Review article

Unravelling the "Secret of life": The story of DNA Double Helix discovery and a tribute to Dr. James Watson

S. Sreekumar
Former faculty, Department of Zoology, University College, Thiruvananthapuram, Kerala, India

Corresponding Author: S. Sreekumar, Email: ssreekumar53@gmail.com

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Abstract

Dr. James Watson, the co-discoverer of the double-helix structure of DNA and co-recipient of the Nobel Prize in Physiology or Medicine with Francis Crick, passed away on 6 November 2025. This paper presents a historical account of the contributions made by earlier researchers whose foundational work paved the way for Watson and Crick's construction of the DNA model and also highlights the individual contributions of Watson and Crick to the field of molecular genetics. Furthermore, it serves as a tribute to Dr. James Watson, one of the most brilliant biological researchers of the century.

Keywords: Central dogma, double helix DNA, Francis Crick, James Watson, genetic code, transcription, translation.

Dr. James Dewey Watson

James Watson, the American molecular biologist who co-discovered the double-helix structure of DNA (deoxyribonucleic acid), passed away at age 97 on November 6, 2025, in East Northport, New York. Born in Chicago, Illinois, in 1928, he was the only son of James D. Watson, a businessman, and Jean Mitchell. At the age of 15, he entered the University of Chicago, completing his Zoology degree in just four years. Although initially drawn to birdwatching and Ornithology, he soon realized that genes held the key to understanding life. This led him to pursue a PhD in genetics under Salvador Luria at Indiana University, Bloomington, where he studied viruses that infect bacteria. He earned his PhD in Zoology in 1950.[1] In 1951, at the age of 23, Watson joined the Cavendish Laboratory at the University of Cambridge in England. Same year, he attended a symposium at Naples where he met Maurice Wilkins of King's College, London and saw for the first time the X-ray diffraction pattern of crystalline DNA. The interaction with Wilkins sparked his interest in the chemistry of DNA. Around the same time, he met Francis Crick, a physicist. Realizing their shared fascination with uncovering the structure of DNA, Watson and Crick began collaborative research that ultimately led to one of the most significant scientific discoveries of the 20th century.

The discovery of DNA structure

The key material Watson and Crick used to elucidate the structure of DNA was Photo 51, taken by Rosalind Franklin.[2,3] Franklin was a postdoctoral fellow in Wilkins' laboratory. It was an X-ray diffraction image—a somewhat fuzzy pattern produced by X-rays scattering off DNA molecules. This image was shared to Watson and Crick by Wilkins without the permission or knowledge of Franklin. Photo 51 provided several crucial clues about DNA's structure. It, showed a pattern of black spots arranged in the shape of a cross. It can be reasonably assumed that this black cross of reflections which dominated the image could arise only from a helical structure. Another indication was that the molecule has two matching parts, running in opposite directions.[3] The image also indicated that DNA had a repeating pattern of helical turns, and revealed the dimensions corresponding to one helical turn, and the spacing between base pairs.

Watson and Crick spent considerable time building models and testing each idea against the information obtained from this image. Finally, in 1953, Watson and Crick proposed a model for the molecular structure of DNA. Their model described DNA as a double-helical polymer composed of nucleotides, each consisting of a sugar–phosphate backbone that forms the two strands of the helix.[4] The nucleotide bases project inwards, stacking on top of one another. These bases pair specifically through hydrogen bonding, with adenine (A) always pairing with thymine (T) and cytosine (C) with guanine (G). Of the four bases, A and G have a double-ring structure and are known as purines; while the single-ring structures, T and C are called the pyrimidines. The DNA thus resembles a twisted ladder with rungs formed of base pairs. The two strands of the double helix run in opposite directions. This antiparallel arrangement ensures proper base pairing, making the two strand perfect fits, and thus contributing to the stability of DNA molecule. The discovery further highlighted how the molecular architecture of DNA is intricately designed through evolution and exquisitely suited to its role as the hereditary material in living organisms. The double-stranded structure and specific base-pairing enable DNA to replicate by separating into two individual strands, each serving as a template for synthesizing a new complementary strand. This elegant and highly accurate semi-conservative replication mechanism explains how genetic information is faithfully copied within cells and reliably transmitted from one generation to the next.

