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Discovering the Structure of DNA

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Francis Crick and James Watson are responsible for discovering the shape of DNA to be of a three-dimensional structure in 1953. The two postulated that a genetic material should implement two tasks: the replication and management of the processing of a cell in a specific way; the only molecule that fulfils such requirements is DNA (McCarty, 2003).

DNA was first described in the mid-nineteenth century by Swiss biochemist and physician, Friedrich Miescher. Miescher isolated nuclei containing unusual acidic substances such as nitrogen and phosphorus. In a paper written in 1871, Miescher termed this structure as nuclein; it was later called nucleic acid (Miescher, 1987; Olby, 2003).

The first evidence regarding a relation between inherited disease and proteins was provided by English physician Archibald Garrod in 1902, thus connecting heredity to enzyme abnormalities for the first time (Hopkins, 1938).

In 1928, English microbiologist Frederick Griffith was the first scientist to describe the genetic material as a 'transforming principle'. Griffith displayed that genetic material in bacteria transmits infectiousness in the case of pneumonia (Griffith, 1928). Furthering these studies, McCarty, Avery and McLeod discovered that DNA itself is the 'transforming principle'. This study was finally confirmed by Hershey and Chase to determine that DNA is the genetic material, and that it is not a protein (Hershey and Chase, 1952).

Russian-American biochemist Phoebus Levene described the ribose as a 5-carbon sugar taking part in the structure of nucleic acids in 1909. In a later study in 1929, Levene found specifically deoxyribose in nucleic acids, thus demonstrating a major chemical difference between RNA and DNA: DNA has the 5-carbon su-

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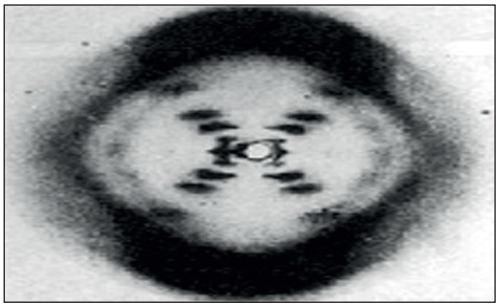
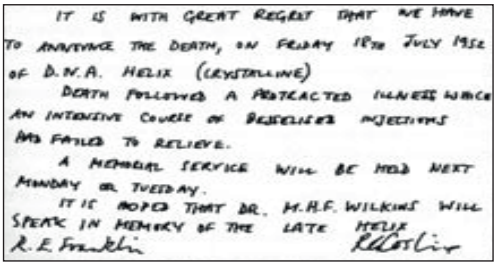
gar deoxyribose, whereas RNA contains ribose. Moreover, Levene revealed that RNA acts as a messenger for information within a DNA molecule that leads the cell to synthesize a particular protein. Levene identified the three parts of a nucleic acid as a 5-carbon sugar, a nitrogen-containing base and a phosphorus-containing component. Levene made a great contribution through elucidating the three components of a building block of DNA now known as a NUCLEOTIDE (Kay,1992).





Erwin Chargaff, an Austrian-American biochemist, displayed that DNA contains equal amounts of the ratio of nucleotide bases between adenine (A), thymine (T), guanine (G) and cytosine (C) (Chargaff, 1978).

English physicist Maurice Wilkins and chemist Rosalind Franklin examined DNA with X-rays utilizing X-ray diffraction. Rosalind Franklin displayed two forms of DNA as a crystalline "A" dry form, and as a liquid type "B" form located in the cell nucleus. In 1952, Rosalind Franklin, a graduate student, spent 100 hours to obtain "photo 51" of the DNA B form (Franklin and Gosling, 1953). The "photo 51" of B DNA taken by Rosalind Franklin was an incremental lead for Watson and Crick in referencing the three-dimensional structure of DNA. The helix was shown as "X" in the center, and symmetrically organized subunits demonstrated in darkened regions around it (Wilkins et.al., 1953a). Rosalind Franklin passed away in 1958 due to ovarian cancer at the age of 37.

Despite several hypotheses proposing that DNA holds the form of a triple helix structure, according to data below it is clearly displayed that DNA actually maintains an alpha helix structure. After the clear evidence provided by "photo

51", Watson and Crick indicated the sugar-phosphate backbone, and soon turned their attention to the bases (Wilkins et. al., 1953b).

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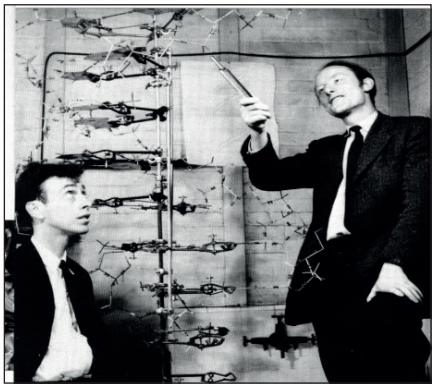
MOLECULAR STRUCTURE OF NUCLEIC ACIDS

A Structure for Deoxyribose Nucleic Acid



At last the puzzle of DNA's structure was finally solved by Watson and Crick. They found that Adenine (A) paired with Thymine (T), and that Guanine (G) paired with cytosine (C) bases. Moreover, they displayed the chemical attraction model of DNA showing the bases to be linked by means of hydrogen bonding. They published their data without ever having made an experiment on April 25, 1953 in an issue of 'Nature' magazine (Watson,1953).

In 1958 Watson, Crick and Wilkins received the Nobel Prize for their 1953 determination of the structure of deoxyribonucleic acid (DNA). As Rosalind Franklin had passed away before this time, she was not included in that Nobel Prize because of the rule regarding posthumous nominations by the Nobel Committee. Although she was not awarded with the Nobel Prize, she has remained a hero for her long unappreciated role in clarifying the structure of DNA.

The Road to the Double Helix

Investigator	Contribution	Timeline
Friedrich Miescher	Isolated nuclein in white blood cell nuclei	1869
Frederick Griffith	Transferred killing ability between types of bacteria	1928
Oswald Avery, Colin MacLeod, and Maclyn McCarty	Discovered that DNA transmits killing ability in bacteria	1940s
Alfred Hershey and Martha Chase	Determined that the part of a virus that infects and replicates is its nucleic acid and not its protein	1950
Phoebus Levene, Erwin Chargaff, Maurice Wilkins, and Rosalind Franklin	Discovered DNA components, proportions, and positions	1909–early 1950s
James Watson and Francis Crick	Elucidated DNA's three-dimensional structure	1953

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