Application of nanotechnology in diagnosis and treatment of diseases: cancer

Health & Medicine, Disease

RESEARCH PROPOSAL APPLICATION OF NANOTECHNOLOGY IN DIAGNOSIS AND TREATMENT OF DISEASES – CANCER. BY OLOWOKERE JOHN 1. 0 Introduction Nanotechnology is the study, design, creation, synthesis, manipulation, and application of materials, devices, and systems at the nanometer scale (One meter consists of 1 billion nanometers). It is becoming increasingly important in fields like engineering, agriculture, construction, microelectronics andhealthcare to mention a few. The application of nanotechnology in the field of health care has come under great attention in recent times.

There are many treatments today that take a lot of time and are also very expensive. Using nanotechnology, quicker and much cheaper treatments can be developed. By performing further research on thistechnology, cures can be found for diseases that have no cure today. We could make surgical instruments of such precision and deftness that they could operate on the cells and even molecules from which we are made - something well beyond today's medical technology. Therefore nanotechnology can help save the lives of many people. Mohd & Jeffery, 2007). The specific purpose of this report is to explain the application of nanotechnology to the diagnosis and treatment of diseases such as cancer in the field of medicine. Applications such as drug delivery system, tissuereconstructionand disease diagnosis and treatment shall be discussed. This report will be of particular interest and help to researchers in the genetic engineering and biotechnology department of the federal university of technology Minna, and other research institutions. 1. 1 Problem Statement

The specific purpose of this report is to delve into the application of nanotechnology to diagnose and treat diseases in the field of medicine using our own indigenous technology. Applications such as drug delivery system, tissue reconstruction and disease diagnosis and treatment shall be discussed as it relates to cancer. 1. 2. Justification of the Study With the raging scourge of cancer in the world today, nanotechnology provides the field of medicine with promising hope for assistance in its diagnosis and treatment as well as improving the general quality of life.

Humans have the potential to live healthier lives in the near future due to the innovations of nanotechnology. Some of these innovations include: Disease diagnosis, prevention and treatment of disease, better drug delivery system with minimal side effects and tissue reconstruction. 1. 3. Objective of the Study This research work is designed to achieve the following objectives: ? Design and production of nano-tech devices and equipment for the diagnosis of diseases such as cancer. ? To develop a model that predicts the method involve in the diagnosis, prevention and treatment of diseases such as cancer. Design of nanoparticles for nano-tech applications such as tissue reconstruction. ? To determine the method that will best optimize the drug delivery system with minimal side effects. 1. 4. Scope and Limitation of the Study The scope of this research work shall be limited to the application of nanotechnology in the diagnosis, prevention and treatment of cancer as highlighted in the problem statement of this research work. 2. 0 LITERATURE REVIEW The word “ nano” is derived from the Greek “ nanos”, directly translating to English as “ dwarf”.

From the very literal meaning of the word, therefore, it is inferred that thescienceis operated on a miniature scale. When working at a nanoscale, the prefix “ nano” is used as an SI unit to denote any value multiplied by 10-9, meaning that a nanosecond is roughly a billionth of a second and a nanometre equates to a billionth of a metre. Ten hydrogen atoms lined up side by side would equate to a length of 1nm; in fact, most atoms are a miniscule 0. 1-0. 2nm wide. Due to the fact that work on a cellular level is done primarily at a nanoscale, it is therefore unsurprising that nanotechnology has paved the way for a vast quantity of iological development, and a great majority of the findings encountered have led to cutting edge breakthroughs in this area (Harry, 2005). Nanotechnology offers various exciting prospects to every aspect of life. From dietary supplements to clothing, nanotechnology is evolving rapidly all around us. It offers numerous possibilities, especially in the medical sector of nanoscience (nanomedicine). Nanomedicine can be defined as “ the design and manipulation of nanoparticles, particularly as applied to the medical diagnosis and treatment of disease. Examples of recent nanomedical developments include; the use of nanoparticles with antibacterial properties in hospital equipment and the development of magnetic nanoparticles being used to target disease, reducing the necessity of surgery and the associated risks. A further innovation in nanomedicine has been manufacturing drugs as nanoparticles as they are thought to be absorbed more easily into the body because of their size. It could offer easier methods of locating and targeting specific cells on a „ nano? size level, on an atomic scale, and delivering drugs to these cells.

