Nanotechnology

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PASS

Research Paper

based on

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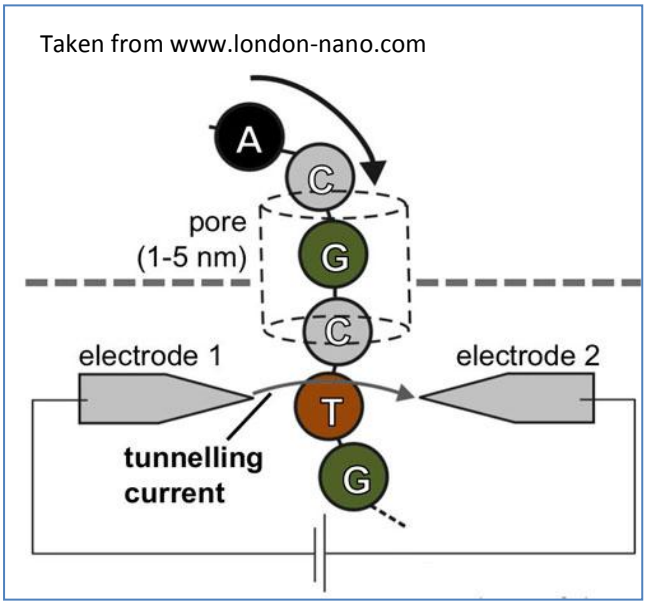
Abstract

Nanotechnology has made a large influence to the world of DNA. I hope to explore the uses of DNA sequencing using graphene. Sequencing DNA not only lets us understand the human genome it can also aid our understanding of the DNA in smaller organisms such as Bacteria and Viruses. Using graphene (sheets of carbon one atom thick) allows us to know each triplet code and therefore each gene from which we can understand which gene causes the certain characteristic to either the Bacteria or Virus that affects the human body. Each Bacterium produces toxins- each species unique affecting one part of the human body causing the symptoms which enables us to determine what the Bacterium is. Using Nanotechnology we can predict how the body will be affected.

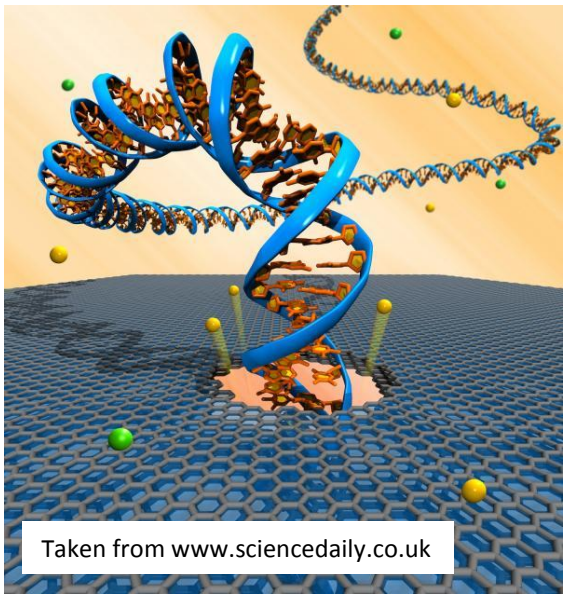
Introduction

Nanotechnology was first envisioned during a lecture "There's plenty of room at the bottom" by the Physicist Richard Feynman during 1959. He talked about scientific engineering from the molecular level, "I want to build a billion tiny factories, models of each other, which are manufacturing simultaneously. . . The principles of physics, as far as I can see, do not speak against the possibility of manoeuvring things atom by atom. It is not an attempt to violate any laws; it is something, in principle, that can be done; but in practice, it has not been done because we are too big." really opened the number of opportunities to use nanotechnology. The development has significantly aided the new generation of ideas within the last decade. Recently researchers from the Imperial College London performed a breakthrough experiment recently which has provided the foundations for the expansion of DNA sequencing. The researchers used graphene with two platinum electrodes on either side of a nano-pore. The DNA strand is threaded through this nano-pore and an electric current is passed between the electrodes. This allowed them to number of nucleotides. This could potentially be developed to evaluate the exact sequence.



The current sequencing technique is costly and requires fluorescent labelling and biochemical amplification. It doesn't allow you to target certain genes or alleles in the DNA. It has been used mostly in Forensics to analyse suspects or victims. Also it can be used to overlay DNA to figure out relatives. The barcode sample which you are left with provides no evidence for what effects different aspects of the body.