The discovery earned Watson and Crick the Nobel Prize in Physiology or Medicine in 1962. Maurice Wilkins was also a co-recipient of the prize for this work. However, Rosalind Franklin could not be honoured, as she had died of ovarian cancer at the age of 37 by that time. According to the rules of the Nobel Committee, the prize will not be awarded posthumously, and it cannot be shared by more than three persons. Many believe that injustice was meted out to Rosalind Franklin twice: first, when her DNA X-ray photograph was shared with Watson and Crick without her knowledge or permission, and later, by being denied the Nobel Prize. During the same period, Linus Pauling, the American chemist who had described the structure of keratin, was also attempting to determine the structure of DNA.[5] In fact, in early 1953, he proposed a three-helix model for DNA. He might well have discovered the correct structure before Watson and Crick had he had access to Franklin's data.

Contributions of earlier researchers

Like many great scientific breakthroughs, Watson and Crick's elucidation of the DNA structure was the natural culmination of insights contributed by numerous researchers before them. DNA was first identified in the late 1860s by the Swiss chemist Friedrich Miescher, who isolated a substance he called "nuclein" from the nuclei of human white blood cells. [6,7] This substance was later renamed "nucleic acid" and eventually "deoxyribonucleic acid" (DNA). Russian biochemist Phoebus Levene made several foundational contributions to nucleic acid chemistry.[8] He discovered ribose, the sugar in RNA, and later deoxyribose, the sugar in DNA. He also correctly described the chemical composition of RNA and DNA molecules. In 1919, Levene proposed that nucleic acids consist of a series of nucleotides, each composed of one of the four nitrogenous bases, a sugar molecule, and a phosphate group. He was the first to identify the correct order of the three major components of a nucleotide (phosphate–sugar–base).[9]

Chargaff's rule

In 1944, Oswald Avery and co-workers provided compelling evidence that DNA is the hereditary material.[8] Soon after, Austrian biochemist Erwin Chargaff contributed key insights into DNA structure. He observed that DNA composition varies among species and discovered that, within any given DNA sample, the amount of adenine (A) is approximately equal to thymine (T) and the amount of guanine (G) is roughly equal to cytosine (C). In other words, the total purines (A + G) usually equal the total pyrimidines (C + T). This relationship is now known as 'Chargaff's rule'. Although Chargaff's findings were essential to later breakthroughs, he himself did not recognise that A pairs with T and C pairs with G in the DNA structure.[10]

Challenges and Breakthroughs

Cobb (2023) has provided a detailed account of the challenges faced by Watson and Crick and how they successfully overcame them.[11] Interpreting the structure of DNA from X-ray crystallography is challenging because the

molecule does not have a fixed chemical structure; the sequence of bases varies along its length. As a result, the diffraction images are not sharp and often appear blurred. In fact, Watson and Crick obtained much of the essential data for their DNA model from the Medical Research Council report prepared by Rosalind Franklin, rather than from Photograph 51, as is commonly believed. DNA exists in two forms: the A-form and the B-form. The drier A-form is slightly different in size from the wetter B-form. In the B-form, each turn of the helix measures about 34 Å, whereas the A-form has only about 28 Å per turn, giving the two forms slightly different shapes. As a physicist, Franklin was initially more interested in the A-form because of its more crystalline structure. Wilkins, meanwhile, preferred the B-form, as DNA inside cells exists in an aqueous environment. Franklin later shifted her focus to the B-form as well. Detailed calculations indicated that if the bases were separated by 3.4 Å, there would be ten bases per turn of the helix. It was also theoretically possible to have twenty bases per turn if the structure involved a double repetition. For a long time, Watson tried to cram twenty bases per turn into his models, reducing the spacing between bases to 1.7 Å.