This is good because often very powerful drugs are needed to kill mutated cells such as tumour cells, and these drugs would be hazardous if they came into contact with normal functioning cells (Mohd & Jeffery, 2007). 2. 1 Nanotechnology preventive approach In general, the best way to eliminate a problem is to eliminate the cause. In cancer, the problem can be perceived differently at various stages of the disease. Most apparently, if genetic mutations are the underlying cause, then we must counteract the causes of the mutations.

Unfortunately, genetic mutations are caused by artificial or natural carcinogens only some of the time. At other times, they may occur spontaneously during DNA replication and cell division. With presentscience and technologythere is very little we can do to prevent this from happening. However, in all other cases, eliminating the carcinogens is indeed a highly effective way of cancer prevention. But most patients do not recognise the problem until it has actually occurred, which makes preventive medicine a rarely utilised, although a highly effective form of cancer prevention.

Even so, is there a way to eliminate cancer through nanotechnology before it starts? Although there is little current research on preventive treatments using nanotechnology, they are indeed possible. After a careful review of the most advanced disease-time nanoscale treatment methods, one can easily see why the proposed nanotechnology alternatives to current preventive treatments have so strongly attracted the attention of the scientific and medical communities in recent years. In fact, nanotechnology-based

treatments are no more challenging to devise than the currently used disease-time treatment methods.

Nonetheless, it requires time and monetary investments to develop such treatment methods in short time. (Greider and Blackburn, 1996). 2. 2 Method of Disease Diagnosis using nanotechnology 1. Diagnosis and Imaging: Nanobiotech scientists have successfully produced microchips that are coated with human molecules. The chip is designed to emit an electrical impulse signal when the molecules detect signs of a disease. Special sensor nanobots can be inserted into the blood under the skin where they check blood contents and warn of any possible diseases.

They can also be used to monitor the sugar level in the blood. Advantages of using such nanobots are that they are very cheap to produce and easily portable. (Harry, 2005) 2. Quantum dots: Quantum dots are nanomaterials that glow very brightly when illuminated by ultraviolet light. They can be coated with a material that makes the dots attach specifically to the molecule they want to track. Quantum dots bind themselves to proteins unique to cancer cells, literally bringing tumors to light. (Weiss, 2005). 2. 3 Application of Nanotech in Drug Delivery System

Nanobots are robots that carry out a very specific function and are just several nanometers wide. They can be used very effectively for drug delivery. Normally, drugs work through the entire body before they reach the disease-affected area. Using nanotechnology, the drug can be targeted to a precise location which would make the drug much more effective and reduce the chances of possible side-effects (Perkel, 2004). The drug carriers have

walls that are just 5-10 atoms thick and the inner drug-filled cell is usually 50-100 nanometers wide. When they detect signs of the disease, thin ires in their walls emit an electrical pulse which causes the walls to dissolve and the drug to be released. Aston Vicki, manager of BioSante Pharmaceuticals, says " Putting drugs into nanostructures increases the solubility quite substantially". (Harry, 2005) 2. 4 Nanotechnology approaches for cancerous cell destruction Preventive treatments are not much good to those who have already developed the disease. And since these are the people who require the most immediate medical help, it is no wonder that a majority of innovative treatments are focused here.

Again, there are several ways to view the problem. The traditional approach is to simply eliminate the causing agents, or the cells that make up the tumour and end their pararcine signalling effect. This method actually dates back to the mid-17th century, when John Hunter, a Scottish surgeon first suggested the surgical removal of the tumour (Denmeade and Isaacs, 2002). Of course, we have made great progress in the last 350 years, but the idea remains the same. If we see the cancerous cells of the tumour as the causing agents of the disease, then the obvious strategy is to remove or to destroy them.

The most significant recent breakthroughs have been made in this area. A relatively long-standing strategy dating back to the 1950s is to flood the body with substances that are especially toxic to tumour cells. Unfortunately, tumour cells are not dissimilar enough from healthy cells to distinguish one from the other using such large-scale techniques. A drug that is especially

toxic to tumour cells is usually also toxic to healthy cells, and simply flooding the entire body with it causes system-wide damage and serious side effects.

