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Implementation of Nanotechnology for Oncological Diagnosis and Therapy

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Abstract : This paper primarily discusses the implementation of nanotechnology as a method of diagnosis and treatment of cancer. It is a superior technique as it is completely safe and does not leave a residue of toxins. Cancer cells are exclusively targeted with the help of a gene reader. The intensity and size of the tumor is approximated with the help of fluorescent dye. The use of Zinc sulfide quantum dots over the traditional use of toxic cadmium selenide is proposed in this model. The main purpose of this technology is to make sure that the remission of cancer does not take place.

Keywords : Nanotechnology, oncology, zinc sulphide, cadmium selenide quantum dots, fluorescent dye.

1. INTRODUCTION

There are a wide variety of technologies used currently in the analysis of biological cells for the diagnosis of cancer cells. This paper deals with Nanotechnology in the treatment of cancer involves various substages. The materials, systems and the devices involved have to be made on a nano scale which put together can can result in curing of the deadly cancer .Cancer cells unlike normal healthy cells have a different set of molecular reactions that take place in the cell. Nanotechnolgy is applied so that even these miniscule molecular changes that occur can be detected. Before the application of nanoscale devices for the treatment of cancer, the characteristics of cancer cells and nanotechnology have to be studied thoroughly. For a nanodevice o circulate through the human body easily they have to be 20nm and a maximum of 60 nm size device can enter the cells. The size of nanodevices and biomolecules are more or less the same, this facilitates in the interaction between them thus giving access to the interior of the cellular structures as well. This helps in the travelling of the nandevices to several parts of the body.

A. Cancer

The primary difference between the normal cell and the cancer cell is its division rate. This paced division rate leads to the formation of an undivided mass of cells called a tumor. These harmful cells also invade the surrounding tissues and form more tumors. These tumors in excess amounts in various parts of the body hinder the proper functioning of the organs.

The three most common methods for cancer treatment are :

1. **Surgery :** The part of the body (organ) affected by cancer is removed partially or completely by surgery.
2. **Chemotherapy :** A method of treatment in which strong chemicals are administered to the body
3. **Radiotherapy :** It is a kind of treatment in which high energy radiation like are passed from the external to the affected part of the body.

B. Problems faced due to standard treatment

All the treatments mentioned earlier have their own list of disadvantages. Also all these treatments kill not only the cancerous cells but also the normal healthy cells. A patient who has undergone chemotherapy cannot survive for a period of more than five years due to the presence of residual toxins. This is because the chemicals used for

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chemotherapy are immensely strong and cause extensive damage to the healthy living tissues as well. Radiotherapy on the other hand causes unnecessary radiation exposure to the healthy tissues. Also radiation cannot be performed on certain delicate organ structures like the liver.

2. MATERIALS AND METHODS

There are several components needed in the making of the nanodevice and various techniques can be carried out as well.

The encapsulation material used is Chitosan. Chitosan is a natural carbohydrate obtained from the biopolymer chitin derived from a crustacean. It is obtained by a partial deacetylisation process. Figure 1 shows the structure of Chitosan. There are four methods of preparation, ionotropic gelation, microemulsion. emulsification solvent diffusion and polyelectrolyte complex formation.

