DNA, genes and genomes - Detailed

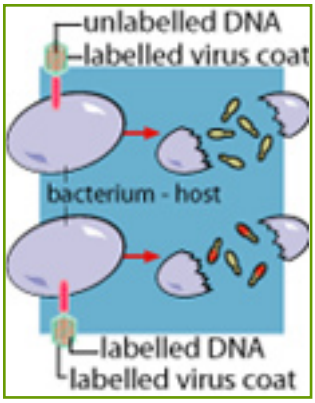
DNA: stuff of life

The chemical

For many years, people who studied genetics thought that DNA wasn't complex enough to contain all of the information needed to make up a genome. However, an elegant experiment carried out by Alfred Hershey and Martha Chase in 1952 began to convince scientists that DNA carried the genetic information, rather than protein.

The Hershey-Chase experiment

In this experiment, Hershey and Chase used a bacterial virus called T2. Although they are only made up of a shred of DNA and a scrap of protein, these viruses can hijack bacterial cells to make more copies of themselves. Scientists knew that either DNA or protein must carry the instructions for making new viruses, but they didn't know which.



When Hershey and Chase added a radioactive label to the DNA of the original virus, they found that the viruses produced were also radioactive. The researchers also labelled the protein of the original virus, but found that the viruses produced then were not radioactive.

Hershey and Chase concluded that the DNA that carried the instructions to make new viruses, and that it was the DNA that was being passed on to subsequent generations.

DNA structure

The function of DNA depends to a large extent on its structure. The discovery of the structure of DNA by James Watson and Francis Crick is one of the most famous scientific discoveries of all time. The two scientists used evidence collected by others, particularly Rosalind Franklin and Maurice Wilkins, to deduce the shape of DNA.

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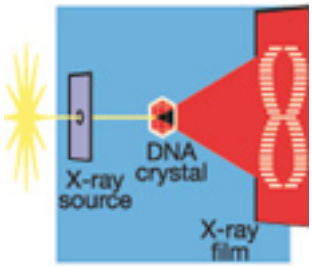
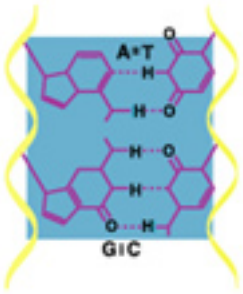
Franklin's experiments

One of the most important pieces of evidence came from Franklin's experiments of shining X-rays through crystals of the DNA molecule, and using photographic film to record where the scattered X-rays fall. The shadows on the film can be used to work out where the dense molecules lie. This technique is known as X-ray crystallography.



In 1953 Watson and Crick published their idea that DNA must be shaped like a double helix. A double helix resembles a twisted ladder. Each 'upright' pole of the ladder is formed from a backbone of alternating sugar and phosphate groups. Each DNA base (A, C, T or G) is attached to the backbone and the bases form the rungs. There are ten 'rungs' for each complete twist in the DNA helix.



Watson and Crick suggested that each 'rung' of the DNA helix was composed of a pair of bases, joined by hydrogen bonds. Thus A would always form hydrogen bonds with T, and C with G.

Working out the arrangement of bases in the DNA helix could also have been assisted by 'Chargaff's rules'.

Chargaff's rules

Erwin Chargaff was a Czech-American scientist who had noticed that within every DNA molecule, the percentage of A bases was always very similar to the percentage of T bases, and that the percentage of C bases was always very similar to the number of G bases.

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From structure to function

The concept that DNA was made of a sequence of paired bases along a chemical backbone allowed Watson and Crick to draw two important conclusions:

* First, the two sides or strands of DNA provide a mechanism for copying: if both strands are copied then the product is two identical 'daughter' molecules.

* Second, the order - the sequence - of bases is the digital code that carries the instructions for how a cell should behave.

If we can understand the code, we are closer to understanding how cells work.