Almost everyone has heard of or seen chemotherapy patients who have lost their hair, lost significant weight, or developed other serious disorders (Silva, 2004). 2. 5 Physics and Engineering Concepts in Cancer Treatment Aside from destroying cells directly, we can take a more elegant approach to tumour elimination. Massand energy balance are well understood and are widely used in all types of science and engineering. Furthermore, these concepts are quite general, and can be applied to other fields as well, such as medicine.

The general principles of mass balance, energy conservation and entropy production are applicable to bio systems as well as industrial processes. Thus, we can define the malignant tumour as our bio system and proceed to investigate the mass, energy and entropy inputs, outputs and accumulations. (Mansoori et al. , 2007). Since our ultimate goal is to destroy the tumour, we realise that this can be achieved by limiting or eliminating the inputs of the needed nutrients and the useful energy that are vital to its growth and survival.

Likewise, we can limit the outputs, which are necessary for the tumour cells to get rid of toxic waste products that are left over from the multitude of biochemical reactions continuously taking place. Furthermore, basic anatomy and biology tell us that cells within the human body get a vast majority of their nutrients and energy from the bloodstream, and likewise use the bloodstream to eliminate the toxins. Cells that are cut off from

circulation quickly undergo necrosis and are effectively eliminated. Therefore, our goal is to separate the tumour from the circulation in order to kill it.

Numerous studies have explored the possibility of isolating cancer tumours from the bloodstream. (Reynolds et al. , 2003). 2. 6 Tissue Reconstruction Nanoparticles can be designed with a structure very similar to the bone structure. An ultrasound is performed on existing bone structures and then bone-like nanoparticles are created using the results of the ultrasound, the bone-like nanoparticles are inserted into the body in a paste form. When they arrive at the fractured bone, they assemble themselves to form an ordered structure which later becomes part of the bone (Adhikari, 2005). 3. 0 Methodology

This research work shall use the following methods or approaches to achieve its aim and objectives: •Top – down technique: The top – down technique begins with taking a macroscopic material (the finished product) and then incorporating smaller scale details into them. The molecules are rearranged to get the desired property. This approach is still under immense research as many of the devices used to operate at nanolevel are still being developed. •Bottom – up approach: The bottom – up approach begins by designing and synthesizing custom made molecules that have the ability to self- replicate.

These molecules are then organized into higher macro-scale structures. The molecules self replicate upon the change in specific physical or chemical property that triggers the self replication. This can be a change in temperature, pressure, application of electricity or a chemical. The self

replication of molecule has to be carefully controlled so it does not go out of hand. 4. 0 Expected Contribution of the Work to Knowledge Though, nanotechnology is still in its early stage, but it is of worthy note to know that it has began to gain application as it is already helping patients all over the world today.

As further research continues in this field, more treatments will be discovered. Many diseases that do not have cures today may be cured by nanotechnology in the future. As part of contribution to knowledge, the result that shall be established in this research work may be useful in the development of indigenous methods and model on the diagnosis, prevention and treatment of cancer. 5. 0 Conclusion Prevention, diagnosis and treatment of cancer have always been a formidable medical challenge. In fact, cancer has long been considered an incurable disease and it is grouped with Hepatitis C and AIDS.

Throughout the bulk of human history, cancer tended to be fatal in those who were unfortunate to develop it. Cancer will continue to be a big problem since it is a disease related mostly to age. As our population average age increases due to medical advances, cancer will be a major disease of the aging. At the end of this research work, we may have been able to develop and design a model that will effectively be used to diagnose the disease of cacer, proffer measures and techniques on how it can be prevented and treated.

Also, the principle surrounding the mechanism of how a better drug delivery system with minimal side effects concerning the cure of cancer must have

been fully explored. All these will be tried and tested using our own indigenous nanotechnology in the area of genetic engineering which promises a brighter future in the field of medicine leading to the actualization of the objective of this research work. REFERENCES Greider, C. W. and Blackburn, E. H. (1996). ‘ Telomeres, telomerase and cancer’, Scientific American, Vol. 274, pp. 80–85. Mohd A. K and Jeffery J. (2007). Nanotechnology: Application in medicine and possible side effects.

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