On The Centenary Of Rosalind Franklin's Birth, The Mother Of Dna.

Celso Luis Levada[(1)]

Osvaldo Missiato[(2)]

Antonio Luis Ferrari[(2)]

Paulo Magno Garcia de Paiva[(2)]

Miriam de Magalhães O. Levada[(1)]

(1) HERMÍNIO OMETTO FOUNDATIONS/ UNIARARAS-BRAZIL
(2) PIRASSUNUNGA AIR FORCE ACADEMY- BRASIL

ABSTRACT

In July 2020, the centenary of the birth of Rosalind Franklin is celebrated. She pioneered molecular biology research, and became known in the scientific world for her work on x-ray diffraction, as well as discovering the helical shape of DNA and earning the posthumous title of "mother of DNA." Maybe she is one of the most wronged women in modern science; Rosalind's recognition was thwarted by her boss, molecular biologist Maurice Wilkins, in the 1950s. Wilkins did not accept her as the author of the discovery of the helical shape of DNA and even offend Rosalind in several letters she exchanged with other scientists in the same field.

Keywords: Rosalind Franklin, DNA, X-ray diffraction

BRIEF BIOGRAPHY OF ROSALIND FRANKLIN

As they mention AUGUSTYN [(1)] et al, Rosalind Franklin, in full Rosalind Elsie Franklin, was born in July 25, 1920, in London, England and died in April 16, 1958, London). Rosalind was a British scientist best known for her contributions to the discovery of the molecular structure of deoxyribonucleic acid (DNA), a constituent of chromosomes that serves to encode genetic information. Franklin also contributed new insights on the structure of viruses, helping to lay the foundation for the field of structural virology. Franklin studied at St. Paul's Girls School and at Newnham College, University of Cambridge. She received her doctorate in 1945 from the University of Cambridge. From 1947 to 1950, she worked with Jacques Méring at the Paris State Chemical Laboratory, studying X-ray diffraction technology. This work led to her research on the structural changes caused by the formation of graphite in heated carbons. In 1951 Franklin joined the Biophysics Laboratory at King's College in London as a researcher, where she applied X-ray diffraction methods to the study of DNA. When she began her research at King's College, little was known about the composition or chemical structure of DNA. However, she soon discovered the density of DNA and, more importantly, established that the molecule existed in a helical conformation. Their work provided the basis for James Watson and Francis Crick to suggest in 1953 that the structure of DNA is a double helix polymer, a spiral consisting of two strands of DNA coiled together. From 1953 to 1958, Franklin worked at Birkbeck College's Crystallography Laboratory in London. Rosalind collaborated on studies on ribonucleic acid (RNA) of the tobacco mosaic virus. She showed that this virus was incorporated in the protein and not in the central cavity. She later discovered that this RNA was a single stranded helix rather than the double stranded found in the DNA of bacterial viruses and higher organisms. Franklin's involvement in cutting-edge DNA research was interrupted by his premature cancer death in 1958.