Based on information available from earlier studies, Watson and Crick began constructing possible models using cardboard cutouts representing the bases and other nucleotide components, arranging the pieces much like solving a puzzle. In November 1951, Watson attended a seminar in which Franklin presented her X-ray diffraction data, suggesting that DNA had a helical structure. Drawing on this information, Watson and Crick constructed their first model of DNA and showed it to Franklin. The first model of DNA that Watson and Crick produced was an unsuccessful three-helical structure, a triple helix. As Cobb notes, "It's a disaster. Franklin takes one look at it and laughs." Franklin identified a critical flaw: their model placed the phosphate–sugar backbone inside the helix. One of the corrections required was that the hydrophilic phosphate–sugar backbones must lie on the outside of the molecule, where they could interact with water, while the hydrophobic bases should be oriented towards the interior.[5] Sir Lawrence Bragg, head of the Cavendish Laboratory, was embarrassed by Watson and Crick's blunder and temporarily halted their work.[5] However, a series of developments soon prompted him to reconsider the decision. By that time, Franklin was preparing to leave Wilkins' lab for another position, and her departure created a vacancy in the DNA research project. Bragg was also aware that Pauling was competing to solve the structure of DNA, and given their longstanding rivalry, he allowed Watson and Crick to resume their investigations. Crick's advisor, Max Perutz, then permitted him to read a summary report of Franklin's data. Watson had also seen these results earlier, during Franklin's 1951 lecture at King's College, but he lacked the expertise to interpret X-ray crystallography data. Crick, with his background in X-ray diffraction, immediately recognized that Franklin's findings supported a "twisted ladder" configuration, with two nucleotide chains running in opposite directions. Their progress was further hindered by an incorrect understanding of the atomic configuration of thymine and guanine rings. This was because the reference books they relied on depicted the bases in incorrect tautomeric forms. It was Jerry Donohue who provided the final cue and pointed out that they were using the wrong base configurations and suggested the correct forms.[11] His advice provided the crucial intuition they needed to revise their model. From there, everything fell into place. On the advice of Donohue, Watson prepared new cutouts based on accurate atomic configurations and placed the two strands of the molecule in the opposite direction *i.e.,* antiparallel to each other, a small crystallographic detail that Crick had long been fixated on and which Watson had not fully understood. One Saturday morning, Watson turned one of the cardboard base cutouts over and suddenly saw that A pairs with T, and C pairs with G. This pairing created rungs of constant width between the two phosphate backbones in their model. It also became clear that hydrogen bonds form between these base pairs, giving the molecule a consistent and accurate shape. This adjustment proved decisive as the complementary bases now fit together perfectly (A with T and C with G). The base-pairing now made perfect sense as the model satisfied Chargaff's rule.[5]

Significance of hydrogen bonds

Initially, Watson and Crick believed that hydrogen bonds played no role in the

interactions between the bases, but they later recognised their critical importance in the structure of DNA. It is now known that the complementary base pairs in DNA are held together by hydrogen bonds.[3] Adenine and thymine share two hydrogen bonds, while cytosine and guanine are linked by three. Although individual hydrogen bonds are weak, the presence of a large number of hydrogen bonds can provide considerable stability to the DNA molecule. Another advantage of hydrogen bonding is that it allows the two DNA strands to separate readily during replication. Moreover, hydrogen bonds contribute to the specificity of base pairing; they form only between complementary bases. For example, hydrogen bonds can be formed between A and T or between G and C, but not between A and G or between T and C. This pairing rule is of considerable biological interest as it suggested a copying mechanism for DNA.[5,8] The specificity in base pairing also ensures that genetic information is accurately copied during DNA replication. Any errors in base pairing can lead to mutations. Hydrogen bonds also help protect genetic information. In the double-helix structure, the base pairs—where the genetic information is contained—are positioned internally. This arrangement shields the genetic material from chemical reactions, thereby preserving the integrity of the genetic information.

Watson and Crick published their findings in a one-page paper, entitled "A Structure for Deoxyribose Nucleic Acid," in the British journal *Nature* on April 25, 1953.[12] This paper carried a schematic drawing of the DNA double helix prepared by Crick's wife, Odile. A coin toss decided the order in which they were named as authors. Their article revolutionized the study of biology and medicine and laid the foundation for modern molecular genetics. It provided crucial insights into DNA replication and synthesis, the genetic code, the flow of genetic information leading to protein synthesis, and the development of new technologies such as DNA sequencing, recombinant DNA technology, Polymerase chain reaction (PCR), and several other advancements in modern genetics.

Watson and Crick's views on DNA replication were presented in a second article in *Nature*, published on 30th May 1953.[13] In the years that followed, Crick further elaborated on the implications of the double-helical model, proposing that the sequence of bases in DNA constitutes codes, representing amino acids, through which genetic information is stored and transmitted. Watson and Crick's original article in *Nature* initially received limited attention. Its full significance became widely appreciated only towards the end of the 1950s, when their conclusions were experimentally confirmed by Matthew Meselson, Arthur Kornberg, and others, through studies establishing the genetic code and its role in protein synthesis.[4]

Deciphering Genetic information

In 1961, Crick and his collaborators first demonstrated that a continuous sequence of three bases on a DNA strand could code for an amino acid.[14] The first codon was cracked in 1961 by Marshall Nirenberg and J. Heinrich Matthaei, who performed an experiment using a cell-free system from *E. coli*.[15] They found that an artificial RNA chain composed solely of uracil bases (poly-U) produced a polypeptide made entirely of the amino acid phenylalanine, demonstrating that the triplet UUU codes for phenylalanine. Subsequently, it was established that a poly-adenine RNA sequence (AAAAA...) produced a lysine polypeptide, and a poly-cytosine sequence (CCCCC...) yielded a proline polypeptide. This showed that the codons AAA and CCC specify lysine and proline, respectively. Over the next few years, Nirenberg, Philip Leder, and Har Gobind Khorana deciphered the full genetic code. [16,17] Crick and others further contributed by demonstrating that codons are read in a non-overlapping, three-nucleotide sequence.