The first draft entire human genome sequence was announced in 2001 which was done using enzymes which could break down the DNA strand. It is then dyed to label each base pair which is then separated to be read out using gel electrophoresis. This method has later been developed to enable more efficient, faster and more detailed coding. The previous method can be used theoretically to develop our future developments of DNA sequencing. For example at the present time we cannot determine which bases are in the genome however using the method of fluorescent dye and biochemical amplification we could be able to see each base in the full 46 chromosomes in the human being or any number present with all living organisms. From this we can see patterns in the DNA and understand where our characteristics come from. However the aspect that I find the most intriguing is spotting mutating genes and those that rapidly replicate. I believe that this knowledge could enable scientists to beat cancer. The knowledge of the DNA of certain Bacteria may enable use locate where the toxin producing genome is. When the bacteria replicates by mitosis the DNA is unzipped using the enzyme Polymerase. The strand is open for split seconds whist the free nucleotides join by hydrogen bonding. Helicase is then the enzyme which joins the deoxyribose sugar with the phosphate backbone. From our knowledge of enzymes we know that they can be prevented from catalysing reactions from the use of Inhibitors. The nucleotides will then not bind the Phosphate backbone hence stopping the production of new Bacterium. By using nanotechnology we can see the structure of the protein enzymes and develop artificial complementary substrates which will act as competitive inhibitors. If we can create these artificially by manipulating atoms on a nano scale then we can create drugs to combat this Bacterium or in fact a virus.



Taken from www.sciencedaily.co.uk

At present we vaccinate to prevent people to provide long term memory of antibodies which can readily attack the bacteria by attaching themselves to the antigen markers which are present on the surface of the Bacteria. This will still be the best way of dealing with disease and has been done since 200 BC in ancient china. “Prevention is better than a cure” the phrase dated back to 1240 will never change no matter what technology brings us. The use of the SEM (scanning electron microscope) and TEM (Transmission electron microscopy) has aided our knowledge of single celled organisms and there organelles. We can also use ultracentrifugation to extract organelles for further examination. All we examine has its own DNA whether it is within a nucleus or not, the building blocks of biological substances is the DNA. Looking at organisms at the nano scale is the way forward as I belief that DNA sequencing is the foundations of the future.

But how will it work? The DNA would be within a solution containing ions. The sheets graphene will be within the mixture. The highly conductive graphene will attract the ions and will bring the DNA strands though the nano-pore which had been delicately cut. The electric current will calculate the number of genes through the pore. The sequence can be slowed down so the base seen. If the bases can be dyed then each of the 4 bases (A,T,C and G). Scientists who conducted the experiment found that the current reading on the ammeter changed as each different nucleotide went through the nano pore this allows them understand the entire sequence of nucleotides. As I have suggested this would be a breakthrough in the understanding of pathology and the development of drugs. The ammeter readings would be stored as data on a computer which eventually once the current for each nucleotide is documented the current readings can be changed to the names of the bases. Once these are calculated a whole world of opportunities opens up for the use of this data. Once this has been done a number of times the data will be collected more efficiently.

Discussion

I believe that the research into DNA sequencing could put an end to cancer and the symptoms produced by pathogens. We must go deep into the origins of the cancer growth which is where the nanotechnology comes in. Firstly the inter-phase production of mitosis is corrupted. This phase should take up 90% of the cell division process. The DNA is arranged and the cell must take up a lot of energy in order to divide and grow. The mitochondria of the cells constantly have to work to deliver enough energy for the cell to undergo this process. In a cancer the inter-phase stage happens much quicker, causing the DNA to be under developed. When the DNA is in the process of unzipping the nucleotides may become damaged due to this fast replication. Cancer can develop in two types. Benign tumours are the less aggressive types and are more easily treated as they do not spread to other parts of the body. The other type is malignant these tumours spread and therefore are far more difficult to treat because there is not one area to target which make radiotherapy much harder. The lymph system is affected causing the host to become much more open to disease.

Fortunately because of the development of DNA sequencing we can potentially know the areas of the DNA which have been mutated therefore not matching the original copy of DNA. With this knowledge we can develop a drug which will act as inhibitor only to these mutated cells. I realise that at the present time we use the drug Cytarabine (cytosine arabinoside) to treat acute myecloid Leukaemia. The drug once ingested is converted to cytosine arabinoside triphosphate which is structurally similar to the nucleotide, deoxycytidine triphosphate which will form DNA in the form cytosine. This drug binds to the end of the DNA chain and prevents any other addition of nucleotides because the phosphate will not bind the deoxyribose sugar. This stops the development however of any rapid growing cells such as hair, teeth and nails. (Hence the formation of cysts) Also many

people suffer with sore mouths as people are constantly cutting their mouths and with are poor lymph system the cuts do not heal. This causes lack of nutrition which then leads to depression. All of these damage the ability of people to stay strong and combat their illness. This is why the effects of chemotherapy are so horrific and in many ways upsetting.

