

DNA – the breaking of the
genetic code.

Uses, good and bad, of our
knowledge of DNA

Nucleic Acids

- Deoxyribonucleic acid or DNA contains instructions an organism needs to develop, live and reproduce
- DNA has a double helix structure and this feature is an essential part of DNA's ability to carry the genetic code
- Ribonucleic acid or RNA has a single helix structure
- RNA plays an essential part in copying genes and getting them translated. This type of RNA is called messenger RNA (mRNA) and the message is 'translated' in a ribosome

Human DNA

- Humans have 23 pairs of chromosomes found inside the cell nucleus
- Each chromosome consists of a single DNA molecule
- Females have two X chromosomes and males have an XY
- DNA molecules are very long – too long to fit into cells without packaging. DNA is coiled very tightly to form a chromosome

Timeline from the 1859 to 1961

- 1859 – Charles Darwin publishes ‘The Origin of Species’
- 1866 – Gregor Mendel discovers basic principles of genetics
- 1869 – Friedrich Miescher identifies ‘nuclein’ (now known as DNA)
- 1900s – The Eugenics Movement
- 1924 – Immigration Act passed in USA House of Senate
- 1944 – Oswald Avery identifies DNA as being responsible for heredity
- 1950 – Erwin Chargaff discovers the DNA composition is species specific. Findings included: in any DNA strand the guanine units equal the number of cytosine units; adenine equals thymine

Timeline from 1859 to 1961 continued

- 1952 – Rosalind Franklin photographs crystallised DNA fibres. She calculated the dimensions of the strands and from her deductions she concluded that DNA probably had a helical structure. This was a major breakthrough
- 1953 – James Watson and Francis Crick discover the structure of DNA – the double helix. In 1962 they were awarded a Nobel Prize along with Maurice Wilkins who had worked with Franklin.
- 1959 – an additional copy of chromosome 21 is found and linked to Down's Syndrome
- 1961 – Marshall Nirenberg is the first person to discover a sequence of 3 bases that codes for one of the 20 amino acids that serve as the building blocks of proteins – the codon

DNA – the genetic code

- For a long time scientists puzzled over what material in a cell could possibly carry the information for the complexity of a living organisms. Proteins were considered the best possibility as they are complex
- When nucleic acids were identified as the heredity material (1944), the hunt was on as to how this material could possibly code for vast amounts of data
- DNA is made up of nucleotides; each nucleotide contains a phosphate group, a sugar and a **nitrogen base**
- There are 4 types of nitrogen bases, these are: adenine (A), guanine (G), thymine (T), and cytosine (C)

The Codon

- The bases on one strand of DNA pair with the bases on the other strand
- In 1961, Marshall Nirenberg breaks the genetic code when he determines that a sequence of 3 bases codes for one of the 20 amino acids which made up proteins. This triplet is called a CODON. Eg. AAA codes for the amino acid lysine; CCC codes for proline
- Messenger RNA for a protein will copy the code from the relevant gene and get it 'translated' into a protein in a ribosome

A pairs with T

G pairs with C

Timeline from 1961 to the present

- 1977 – Fredrich Sager develops a rapid DNA sequencing technique
- 1983 – Huntington’s disease is the first mapped genetic disease. Gene finally isolated in 1993 and is on chromosome 4
- 1990 – first gene found to be associated with increased susceptibility to familial breast and ovarian cancer. BRAC1 on chromosome 17; second gene BRAC2 located on chromosome 13
- 1990 – the Human Genome Project begins (3.2 billion letters in it)
- 1995 – first bacterial genome sequenced
- 1996 – first mammal to be cloned – Dolly the sheep

Timeline from 1961 to the present

- 1996 – Bermuda Principles established. All genome sequence data to be freely available in the public domain within 24 hours of generation
- 1999 – first human chromosome is decoded. Chromosome 22. It contains 33.5 million ‘letters’ or chemical components
- 2002 – the mouse is the first mammal to have its genome decoded. 90% of the mouse genome can be aligned with the corresponding regions on the human genome
- 2003 – the human genome project is completed

Timeline from 1961 to the present

- 2013 – discovery that identical twins have differences in their genetic make-up
- 2014 – creation of an organism with an expanded artificial genetic code. This success could eventually lead to the creation of organisms that can produce medicines or industrial products
- 2014 – 100 genes play a role in the development of schizophrenia
- 2014 – Epigenetics – the study of changes in organisms caused by altered gene expression

Spin-offs from our knowledge of DNA

- Identification of genetic disorders; more targeted drug treatment
- In forensics used to identify criminals (1984 first DNA profiling test). 1986 first use of DNA to solve a crime – murder of two girls
- Stem cell transplants
- Gene therapy
- Genetic manipulation(GM) in crop development
- Paternity cases
- Used as a code to record information for the future (like a library)
- Inventory and monitoring of aquatic species – environmental DNA
- Ability to study gene expression in individual cells
- Biohacking – unconventional experimental biotechnology often conducted outside conventional laboratories

What next?