Watson's Professional life

Immediately after the elucidation of DNA's structure, Watson joined the California Institute of Technology, where he worked from 1953 to 1955 with Alexander Rich, for studying the structure of RNA using X-ray diffraction.[1] He then spent another year (1955–56) at the Cavendish Laboratory in England, again collaborating with Crick on the general principles of virus construction. In 1956, Watson joined the faculty of Harvard University, where he continued his research on the role of RNA in protein synthesis and gathered evidence for the existence of

messenger RNA (mRNA). Watson married Elizabeth Lewis in 1968.

In 1968, Watson became the Director of the Cold Spring Harbor Laboratory (CSHL) on Long Island, New York, taking on roles in both scientific administration and research. In 1994, he became its President and afterwards, its Chancellor. [1,5] Though sometimes described as absentminded, he played a major role in transforming CSHL into a leading research and degree-granting institution, with the establishment of the Watson School of Biological Sciences.

Watson, was at the helm of the Human Genome Project (HGP), when this was officially launched in 1990. [1,4] The HGP was an international effort to sequence and map all of the genes of *Homo sapiens*. He served as the first director at the U.S. National Centre for Human Genome Research (later renamed the National Human Genome Research Institute, NHGRI) from 1988 to 1992. Watson's explanation for why he accepted the offer to lead the Human Genome Project was deeply emotional. One of his two sons, Rufus, was diagnosed with schizophrenia. In his own words: "As he (Rufus) passed into adolescence, I feared that the origin of his diminished life lay in his genes. It was this realisation that led me to help bring the Human Genome Project into existence."[5] As the project's director, Watson strongly advocated for open data sharing, ensuring that DNA sequence information was made rapidly accessible to scientists globally. He also advocated for strong ethical guidelines, including dedicating a portion of the budget to studying ethical, legal, and social implications (ELSI) of genome research. He was instrumental in establishing the project's international collaborative efforts and open nature. In 1992, Watson stepped down from the HGP because of alleged conflicts of interest involving his investments in private biotechnology companies. He also could not agree with Dr Bernadine Healy, who was then the new director. Watson opposed the attempts to patent gene sequences, which he believed were not subject to ownership because they were 'laws of nature'.[5] Completed in 2003, the Human Genome Project produced the first full reference sequence of the human genome—a milestone that has since transformed biology, medicine, and biotechnology. Interestingly, in early 2007, Watson's own genome was sequenced and made publicly available on the Internet, being the second person to have a personal genome sequenced in its entirety. Later, he accepted a position as an advisor to the Allen Institute for Brain Science in Seattle, Washington, where the ultimate goal was to create an integrated gene atlas of the brain and make it universally accessible online.[5]

Controversies

Watson's later public image was marred by repeated controversy. In 1968, Watson published a book titled *The Double Helix,* in which he recounted how "the secret of life" was discovered, solving a fundamental scientific mystery: how genetic instructions are stored in living organisms and passed from generation to generation.[18] In this book, he made degrading comments about Rosalind Franklin, describing her as "hostile," suggesting that she guarded her work jealously and worked in isolation and even referring to her by the nickname "Rosy." However, Watson himself admitted in this book that he and Crick had obtained Franklin's data from her 1952 progress report to the Medical Research Council, without her knowledge. He also noted that Franklin indirectly contributed to their work by suggesting certain corrections to their initial DNA model. The book included unnecessary comments about her appearance[5] that she "did not emphasise her feminine qualities" and questioned her intelligence and speculated that she may have had Asperger's syndrome.[19] Watson's portrayal of Franklin upset many, including Crick. He also felt that Watson misrepresented the partnership between them and betrayed their friendship.