INTRODUCTION

This article has two purposes: to honor Rosalind Franklin for the centenary of her birth and to present a summary of her work, especially her work on the structure of DNA. Although there is much controversy in the reports, there is evidence that Franklin had her work misused and was not initially recognized. One of the most important scientific events of the last century was undoubtedly the construction of the DNA double helix model, which was presented to the scientific community in April 1953 by James Dewey Watson[6] and Francis Crick in the journal Nature. The importance of the model, which detailed the structure of the DNA molecule, can be summarized in the fact that, with it, the molecular genetics research program received a considerable boost for its development. Among the most remarkable scientific episodes in the history of the development of such a model, the participation of physics Rosalind Elsie Franklin in its construction has received the attention of historians and biographers. Sometimes a person gets full credit for a scientific breakthrough, but that doesn't mean they worked alone. In particular, we will mention four scientists, James Watson, Rosalind Franklin, Francis Crick, and Maurice Wilkins, who helped reveal the structure of DNA. Watson and Crick were not the discoverers of DNA, but the first scientists to formulate an accurate description of the complex structure of the double helix molecule. Moreover, Watson and Crick's [(3)] work depended directly on the research of many scientists before them, including Friedrich Miescher, Phoebus Levene and Erwin Chargaff. Many scientists, including the great Linus Pauling, were trying to unravel the secret of life, and there was a sense of competition over who would solve the problem first. The physicist Maurice Wilkin and his assistant Raymond Gosling [(7)] began their studies by experimenting with technology, considered new at the time, called X-ray diffraction. The process was to focus the x-rays through the DNA molecules and then observe the scatter of this beam. Based on this test, DNA has a simple repeating structure in the form of a helix. Meanwhile, Watson and Crick decided to start building models. Molecular models resemble a type of construction toy in which balls represent the atoms and rods of the links between them. However, to build the model, they needed more clues. Such clues were provided by Rosalind Franklin during a lecture in London where Watson was in the audience. So Watson and Crick built a model based on these indications and invited Franklin, Gosling, and Wilkins to analyze it, being that all approved of the idea. Thus, in 1953, Crick and Watson, based on the experimental work of Maurice Wilkins and Rosalind Franklin, proposed the structure of the famous double helix molecule called deoxyribonucleic acid (DNA), a constituent of chromosomes and responsible for transmitting the inherited characteristics of living things. The representation reached by Crick and Watson [(4)] is a long molecule composed of two wires twisted around its own axis, like a spiral staircase. The connection between them is made by hydrogen bonds that are weak bonds, that is, they break easily. This work was published April 25, 1953 in the journal "Nature"; it was initially ignored, and gradually gaining recognition from the scientific world, and Crick won the Nobel Prize in Physiology or Medicine in 1962, along with James Watson and Maurice Wilkins. Rosalind Franklin had died.

WHAT'S THE DNA

DNA (9) or deoxyribonucleic acid is a long molecule that contains our unique genetic code. Like a recipe book it holds the instructions for making all the proteins in our bodies. All living things have DNA within their cells. In fact, nearly every cell in a multicellular organism possesses the full set of DNA required for that organism. However, DNA does more than specify the structure and function of living things. It also serves as the primary unit of heredity in organisms of all types. In other words (9), whenever organisms reproduce, a portion of their DNA is passed along to their offspring. This transmission of all or part of an organism's DNA helps ensure a certain level of continuity from one generation to the next, while still allowing for slight changes that contribute to the diversity of life. Even before the structure of DNA was elucidated, genetic studies clearly indicated several properties that had to be fulfilled by hereditary material. One crucial property is that essentially every cell in the body has the same genetic makeup; therefore, the genetic material must be faithfully duplicated at every cell division. Secondly, the genetic material must have informational content, since it must encode a lot of proteins expressed by an organism. Finally, although the structure of DNA must be relatively stable so that organisms can rely on its encoded information, it must also allow the coded information to change on rare occasion. These changes, called mutations, provide the raw material, genetic variation, which evolutionary selection operates on. In nature, DNA molecules carry the hereditary information. But DNA has physical and chemical properties that make it attractive for uses beyond heredity. DNA has potential for creating machines that are both encoded by and built from DNA molecules. There are many methods that allow the assembly of DNA

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nanostructures, which allow advances in the construction of increasingly complex molecular structures. This provides strategies for creating machine, like nanostructures, that can be driven and moved. The result points to applications of custom DNA nanostructures as scientific tools to meet the challenges of biology, chemistry and engineering.

