

Application of Nanotechnology in Cancer

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Abstract— This paper gives the theoretical application of the Nano devices in the cancer treatment. The recent technology for the cancer treatment is the chemographic method. In this method the specific composition of drugs are given to the victims or the patients depends upon the biopsy of the tumor which the patient is having. The main disadvantage of this method is that the drug used is not specific and it can damage the surrounding healthy cells in which no tumor occurred. To avoid this problem the Nano devices will be very effective that uses the Nano sensors to sense particularly the damaged cells. So the efficiency of the operation is very high. This paper is only the theoretical proof for the treatment of the cancer. But there is a great possibility to implement this method.

Key Words: ATP, Nano pumps, Nano robots, Chemotherapy, MAb , Nanosensor ,Positional assembly ,Self-replication.

1 INTRODUCTION

PHYSICIST Bernard Yurke of bell laboratory had already said that this technology has the potential to replace the current manufacturing methods for integrated circuits. With the introduction of Nano technology we are given a wonderful opportunity with which .we can solve our problems related with physiology. This technology was from the days of Darwin as he found a lot related with the nanotechnology.

2 NANOTECHNOLOGY

Nano is the billionth of one. Now there are the microprocessors and microarray technologies that can reach the Nano level within some decades. Some of us call this technology as molecular nanotechnology, to be specific. The following steps are used to make any Nano materials or the Nano devices,

1. Every atom is placed in the right place.
2. Create any structure consistent with the law of the physics which can be specified in the molecular details.
3. Have manufacturing cost which does not exceed the cost of the required raw materials and the energy.

3 CONCEPT OF THE NANO-TECHNOLOGY

The main concepts are,

1. Positional assembly
2. Self-replication

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In the field of mechanical Manufacturing both the above methods are new, but they are common in the human system. The self-replicating model of the human DNA, which orders the thiamine, guanine, adenine and cytosine with the bonds of H₂ in between them, is the best self-explanatory for both the positional assembly and the self-replication[1].

4 BIOLOGICAL ASPECTS

Cancer

Many cellular units forms a human body which worn out themselves regularly and replaced by a new cells called as metosis. There are certain units that can control the division mechanism of the cells. The cancer cells are the cells which cannot follow the controlled mechanism of growth[2]. Cancer starts with while the changes occur in the DNA structure which is permanent called as Mutation.

5 STEPS TAKEN BY THE GENES TO CHANGE ITS STRUCTURE

5.1. Primary Steps:

1. Immunity fails

2. Chemotheraphic Process:

Cells communicate with the other cells by receptor organs through this process.

The following changes took place in the DNA structure, **i.Proto-Oncogenes Become Oncogenes**

Oncogene which gives message about the repeated multiplication of the cells, It is the main cause for the cancerous cell growth[1].

ii.Stunted work of the tumor- suppressor cells

The nearby cells can give the tumor suppressing activation to control the growth of the cells. Some times this may also malfunction.

iii. Cell Cycle Clock Malfunctions

The cell nucleus contains a number of proteins which can control the multiplication of the cells, called the cell cycle. If the DNA is damaged then the cell will be destroyed by the tumor suppressor gene.

iv. Cells Achieve Immortality

The life span of the cells is controlled by the telomeres, a protector of DNA that reduces in amount while cell division occurs[3]. But the cancer cell produces the telomerase that can extend the production of the telomeres which causes the increase in the life span of the cells.

5.2. Secondary Steps:

1. The growth of the cell will be excessive.
2. The lifetime of the natural cells are also reduced without the extra cellular matrix, which is not in the case of cancer.

i. Tumor forms

The tumor is the collection of cells without the help of the extra cellular matrix, which maintains the blood vessel network by angiogenesis.

ii. Benign tumor

1. It is prevailing in only one part
2. Here the removal can be done by surgical method.

iii. Malignant tumor

1. It acts as a tissue for pre-cancer
2. Here removal cannot be done by the surgical method.

iv. Tumor spread

1. The Malignant tumor will be spread to the entire region.
2. It affects the nearby regions to start the secondary growth of the cells.
3. Adhere to one another thus it increase the danger of spreading of the tumor cells.

6 CURRENT TECHNOLOGY TO TREAT THE CANCER

The latest technology for the cancer treatment is the "Chemotherapy". This method uses the anticancer i.e. cytotoxic drugs. These drugs will stop the growth of the tumor cells or it will fight with the tumor cells. This is called as the taxol[4]. This has been proven effective in destroying the breast cancer cells.

Cancer treatment can be done using these current methods,

1. Chemotherapeutic drugs
2. Immunology
3. Radiotherapy

7 GOALS OF CHEMOTHERAPY

1. To control and shrink the tumor cells which are primary.
2. To reduce the growth rate of the tumor.
3. To destroy the tumors which are spreaded to adjacent areas.