In his autobiography '*Avoid Boring People'*, Watson alienated further colleagues by calling fellow academics "dinosaurs," "deadbeats," "fossils," and "has-beens."[20] A wider ethical and social storm arose when he proposed that society might screen out people of lesser intelligence through genetic testing. He also made provocative and often offensive remarks, most infamously speculating about links between race and intelligence.[19] Watson stated that the intelligence of Africans might differ genetically from that of other races. Similarly, he opined that the skin pigment melanin boosts sex drive. His remarks were immediately condemned as racist. The controversy

ultimately prompted Watson to resign from his position at Cold Spring Harbor Laboratory. In January 2019, the Cold Spring Harbor administration revoked the honorary titles previously bestowed upon him, following the airing of the TV documentary *American Masters: Decoding Watson*, in which Watson reiterated that his views on race and intelligence had not changed. His long-criticized remarks about intelligence and race also compelled London's Science Museum to cancel a planned lecture, stating that his views "went beyond the point of acceptable debate." Furthermore, Watson sparked outrage for saying that having more women around in science makes things "more fun for the men" and they are "probably less effective". [19] Another controversial statement was that women should have the right to terminate a pregnancy if prenatal tests indicated the child would be homosexual. What was most troubling about Watson's offensive statements was how a Nobel laureate in science could make such profoundly unscientific pronouncements. In 2014, Watson became the first living Nobel laureate to auction off his Nobel Prize medal — in part to support future scientific research. A Russian businessman purchased it for $4.8 million (about £3 million) and then returned it to him.

Dr. Francis Harry Compton Crick

The story of unravelling the "secret of life" would be incomplete without acknowledging the individual contribution of Francis Crick. Francis Crick was born on June 8, 1916, in Northampton, England. He graduated with a BSc in Physics from University College, London in 1937.[3,21] During the Second World War, he worked as a scientist at the Admiralty Research Laboratory, focusing on the design of magnetic and acoustic mines. In 1947, Crick shifted his interests from physics to biology and moved to Cambridge, supported by a studentship from the Medical Research Council (MRC). In 1949, he joined the MRC unit headed by Max Perutz, which later became the MRC Laboratory of Molecular Biology. During this period, he worked on the X-ray crystallography of proteins and obtained his PhD in 1954. A crucial turning point in Crick's career was the beginning of his friendship in 1951 with the 23-year-old James Watson. It was their collaboration that ultimately led to the Nobel Prize winning discovery of the double-helix structure of DNA.

Contributions of Crick

In 1958, Crick proposed the fundamental framework known as the 'Central dogma of molecular biology'.[22] It states that genetic information flows in a single direction—from DNA to RNA to protein, or in some cases from RNA directly to protein. This flow of information involves three key processes:

- Replication (DNA to DNA)**:** DNA makes an exact copy of itself.
- Transcription (DNA to RNA): The genetic information in a segment of DNA is transcribed into messenger RNA (mRNA).
- Translation (RNA to Protein): Proteins are synthesized by linking specific amino acids in an order dictated by the sequence of codons in mRNA.

A crucial part of Crick's original formulation was that information cannot be transferred from protein back to nucleic acid. Over time, several exceptions to the central dogma have been recognized. For example, certain RNA viruses perform reverse transcription, synthesizing DNA from an RNA template. Similarly, infectious proteins known as prions can replicate without mediation by DNA or RNA. Crick also hypothesized that there must be an adaptor that mediated between mRNA and amino acids which is now known to be the transfer RNA or tRNA. This is referred to as the 'Adaptor hypothesis'.[23] Meanwhile, Paul Zamecnik and collaborators discovered the transfer RNA (tRNA);[24] but, due to its peculiar structure, Crick was initially hesitant to accept that it was indeed the adaptor.[25]

The theories proposed by Crick persuaded researchers to work on the processes of transcription and translation, leading to the elucidation of the genetic code. The elucidation of the genetic code stands as one of the greatest scientific achievements of the 20th century.[22] In 1961, Francis Crick, Sydney Brenner, Leslie Barnett, and Richard Watts-Tobin demonstrated that three consecutive bases in DNA specify a single amino acid.[26] With this discovery, scientists began cracking the 'code of life.' The first actual decoding of a "word" of the genetic

code—identifying the specific amino acid signalled by a given codon—was also reported in 1961 by Marshall Nirenberg. Nirenberg and his colleagues, including Heinrich Matthaei and Philip Leder, carried out a major part of the work in deciphering codons [15,16] that was completed by Har Gobind Khorana.[17] Eventually, Brenner, Barnett, Eugene Katz, and Crick placed the final piece of the decoding puzzle by demonstrating that UGA was the third stop codon.[27] The codons are believed to be the same in all living organisms. To account for this universality, Crick proposed the 'Frozen accident hypothesis,' suggesting that the genetic code evolved in the last universal common ancestor and became fixed after it was established.[28]