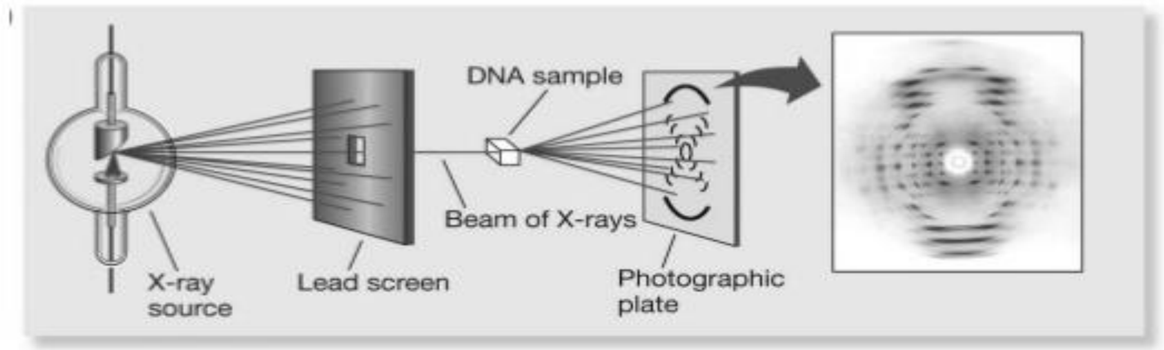

Fig.1 – Developed X-ray diffraction images of DNA

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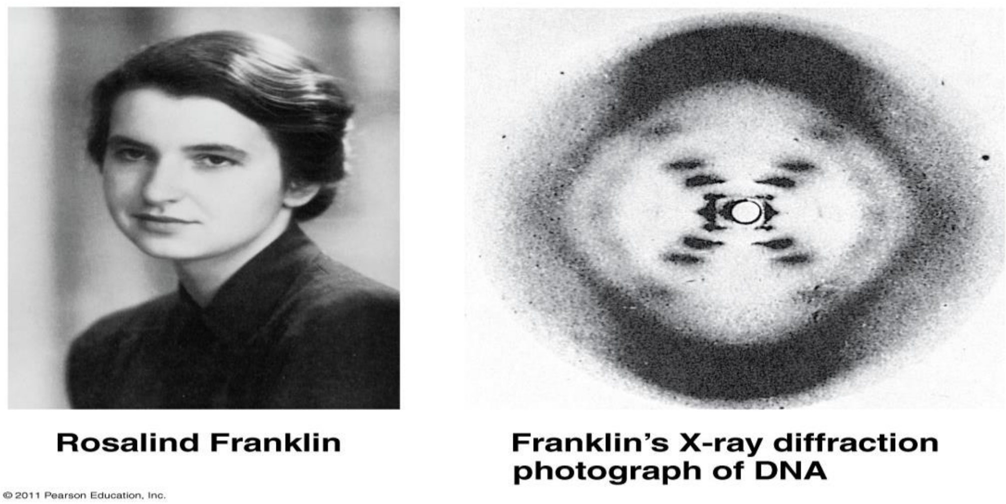

Fig.2- Picture of Rosalind and x-ray diffraction of DNA

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ONE OF THE BIGGEST SCIENTIFIC DEVELOPMENTS OF THE 20th CENTURY

The discovery of the structure of DNA opened a new era for science and has since sparked a revolution in scientific research linked to the life sciences. By the time Watson and Crick began their study of DNA structure, they had both read Schrodinger's classic book, "What's Life" or "What's Life." In this paper, Austrian theoretical physicist Erwin Schrodinger [12] tried to explain using only concepts of physics and chemistry, how heredity could be transmitted and codified in living organisms. At that time the concept of vitalism prevailed, according to which biological organisms were composed of a kind of magical force, the élan vital. The Schrodinger's book, published in 1944, was merely an attempt to explain the heredity without any appeal to vitalism. This exciting magic of living forces was used as an explanatory model of life in ancient Greece. In his work, Schrodinger argues that the gene should be understood as a molecule; It was a molecule as large and stable as a crystal. She, however, could not be as organized and rigid as a crystal for one very simple reason: she needed to store information; biological information for cell function and heredity. A crystal is well known, it is a highly ordered set of molecules that, however accurate and repeatable, cannot hold complex forms of information. Schrodinger's important contribution laid the theoretical foundation for DNA discovery, but his contribution did not come from an observation of the way molecules suggest the most likely way to carry this information. On the other hand, as you mention RAMOS [9], the biologists considered proteins, most of the molecules studied at the time, as the most likely molecules for the transmission of information. Moreover, they were the most well-known molecules, while exhibiting striking and elegant characteristics, such as fermentation enzymes. So it was not a big leap to imagine them also to maintain the hereditary code. Acceptance of the duplex model was the starting point for attempts to clarify genetic transmission at the molecular level. But let us not forget that the proposition of the structure model of DNA molecules was the result of several decades of research by numerous scientists, predecessors and contemporary scientific facts, whose observations and theories were indispensable as stages of scientific production. This scientific movement was called the knowledge circle, a concept defined by FLECK [10], formed by knowledge producers, referring to the group that began to work with the structure of the DNA molecule before the model proposed by Watson and Crick. Many people wonder if Watson and Crick were really fair to Franklin since they didn't give him credit for much of the evidence that made it possible. Obviously, all the information Watson and Crick needed was provided by Rosalind Franklin; reason enough to recognize its importance in determining the structure of the double helix. But what is surprising is that a whole tradition of historiographical research was built on an attitude of lack of scientific recognition. DNA is the genetic material that contains critical inheritance information that determines the phenotype of individuals. The discovery(3) of its structure represents a milestone in the development of biology over the past two centuries, which began with the discovery of Mendel inheritance laws, contributing to significant advances in the improvement of living organisms and the understanding of biological processes.

