another. It is the basis for all our genes which controls how our bodies work and, more importantly, what diseases we are susceptible to and how we combat them. DNA is in essence nature's programme for all life, deciding everything from the colour of your hair through to such complexities as how your body grows from birth to old age. Old age itself is even triggered by a strand of DNA, with the genetic code in your body beginning to degrade as you grow older.

It is the evolution of DNA that altered our genetic coding to differentiate us from primates. So much so that we have learned to communicate, invent and learn, evolving into a completely different species. To make a comparison of just how complex DNA is, we still share almost 98.5% of our genetic code with primates, but it is just that specific 1.5% that makes us human.

In 1990, the Human Genome Project was founded to decode the 25 000 genes found in human DNA, in turn sequencing more than 3 billion pairs of genes to aid the development of medicinal techniques using gene therapy and manipulation. Now that the project is completed, every single gene of human DNA is sequenced, and research has begun on how this information can be used in science across the globe.

The science

As far back as Aristotle (384–322 BC) scientists have recognised that characteristics of one generation pass onto the next. However, it wasn't until the early 20th century that researchers worked out that chromosomes – the structure found in the nucleus of a cell, made of DNA and proteins, that contains genes – were the vehicle that passed this information on from parent to child.

Further research then showed that chromosomes were composed of proteins and DNA. Scientists were unsure whether proteins or DNA carried the hereditary code needed to pass on genetic information.

It wasn't until the 1950s, when geneticists Alfred Hershey and Martha Chase used radioactive labelling, that DNA was indeed discovered to be the "carrier". Their research determined that DNA produced new infected cells after being infected itself, while the proteins remained unaffected. Therefore it had to be DNA that was capable of passing on information.

These findings led US biologist James Watson to travel to the University of Cambridge to work with renowned UK physicist Francis Crick, along with Rosalind Franklin, who worked in the physics department at King's College London. Both were already studying the structure of protein molecules. Together their mixture of backgrounds led to an astounding discovery. They created the image we now all think of when someone mentions DNA: the double helix.

Their first results were published in April 1953, in the well-known UK journal *Nature*. They described the double-helix structure of DNA, also noting that the pairing and construction of DNA immediately point to the possible copying of genetic material.

The scientific world was amazed by these findings and Watson and Crick were awarded the 1962 Nobel Prize in Medicine "for their discoveries concerning the molecular structure of nuclear acids and its significance for information transfer in living material". Unfortunately Franklin missed out, having died four years earlier from cancer.

Since then the importance of this discovery has grown. Scientists have now been able to detail the genetic code for all life forms, plus understand and manipulate genetic code and its effect on the human and non-human genome. Many more discoveries are set to happen thanks to their breakthrough.

DNA timeline

1869	DNA (first called nuclein) is identified by Friedrich Miescher as an acidic substance found in cell nuclei. The significance of DNA is not appreciated for 70 years.
1902	A human disease is first attributed to genetic causes.
1905	The word "genetics" is coined by the original "geneticist", William Bateson of the UK.
1944	It is first discovered that DNA is the molecule that mediates heredity, thanks to experiments by scientists Avery, MacLeod and McCarty. However, most people were sceptical of these findings until 1952.
1952	Bacteriophage labelling experiments by Alfred Hershey and Martha Chase confirm the 1944 results, convincing the scientific community.
1953	Watson, Crick and Franklin's research leads to the discovery that DNA is in the shape of a double helix.
1959	Ribonucleic acid is discovered as the intermediary between DNA and protein, and is called "Messenger RNA".
1962	Watson and Crick are awarded the Nobel Prize in Medicine "for their discoveries concerning the molecular structure of nuclear acids and its significance for information transfer in living material".
1972–3	Recombinant DNA, formed by combining segments of DNA from different organisms, is first constructed.
1977	DNA sequencing technology is developed by UK biochemist Fred Sanger.
1990s	Genome projects are begun. The yeast genome is complete in 1996. DNA fingerprinting, gene therapy and genetically modified foods become more widespread.
1995	Automated sequencing technology, using computers to sequence DNA faster, accelerates genome projects considerably.
1996–7	The first cloning of a mammal (Dolly the sheep) is performed by Ian Wilmut and colleagues from the Roslin Institute in Scotland in collaboration with Scottish company PPL Therapeutics.
2000	The human genome is reported to be completed. This project was partly funded by the UK's Wellcome Trust.
2001	The sequence of the human genome is released and the "post-genomic" era officially begins.
TODAY	Scientists in Newcastle have successfully created the UK's first cloned human embryo.

Nanotechnology

Genome research can also aid the advancement of nanotechnology, the development of "atom-sized" devices, leading to minuscule machines capable of altering a subject's DNA at a molecular level, helping to fight disease, defective DNA strains and even old age.

Moral responsibilities

Whatever the future of genetics, the scientific community has a great moral responsibility. Cloning and gene therapy have been at the forefront of international debate in recent years. Advances in science and medicine are of paramount importance, but should they come at the expense of moral values? Clearly there is a medium between the two poles, and genetics will continue to be a talking-point for years to come. Genetics can play a big role in the future, but only time will tell how far scientists, governments and public opinion allow it to go...

Future developments

The future of genetics depends on the continued support of the scientific community and commercial enterprise – particularly from the UK, if it wishes to continue playing a leading role in the future of genetics. It was UK commercial enterprise that created the world's first clone, and commercial enterprise may well play its part in advancing the future of mankind. For example, research is now beginning in earnest to find the gene that makes some people more susceptible to contracting cancer. This could lead to a widespread gene-therapy procedure, lowering the risk of cancer worldwide.

The Wellcome Trust Sanger Institute made the largest single contribution to the human-genome sequence and the "genome browser" ENSEMBL, run by the Sanger Institute and the EMBL-European Bioinformatics Institute, is a leading resource for researchers around the globe.

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