Discovery of DNA and Its Molecular Structure

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Abstract— **In this research paper I have compiled the major contributions by different scientists which led us to the present worldwide accepted structure of deoxyribose nucleic acid. Starting from the Gregor Mendel's "Laws of inheritance" this research paper talks about the contributions of Friedrich Miescher and Richard Altmann, Theodor Boveri and Walter Sutton, Phoebus Levene, Oswald Avery, Erwin Chargaff, Maurice Wilkins, Rosalind Franklin and brief description of the research paper published by James Watson and Francis Crick in "Nature"(journal) with the tittle "Molecular structure of nucleic acid".**

I. GREGOR MENDEL:

Gregor Mendel (1) started his study on Pisum sativum (pea Plant) in 1857 and later discovered the fundamental laws of inheritance. He deduced that gene come in pairs and are inherited as distinct units, one from each parent. Studies of Gregor Mendel provided the idea that there is something which is being transferred from parent to their offspring and these were called Genes by Mendel but the chemical nature of the genes was still unknown.

II. FRIEDRICH MIESCHER AND RICHARD ALTMANN

Years after Mendel's discoveries Miescher (2) in 1869 performed biochemical investigations of Salmon Sperm, from which he succeeded in isolating protamine, an important constituent of spermatozoa. But then Miescher fell into an error, he found the presence of purine bases in the protamine he had isolated by the murexide reaction (an analytical technique to identify the presence of caffeine and other purine derivatives in a sample). However, he concluded that nuclein also contained purine bases. But this was still a confusion until R.Altmann a student of Miescher in 1889 separated protein (free of purine bases) from nuclein(called by him nucleic acid) containing xanthine bases.

III. THEODAR BOVERI AND WALTER SUTTON:

After the discovery of chromosomes by Walther Flemming in 1882 Sutton and Boveri gave the theory of inheritance which states that genes are found at specific locations on chromosomes and that the behavior of chromosomes during meiosis can explain Mendel's laws of inheritance.

IV. FREDERIC GRIFFITH:

It was clear that there is something which is been transferred in every generation but what is transferred was still a question until the discovery of Frederic Griffith who proved that the DNA is the genetic material which is been transferred in every generation with the help of his experiments on Streptococcus pneumoniae and mice.

V. PHOEBUS LEVENE:

Phoebus Levene played a very vital role in the discovery of the structure of the DNA. He discovered "ribose sugar" in 1909 and "deoxyribose sugar" in 1929 and suggested the structure of nucleic acid as a repeating tetramer. He called the "phosphate-sugar-base" unit a nucleotide. He found that DNA contained adenine, guanine, thymine and cyteisine, deoxyribose and a phosphate group. Levene gave a "Tetranucleotide hypothesis" which proposed that DNA was made up of equal amount of adenine, guanine, cyteisine and thymine. But the hypothesis was proved wrong as it was realized that a dull structure in which a four-member unit is being repeated could not carry the plethora of information that must be involved in heredity.

VI. OSWALD AVERY:

Avery continued the research done by Frederick Griffith while working with Colin Macleod and Maclyn Mccart on the mystery of inheritance and gave the transforming principle of DNA.

VII. ERWIN CHARGAFF:

After the "tetranucleotide hypothesis" proposed by Phoebus Levene which was later proved wrong Erwin Chargaff in 1940s gave another hypothesis that the ratios of Adenine to Thymine and Guanine to Cytosine are equal. This is also known as Chargaff's rule.

VIII. MAURICE WILKINS:

At King's college, Wilkins pursued X-ray diffraction work on ram sperm and DNA that had been obtained from calf thymus by the Swiss scientist Rudolf Singer. The DNA from Singer's lab was much more intact than the DNA which had previously been isolated. Wilkins discovered that it was possible to produce thin threads from this concentrated DNA solution that contained highly ordered arrays of DNA, suitable for the production of X-ray diffraction pattern. Using a carefully bundled group of these DNA threads and keeping them hydrated, Wilkins and a graduate student Raymond Gosling obtained X-ray photographs of DNA that showed that the long, thin DNA molecule in the sample from singre had a regular, crystal-like structures in these threads. Maurice Wilkins shared the 1962 noble prize in physiology or medicine with James Watson and Francis Crick.

IX. ROSALIND FRANKLIN:

Dr Franklin joined the laboratory of John Randall at King's in 1950. At king's, by controlling the water content of the DNA specimens, she showed that the molecule could exists in two forms (A and B). In may 1952 she and PhD student Ray Gosling captured the image of the B form that James Watson of Cambridge save early in 1953, giving him and Francis Crick vital information for the building of their DNA model in march. Her creation of the famous photo 51 demonstrated the double-helix structure of deoxyribonucleic acid. The molecule containing genetic instructions for the development of all living organisms.

X. JAMES WATSON AND FRANCIS CRICK:

The question that what is been transferred was answered but now the question which was yet to be answered was that what is the structure of DNA. With the help of the X-ray diffraction pattern and pictures of DNA produced by Maurice Wilkins and Rosalind franklin and based on their own research and observations James Watson and Francis Crick (3) proposed a structure of DNA. That structure had two helical chains each coiled round the same axis. They made an assumption that each chain consists of phosphate diester groups joining deoxyribofuranose residues with 3',5' linkages. The two chains (but not their bases) are related by a dyad perpendicular to the fiber axis. Both chains followed right-handed helices but the two strands are antiparallel to each other. The bases are on the inside of the helix and the phosphates on the outside. The sugar is roughly perpendicular to the attached base. There is a residue on each chain every 3.4A in the Z-direction. They assumed an angle of 36 degree between adjacent residues in the same chain, so that the structure repeats after 10 residues on each chain, that is, after 34A. The distance of a phosphorus atom from the fiber axis is 10A.

The structure is an open one, and its water content is rather high. At lower water structure they expected the bases to tilt so that the structure could become more compact. They mentioned in their research paper that the novel feature of the structure of DNA is the manner in which the two chains are held together by the purine and pyrimidine bases. The planes of the bases are perpendicular to the fiber axis. They are joined with the help of hydrogen bonds where one single base of one chain pairs with one single base of another chain. If one of the pair is purine than the other has to be pyrimidine for bonding to occur. They wrote that if it is assumed that the bases only occur in the structure in the most plausible tautomeric forms it is found that only specific pairs of bases can bond together. These pairs are: adenine(purine) with thymine(pyrimidine) bonding by two hydrogen bonds and guanine(purine) with cytosine(pyrimidine) binding by three hydrogen bonds. And its experimentally found that the ratio of the amounts of adenine to thiamine, and the ratio of guanine to cytosine, are always very close to unity for deoxyribose nucleic acid. They reasoned why it is impossible to build this structure with ribose sugar in place of deoxyribose by stating that the extra oxygen atom would make too close a van der Waals contact.

REFERENCE

[1] www.dnaft.org{1}, jnorman.com{2}, Nature (journal){3}