Disadvantages

1. Destroys all the cancer and healthy cells.
2. It can induce the anemia that exacerbates in the tumor cells.
3. Treatment is made specific by means of the Nano devices which use the Nano sensors to be more specific in killing the cancerous cells in the malignant tumors. Therefore the safety is also increased.

8 RADIOTHERAPY

In Radiotherapy, the therapeutic effect is improved by following methods,

- I. Multi-Fractioned irradiation combined with the chemotherapy.
- ii. Radiosensitizers
- iii. hyperthermia technique.

In an aerobic area the radio sensitivity of the cancer cells is about three times greater than the hypoxic cells. The blood can produce the oxygenated cell from the hypoxic cell if it is artificially developed. And also it may improve the radio sensitivity[5].



Figure 1: Radiotherapy method of treatment

9 IMPLEMENTATION OF THE NANO TECHNOLOGY

Monoclonal Antibody

Monoclonal antibody (MAb) which is a laboratory produced protein molecule. It can be used with medicine to detect the pregnancy, diagnose the disease, hepatitis and most importantly the AIDS can also be identified. They can also be used in the detection of the cancer diagnostic tools and treatment aids[6].

10 SYNTHESIS OF MAB (MONOCLONAL ANTIBODY)

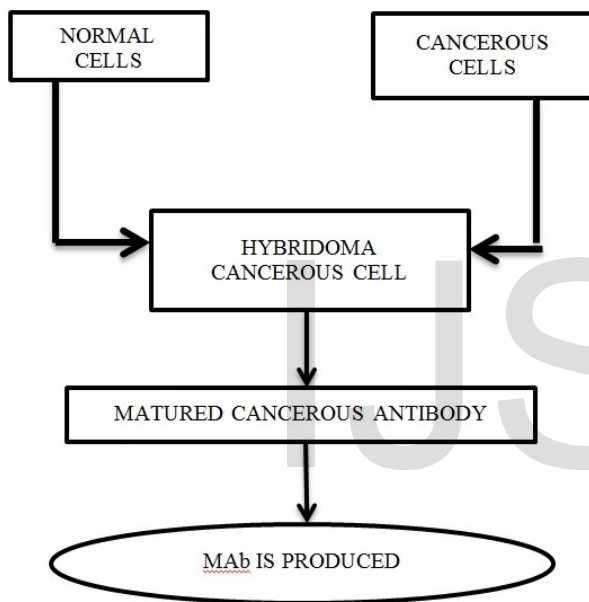
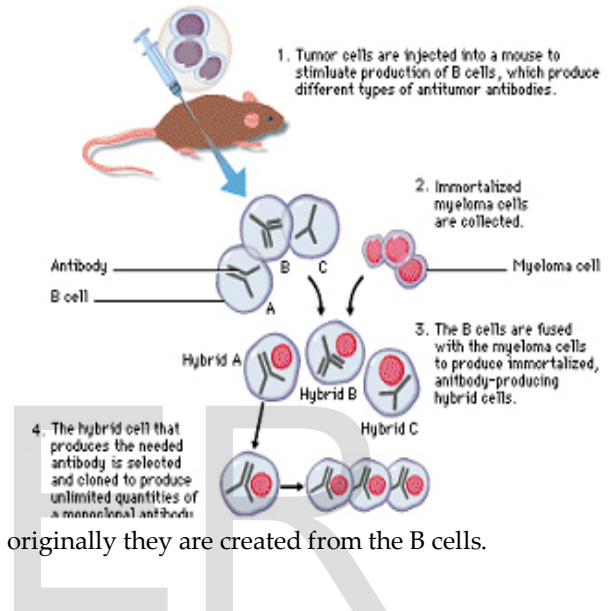


Figure2: Synthesis of MAb

11 PRODUCTION OF MAb

A Monoclonal antibody is created by the action called fusing in the laboratory. A normal blood cell which dies after some weeks is combined with the cancerous blood cell which doesn't die quickly. This fusion will create a hybrid cell called hybridoma[8]. This cell can live forever and it can produce unlimited supply of the antibody. A special technique was developed which combines the myeloma cell's ability to produce a large amount of antibody and also the ability of the B cell to produce the

antibody. The normal cells (A, B, C) and the myeloma cells are injected into the rat. Inside its body it produces the three types of hybrid cells (A, B, C). Normally the B cell and the myeloma cells can be grown in the laboratory itself. That method uses a chemical which combines the membrane of these both cells to form the hybridoma cell[7]. The hybridoma cells cultured on the medium in the laboratory grows in large amount and in the rate of the original myeloma cell from which it was derived but



originally they are created from the B cells.