It has been shown that the Leukaemia drug is vastly effective so theoretically the graphene nanotechnology should revolutionise the cancer treating drugs. The more we understand about the cell cycle the more likely we are to be able to develop our technology. If for example during inter-phase there is a lack of a certain free nucleotide, which is causing the mutations to occur the use of the sequencing will find the error. How then will the error be fixed? Only those cells which are cancerous will have the different DNA which enables a drug to be developed specifically to target the cancer cells. This will stop the traumatic effects of the chemotherapy. A drug must be able to bind to the differentiated nucleotides only so it must be complementary. Once the drug is bound it stops the phosphate from binding to the nucleotide to stop the replication of that DNA.

I understand that there would be ethical issues surrounding this discovery because there must be testing involved to allow the techniques to move forwards. The use of stem cells would not be able to be used because they contain no DNA. The cells must be taken from the human. However the human would not be harmed as the extract of blood or skin for example doesn't cause a great deal of pain. DNA is long lasting and easy to get hold of. However the testing of the drug could cause issues as it could cause the death of an animal. Animal protection societies would become involved as it could cause the loss of life. I think that most people would understand that the research is important and not needless such as the testing within the cosmetic industry. I understand that some religious protestors may feel that it is the act of "playing god" which could cause more problems than there were to begin with. As cancer is a rapidly growing group of cells any human manipulation could cause greater harm such as MRSA the superbug which has become immune to the common hospital drugs. It has evolved over many years to create a harmful killer. Our changes made to the DNA could be manipulating the cell to have the same characteristics as the super bug. We have 50% the same DNA as a banana so obviously we can't make too many changes!

Also people believe that God chooses when to end the human live "God chooses a time to die" so by stopping the death of people is prohibiting the choice of God. Many people may opt out from being given the drug because they believe that God has a plan for them. This leads to the euthanasia scenario, people may not be able to make their own decisions perhaps if they are not in the "right mind." Many doctors have had to make a decision themselves and then been persecuted for wrong doing. Many arguments were taken to the courts to discuss the law due to these ethical conflicts which can tear society. This could cause disruption in the research and the future usage of nanotechnology due to the number of problems. For every scientific project there must be money to fund the findings and for this there must be interest which may be a problem. Overall though I think that there would

be enough interest to overcome those setbacks. After all cancer directly affects 1 in 3 people so it would be a wonderful scientific breakthrough if a treatment is found.

Again population could be a problem after all overpopulated countries find themselves in many problems as they cannot the increased demand. Resources are limited so it could be argued that we need to limit the amount of people that we treat however heartbreaking it may be.

Conclusion

Despite the conflict I believe that this research is vital to the future of drug creation and knowledge of all biological organisms. Viewing the happening of cell organelles and the actions and impact of DNA will enable the future generations of researchers to develop new ideas and provide evidence from which new development can emerge. I am passionate about the research of DNA as it is the roots of all living organisms.

Graphene is a new material which was isolated in Manchester University in the UK by Andre Geim and Konstantin Novoselov who both shared the 2010 Nobel prize for physics for their efforts. The highly conductive property suggests that it is the perfect material for DNA sequencing. Its regular arrangement means that the current flow through the material is extremely unlikely to become corrupted by the carbon atoms. There are no impurities so the resistivity of the material is the same throughout.

Previously many companies have not got the money or the patience to turn this innovative discovery into a reliable commercial product. Currently Universities are looking into the mechanism of nanotechnology in order to create a reliable device. In November 2009 Taiwan were developing a fluorescent single molecule analyser which was joined later by many other companies. Now though there are many progressions arising from nanotechnology and there seems to be many areas which would benefit.

This usage of DNA sequencing will aid the understanding of all diseases and I believe cancer treatment can develop greatly. There is a lot of funding in this section of medicine so nanotechnology should be an option for further discovery. Cancer- treatment has been an icon for every possible progression. Drug delivery systems, Carbon Nanotubes which are inserted into the cancerous cells and then heated up to about 70 degrees in a matter of seconds by infra-red light destroying the surrounding cells- simple but very effective. Nanotechnology is proving to be a real eye opener for the future of science.

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