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# DNA - Reviewing the Structural and Functional Diversity

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**Abstract:- DNA (Deoxyribonucleic Nucleic Acid) is the most important structure in the human body.It was first identified by Watson and Crick. And it is also called as Watson and Crick model of DNA structure. It has many applications and gained popularity among researchers in various fields. Knowing the basics of DNA and its structure and functions helps in understanding the concepts of different pathways and mechanisms involved. It is found that DNA can be isolated from dental tissues such as, tooth and pulpal structures and recently it is found that DNA can be recently isolated from the dentinal tubules.**

***Keywords:-*** *DNA, Dental Tissues, Dentinal Tubules, Molecular Proteins.*

## I. INTRODUCTION

DNA is one of the most important and informative molecule, it stores instructions for making large molecules, called proteins. It is known as instruction manual of life. During the first of 20$^{th}$century, it was hypothesized that proteins carry genetic information's but later changed in 1944, when three scientists at the Rockefeller institute made their fundamental discovery of DNA molecule - Avery et al**.** This remarkable structure of DNA, from nucleotide up to chromosome, plays a crucial role in its biological function. The ability of the DNA to function as the material through which genetic information is stored and transmitted is a direct result of its elegant structure. In 1953, Watson and Crick unveiled two aspects of DNA structure, pairing the nucleotide bases in complimentary fashion and the double helical nature of DNA. [(1, 2)]

## II. DNA STRUCTURE- CELLULAR

In eukaryotes, histone proteins are used to condense the DNA into chromatin. The basic structure of chromatin is the nucleosome, contains DNA wrapped almost two times around the histone octamer. The nucleosomes are folded upon themselves to form the 30-nm fiber, this is then folded again to form the 300-nm fiber and during mitosis further compaction can occur forming the chromatid which is 700 nm in diameter. [(3)]

**Table 1:** Difference between prokaryotic and eukaryotic DNA [(2, 4)]

| Prokaryotic DNA | Eukaryotic DNA |
|---|---|
| They are present diffused in a central dense region of cytoplasm called nucleoid | It is present in the nucleus surrounded by nuclear membrane |
| Double stranded circular with one origin of replication | Linear double stranded with multiple origins of replication |
| Introns or non-coding region are absent | Introns are present |
| Plasmids present | Plasmids absent |

## III. MOLECULAR

### *A. Determining the Structure of DNA:*

At king's College London, Rosalind Franklin and Maurice Wilkins having obtained data using X-ray diffraction,had proposed that DNA had a helical structure.In Cambridge,James Watson and Francis crick used model building together with data from variety of sources including Franklin's X-ray diffraction pattern and Chargaff's base composition data to work out the now well-known Double helix structure of DNA which was published in nature in 1953. [(5)]

### *B. Molecular structure*

- *DNA monomers*

DNA is polymer composed of monomer called nucleotide. A molecule of DNA is a bunch of monomer joined one after another into a very long chain

➢ *Four nucleotide monomers*

A, C, T, G adenine, Cytosine, Thymine and Guanine are the basic nucleotide. Each nucleotide monomer is built from simple partsa sugar, phosphate group and nucleo-bases. [3]

➢ *Sugar*

Deoxyribose sugar it a cyclical molecule arranged in ring structure, contains one oxygen five carbon atoms and hydroxyl group.

➢ *Phosphate group*

It contains a phosphorous atom and four oxygen atom are bonded

➢ *Phospho-diester bond*

Nucleotide monomers are connected by strong electromagnetic attraction called Phospho-diester bond, which joins one DNA nucleotide to another:3' carbon of 1st nucleotide to 5' carbon of 2nd Nucleotide. These are called 3'-5' bond, each time during the bonding process, water molecule is removed this is called ' dehydration synthesis's. [3, 6]

*C. Properties:*

- Bases are regularly spaced at 0.34nm apart along the axis of the helix
- Helical diameter of 1.9nm
- Backbone of DNA helix has two helical groove with different widths known as major and minor groove
- Minor groove – space between two anti-parallel DNA strands that run closest together
- Major groove – the space where they are furthest apart
- These are the specific dimensions for Bform of DNA [7]

*D. Types*

- **A** form - These are right handed double helix with less distance between the bases (0.256nm) and have smaller helical rotation
- **Z** form - These are left handed double helix most present in human genome where the Purine and pyrimidine groups are in alternating sequence [6, 7]

**Table 2 Function**

| Structural features | Function |
|---|---|
| Strong, covalently bonded | Preserves the base sequence of genetic |
| sugar-phosphate backbone | information during the lifetime of the cell and allows shortening of the DNA during chromosome formation in cell division |
| Complementary purine-pyrimidine base pairing | Keeps an equal distance between the two polynucleotide strands, increasing the stability of the double helix |
| Numerous but weak H-bonds between complementary bases | Enhance stability of the helix but are easily broken by enzymes to allow DNA replication and transcription |
| Large, insoluble molecule (molecular mass approx. 100000 units) | Restricts DNA to the nucleus, protecting it from biochemical damage, thus preserving the genetic code |

## IV. APPLICATIONS AND RECENT ADVANCES IN DNA

- Cloning - Reproductive cloning is used to make a clone (or) identical copy of an organism, Sheep as the first mammal to be cloned in 1996. Identical twins are one of the example in cloning they have identical DNA as developed from same fertilized egg.
- Genetically modified organisms - using horizontal gene transfer genetically modified organisms, food and medicines are developed.
- Application of DNA markers in Agriculture - Compared to cytological, morphological markers DNA markers are more informative and used in identification of crop variety instead of many factors ,Used in cultivator identification and Analysis of seed purity.
- Gene marker assisted Breeding - Short Comings of traditional field selective breeding methods are overcome by gene marker assisted breeding. Shi at al, developed blast resistance trait of rice and soybean mosaicvirus of soybean sing molecular marker assisted breeding
- Quality improvement of crops - Using transgenic technique qualities such as amino acid content, starch composition polysaccharides compounds and lipid in seeds and other storage organs
- Medical applications - Human gene therapy using modified viruses human Genes are alteredGene Therapy is used to treat sickle cell anaemia and Parkinson's disease.
- Fingerprint - Professor Jeffrey's compared the fingerprint of different individuals and finalise that, father and mother had different fingerprint pattern. While children had finger print pattern as combination of both father and mother
- Diagnosis of disease - genetically transferred diseases like sickle cell anemia , Hutchinson diseases are diagnosed using DNA technology
- DNA based Nano-materials- used in skeletal muscles regeneration, NIR- DA near infrared light activated DNA agonist
- DNA biomaterials - skin injury like burns, chronic skin diseases, wounds can be regenerated using DNA Nano-materials [4, 5, 8]

## V. CONCLUSION

DNA is used in a vast variety of resources and serves as diagnostic, reparative and regenerative tool. It also plays a vital role in stem cell therapy, forensic science, agriculture to improve the quality of crop culture and reduces the pesticides from damaging the crops and also used in industries for various purposes.

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