DISCOVER A NEW DNA STRUCTURE IN HUMAN CELLS

For the first time, scientists have identified the existence of a new DNA structure never seen before in living cells. A group of scholars (13) at the GARVAN Institute for Medical Research in Australia discovered a different DNA structure of human cells. The discovery was called a "twisted knot" in DNA confirming that our complex genetic code is endowed with a far more complex symmetry than just a double helix structure that everyone associates with DNA. This molecular variant affects how our biology works. This research reminds us that there are completely different DNA structures. The new DNA component identified is called the intercalated motif represented by the acronym (i-motif). In this structure, Cytosines (C) from one strand of DNA bind to other cytosines on the same strand. This is very different from what happens in the double helix, where "letters" of the opposite ribbon are recognized and C binds with G (Guanina). Apparently, this structure forms in the later part of the cell cycle, especially in the G1 phase, when DNA is being actively read. I-Motifs also tend to appear in what are called promoter regions, areas of DNA that control which genes are turned on or off. Now that we definitely know that this new form of

DNA exists in cells, it will give researchers assignment to find out exactly what these structures are doing inside our bodies.

FINAL CONSIDERATIONS

The discovery of the structure of DNA, with all its biological implications, was one of the greatest scientific events of the twentieth century. The number of researches this discovery has inspired is incredible; caused an explosion that transformed the biochemist and opened a wide door to the field of molecular biology. According to Brown (8) , the proposition of this model was one it was a great demonstration of a multidisciplinary work unprecedented in the history of science. The work was attended by great personalities of science, as Linus Pauling, a chemist from another circle of knowledge, who contributed with Watson and Crick, that provided the model of reference protein structure(8). To unravel the structure of DNA Pauling's focus was on molecular proteins, especially the alpha helix protein, precursor of DNA. Prior to this, Pauling (5) was already considered the most influential chemist of his time. His book, The Nature of Chemical Bonding, has served as inspiration and reference for many scientists of his day and is still considered a milestone in scientific publications. And his method, combining model building, along with knowledge of modern chemistry and physics, served of reference James Watson and Francis Crick to investigate DNA. What few know is that Linus Pauling simply did not discover the structure of DNA before James Watson and Francis Crick by little details. Pauling was in the runway's DNA. He could travel to England and see the new X-ray plates made at King's College London by Rosalind. And the new X-ray diffraction technique would help interpret the helical structure of DNA and the internal position of the bases. Reading one of Pauling's on the subject, Watson found a mistake Pauling made and tried to convince Wilkins and Franklin that they had the correct interpretation. As a double-stranded model to adequately fit the crystallographic data of Rosalind Franklin's preparations, Pauling immediately gave up his model. After publication, Watson continued his studies in this precursor area of molecular biology, which is why he is often more associated with this subject. In The Double Helix, James Watson chronicles his version of the DNA double helix model construction, in which he indicates that Rosalind Franklin, a physicist specializing in X-ray crystallography, has developed fundamental empirical work for the construction of the Watson and Crick model. Watson's account gives rise to a historiographical problem: Why did FRANKLIN [11], who had his own empirical data, not decipher the molecular structure of DNA? Watson himself provides an answer by suggesting that Franklin would have no theoretical inclination for the helical representation of DNA, doing strictly experimental work. This suggestion has received replies from historians, so that the historiographical problem implied in Watson's account has remained to this day. However, it is possible to gain clues that, before being involved in building a structure for DNA, Franklin was concerned with mapping out all aspects of the molecule. Fifty years after the description of the double helix, another major discovery caught the attention of the scientific community: the sequencing of the human genome. The discovery of the DNA double helix, which paved the way for modern molecular biology which can give rise to drugs tailored to each one's genetic code, that is, we can get more effective drugs with a better toxicological profile. In addition, modern media enable a scientist working anywhere in the world with a computer and an internet connection to register and gain access to vast gene banks and predict which amino acid sequences and protein function these genes have. All this knowledge and freedom is expected to be used for the good of human beings and society as a whole.

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