Figure 3: Production of MAb from the rat

12 USAGE OF MAb

Nowadays the scientists are using the MAb to identify the cancer by checking the hormones, infected substance, tissues and body fluids. MAb can also be used for identifying the malignant cells which has abnormal growth in tissues. But in our case the radioactive substances are attached to the MAb to correctly identify and target the tumor cells. These MAb are injected into the patient's body and then it recognizes the required cells to be destroyed. First a picture is taken showing the tumor cells in internal part of the patient's body[9]. This image can reveal to which cell our MAb should be attached.

13 HYPOXIA ENVIRONMENT(LESS OXYGEN)

- i. It induces the angiogenesis (blood vessel growth into the damaged tumor cell).
- ii. It promotes the tumor growth.

iii. Finally, the hypoxia leads to anemia.

The best way of examining the blood oxygen carrying capacity is to measure the hematocrit and the hemoglobin levels. Since, cancer cells produce a hypoxic situation the oxygen carrying capacity of the blood is very much decreased. So, it must be managed more than one-third of the normal to initiate the chemotherapy.

14 ROTARY MOTOR

Bio-molecular nanometer is used for the transportation of the drugs to the cells. To transport the Chemotherapeutic drugs the Bio-Molecular Nano motor is used.

It uses the concept of ATP synthesis which is served for two purposes,

1. ATP TO ADP BY HYDROLYSIS – The F1 subunit rotates
2. ADP TO ATP SYNTHESIS – hydrogen ions are used to rotate the F0 subunit

15 ATP (ADENOSINE TRI PHOSPHATE)

ATP is used as the basic fuel for our life function, such as growth of the cell and muscles. Boyer explained the complicated process in which the ATP synthase is converted into the ATP by using the energy. The energy is taken from the food, sunlight and the chemical energy. This energy is absorbed by the enzyme ATP and converted to the fuel like ATP and the energy gets transferred to the functions of the human body [9]. It can also be used in the transmission of the nerve messages and in the muscle contraction. To get the ADP (Adenosine Di Phosphate), the ATP synthase transfer the energy to the ATP molecules by adding the phosphate ion to the ADP molecule.

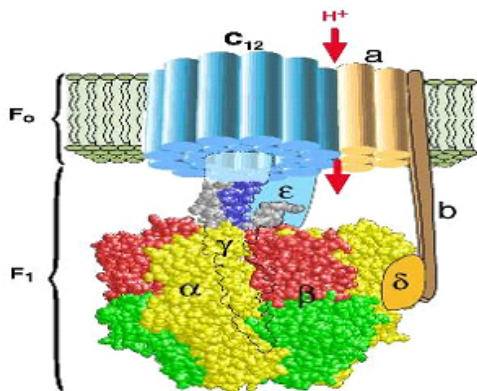


Figure 4: Production of the energy for the movement of the Nano-robot

Bonding molecules makes the ATP stronger and stable. In this hydrolysis action the ATP solution is diffused to catalytic site and is weakly bound [10]. This rate is proportional to the ATP concentration in the solution. The ATP which is weakly bound may dissociate into the solution. So, it leads to the strong binding from the weak binding.

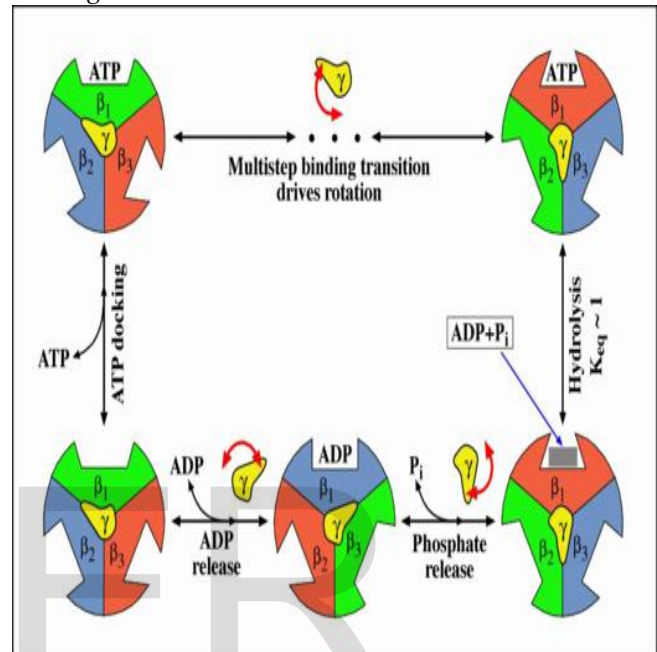


Figure 5: ATP to ADP circulation

In this transition, the bond is produced between the ATP and catalytic site. So, the ATP bond affinity increases exponentially, leading to the release of the energy. After this binding action, the ATP is in chemical equilibrium with the Pi. The transition from the ATP to the ADP and Pi weakens the ATP binding.