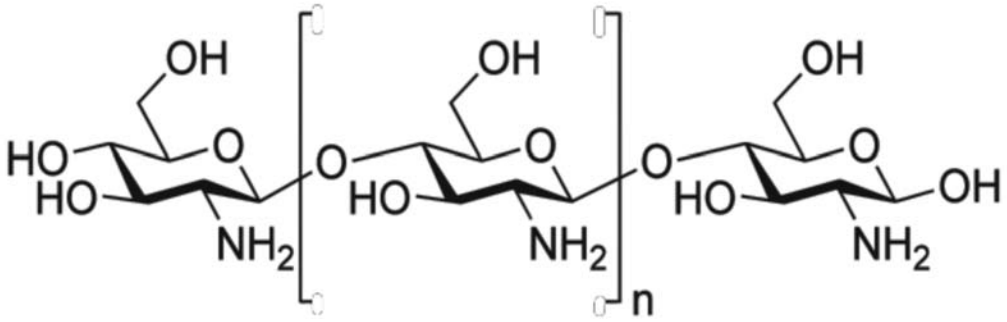

Fig. 1. Structure of Chitosan

Ideally Nano sensors used to detect tumors use cadmium selenide as quantam dots. These dots are injected to the body and they possess he property of fluorescence. Due to this property the tmors can be easily found. However cadmium is highly toxic to the body so we propose the use of zinc sulfide quantum dots over cadmium selenium dots. The sensor setup would also consist of an optode, an optical sensor device that optically measures the fluorescence. Heptamethine dyes with good pharmacokinetics and fluorescence above 680nm are used for its property of tissue penetration

In place of a motor we employ a fluid device to produce a concentration gradient between glucose oxidase and glucose. A hydrogen peroxide gradient is produced between the two substrates. Catalase migrates towards the glucose oxidase. This migration is induced.

3. PROPOSED MODEL

A. Sensors

The Nanosensors are generally sensory points either of biological or chemical origin. These sensors help in the transmission of the information from the nano particles to the external setup. The Nano sensors used in this device is based on the quantum dot technique.

B. Motor

A nanomotor is similar to any other motor where the energy can be converted into movement. Immense effort is required in producing a nanomotor and hence the enzyme acts as the nanomotor. The principle behind the enzyme based motor is the concentration gradient created by the enzyme.

C. Cantilevers

The Nanoscale cantilevers are used to house the gene reader. These are coated with molecules which can bind a specific DNA substrate complementary to a specific gene sequence. Thereby these cantilevers play a vital role in the sensitive detection of cancer cells. These molecules help in the detection of the specific gene sequence of cancer cells.

Fiigure. 2 Shows the depiction of the cantilevers acting as biomarkers of cancer [3].

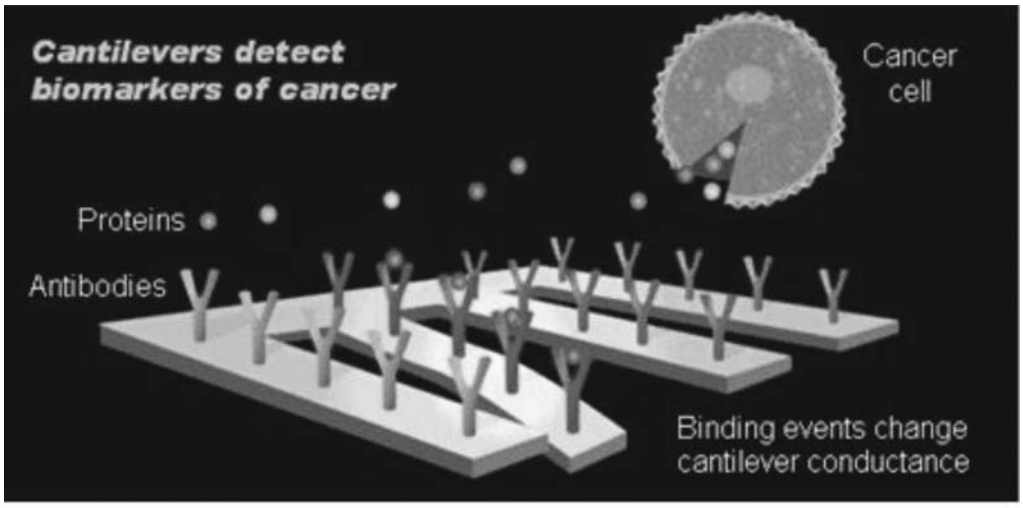

Fig. 2. Cantilevers to detect biomarkers of cancer.

D. Camera

A nanocamera can be used in the medical imaging. This is inexpensive and can be operated at the speed of light. This camera is primarily used for navigation purposes.