Another important contribution from Crick was the 'Wobble Hypothesis'.[4] Although there are 61 codons that specify amino acids, the number of tRNA molecules is much lower (around 40). This is to say that most amino acids are encoded by more than one codon, indicating redundancy or degeneracy of the genetic code. Crick's Wobble Hypothesis (1966) explains the basis of this degeneracy. [4,29] According to the hypothesis, the first two bases of a codon pair strictly and precisely with the corresponding bases of the tRNA anticodon, whereas the pairing at the third position is more flexible and can "wobble." In other words, while the first two codon–anticodon interactions must be complementary, the third pair can vary. This relaxed base-pairing rule allows a single tRNA to recognize multiple codons, enabling efficient translation despite the limited number of tRNAs.

Crick's views on Consciousness and Evolution

In his later years, while working at the Salk Institute for Biological Studies in La Jolla, CA. Crick turned his attention to neurobiology, focusing on how the brain works and the nature of consciousness. [3, 22] He avoided active experimentation, believing that invasive studies of the human brain were unethical. Instead, he preferred to synthesize existing research into hypotheses about the molecular origins of consciousness. However, many found his ideas on consciousness to be speculative and difficult to substantiate.

In 1973, Crick, along with Leslie Orgel advanced the 'Theory of Directed Panspermia', proposing that life on Earth may have originated from microorganisms deliberately sent by an extraterrestrial civilization aboard unmanned spacecraft. [22] He was so much fixated with this idea that he published a book '*Life Itself: Its Origin and Nature*.' However, the theory is considered to be far outside mainstream science and has been widely regarded as a speculative exaggeration lacking solid empirical support. Additionally, Crick voiced views on eugenics that were troubling and not shared by the scientific community. These opinions are widely considered problematic and do not reflect contemporary scientific or ethical standards.

As narrated by Tamura, Francis Crick continued to apply his formidable intellect throughout his life.[22] He favoured collaborative work with exceptional partners: James Watson in discovering the structure of DNA, Sydney Brenner in deciphering the genetic code, Leslie Orgel in exploring the origins of life, and Christof Koch in investigating human consciousness. He succeeded in coordinating research across diverse fields, performing like "a conductor of the scientific orchestra".[30] He was the author of several books that include "Of Molecules and Men", "Life Itself: Its Origin and Nature", "What Mad Pursuit: A Personal View of Scientific Discovery" and "The Astonishing Hypothesis: Scientific Search for the Soul."[3]

Francis Crick died on July 28, 2004 at the age of 88.

Conclusion

Watson and Crick were relatively young and had limited research experience when they began their collaboration. Watson had studied Zoology, while Crick's background was in Physics; together, their strengths complemented each other like the two strands of DNA. In scientific research, intelligence, logical reasoning, and the ability to integrate information often matter as much as, or even more than, extensive experimental work.

Indeed, many classical scientific discoveries are rooted in simple but powerful logical insights. The achievement of Watson and Crick exemplifies this: they did not perform extensive experiments or rely on sophisticated instruments and lengthy protocols. Instead, they synthesized existing data into a coherent and groundbreaking model.

The nucleotide composition of DNA was identified in 1906. However, it took nearly fifty more years to determine its three-dimensional structure, and another 10 years to fully appreciate its biological significance with the deciphering of the genetic code in 1961. It is worth mentioning that the Nobel Prize for this discovery was awarded just after that in 1962. It is widely believed that Watson and Crick's success in determining the correct structure of DNA was largely due to their access to Franklin's data and images. These undoubtedly helped them significantly, but they were not the sole resources in their achievement. According to Cobb, nothing in Franklin's data directly "gave" Watson and Crick the structure of DNA. If the data alone had been sufficient, Franklin herself would have determined the structure. The fact is that she too was working with incorrect representations of the bases, relying on the same sources for information and she did not have a Jerry Donohue to point out the correct base forms.[11] The model of DNA proposed by Watson and Crick not only revealed its chemical configuration but also delivered a package of concepts and ideas, on DNA replication, the genetic code, transcription of genetic information, and its translation into proteins. The passing of James Watson signifies the end of an era in molecular genetics, that established its foundation and spurred decades of sustained, transformative research.

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