16 NANO ROBOTS

The treatment of cancer can easily be done by the Nano robots as told earlier.

Features

The Nano robot that is used here comprises of the following parts. They are

- i. Nanomotor
- ii. Nanosensor
- iii. Nanopumps
- iv. Nanodevices

The nutshell is also the important part of the treatment.

17 FEATURES OF THE NUTSHELL

Chemical Element:

The carbon is the main element used here. The Diamond or the Diamond Fullerene composites are in this form. It is used because of their strength and it's inertness to the chemicals.

Size

The size can be around 500-3000nm

Drug Carrying Capability

0.5cc of the drug can be transported by injecting 1cc of 1 μ Nano devices.

Power

The required power for the nutshell is given through the explicitly supplied acoustic signals.

Assembling

It is done by the streptavidin linkages.

Tracking Capability

It is done by the usage of the Nano robots which are navigational.

Communicating With the Nano robot

Acoustic messaging is used here which involves the encoding of the messages of the acoustic waves at frequency 1-10 MHz. This can be done by the VIVO Nano robots.



Figure 6: Nano-robot for the treatment

18 IMPLEMENTATION AND PROCESSING

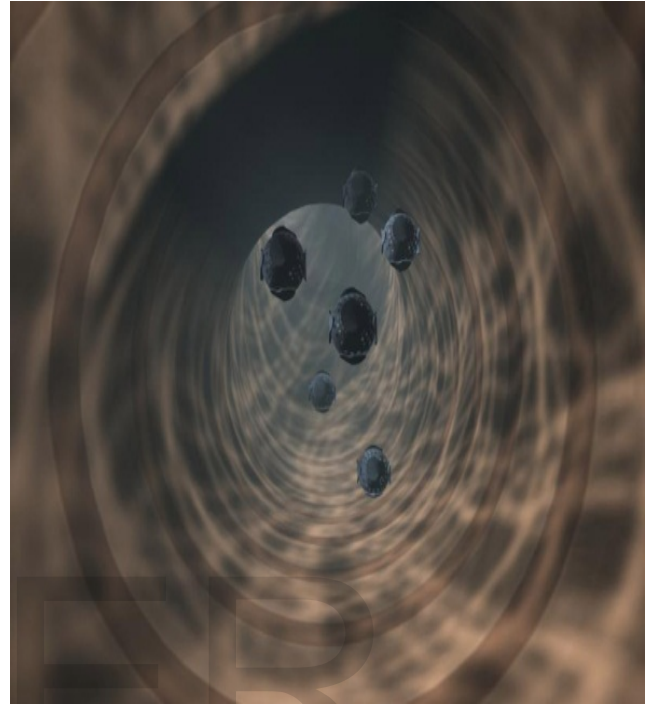


Figure 7: Nano-robot's action inside the body

This is the algorithm followed in this process.

1. The Nano robots which are specially designed for the transportation of the drugs are used in the first step.
2. The ATP powered bio motor is used for the creation of the lower hypoxia environment which lessens the danger of spreading of the tumor cells.
3. The location of the cancerous cells can be identified by the usage of the MAb (Monoclonal antibodies) or it can be identified by the present radiation method too.
4. Then the drug is supplied to that the particular part

GROUPS IN RESEARCH	BIOMOLECULES USED	NANO-DEVICE USED	APPLICATIONS
Dow coming	Peptides	Carbon nanotubes	Electronics, sensors
Mehmet Sarikava	Plant virus	Gold and platinum	Materials manufacture
M.GFinn	Plant virus and DNA	Gold nanowire	Electronics, sensors
Dupont	Peptides.DNA	Carbon nanotubes	Nanotube sorting and sensors
Angela Belcher	Peptides, Bacteriophage virus	Nanowire	Electronic displays and Magnetic storage

Table 1: Various industries involving in the production of Nano robots

which should be destroyed in order to remove the tumor cells. The identification of the tumor cells is only done by the Nano sensor which senses the variation in the temperature and the oxygen content in particular area which then injects the drugs using Nano pumps

19 FUTURE VISION

Biomedical Applications

It can be a useful technique in the biomedical field especially it can be used for the blood clot removal.

Genetic Research and Engineering

A lot of researches can be done on the genes and the disorders can also be rectified.

20 CONCLUSION

This paper is only a theoretical justification of the cancer treatment. Now as the nanotechnology is going on improving it can be easily utilized to make this treatment as possible. This technique can also be expanded to cure some critical diseases like AIDS also. So, by this technology a better medical treatment is possible.

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