E. Fluorescent dye

There are some dyes which are fluorescent in nature as well as bicompatible. In this a model Heptamethine dye is used as has good characteristics like pharmacokinetics and fluorescence.

Dyes which have a fluorescence above 680nm are used for its property of extensive tissue penetration. This fluorescence produced in the tissues can be measured with the help of an optode.

The nano devices are used to detect the cancer cells and then destroy them without causing harm to the surrounding healthy cells, unlike the conventional methods of treatment of cancer. These nano devices are not toxic or harmful to the human body as the encapsulation material used here is Chitosan. Chitosan is a biodegradable material and is thus adaptable to the body as well. Preparation of this material is also quite simple and can be done using any one of the four techniques.

4. WORKING PROCEDURE

The working procedure involves several steps like positioning, navigation, imaging, identification and destruction. The Nano device is loaded with the microchip. It also contains sensors, enzyme based motor, gene reader, processor, transceiver, camera, fluorescent dyes and cantilevers based biomarkers of cancer. These devises are injected to the blood stream and are made to circulate through the blood stream and then reach the required destination based on the feedback received from the nano device.

Figure 3 shows the working procedure of the nano structure.

A. Positioning

The Nano device performs the positioning operation with the help of the nanosensors present in the device. The difference in coordinates are calculated and the position of the cells are found out.

B. Navigation

After positioning the step that follows is navigation. Since a nano motor is difficult to synthesize we used glucose and glucose oxidase to create a hydrogen peroxide concentration gradient which helps in acceleration of the nano device.

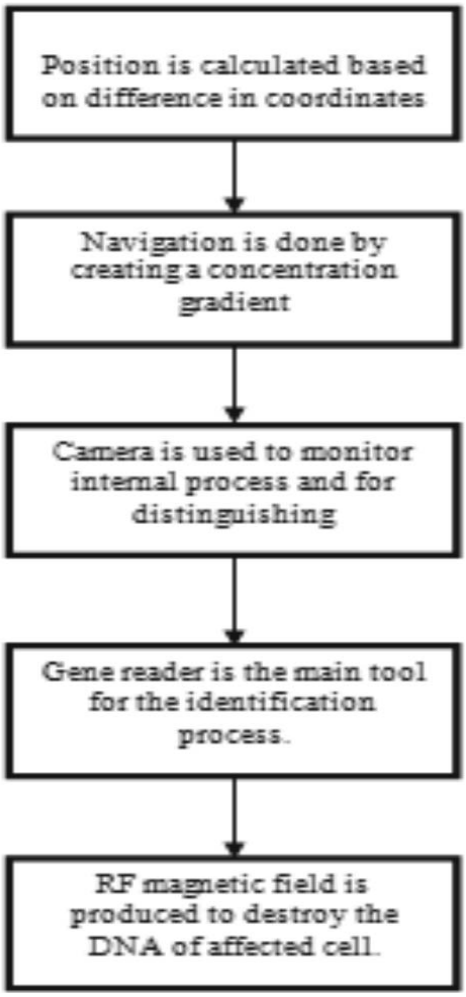

Fig. 3. Block Diagram of working procedure

C. Imaging

A camera is present in the nanodevice to monitor the internal condition .The camera is based on the property of absolute scattering. Based on the amount of scattering we can differentiate between normal and abnormal cells.

D. Identification

For the process of identifying the cancer cells a nano device called the gene reader is used. This gene reader is comprised of either the DNA or the samples of cancerous cells which helps in the detection of cancer cells.

E. Destruction

Using RF energy the behavior of the DNA can be controlled. An RF magnetic field has to be set up. The DNA is linked covalently to a nanocrystal antenna. This is inductively coupled to the RF magnetic field.

Thus the RF signal generated can destroy the affected DNA.

5. CONCLUSION

The main aim was to demonstrate the application of nanotechnology and RF signals in the treatment of cancer while still keeping the normal cells intact. Also the person remains healthy after treatment. Another advantage is that is that it does not take a longer time for treatment like the other methods.

This technology can also be used for the treatment of other dangerous diseases.

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