

Submitted by

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Trapping Of DNA

What is DNA?

DNA (Deoxyribonucleic acid) is a nucleic acid in which all kind of information about the functioning of all living organism is stored. We can say that DNA is a kind of information storage system. This is the reason why DNA is a very interesting topic to study. There are many Universities and Lab that are working in DNA and trying to explore there knowledge about the DNA.

DNA consists of two long polymers made up of Sugar and Phosphate and these two polymers are joined by base groups. There are four different types of base groups as **adenine (A), thymine (T), cytosine (C) and guanine (G)**.DNA consists of two helix shape joined by base pairs. Due to this helix shape made by two polymers such kind of DNA is called Double Strand DNA (dsDNA).This is also possible to separate these two polymers have a single polymer chain and then it is called single strand DNA (ssDNA).

Facts about DNA:-

1. DNA is a negatively charged molecule, this negative charge on DNA is due to phosphate group present in its structure.
- 2.Length of DNA molecule is depend upon its base paires.Length of one base pair is 0.34nm.This means if you want to calculate the length of 4 kbp DNA it is $0.34 \times 4000=1360$ nm. Similarly length of 6 kbp DNA is $0.34 \times 6=2040$ nm.Here kbp stand for kilo base pair.
3. Diameter of human ssDNA is around 1.7 nm and for dsDNA it is around 3.0nm.
4. Total length of all DNA molecules in the human body is equal to the 70 times the round trip from earth to sun.

So we can say that DNA is a negatively charged long molecule that stores the valuable information.

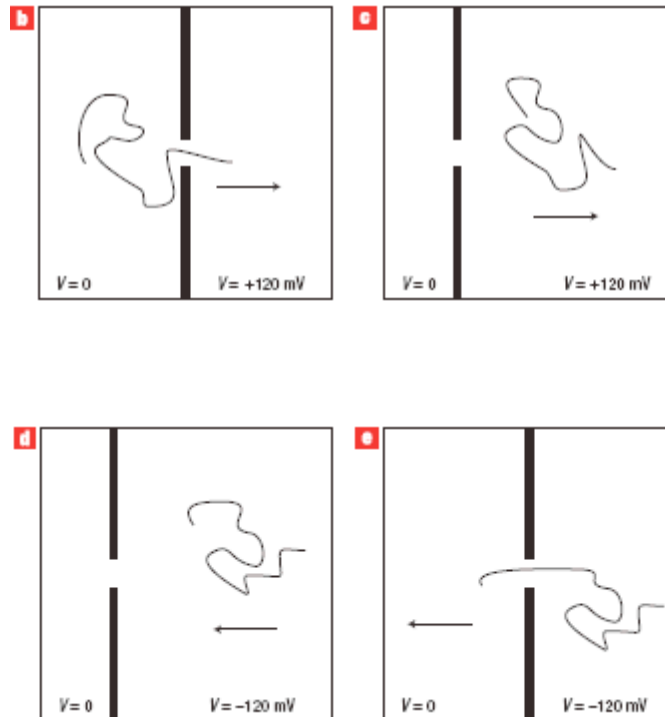
Sequencing of DNA:-

Although 99.9% of human DNA sequences are same in every person, but it is still enough of the DNA is different to distinguish one individual from another. DNA use repetitive sequences that vary a lot in its structure and all the information stored in it is based in the fact of the repetition of base pairs in it. This repetition is quite similar between closely related humans but also so variable that unrelated individuals are extremely unlikely to have the same type of repetition. So our aim is try to find a simple and economical technique to find the sequence of these base pairs in the DNA. This sequencing is very important because this sequence encodes the necessary information for living things to survive and reproduce. Determining the sequence is therefore useful in fundamental research into why and how organism lives. Knowledge of DNA sequence may come in useful in practically any biological research. For example in medicine it can be used to identify, diagnose and potentially develop treatments for genetic diseases.

Experiment :-

In the paper that I have chosen, explains a new method to explore the properties of DNA and how it behaves as it crosses the nanopore. Here in the paper they have chosen a nanopore of dimensions $5\text{nm} \times 7\text{nm}$ and the length of nanopore is 20nm . A constant bias current is maintained around the nanopore buy using electrolyte solution. As the DNA molecule Crosse the nanopore there is drop in already maintained base current, the time for which this drop occurs gives an idea about the length of DNA and how much this drop is, is proportional to diameter of DNA.

DNA molecules are lying on one side (say side 1) of nanopore then a positive potential is applied on the other side (say side 2) of nanopore. As we know DNA molecule is negatively charged it starts to move to the other side at positive potential through the nanopore. The current drop across the nanopore is measured and analysed. But as the DNA molecule crosses the nanopore after some time polarity of potential applied is reversed so now the positive potential is on side 1 and DNA molecule is on side 2. So now again the same DNA molecule starts to move back to side 1. as the DNA molecule reach the side 1 the same procedure repeats again. In this way same DNA molecule crosses the nanopore again and again. This is why it is called **trapping of DNA**. The whole procedure is illustrated in the diagram as



Now the important thing is that when we have to reverse the biasing of voltage, because if we reverse the polarity after longer time then it is not possible to recapture the same DNA molecule again. This is because DNA molecule is also under the influence of diffusion forces also. The electric field generated by the voltage that we have applied has its influence up to a certain distance (Semi Spherical region of radius ' r ') from the nanopore. Lets say this distance as ' r '. In this spherical region the force on DNA molecule due to electric field is more dominating then the force on DNA molecule due to diffusion. So we have to reverse the polarity of potential in a way that the DNA molecule should not crosses this spherical distance ' r '. Because if DNA molecule crosses this Semi Spherical region then this is not possible to recapture it even by voltage reversal. The distance before which we need to reverse the voltage is called **capture length 'L'**.

Results :-

In this paper they have calculated the capture length for 4 kbp dsDNA and for 6 kbp dsDNA. For 4 kbp dsDNA ' L ' is 940 nm and for the 6 kbp dsDNA it is 1200nm. Details about the experiment will be discussed in the class.

Advantages:-

The main achievement of this method is that, this method gives a way to study the behavior of DNA molecule in its natural environment. Natural environment of DNA means we are not making any chemical change in the DNA .Secondly by this method we are able to study the properties that gets changed as the DNA molecule crosses the nanopore.